Maria Boştenaru Dan
Cerasella Crăciun *Editors*

Space and Time Visualisation

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Preface

Knowledge as Virtuality, Virtual Knowledge

A scientific publication which has as its aim the study of the virtual imaginary can be described, alternatively, as a parcour from pre- to postimagination, going through fiction. And this because any sincere architect knows that the vision of a future building (reconstruction or construction) is fiction, whereas any art historian knows that when looking at an art volume, in any shape, it is the viewer's duty to delineate the critical judgement of the through layers of technique involved which are to be 'received' in the same image (the artist, the photographer, the editor).

The discourse on the value of such an event dedicated to virtuality is thus based on the research of the associated professional ethics.

Because we apply to a reality the emergence and existence conditions, we always only partially master the logical argument and the good intentions of (re) discovering the truth. it is almost impossible to know the exact date of the start or finish of an exedra, the historical, social, or architectural commands under which these moments would have happened. We can study it on the basis of some architectural or archaeological remains; we can place it in a context about which we know the most data possible; we can connect it with the wish of affirmation of this or those senior or cardinal, the name of a craftsman, architect, or work team, or we can report it, on the basis of some size orders or aesthetical approach of a given stylistic arch. We construct, thus, a virtual image which we wish to contain, finally, as few unknowns as possible. Let's admit that, very probably, this is the image of the science in becoming, in evolution, an action which has as a goal results as precise as possible, obtained through repetitive actions, known, and through the as drastically as possible, limit of variables.

Is it, in this sense, the virtual image, the 2D or 3D representation, a tool or can it be also 'reality', a 'goal' in itself?

In other words, is it auxiliary or autoreferential from the point of view of the scientific? When a project is constructed via the Internet by teams situated on four continents, in realtime, very probably the idea becomes concept at the same time with its whole virtual 'meat', which gives the freedom of being to the all possible. The final edifice will be, more or less, 'travelled' built fiction – said in other words – the structure of such a house is that of the virtual which is imagined, constructed, at the limit 'it thinks about itself'. Whereas, evidently, when we reconstruct the façade of a given palace, the digital technique can set as an aim at most to merge with the existing real, on which it folds and which it models. A model through which one sees and that allows the reading of more layers of reality is, in any case it is considered, an instrument that can offer openings, multiple and extensive understandings of the architectural act.

The 17 chapters of this book contain, more or less, 'options' of the two 'extreme' projections, suspended architectures which causing us a a-tectonic thought, covering large intellectual spaces, from the basic mnemonic function to the launch of incisive paradoxical discourses on the concrete, the reality, the vision, the transformation of the city, the people, life. Any of these have to be seen, as we suggested at the beginning of these rows, as professional challenges which affect, in any case, the ethics and aesthetics of the arts among which we live or which we inhabit. Interdisciplinarily speaking, we can see these researchers of the possible projections as probe instruments of the 'laws of the big cathedral', as auxilia of the restoration of the ideal truth of space–time, as history shows itself, in most of the cases, reconstruction. The real progress of the discipline of architecture, of 'humanities' seems to be done, following Einstein's saying, more following the seduction of imagination than the rules of applied, insular knowledge.

Bucharest, Romania Constantin Hostiuc

Editors' Note

This book is written at the close of the Network for Digital Methods in Arts and Humanities (acronym NeDiMAH) Research Networking Programme cofunded by the European Science Foundation and by 17 ESF Member Organisations in 16 ESF member countries, among which is the National Research Council (CNCS) for Romania, with the project number 25-RNP. The book is an effort of the editors, of whom the first is the steering committee member for Romania in the network and the second is a hierarchical superior at the organisation represented, to gather views related to the Romanian contribution to the network. The position of Romania is special as the majority of the other members worked with text, whereas Romania focused on the part dedicated to images. The 'Ion Mincu' University of Architecture and Urbanism, which the editors represent, is classified in Romania as a university of arts. The doctoral school of the university deals with both aspects, text and image, the image part being that of the representation of architecture. Therefore the book shows the importance of digital methods for the study of image as a means of representation in architecture and urban planning. The introduction of the book gives an overview of the Romanian NeDiMAH activities, and in the conclusions the theoretical framework of these means is drawn on the basis of this experience and on the invited opinion of the experts who contributed to the book. The experts were not all involved in NeDiMAH activities, but are related to aspects covered by the Romanian contribution as presented.

Topics of the contributions include:

- Network analysis of heritage architecture
- Historic cartography investigation of lost landscapes
- Digital cartography
- Digital landscape architecture techniques
- GIS representations, including of natural hazards
- Computer-aided priority setting of risk mitigation on cultural artefacts
- 3D modelling of historic sites affected by natural hazards
- Virtual reality robots

– Digital building survey
– Virtual architecture design studio
– Essays on digital archives and media architecture
– Review of digital art conservation

The authors are from three continents, including countries such as the United States, Sri Lanka, Italy, Switzerland, Greece, Germany, and Romania.

Additional support for the review process of the papers was given by a project on "Hazard Impact on Settlements: Digital Means for Visualisation and Analysis" which the first author performed as a postdoctoral researcher at the University of Bucharest, in the framework of a postdoctoral grant supported by the strategic grant POSDRU/159/1.5/S/133391, Project "Doctoral and Post-doctoral programs of excellence for highly qualified human resources training for research in the field of Life sciences, Environment and Earth Science" cofinanced by the European Social Fund within the Sectorial Operational Program Human Resources Development, which also contributed to some of the publications started under NeDiMAH short visit funding.

We would like to acknowledge also the Vasile Pârvan fellowship of the Romanian government at the Accademia di Romania a Roma for the final phases of verifying the proofs of the book and for the support for the book launch on the 13th of June 2016.

Cooperation started with NeDiMAH funding between Romania and Germany will, it is hoped, continue beyond the runtime of the project with future publications, teaching assignments, and research. The final phase of the book was completed during the stay in Karlsruhe, in frame of the Karlsruhe 300 years anniversary, to which this book is dedicated.

We would first like to thank the authors who participated in this editorial project. Without their high-quality contributions and patience during the long publication process the book would not have been possible.

We would like to acknowledge the following reviewers:

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We also thank the assistance of the publishing editor Dr. Robert Doe and of the editorial assistants Naomi Portnoy and Marielle Klijn, for their very kind guidance and their patience during the long production time of this volume.

Bucharest
16 June 2016

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Contributors

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Maria Boştenaru Dan diploma engineer (University of Karlsruhe, 1999) in architecture, focus on urbanism, PhD ('Ion Mincu' University of Architecture and Urbanism, 2012) is a scientific researcher at the 'Ion Mincu' University of Architecture and Urbanism, affiliated with the Centre for Architectural and Urban Studies and the Department of Urban and Landscape Design and postdoctoral researcher at the Accademia di Romania a Roma.

Gregor Bourlotos is a civil engineer (University of Karlsruhe, 2001) and currently leading his own enterprise in construction management in Athens, Greece.

Daniela Calciu is an architect and assistant professor at the 'Ion Mincu' University of Architecture and Urbanism in Bucharest, where she obtained her PhD with highest honours based on the dissertation about the concept of 'urbanity' and its role in the discourse formation of urban design. Awards and recognitions include a doctoral grant from the Romanian National University Research Council (2008–2011), the Fulbright Junior Award (2012–2013), and participation in a Harvard research seminar led by Professor Alina Payne, and funded by the Getty Foundation (2014–2015).

Oana Andreea Căplescu architect, PhD architect, PhD ("Ion Mincu" University of Architecture and Urbanism, Bucharest), is currently leading her own studio focused on architectural, interior, and graphic design.

Cerasella Crăciun is an architect, PhD, Associate Professor Architect, Vice-Dean of Urban Planning Faculty – "Ion Mincu" University of Architecture and Urbanism, Bucharest, Romania; Coordinator of "Planning and Landscape Design" Bachelor's Program and "Landscape and Territory" Masters Program.

Alex Dill architect (Technical University of Darmstadt, 1982), is academic counselor and head of the Chair Architecture and Design, at the Institute of Design, Art and Theory, Karlsruhe Institute of Technology, Germany, board member and chair of docomomo Germany and THICOM.

Florian Faion is research assistant in computer science with a focus on extended object tracking and telepresence at the Chair for Intelligent Sensor-Actuator-Systems (ISAS) at the Karlsruhe Institute of Technology (KIT) in Germany. Florian Faion is currently working towards his PhD about tracking extended objects in noisy point clouds with application in telepresence systems.

Pia Fricker diploma engineer (University of Karlsruhe) in architecture, Master of Advanced Studies in CAAD, focus on urban and landscape design, has specialised further in computer-based architectural design and CAD-CAM technologies, and is Director of Studies MAS LA at the Chair of Professor Christophe Girot (ILA), ETH Zurich.

Diana A. Gheorghe Popovici economist (BSc) and geographer (BSc, MSc, PhD) is university assistant at the University of Bucharest, Faculty of Geography, Department of Geomorphology-Pedology-Geomatics. Her fields of interest include geomorphology, risk and vulnerability, and decision analyses.

Daniela Elena Gogoaşe Nistoran is a member of the Hydraulics and Environmental Eng. Dept., Univ. Politechnica of Bucharest, Romania.

Uwe D. Hanebeck is Chaired Professor of Computer Science at the Karlsruhe Institute of Technology (KIT) in Germany and director of the Intelligent Sensor-Actuator-Systems Laboratory (ISAS). Professor Hanebeck obtained his PhD degree in 1997 and his habilitation degree in 2003, both in Electrical Engineering from the Technical University in Munich, Germany.

Constantin Hostiuc art historian, PhD, is the secretary general of the Centre for Architectural and Urban Studies of the 'Ion Mincu' University of Architecture and Urbanism.

Augustin Ioan Full Professor in architecture at the 'Ion Mincu' University of Architecture and Urbanism holds MSc and PhD degrees in architecture and philosophy from Bucharest and Cincinnati.

Jesús Muñoz Morcillo is a research assistant with focus on Public Communication of Science, interdisciplinary projects, and New Media at the ZAK | Centre for Cultural and General Studies at the Karlsruhe Institute of Technology (KIT) in Germany. He obtained his PhD degree in 2015 in Art Research and Media Theory from the Karlsruhe University of Arts and Design, Germany.

Beniamino Murgante is Assistant Professor at the University of Basilicata, Potenza, Italy, and chair of the conferences ICSSA and Geographic Analysis, Urban Modeling, Spatial Statistics.

Helena Murteira is an art historian, PhD (University of Edinburgh, 2006) and senior researcher at the Centre for Art History and Artistic Research (CHAIA) – University of Évora, Portugal. She works at the Gulbenkian Archives, Calouste Gulbenkian Foundation, Lisbon, Portugal. Her main research areas are history of architecture and town planning (early modern period), cultural heritage, art theory, and virtual heritage.

Gabriela Osaci-Costache (BSc single Hons in Geography, University of Bucharest; MSc degree in Environmental Morphohydrography and Land Planning; PhD in Geography, University of Bucharest) is Associate Professor at the Department of Geomorphology – Pegology –Geomatics, Faculty of Geography, University of Bucharest, Romania. Her fields of interest for research are Historical Cartography, Thematic Cartography, Landscape Dynamics, GIS, the Didactics of Geography, and Toponymy.

Kulasegaram Partheepan is GIS/Database Officer, United Nations Development Programme (UNDP), Batticaloa, Sri Lanka.

Alexandru-Ionuţ Petrişor PhD (Ecology), PhD (Geography), Habil. (Urban Planning); specialized in the ecology of territorial systems, bio- and geostatistics. Currently he is Assistant Professor of Ecology and Statistics, 'Ion Mincu' University of Architecture and Urban Planning, and Senior Researcher and Scientific Director, National Research Institute "URBAN-INCERC".

Caroline Y. Robertson-von Trotha is Director of the ZAK|Centre for Cultural and General Studies at the Karlsruhe Institute of Technology (KIT) in Germany. She studied sociology, philosophy, and history in Heidelberg and Karlsruhe and holds a PhD degree in sociology. She habilitated in Karlsruhe in 2004 and is i.a. member of the Culture Committee of the German UNESCO Commission.

Paulo Simões Rodrigues PhD.(Art history), Assistant Professor at the History Department and Director of the Centre for Art History and Artistic Research (CHAIA) of the University of Évora (Portugal), coordinator of the HERITAS –

Heritage Studies Doctoral Program is also editor of the journal *MIDAS – Museums and Interdisciplinary Studies*.

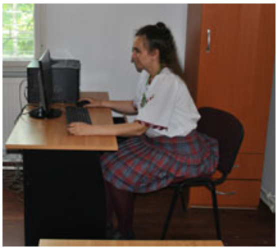
Brînduşa Ana Craia Savin is an engineer (Politechnica University of Bucharest, 2010) working at Hidroelectrica S.A., Piatra Neamt Headquarters, Romania.

Yanan Sun is an urban planner, born in China. Before attending the doctoral program at Cornell University, she earned Master's degrees in City and Regional Planning and Integrated International Urban Studies. She is interested in architectural and urban history from a cross-cultural perspective and explores new ways of interpreting history with the help of social network analysis.

Selvarajah Thayanath is Development Officer, District Secretariat Office, Batticaloa, Sri Lanka.

Antonio Zea is a research assistant in computer science with focus on extended object tracking and telepresence at the Chair for Intelligent Sensor-Actuator-Systems (ISAS) at the Karlsruhe Institute of Technology (KIT) in Germany. Antonio Zea is currently working towards his PhD about pose and shape estimation of complex extended objects.

About the Editors



Dr. Dipl.-Ing. Maria Boştenaru Dan, Universität Karlsruhe/Germany graduate in architecture, specialisation urbanism. Currently scientific researcher (permanent position) at the "Ion Mincu" University of Architecture and Urbanism. She represented the university and Romania as Steering Committee member in the Network of Digital Methods for Arts and Humanities (NeDiMAH). Currently also postdoctoral researcher (EU funds, POSDRU project 133391) at the University of Bucharest, Faculty for Geography.

Studies

Dipl.-Ing. in architecture, specialisation urbanism, at the University of Karlsruhe, Germany (1999).

Postgraduate certificates in "Working with multimedia" and "Project management" as well as "English for Business" at the University of Karlsruhe, Germany. Attendance of postgraduate courses in civil engineering (regional planning) and in international competence at the same university.

Postgraduate certificate in psichopedagogy at the University of Bucharest, qualification of teaching plastical education in schools and at universities.

Master studies in Practical informatics, FernUniversität Hagen, started 2016.

Doctorate in architecture, "Ion Mincu" University of Architecture and Urbanism (2012).

Selected Research Projects

SFB 315 "Preservation of historically relevant constructions", University of Karlsruhe: a building survey in Poland (1997–1998)

SFB 461 "Strong earthquakes", University of Karlsruhe, research assistant (2000–2001)

DFG scholarship/GK “Natural Disasters”, University of Karlsruhe “Applicability and economic efficiency of seismic retrofit measures on existing buildings”. (2000–2003)

Marie Curie Training Site scholarship, Istituto Universitario di Studi Superiori di Pavia (IUSS), Italy (2002–2003)

Marie Curie Intra-European Fellowship, IUSS Pavia “Preservation of historic reinforced concrete housing buildings across Europe”, experienced researcher (2005–2007)

Marie Curie Reintegration Grant, “The innovation in the plan of the current floor”, Foundation ERGOROM ‘99, Bucharest, Romania. (2007–2010)

CNCSIS project “Arts, Urban Communities, Mobilisation”, “Ion Mincu” University of Architecture and Urbanism, team member (2008)

Architects’ Stamp cofunded project: Tzigara-Samurcas archive, “Ion Mincu” University of Architecture and Urbanism, team member (2009)

Architects’ Stamp cofunded project: Urban route Virginia Haret, coordinator (2013)

“World Housing Encyclopedia” since 2001 (editorial board 2003–2006), EERI Oakland, USA

CNMP project “Multihazard and vulnerability in the seismic context of Bucharest city”, University of Bucharest, consultant (2007–2010)

CNCS project “Spatial and temporal patterns of vulnerability”, University of Bucharest, research assistant (since 2012) coteaching the course has nothing to do with the University of Bucharest, maybe it is better to leave it out since it is not a research project, I will put it at teaching experience

COST action “Semantic enrichment of 3D city models for sustainable urban development”, Management Committee member (2009–2012), Short Term Scientific Mission (5 weeks) to the University of Algarve (2012)

COST action “The EU in the new complex geography of economic systems”, Management Committee member (since 2012), Short Term Scientific Mission (5 weeks) to ISCTE-IUL, Lisbon (2013)

COST action “Renewable energy and landscape quality”, Management Committee substitute (since 2015)

COST action “Intelligent Management of heritage buildings”, Management Committee substitute (since 2015)

COST action genderSTE, Management Commitee observatory (since 2013), as working group cochair of m-WiSET (women in science) of the Marie Curie Fellows Association (advisory board member 2003, administrative board member since 2011)

ESF “Network for Digital Methods in Arts and Humanities”, steering committee member (2012–2015)

Canadian Centre of Architecture support grant (2010)

DOMUS grant from the Hungarian Academy of Sciences at the Corvinus University, Budapest, Hungary (2014)

Dumberton Oaks Harvard Institute, won postgraduate stipend which could not be entered

POSDRU postdoctoral project "The impact of hazards on settlements: Digital means for representation and analysis", University of Bucharest (2014–2015)
Vasile Pârvan postdoctoral scholarship "Gender issues in planning with water. Water as hazard and water as heritage", Accademia di Romania a Roma, Italy (2015–2016)

Teaching

Coteaching "Protection of settlements against risks", "Ion Mincu" University of Architecture and Urbanism (2009–2010, assisting and consulting since 2010)
Visiting lecturer "Participative planning", University of Algarve (2012)
Visiting lecturer "Sustainable planning" and "Land art", Corvinus University of Budapest (2014)
Teaching contract "Trends in Design and Interior in the 20th century", Karlsruhe Institute of Technology (2015–2016)

arch. Cerasella Crăciun PhD – Associate Professor Architect, Vice-Dean of **Urban Planning Faculty** – "Ion Mincu" University of Architecture and Urbanism, Bucharest, Romania; Coordinator of "***Planning and Landscape Design***" **Bachelor's Program** and **"*Landscape and Territory*" Masteral Program. Publications**: author of three books; editor coordinator of three books (including Springer Publishing House); over 40 articles in journals such as: *Romanian Academic Forum (FAR XXI)*, *Urbanism – New Series*, *Arhitext*, *Argument-Education and Scientific Research of Architecture and Urbanism*, *Architecture Annals*, among others; over 80 projects, studies, research and documentation of landscape, urbanism and planning, architecture, interior design, object design, jewelry, costume and set design, and scenography.

Awards and Nominations

– 2015 – Romanian Nominated by the **Fundació Mies van der Rohe Barcelona, to participate to the Prize for Contemporary Architecture – Award 2015** with Promenade Mall Landscaping Project – "Cosmic Archetypal Garden" – "TowerScape-LandScape" / Barcelona, Spain.
– 2014 – The **Award of "Architecture and Urban Space" Section – National Biennial of Architecture**, "*The dilemmas and challenges architectural space – Romania 2013–2014*". With landscape project – "The Archetypal Cosmic Garden" / "TowerScape – LandScape" – Terrace Promenade Mall Garden.
– 2013 – Nominated by the Faculty of Urban Planning – IMUAUB for **ECLAS (European Council of Landscape Architecture Schools) – The "*Outstanding Educator Award*".**

- 2013 – The Award in the Field of Sustainability for "***The Educational Initiative in the Field of the Year's Green Buildings***" given to the Faculty of Urban Planning (team award) offered by the Romania Green Building Council.
- 2012 – The Award of the Ministry of Regional Development and Tourism (team award) with a "*Diploma for the contribution to the consolidation and development of strategic planning of urban areas and territory*" awarded by the Ministry of Regional Development and Tourism for the "**Integrated Urban Strategy for the development of the city of Bucharest and of its support and influential territory – Strategic Concept Bucharest 2035**" developed by the team of the "Ion Mincu" University of Architecture and Urbanism – (Section: "*Public space, quality of urban life and Landscape as a fragile resource – The mezzo-landscape and the natural, anthropogenic and cultural landscape in Bucharest*" – developed by Reader PhD Architect Cerasella Crăciun) within the National Architecture Biennale Bucharest 2012, The National History Museum, October–November 2012.
- 2010/2011 – "**Honor of Understanding Performance and Dedication" –** ***"Best Gardens Designer Exhibition – 'Le Notre' Jardins a la francaise"***, organized by Chateau de la Huardiere, France.
- 2010 – Winner of the **Cultural Project "*Lost Gardens*"**, as a result of the selection organized by the Union of Architects of Romania.
- 2008 – The Prize for Landscape Design of the Romanian Register of Urban Planners for the **"Protection of the Bucharest Parks – Herastrau, Cismigiu and Carol."**
- 2008 – Selection by an international jury for the Publishing Section within the Architecture Biennale for the book ***The Urban Metabolism. An Unconventional Approach to the Urban Organism***.
- 2000 – Winner of the "*Urban-Landscape Design and Architecture Management – Red Islands – Danube's Delta*" Contest, organized by UAUIM.
- 1995 – Winner of the Competition ***"Bucharest to the North of the Lakes,"*** organized by UAUIM.

Introduction: The Context of Participation of Romania to the NeDiMAH RNP

Maria Boştenaru Dan

Abstract Romania was part of the European Science Foundation Research Networking Programme 'Network for Digital Methods in Arts and Humanities' (NeDiMAH) between 2012 and 2015, cofunded by CNCS, the Romanian Council for Scientific Research. NeDiMAH ran four years in total, from 2011 to 2015. The Romanian participation was singular in focusing on the image part dealt with in the network, as a result of the 'arts' dimension, whereas the majority of partners dealt with text and humanities. This book is an overview of initiatives in Europe related to the Romanian one, in order to contribute to one of the outcomes of the network, namely the mapping of the approaches. In this introduction the context of the Romanian contribution is presented in order to give the framework for the invited contributions to the book. The conclusion shows how these are and will be linked for future cooperation.

Keywords Digital methods • Arts • Humanities • Architecture • Events

NeDiMAH Report

The NeDiMAH 'Network for Digital Methods in Arts and Humanities' (http://www.nedimah.eu/) research networking programme was funded by the European Science Foundation (ESF) and cofunded by the participating countries, in the case of Romania by CNCS. There are 16 participating countries: Bulgaria, Croatia, Denmark, Finland, France, Germany, Hungary, Ireland, Luxembourg, the Netherlands, Norway, Portugal, Romania, Sweden, Switzerland, and the United Kingdom. The chair was Dr. Lorna Hughes, the United Kingdom, and coordinator in the first phase was Dr. Malte Rehbein, Germany, until he became professor. Dr. Malte Rehbein is a Marie Curie Fellows Association member and contact came through the administrative board of the association. NeDiMAH was funded May 2011–May

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2015, with Romania adhering in February 2012. CNCS assured the contribution for three years stipulating the participation of as many young researchers as possible, apart from the author, steering committee member. Reporting was done to Monica Cruceru. The funding comprised mobility: working group meetings and visits for scientific exchange. Through this mapping was aimed for at the European level of initiatives in digital humanities. As at the author's doctoral school, the media discussed are image and text. The network comprises six working groups: WG1 Space and Time, WG2 Information Visualization, WG3 Linked Data and Ontological Methods, WG4 Building and Developing Collections of Digital Data for Research, WG5 Using Large Scale Text Collections for Research, and WG6 Scholarly Digital Editions. Apart from this there are two cross-team workgroups: Developments of the ICT Methods Taxonomy and Impact of ICT Research Methods on Scholarly Publishing. Each year each working group organised a meeting, and there was one steering committee meeting each year. In addition to this there were a number of short visits.

In 2012 in Hamburg, in conjunction with the Digital Humanities World Conference, workshops of WG1, WG2, and WG3 were organised. The author participated, presented, and moderated a work session (collection of ideas for 'Theory') at the WG1 workshop, and also young PhD candidate Irina Paţă, working on the topic of video landscape, participated. The workshop took place on the 17th of July 2012, before the conference, with the title 'Here and There, Then and Now – Modelling Space and Time in the Humanities.' In the morning there were eight presentations, and in the afternoon a break-out session of ideas exchange on four categories: theory, methods, instruments, infrastructure, and a discussion of conclusions, details of which can be found at http://spacetimewg.pbworks.com/w/page/51699274/Second%20Workshop. The workshop was a big success with numerous participants. Following the participation in Hamburg an ERASMUS agreement with the local university was signed. At the WG2 workshop in Hamburg, organised as a postconference workshop, on the 21st of July 2012, under the title 'Visual Tools and Methods in Digital Humanities: Representing, Reading, and Thinking about Knowledge Creation', young researcher PhD candidate Alexandru Calcatinge, architect, participated, replacing Andreea Popa, with a presentation on a project funded by the Romanian Architects' Union, presented in this book by the coordinator of the project, Cerasella Crăciun. Following the success of the participation in WG1 and WG2, the coordinators of the two working groups decided to organise a workshop to discuss the results asking Bucharest to act as host. The leadership of the 'Ion Mincu' University of Architecture and Urbanism agreed to host it at the Centre for Architectural and Urban Studies on 1–3 November 2012, funded by ESF, and a detailed report follows. Involved were mainly young researchers. The workshop aimed at a roadshow of the digital initiatives in Romania, to be integrated in the general mapping. WG5 and WG6 organised workshops in conjunction with the Ninth Conference of the European Society for Textual Scholarship, 'Editing Fundamentals: Historical and Literary Paradigms in Source Editing', 22–24 November 2012, Amsterdam, The Netherlands. The author contributed to WG6 along with Andreea Popa, another young researcher who also participated with a presentation of using databases of historical journals. Conclusions on all these participations were presented at the steering committee meeting in Dublin, Ireland, 26–27 November 2012. At the steering committee the webpage of the action was discussed, and the author got access to it, reporting about activities, publications, and outreach events within the network. The author also applied for workshop funding from Romanian means, in cooperation with Austria, for a digital humanities workshop, and at the European Geoscience Union, in 2012, but the evaluation process was stopped for lack of funds. Some chapters in this volume reflect proposed talks for that workshop (e.g., the one by Helena Murteira). These contacts were deepened by visiting the Portuguese NeDiMAH colleagues with COST STSM funding. The presentation from the Bucharest workshop was thus published as a joint NeDiMAH and COST TU0801 result with funding for printing from the Marie Curie Alumni Association in 2013. The book is open access, according to NeDiMAH principles.

2013 stayed under the sign of intermediate evaluation of NeDiMAH RNP. The whole steering committee contributed to the input of the report, especially regarding activities and publications. The author elaborated a multimedia version of a poem, which was discussed also in the framework of the EEA grant funds for cultural diversity as promising in the context of collaboration with music. The report was evaluated favourably with some observations. The questionnaire done during the workshop in Bucharest (available at https://www.surveymonkey.com/s/R3KNWG9 ‘Understanding the Uses of Visualisation in the Digital Arts and Humanities’) was one of the key results, and even more participation of young researchers, and of researchers working with image data was encouraged. An instrument for involvement of young researchers was bursaries without presentation for young researchers for the Lisbon WG1 meeting. The next workshop of WG1 took place in 2013 in Lisbon, with young researchers from Cluj-Napoca (Anca Horvath) and Bucharest (Marilena Doina Ciocanea), both architects, participating. The next workshop of WG2 took place 7–8 March 2013 in Umea, Sweden, on the topic ‘Visual Tools and Methods in Digital Humanities: Capturing, Modelling, Reading, and Thinking about Knowledge Creation’, and young researcher Mihaela Hărmănescu from Bucharest, who also participated in the Cross workgroup meeting in Bucharest in 2012, participated with a presentation and as a respondent to discussions. Andreea Popa became a member of the crossteam WG Scholarly Publishing, representing Romania. Andreea Popa also participated on her own in the WG3 workshop at the 8th International Digital Curation Conference, in Amsterdam, 14–16 January 2013 with the presentation “Use of Digital Data in Landscape Planning – Transdisciplinary Approach”. Hungary and Luxembourg adhered in 2013. From Hungary one of the cofunding institutions is the Hungarian Academy of Sciences, where the author is a member of the external public body. From Luxembourg the steering committee member is another Marie Curie Fellows Association member. NeDiMAH also became an associated member of the Marie Curie Initial Training Network DiXiT.

For 2013 Romanian participation also featured involvement of the author in the conference on Historical Network Research in Hamburg, Germany, 13–15 September 2013 http://historicalnetworkresearch.org/index.php/the-future-of-hnr-conference. The conference had three sections, dedicated to WG1, WG2, and WG3, respectively. From 22 January to 7 February 2013 the author undertook a short visit at the Karlsruhe Institute of Technology on the topic 'Architectural Heritage Protection of the Central Area of Bucharest: Mapping Ways of Visualisation in GIS and Archives', host Alex Dill. During the short visit the grantee participated in conferences and seminars, discussed with the publisher the project for this book, and visited the exhibition on digital art conservation about which a contribution is included in this book. The results of the research in the short visit were included in another Springer book publication, also discussed then, which was published in 2014 (Boştenaru Dan and Dill 2014) by the same editors as this one. The short visit also resulted in a book as a joint effort with the return short visit in 2015 of Alex Dill to Bucharest (Boştenaru Dan et al. 2015), about the launch of which we report later on. Among others, the visit facilitated contact with the nephew of an architect about which we wrote in this book, and we are preparing another. Other publications were done in different journals, some of them extending to the current postdoctoral project. Another book in discussion with Springer from this time is an authored book on disaster images research, based on archive research funded by the Canadian Centre for Architecture. For research on these two books a visit was made to the exhibition 'Atlantis Till Today' – the images of disasters exhibition in Mannheim in 2014, in the framework of the postdoctoral project. Other work related to NeDiMAH included participation in the Digital Landscape Architecture Conference (see report at the conclusion) leading to establishing contact with Pia Fricker, who later participated at the NeDiMAH event and wrote in this book, and also Anca Horvath who was trained in parametric architecture and the author participated in some conferences presenting this approach, as well as at presentations on virtual heritage approaches in Romania, as NeDiMAH ambassador. From the Hamburg conference Yanan Sun participates in this book.

In 2014 the author participated in the steering committee meeting on 11–12 November in Zagreb, Croatia, to obtain funds for future activities, because the Romanian participation decreased that year. Applications were made for some workshops, without acceptance (WG4, cross WGs). The second day of the meeting was dedicated to a roundtable at the Croatian Academy of Sciences where the author was one of the speakers, talking about initiatives in Romania, the virtual heritage just mentioned, and the first project in digital humanities she did, the Tzigara Samurcaș archive. In 2014 cooperation with ESF extended to co-organising a workshop at the EuroScience Open Forum in Copenhagen on the topic of 'New Models of Mobility' on behalf of the Marie Curie Fellows Association. Before participating in NeDiMAH the author acted as management committee member in the COST action TU0801 'Semantic Enrichment of 3D City Models for Sustainable Urban Development', on a related topic. At the close of NeDiMAH participation started with the COST action TD1406 'Innovation in Intelligent Management of Heritage Buildings'. Also related to this was the activity of the author as evaluator for the 3D heritage projects in the framework of the REFLECTIVE 7 call of Horizon 2020 in 2014. The current postdoctoral project is in the same line, dealing with digital means for analysis and visualisation of hazard impact on settlements.

In 2015 the participation of Cluj-Napoca as university research centre was extended with the newly founded (in 2014) Centre for Digital Humanities. A short visit of its chair, Corina Moldovan took place at a workshop in Debrecen, and a training school for young researchers was organised. Another short visit was the return of Alex Dill to Bucharest, about which we report later, along with the book for which funding was approved. The author reported on the mentioned digital humanities projects in Romania, which are now available for mapping on the website. Also the very first entry from the Hamburg WG1 workshop is available there. In continuation, the author got in contact with the Europeana database to include 3D models of Romanian heritage, needing though a stronger institutional involvement, such as the poetry publication mentioned. Another digitalisation initiative of the author included archiving materials about student life in Karlsruhe. This furthers the cooperation with Karlsruhe in the framework of this project, which also included an interview published on the NeDiMAH network, as an outreach of the workshop. Currently a profile as former researcher is in work as well, and an invitation for teaching will follow. In 2015 at the European Geosciences Union General Assembly in Vienna, in the framework of the postdoctoral project, we participated at another ESF workshop, disseminating the results of the geohazards conference in Sant Feliu from 2011, where we actually were invited to participate in an ESF RNP, the result of which was the adherence to NeDiMAH. The NeDiMAH network closed with the event ‘Beyond Digital Humanities’ in London on the 5th of May 2015, in which the author participated. Last but not least, this book was finished at the closure of the NeDiMAH project.

A “Story of Houses” Which Continues: The Radu R. Rosetti House in Moxa Street Nr. 5

The R. Rosetti house in Moxa Street nr. 5 was designed by the architect Nicolae Ghica-Budeşti and built in the years 1910–1911 (Fig. 1). The builder was Cesare Fantoli, the brother of the rector of the Politechnic of Milan. Radu R. Rosetti was the son of the writer and historian with the same name, married to Ioana Ştirbei, the younger sister of Eliza, the wife of politician I. C. Brătianu.

Ruxandra Nemţeanu (2014) includes the house as being emblematic for the project of the Neo-Romanian villa. In this context, the dining room of the house is compared with the project of an ideal dining room in *Arhitectura* magazine 1/1906.

The house is a neighbour of the Romanian Academy and its park, being situated on a green island. The exterior façades are marked by visible bricks, and in the interior the look is given, especially in the reception rooms on the ground floor and in the main lobby, by the timber covering and marmor stuccatures. The entrance

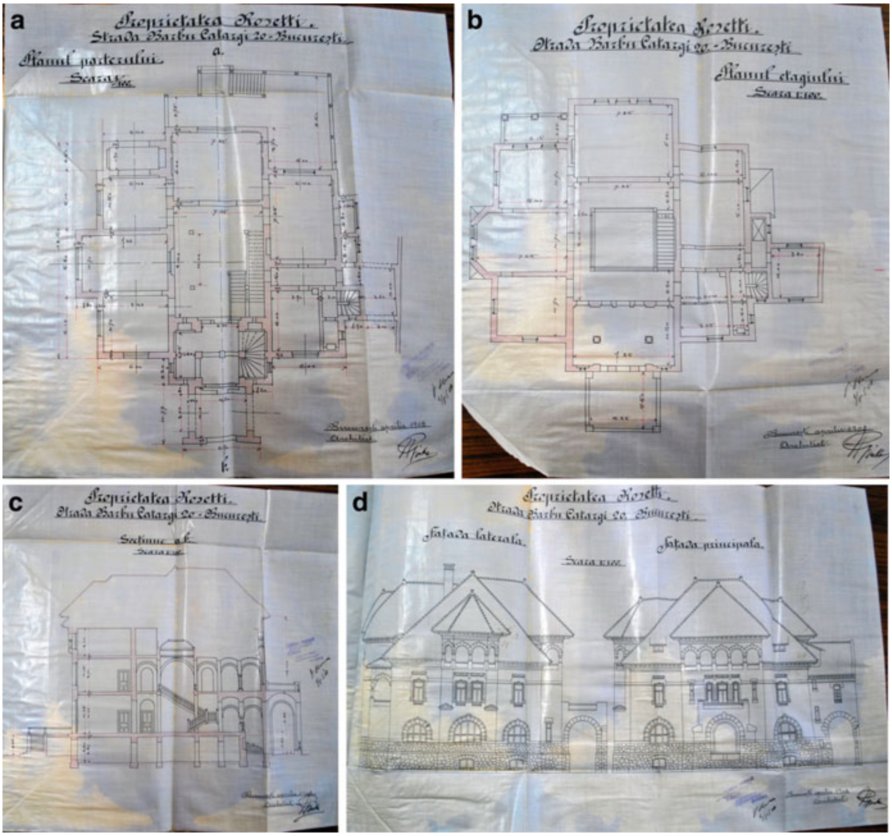

Fig. 1 Plans of the building in Moxa Street (Courtesy of the Romanian National Archives, section of Bucharest)

was conceived with a covering, for a time when transportation was done with carriages.

In the volume *Povestea caselor* (*Story of Houses* 2000) an article was published about the history of the building. According to this, the Rosetti family lived in the house for 25 years; it was bought by the House of Work by the Romanian Railways, and rented to the Legacy of the Netherlands. After the war, the Railway Institute had its headquarters in the building, with the Transport Faculty of the Politechnical Institute and the Academy of Economic Studies (which even today has some places close by). Therefore, in this time courses were held in the building, and the archive of the Professor Grigore Moisil, member of the academy, was kept here and prepared for publication. Finally it went over to the Ministry of Education and the Sports Club 'Student Sport'.

To continue the story of the house, currently the building is under the administration of the University of Architecture and Urban Planning 'Ion Mincu', being the headquarters of some of its research centres (Fig. 2). The former rector of the

Fig. 2 Photos of the building in Moxa Street by (Maria Boştenaru 2009)

university, Professor Doctor Architect Emil Barbu Popescu, currently honorary president, also supported the activity of the sports club. Thus, the building functions as the Centre of Architectural and Urban Studies (CSAU http://www.uauim.ro/cercetare/csau/) of the university, led by Professor Doctor Architect Nicolae Lascu, the secretary general of which was the late Marica Solomon. The centre organises various events, and conducts research not connected with the contracting type of the Centre for Research, Design, Expertise and Consulting (CCPEC) of the university (e.g., European projects but also those through the means of the university), and through affiliated researchers publishes these research results as books. Such themes referred to the housing of the twenty-first century, the Bellu cemetery series, public space, and recently work has started on architects' monographs. In 2013 the Centre for Excellence in Planning (http://www.cep-edu.eu/) was funded, founded in cooperation with the university, especially with the Urban Planning Faculty, led by Mircea Enache. Here the master ASURED takes place, as well as research activity. Also, it is the headquarters of the Centre of Excellence in the Study of the Image (CESI http://cesi.ro/), which leads in consortium with the university the doctoral school 'Space, Image, Text, Territory', but also independent masters. CESI is one of the best recognised centres in the country.

As a researcher of the 'Ion Mincu' University of Architecture and Urbanism the author is a member of the Centre for Architectural and Urban Studies, and organised a series of events in the house in Moxa. One of them was the Cross Working Group Workshop of the Network for Digital Methods in Arts and Humanities in 2012. The lobby with a skylight became the entry hall, and in the rooms reunions took place. Our office on the first floor even has a balcony. More recently, collaboration discussions with Professor Thomas Panagopoulos from Portugal took place there, in the framework of a COST visit. Our intention is for further such invitations. The building also headquarters other offices, for example, those of the foundation Arhitext, which, in the published journal, included articles about CSAU activity (Boştenaru Dan 2013).

In 2010, Professor Dr. Arch. Sergiu Nistor, the director of the Centre of Studies for Vernacular Architecture, with headquarters in the fortified church at Dealu Frumos, published a book about this, with the title *Transylvania – A Heritage Looking for Its Inheritance* (Nistor 2010). Maybe the house in Mihail Moxa no. 5 would also deserve such a publication, which, like the mentioned book, would describe the life of the house before and after it became a research centre, with all the events taking place here, a new life for historic monuments. In 2013, on the occasion of the European Association for Architecture Education evaluation visit, the author made a report on the last year of activities of CSAU, which could be a starting point.

Space and Time and Information Visualisation in Digital Landscape Architecture: A Dialogue with Digital Humanities NeDiMAH Workshop in Bucharest, November 2012

Key representatives from at least two working groups of NeDiMAH, a European Science Foundation (ESF) funded Research Networking Programme (http://www.nedimah.eu), brought together the experiences and knowledge from the workshops arranged during 2012 (Fig. 3). By doing so we can start structuring the taxonomy of methods and ICT-tools in digital landscape architecture seen as a branch of digital

Fig. 3 Event images of the NeDiMAH crossworking group workshop in Moxa Street in November 2012 (Photos: M. Boştenaru)

humanities which is an important objective part of the NeDiMAH network. The work will be a bottom-up approach using the experiences from the workshop and then mapping methods, procedures, tools, criticism, awareness, challenges, and solutions to the eras covered by the Time and Place working group as well as the Information Visualization working group. This work requires competencies and experiences from different fields.

Outputs from the meeting were presented to the steering group of NeDiMAH in November 2012 in Dublin, Ireland.

There is mutual interest among the active persons at the host organisation, the Centre for Architectural and Urban Studies of the 'Ion Mincu' University of

Architecture and Urbanism to take part in this activity as well as sharing its own experiences. There were three full days of meetings, mainly containing collaborative work but also some room for presentations to a wider academic audience. The host in Bucharest also invited key persons to participate in the meeting.

Apart from the NeDiMAH funded working group leaders, members, and the steering committee member who organised it we had two further international participants: Tincuta Heinzel from Germany and Daniela Calciu from the United States (in contact with a WG leader for exchange of ideas on virtual heritage). The Romanian participants were mainly from the host university but not solely (there were participants from other universities and from the Romanian Academy as well). From the university we attracted participants from the urban and landscape planning and from the design departments (where the coconvener was from). The coconvener also involved her students in the presentation and discussions. The invited NeDiMAH members presented the progress thus far within the network and possibilities of involvement. The presentations of the meeting will be published electronically and with traditional support, at Versita Emerging Science publishers.

In the first two days a questionnaire was developed to assess the state of the art in Europe, in addition to the mapping of the state of the art in Romania which was the subject of the public presentations. It available online from https://www.surveymonkey.com/s/R3KNWG9.

On the third day of the meeting 22 participants (4 participants not being speakers, and the speakers listed in the attached programme) presented and discussed their work in the wider field of Digital Arts and Humanities (not only connected to the WG). It was a rare possibility for Romanian participants who couldn't attend a NeDiMAH workshop abroad to present their work in the field.

The presentations of the NeDiMAH WG leaders, members, and the steering committee member were divided between morning and afternoon, half of them taking place in the first and half in the second, to provide a good mixture with the Romanian presentations. The international presentations of the invited speakers included reports on the previous workshops: to two of them in Hamburg in July we had Romanian participants, apart from the steering committee member, who unfortunately could not attend this time. Romanian presentations were mainly from two fields, namely landscape planning (readability of the landscape with modern techniques and landscape in the age of information technology, the educational dimension of digital methods in parametric design in landscape planning, and Dacical castles in the Orastie mountains) and architectural design, for the speakers coming from the host institution, with four different presentations, two regarding digital methods in the representation of natural disasters (flood risk assessment using GIS and the impact of the 1755 Lisbon earthquake digitally represented), by a speaker from the University of Bucharest and the organiser herself, as well as, respectively, digital methods in industrial design (Tincuta Heinzel), a cultural project, and an history of architecture (Daniela Calciu). The digital methods in architecture and landscape thus involved two different scales. There was an important report of the teaching dimension, in both cases, with one presentation on digital methods in teaching of landscape design and, for the architectural design part, the involvement of students presenting their designs rendered digitally. The presentations were widely discussed, with links to related research (e.g., Iannis Xenakis was a pioneer of new media in architecture), and suggestions for further work (representing landscape not just as another 3D model but as historic evolution with specialised tools).

A Web page has been developed to better organise the information on the event to a level of detail this report does not allow (http://nedimah.uauim.ro/). The event enjoyed wide outreach activities: in the university (http://www.uauim.ro/events/nedimah/), also being added to the activities of the research centre, and in the media (magazines such as *Arhitext*, newsletters, and radio including Romania Cultural).

Several possibilities of further collaboration and investigation of the issues raised have been identified, including application for different funding (national, COST) but also other instruments of the NeDiMAH network or simply meetings in the framework of other conferences (the European Geosciences General Assembly in Vienna 2014).

Digital Architecture History, Heritage Conservation, and Landscape

The Network for Digital Methods in Arts and Humanities was funded between May 2011 and May 2015 as a Research Networking Programme by the European Science Foundation. On the 5th of May 2015 the closure event under the title ‘Beyond Digital Humanties’ was held in London. Romania joined in 2012, with CNCS cofunding. The Romanian participation featured participation of some doctoral candidates and teaching staff to workshops from the ‘Ion Mincu’ University of Architecture and Urbanism and other universities (Technical University of Cluj Napoca, Babes Bolyai University), the organisation of a crossworking group workshop in 2012 at the ‘Ion Mincu’ University of Architecture and Urbanism (http://nedimah.uauim.ro/), of a training school at the Babes Bolyai University Centre for Digital Humanities in 2015, as well as a couple of short missions. As a result, a number of publications emerged from the European cooperation. A couple of Romanian projects are also featured in the directory of mapping them in Europe (http://www.nedimah.eu/).

The aim of this review is one final event organised in conjunction with the returning short visit of architect Alex Dill, from Karlsruhe University of Technology, Academic Councilor, at the doctoral school of the ‘Ion Mincu’ University of Architecture and Urbanism. The event repaid the short visit of Maria Boştenaru Dan, from the host university, which took place in 2013. Continuous cooperation between the two visits led to synchronising the research efforts dedicated to the conservation of Modernist architecture. As a result, a book was launched at the closure of the event on the 23rd of April 2015, the International Day of the Book. Before, a series of lectures was held at the doctoral school. Apart from Alex Dill, the series of lectures featured architect Pia Fricker, from the ETH Zürich, talking on digital landscape architecture, the teaching programme which she leads. She and Pia Fricker, the host, were students of Alex Dill at the Karlsruhe University a number of years ago.

On the 23rd of April the author first launched the book. After writing more, this *Digital Architecture History of the First Half of the 20th Century in Europe*, was the first to be launched. It was accompanied by a lecture event from a student colleague from the time the author did undergraduate studies in Karlsruhe, Germany, and a former teacher from there. The current university was so kind as to provide a webpage for it, however, the programme as well as the digital version of the book is available only in the Romanian version (however, the book is in English). For better coverage, the author applied for it to be included in the ICOMOS open archive (http://openarchive.icomos.org/1540/).

Pia Fricker is leading the masters in digital landscape architecture at the chair Christophe Girot at the ETH Zürich. The chair was active in 2014 in hosting the Digital Landscape Architecture Conference, an established forum in the field. The lecture included presentation of video techniques for creative landscape exploration, and also of 3D landscape scanning in Switzerland and in Singapore, where a branch of ETH is based. The closing of the lecture was dedicated to the parametric floor plan housing design. Presenting this followed the purpose of mutual acquaintance with the host university with the goal of future cooperation. A summary of the lecture will be published in a forthcoming edited book at Springer, emerging from the NeDiMAH network, although, as a special guest, Pia Fricker did not take part in the NeDiMAH funding programme. Pia Fricker participated in the Le Notre Landscape Forum taking place in Bucharest in the same week instead.

The research of Alex Dill in the field of conservation of Modernist heritage took place as a series of expert conferences over more than a decade (starting in 2004). During the first seven years expert practitioners each year from one or two different countries (if two, then one from the east and one from the west) were invited to present recent conservation efforts of this heritage. This gave a European context to the research. Since 2012, the conference has been focused on thematic approaches, such as technology, authenticity, housing, landscape, and so on. In his lecture, Alex Dill presented the university, and some detailed aspects of the research, particularly the approach to authenticity in Eastern and Western Europe (Russia, Germany, and, respectively, Mies architecture in Spain and Czech Republic). The approach in Czech Republic was based on the experience working with the international board THICOM of the Villa Tugendhat restoration in Brno. In continuing the lecture thoughts to propose a UNESCO list for the Werkbund Siedlungen were given, a transnational common heritage. Alex Dill is also a Werkbund member. In addition, Dill took part in the Le Notre forum.

As stated, the research of Alex Dill was in dialogue with that of the host. As such, it has already been published, in a book called *Digital Architecture History of*

Fig. 4 Event images of the book launch in Moxa Street in 2015 (Photos: M. Boştenaru)

the First Half of the 20th Century in Europe by Maria Boştenaru Dan, Alex Dill, and Cristina Olga Gociman, printed at the ‘Ion Mincu’ publishing house, available open access in the ICOMOS archive. The closure of the event included the launch of the book (Fig. 4). Professor Dr. Arch. Cristina Ochinciuc and Dr. Art Historian Constantin Hostiuc accompanied all the authors in telling a few words about the book. Ochinciuc discussed the necessity of study trips to enrich the expert views at architecture conferences. Hostiuc, with a view to the foreign guests, presented the conditions in which Modernism appeared in Romania. The book is structured in introductory essays, followed by forms on architects and sites. The introductory essays are first dedicated to the Romanian heritage, then an essay on the spread of reinforced concrete in Europe, followed by reviews of the conference of Alex Dill, then the topics discussed at the presentation, and the review of a book in the field. Forms on 14 international architects and several architects in Hungary are included, presenting biographies, lists of works, and visual material. Finally, there is an overview of study trips by Maria Boştenaru Dan to sites of early twentieth-century heritage, including the occasion of the trip, literature to identify the buildings, and an exemplary image. More images are available online, for which reason the book reads better electronically than on paper.

As such, the book is the result of my mobility story. After a few trips abroad to other Eastern European countries in the time of Socialism and shortly after, the author went to Germany for study in 1996. These connections are from then, when the mobility programme between Eastern and Western Europe was not ERASMUS, but TEMPUS. The teacher from Karlsruhe came with ERASMUS. But the book and part of the travel were funded by the Network for Digital Methods in Arts and Humanities. The network was applied for and coordinated at the beginning by another Marie Curie fellow, Malte Rehbein, now professor for digital humanities after his reintegration grant, also from Germany. Marie Curie Fellowships were for him the entry into the world of research after doing his doctorate parallel to industry activity. In fact, digital humanities are much more widespread in Germany, and, as a consequence, the Karlsruhe Institute of Technology asked for an interview with the author on this topic (https://www.rsm.kit.edu/3759.php). As at the workshop at the ESOF in Copenhagen about which the author reported in the MCAA news, together with the European Science Foundation, the funding body for NeDiMAH, the discussion was between geographical mobility and virtual mobility.

The geographical context is necessary, as person-to-person contacts are needed. However, this book also features virtual mobility, as it is at a more senior level when one is no longer a student, at the doctoral and even postdoctoral level for a year or more abroad. The book is a crosscountry cooperation connected with short visits (funded by NeDiMAH). Geographical mobility permits not only knowing the persons also their culture. Learning a language might seem easy compared to integration in another culture and other habits. At the EXPO 2015 in Milan gastronomic culture was the subject. But architecture is also such a part of perceived culture when abroad. And this is the subject of the book.

Starting with the author's Marie Curie Intra-European Fellowship in 2005–2007 in Italy the focus of my research shifted from the centre of Bucharest to the European context of the investigated building typology. The Fellowship was concentrated on four to five countries, but later the reintegration grant enlarged this, with a focus on Romania and Italy for the doctorate (Boştenaru Dan 2012), and after that, when no funding for travel was available anymore through grants, travel grants for conferences assured 'seeing the world through science', as written earlier for the journal *Science* (in Arnette 2006). The book was funded for the digital part, which features a database of buildings from the first half of the twentieth century across Europe. This is enriched by introductory essays in cooperation with the other authors, and by forms on architects.

The author's current postdoctoral project in Italy, returning to geographical mobility, will be on architecture from this time, but by and for women, because it was a pioneering time for women. Work on it has already started, and in a recent panel at a conference (17th April at Vienna University of Technology) the author was asked if there are any cultural differences between how this power relation to women is treated in the different countries. The question is not new, as the author's scientist in charge during the first project of this kind, the Marie Curie IEF (about which there is also a report in the MCAA news), asked if in the project different methods of retrofit for earthquakes which are suitable for the typological variations of Modernism in the different countries considered could be identified. In fact, the differences are not so big, thus the answer, because these pioneer architects were also mobile. Like the author, they studied in countries other than their own and brought back their ideas. It was also the message that was reported by the guests at the event.

While searching for the answer, the author was happy to explore Europe and document the typology. And the database in the book is ever growing, also with the travel to the closure of the NeDiMAH network in London, buildings not yet included. An online publication of the database is hence perhaps better suited than the book form. And it can also include related videos. A second edition maybe can send readers from the paper version to the online version via QR code as in the photo book of the EGU (Blöschl et al. 2015).

Today, when looking to mobile people we look not only to the planners of our heritage, but also at their researchers. With the GEMS group of the MCAA a booklet of mobile women including also some doing research on buildings or on water issues was prepared (Avellis and Chmielowski 2015), giving an example for future research in Italy. The author hopes that this will be the next book, and, even if not launched on the International Day of the Book, to be launched and accompanied by a roundtable event at the Romanian Academy in Rome. Some people from eurodoc, the Romanian League of Students abroad, genderSTE, and EuroScience who reside in the Rome area have already been invited. On 13-14 June 2016 there will be a workshop on "Water as hazard and water as heritage" continuing the presentation from the 20th of January 2016 on a larger scale, in frame of the exhibition Spazi Aperti. At this event this book will be launched.

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Part I
Digital Landscape

The Natural, Anthropogenic, and Cultural Landscape Between Space and Time. Case Study: The Lost Gardens of Bucharest

Cerasella Crăciun

Abstract This study aims at promoting the research methodologies applied in landscape studies in all their quasi-natural, urban anthropogenic and cultural and historical components and on all research scales (at a macro-territorial, mezzo-territorial, or detail level). The study materialized in a series of case studies decrypted as being evolution research that focused on the serious issues of the loss and destruction of the cultural landscape heritage and of the decrease of green areas, of public spaces, and of valuable urban landscapes in Bucharest, Romania, especially in the context of historical evolution, including the communist and post-communist, transition period.

The project was conducted by studying historical records from the past until the present day, by using a transdisciplinary and multicriteria approach (Crăciun Metode de Abordare si Cercetare Exploratorii in Urbanism si Peisagistică. Epistemologia și Transdisciplinaritatea – Instrumente de cercetare a Peisajului Natural, Antropic și Cultural [Exploratory methods of approach and research in urban planning and landscape studies. Epistemology and transdisciplinarity – instruments in researching the natural, anthropogenic and cultural landscape], “Ion Mincu” University of Architecture Publishing House, Bucharest (2012)) and by overlapping historical, urban, and architectural layers and elements, by overlaying genius-loci and material and immaterial cultural landscape elements and by converging social, demographic, legislative, anthropological, linguistic, and archival components.

The research is based on the study of historical gardens that have totally or partially disappeared and that have a symbolic value and a coagulating function within the urban space and within the immaterial cultural landscape (traditions, general and local customs, etc.). The project highlights the expansion, development, and especially the decrease, destruction, and elimination of the landscape heritage and green areas, as well as of the urban-community areas in the last decades, by analyzing what has existed until present times with the purpose of achieving a balance in the time/space relationship within the landscape.

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Introduction. History Between Space and Time

A country with a special history, with a nation considered in Europe to be a miracle (Bratianu 1986) of strength and permanence in time and space, Romania is a “Latin island” (MacKendrick 1978:9) that has preserved its essence for millennia in the midst of Slavic peoples and always under the pressure of migratory peoples and the Ottoman Empire. Located in a special strategic territory between the Carpathian Mountains, the Danube, and the Black Sea, a territory known in ancient times as Pelasgus, Ramania, Thrace, Dacia, Wallachia, or the Romanian Principalities, Romania has a long and rich history, filled with important historical events that have led to major dramatic changes not only locally, but also on a European level.

> “It is the hearth of what we called Old Europe, a cultural entity between 6500–3500 BC, focused on a matriarchal society that was peaceful, loving and creator of art and that preceded the Indo-Europeanized patriarchal societies of fighters from the bronze and iron ages,” said Maria Gimbutas in the foreword to the Romanian edition of the book, *Culture and Civilization*. (Gimbutas 1989:49)

Located at the confluence of several sacred areas, transhumance paths, and, later on, of the trade routes that linked Western Europe to Eastern Europe and to the Middle East or Asia, the history of Romania is an example of endurance in space and time.

The first fragments of anthropogenic landscape in Bucharest, the capital of Romania, appeared in 1800 BC when evidence attesting the Paleolithic and Neolithic cultures (Rossetti 1932; Berciu 1967; Gimbutas 1965) on the banks of the rivers Dambovita and Colentina appeared, in the areas now occupied by the neighborhoods Dudesti, Lacul Tei, and Bucurestii Noi. This area’s passage through the development process of the Bronze Age and all the way to 100 BC led to archaeological discoveries which revealed that sites located in the areas of Herastrau, Radu-Voda, Pantelimon, Dealul Mihai-Voda, Popesti-Novaci, and Popesti-Leordeni were populated by Indo-European Geto-Dacians. The first fragments of dwellings after the Aurelian retreat in 273 AC were attested in centuries three to thirteen and up to the Middle Ages.

At the level of the cultural landscape, the legend says that the city was founded by a rich shepherd who was the leader of several other shepherds and his name was Bucur, a word that has Thracian origins. His name gave the final name of the city “Bucuresti”, from “Bucur-esci” and “Bucur-esti”, this settlement being located on an important, sacred transhumance route. The toponyms which come from group names that end in “- *eşti*” are always based on a person’s name in Romanian and the suffix “- *eşti*” which appears in the structure of the group name and of the settlement name refers to the origin of a person even when used in singular.

In *Dicţionarul toponimic al României. Muntenia* (*Romania's Toponymic Dictionary. Muntenia*), *vol. I.*, the settlement name *Bucureşti* comes from the name "Bucur" (Iorgu 1963:160), which appears toponymized: "Bucur" (DTRoM 2007:356), as well as "Bucura" (DTRoM 2007:392).

Thus, the name of the human settlement, the name "Bucureşti", designates those *Bucur-esti*, or Bucur's descendants; because Bucur was supposedly the leader of the shepherds, his descendants were also important personalities of the settlement that stood out in the original village community.

Therefore, the evolution of Bucharest starts, according to historical sources, from Bucur, the rich leader of the shepherds who, in his attempt to defend himself from the Ottomans, built a fortress on the banks of the Dambovita River, in an old sacred place located on a transhumance route where, later on, he also built a church.

Several hundreds of years later, due to economic and demographic development of the population during those times, the fortress became the capital fortress of the ruler of the Romanian Country (the so-called *Tara Romaneasca*).

From a strictly historical point of view, the city was attested much later when Mircea cel Batran founded the city in the sixteenth century, and from a documentary point of view, it was attested through the document issued by Vlad Tepes on September 20, 1456, through which he strengthened the estates of some noblemen.

Bucharest was originally a small village located near a fortified castle built by Mircea cel Batran on the river Dambovita in the sixteenth century, considered to be located next to the "original village of Bucharest" (Leca 1937:94) that expanded in the fifteenth century at the same time as the trade fair that existed around the fortified castle and which was located on the transhumance road that linked the Carpathian Mountains to the Danube, the Black Sea, and the Ottoman Empire, the Middle East, and Asia.

Later on, the villages located in the vicinity were also incorporated, becoming the so-called "slums" of the administrative-territorial unit, slums that had a sort of pivot or coagulating function for certain areas which had a strategic potential or were an access way at a later stage, located on the structuring axis of the river Dambovita and of Lake Colentina, and so on. This is the case for many villages that were thus incorporated into the city and which were located along the structuring shaft represented by Dambovita's river path: Cotroceni, Grozăveşti, and so on.

The first scientific paper written about the early history of Bucharest and that sought to solve the quest for the roots of the present capital was written in 1891 by Lieutenant-Colonel Dimitrie Papazoglu who gathered all the legends and stories woven around Bucur's fortress in the paper "The history of the foundation of Bucharest – the capital of the Romanian Kingdom – from 1330 to 1850 – taken after many ancient writers" (Papazoglu 2005), which gathered the information that referred to the history of the city between the fourteenth and the nineteenth centuries.[1]

[1] The legend was picked up by other documents such as the monograph done in 1820 by the British Consul William Wilkinson.

The agricultural development between the fourteenth and the sixteenth centuries leads to an unprecedented population growth and human settlements develop while the first pre-urban seeds emerge. In fact, archaeological research revealed that on the banks of the river Dambovita and of Lake Colentina there were 41 rural settlements, such as Ştefăneşti, Militari, or Bragadiru that had strong trade connections with the Bucur fortress.

Later on, in the second half of the fifteenth century, the Bucur fortress became the seat of the Romanian ruler Vlad Tepes and witnessed a powerful development due to its location at the crossroads of two very important trade routes which was a favorable condition for the development of commerce.

Around that initial trade area and the fortress, a political and administrative center developed later. The first written reference to Bucharest appeared on September 20, 1459 in a document signed by ruler Vlad Tepes who built his royal court there, a court that was later rebuilt during Mircea Ciobanu's times (1545–1558). Around this morphofunctional core, guilds developed over time (bankers, furriers, merchants, etc.) and the city gradually grew due to the demographic and economic expansion.

Further development ensued as a result of the city being located on the sacred transhumance route that turned into a major commercial route, connected to the river Danube and the Black Sea. Its supervisory and strategic role over the road from Bucharest to Giurgiu, where an Ottoman garrison was located, and up to Targsor, led to the formation of the core of Bucharest's central area, namely Curtea Veche, where, between 1558 and 1559, the ruler Mircea Ciobanul built the church, Biserica Domneasca, which stands today as the oldest place of worship of the capital, preserved in its original shape as a sacred core that has a crucial polarizing function.

This polarizing core represents the archetypal and morphostructural seed for the cultural landscape that defines the coagulation of the future human settlement seen as an interaction between natural and anthropogenic factors and which contributes to the formation of local culture.[2] Cultural landscape is a basic component of heritage but also a resource for economic activity, an environmental and social landmark that contributes to human welfare and to strengthening human identity (Enache and Crăciun 2013), in the context of avoiding the rapid transformation of cultural landscapes.

Bucharest, Romania's capital, in 1840 witnessed the first horse-drawn omnibuses, being among the first cities in Europe that had such means of transportation, and in 1857 it became the first city in the world to employ kerosene for public lighting; at present, it is the sixth largest capital in the European Union.

Although nowadays Bucharest does not seem to have an old history in the field of landscape heritage, considering also the irreversible destruction that took place

[2] See also the definition of *landscape* as "an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors," according to the European Landscape Convention in Florence, on October 20, 2000, ratified by Law no. 451/8 July 2002.

in communist times, the archives still mention valuable elements and memories of the capital's gardens, many of which are now gone.[3] The transformation or disappearance of these archetypal landscape elements is due to major urban changes as a result of a natural evolution in the city's development in time and space, due to excessive urbanization or due to massive transformations through demolition and urban restructuring as the result of the totalitarian political view applied in the communist period.

These changes and the loss of the old landscape areas that have morphotypological value and sometimes a sacred archetypal nature are unfortunately still going on at present, due to unsuitable real estate projects and to the pressure of foreign investment companies that, under the guise of not knowing the historical importance of the area (*genius-loci*) and under the protection of permissive laws and dysfunctional administrative authorities, want to obtain a quick financial advantage at the expense of local history and urban landscape.

Research Methodology

Initiating a methodology for the study, analysis, and decryption of the morphogenetic and functional seeds of the natural, anthropogenic, and cultural landscape led to understanding the development of the capital's urban settlement typology and to understanding the way it functions and establishes relationships at a territorial and regional level.

These elements, correlated with the historical evolution component, with anthropological and social study, with ethnology and ethnography, linguistics, and toponymy, but also with particular cultural landscape elements (morphotypology and urban structure units, urban life and framework, traditions, general and local customs, etc.) can lead to valuable results in historical, anthropological, social, architectural, urban, and landscape research.

This methodology (Crăciun 2012) has set out to research the future city through the lens of the past, in the sense of discovering and theorizing new ways of solving current dysfunctions and the necessary strategy for resilient future development (Crăciun 2014a:98–102) of the city of Bucharest. The study aims at supporting and forming a genuine research pillar for future major urbanism documentation, for large-scale urban strategies and projects, or for specific research in the field of spatial, urban, and landscape planning and of architecture or local history.

Such research can provide a theoretical approach through a specific and special type of theorized approach that can underpin the process of informing and putting

[3] See also the Exhibition Project – *Palatul Sutu and the Lost Gardens of Bucharest* (March–July 2015; currently in progress at the time of writing this chapter), organized by the author of this chapter in partnership with the Museum of Bucharest between March and June, 2015, as well as the *Lost Gardens* Project done by this author as a result of winning the selection contest for cultural projects organized by the Union of Romanian Architects in December–January 2010.

together an important bibliographical database. These data and conclusions can represent the research basis necessary for other studies and specialists in the field that come from cultural spaces other than the European one and which may not have benefited from a local culture and an evolution with decisive historical connotations.

These elements were often decisive for the destiny and morphotypology of a human settlement, sometimes, as in the case of Bucharest, also having a tragic side at the level of the population's emotional and community memory. Major changes were often the unnatural result of political will (forced demolition, restructuring, conversions) and, for decades in a row, they were not assimilated in the collective memory or in the city's physical evolution.

The methodology aims at carrying out a theoretical applied study that connects the details with the mezzo- and macroterritory, in a multicriteria and transdisciplinary approach of the landscape's historical heritage and of all of its components: quasi-natural and semi-natural, anthropogenic or built, by scanning history and the sacred from the beginnings until today, while overlapping the analysis with fields that relate to urbanism and landscape studies (architecture, ethnology, ethnography, anthropology, sociology, horticulture, etc.).

The research, in a transdisciplinary (Crăciun 2014c:3–14) sense, integrated archival documents, memoirs, literary documents (prose, poetry, literary memoirs), and folkloric documents (legends, stories, popular sayings, old songs, folk dress, folk symbolism, and iconography), research (in fields such as history, anthropology, ethnography, ethnology, etc.), urban planning documentation, projects and plans that emphasize the city's history,[4] as well as works of art that represent images from old Bucharest (engravings, lithographs, prints, paintings, drawings, watercolor drawings), completed by multicriteria analyses and related social and anthropological studies (Pic. 1).

Objectives of the Historical Evolution Research

The general objective of the research was to update the information regarding Bucharest's landscape, as well as to promote, raise awareness, and inform the different categories of urban actors on the importance of history, the urban and cultural landscape, and green areas and their role in improving the quality of the natural environment and of the health of the population. This general objective is vital in supporting an urban development policy for the capital.

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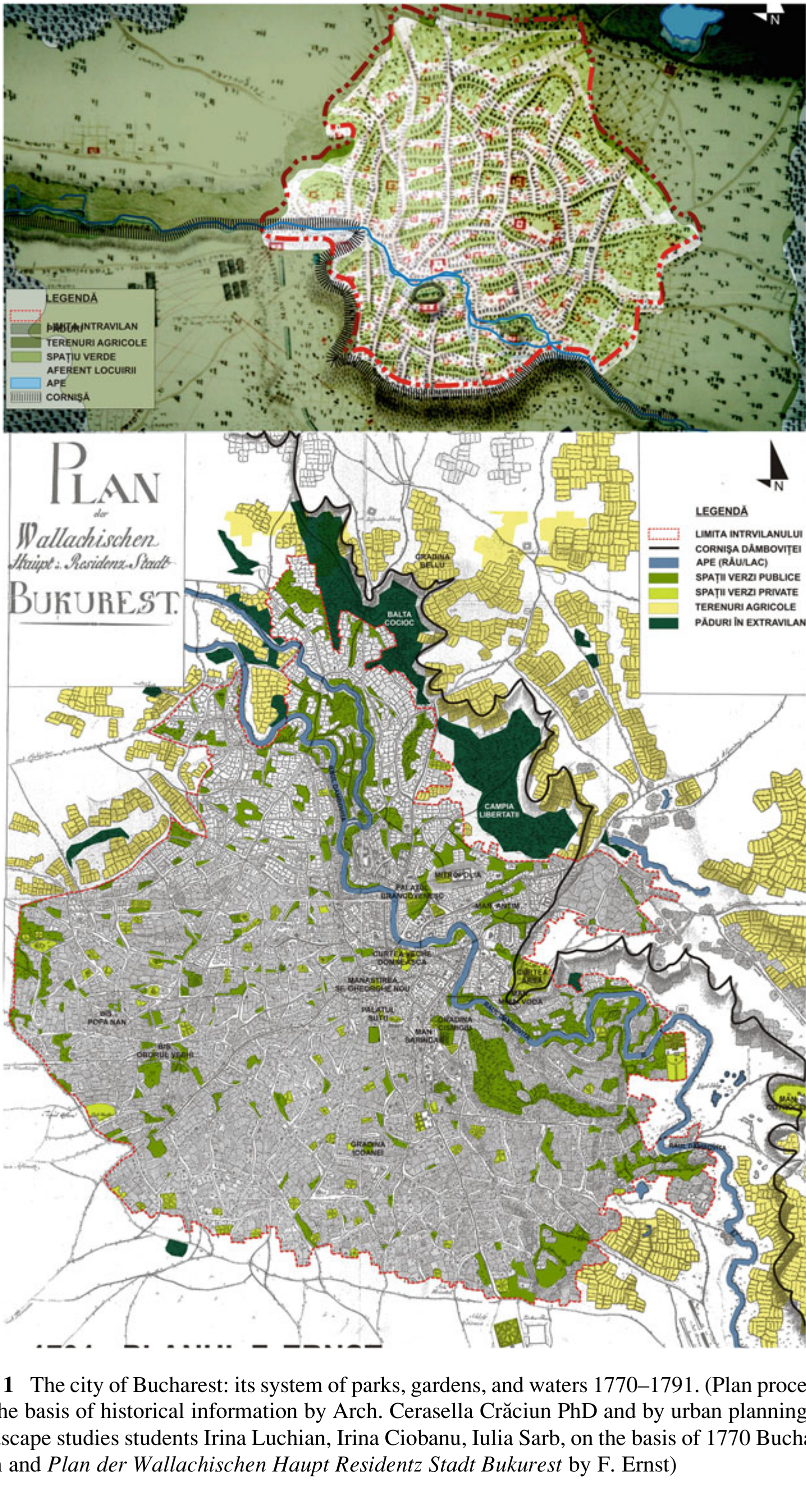
[4] Among some of the historical plans used to support this research we include: Plan 1770, Plan Bukurest – F Ernst (1791), Borroczyn plan (1846), Alexander Nicolaevitz plan (1871), *Guide to Bucharest and Its Surroundings* – Fredi Wahnig (1934), Plan of the Army's Geographic Institute (1911), New Plan of the City of Bucharest (1920), Regulatory Plan (1935–1938), Topographic Plan of Bucharest (1989), satellite plans (after 2000).



Pic. 1 The city of Bucharest: its system of parks, gardens, and waters 1770–1791. (Plan processed on the basis of historical information by Arch. Cerasella Crăciun PhD and by urban planning and landscape studies students Irina Luchian, Irina Ciobanu, Iulia Sarb, on the basis of 1770 Bucharest Plan and *Plan der Wallachischen Haupt Residentz Stadt Bukurest* by F. Ernst)

The specific objectives focused on:

- Creating a research methodology for the landscape, through a transdisciplinary approach located at the contact point with other related sciences, research that tackles all the components of the landscape and all its scales
- Raising the interest of local and central administration with regard to the decay of the quality of urban life and implicitly of the health of the human and urban organism (Crăciun 2008)
- Highlighting the expansion of green areas in previous centuries and the decrease of green areas in recent decades
- Examining the quality and quantity of the green areas in Bucharest
- Raising awareness and responsibility and creating a dialogue platform between the different categories of urban actors (decision makers, civil society and community representatives, specialists, the general audience) with regard to landscape and green areas issues
- Creating a forum for Lost Gardens where target groups can participate interactively through opinions, discussion groups, posting archival documents, personal historical documents, anthropology elements, different stories about gardens, family photos, and the like[5]
- Stimulating reflection and a critical attitude in the urban landscape field, as well as making a study that can be the basis of a future instrument for monitoring the health of the population and increasing the quality of urban life for the human settlements in Romania (Crăciun 2009a)
- Preserving and enhancing the natural landscape heritage and assessing the impact and the quality of the interventions made on it
- Disseminating information and supporting the training also of the general public in the field of urban planning and landscaping
- Establishing the relationship between the detail landscape and the mezzo-landscape, namely the outskirts, the green–yellow–blue belt and the macroterritory that can be the basis of a theoretical approach which in turn can be the foundation of Bucharest’s beltway
- Promoting the cultural quality of the landscape, along with the architecture and urban planning product, by popularizing landscape as a message and development vector for the territory

The purpose of the research was to develop specialized conclusions drawn graphically via overlapping, in a form that can be integrated in other studies and databases, as well as to inform, raise awareness and responsibility for all the urban actors involved in the process such as residents, citizens, specialists (urban planners, landscape planners, architects, historians, anthropologists, etc.), the administration, decision makers, members of the general public, civil society representatives, and tourists.

A key element was drawing the attention of local and central administrations with regard to the aggression and reduction of the quantity and quality of the green

[5] See website: www.gradinipierdute.ro

areas and public spaces in Bucharest, as well as proposing a coherent metabolic system for green areas that can form a true green system, integrating the blue areas (waters, lakes, wetlands) and the yellow areas (agricultural fields, orchards, vineyards, pastures). Also, the study can be the basis of future laws and methodologies for elaborating urban planning and landscape documentation.

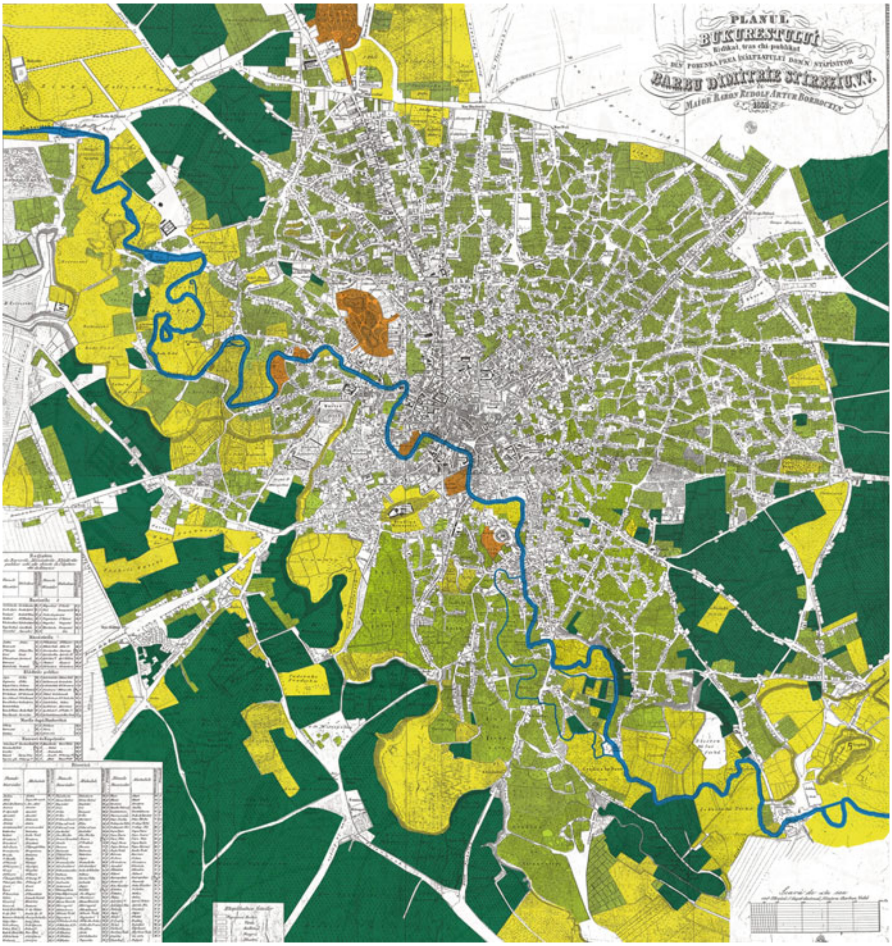
The research activities included:

- Research from specialized written sources (studies, research, books), in libraries, archives, and antique shops, but also with individuals and companies, and gathering documents regarding the missing gardens in the current central area of Bucharest
- Research from drawings and different iconographic sources (historical urban plans, images, sketches), as well as from other sources (engravings, pictures, watercolors, old photos) referring to the lost gardens of the capital's central area
- Research through surveys conducted with specialists, residents, individuals, and companies regarding the adjacent areas and the lost gardens proposed to be the topic of study
- Analyzing and sorting the documentation according to the categories of information obtained until the present
- Cataloguing the information obtained up to the present according to typologies and categories of green areas
- Analyzing the current situation in the areas/subareas in which there were lost gardens, in order to highlight the current situation and presence of possible traces left in time
- Putting the information together and assembling it in drawn parts (plans)
- Completing the graphics and making several panels that were emphasized through several exhibition projects and by starting an interactive forum
- Organizing a public event and a roundtable to which specialists, members of the Romanian Academy, and professionals in the field (landscapers, urban planners, architects, geographers, anthropologists, historians, horticulturists), the local and national administration, as well as students, personalities from other professions, the general public, residents, and representatives of the mass media are invited (Pic. 2).

The Selection of Sites for the Case Studies

After completion of the archival, literary, and anthropological research, the documentation, project, and plans were studied, as well as the works of art that represented images of old Bucharest (engravings, lithographs, paintings, watercolors), by using a multicriteria and transdisciplinary analysis which included related studies.

The examples of gardens that were researched and later on exhibited (included in the series of exhibitions; Crăciun 2011:9–19) were chosen because they are



Pic. 2 The city of Bucharest: its system of parks, gardens, and waters in 1852. (Plan processed on the basis of historical information by Arch. Cerasella Crăciun and by urban planning and landscape studies student Andreea Nicoleta Bunea, on the basis of the Bucharest Plan by Major Baron Rudolf Artur Borroczyn at the request of ruler Barbu Dimitrie Stirbeiu)

representative of the different types of landscape, now extinct, that have a decisive and important role at the level of the chronometabolism and within the complex historical system of green areas (Crăciun 2014b:92–97), such as the symbolic garden, the representative garden, the public/semi-public/private garden, the monastic garden, or the entertainment or leisure garden. The project ultimately aimed at developing a methodology to decrypt the types of gardens specific to the capital, as well as materializing it in measurable elements such as regional surveys and indices.

Various development stages of the historical landscape heritage were proposed as detailed research topics through this project. The first stage dealt with the research of the gardens in Bucharest's current central area on the basis of old archival, historical, anthropological, and urban and landscape planning information with regard to the following gardens: Domneasca, Rasca, Baratiei, Sutu, Universala/Universitatii, Blanduziei, Otetelesanu, Gradina Cu Cai, and Union.

The Results of the Research and Conclusions

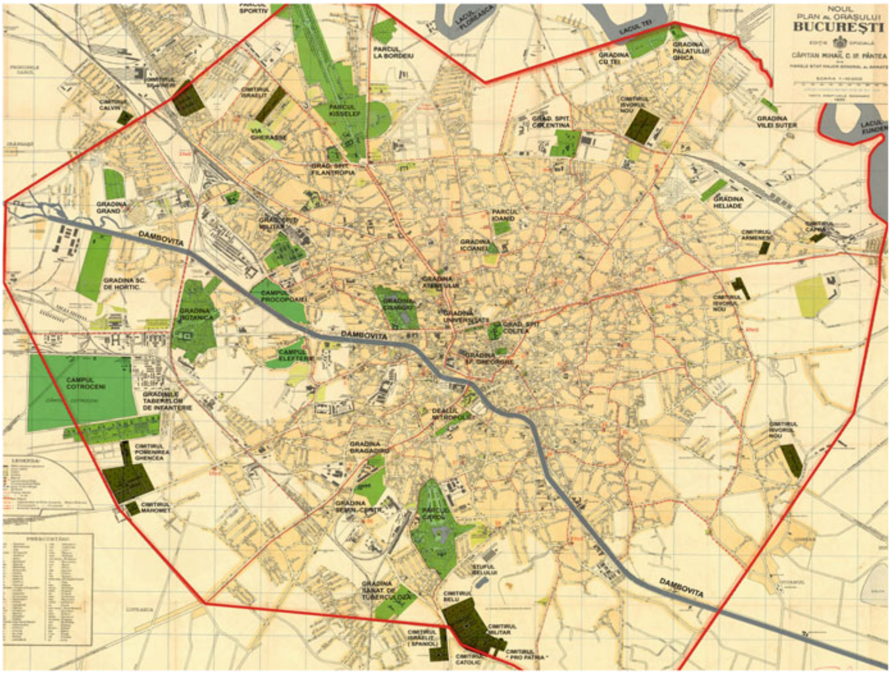
As a result of the transdisciplinary research, important conclusions were drawn with regard to the urban and landscape planning field, to the architecture and historical field, as well as to the social, community, and anthropological field. The study relied on archival information on several levels of research and finally achieved a study methodology for the landscape heritage, as well as a proposed typology of the lost gardens in the history of Bucharest which included the following categories: the typology of the symbolic garden, of the representative garden, of the public/semi-public/private garden, of the monastic garden, or of the entertainment or leisure garden.

The transdisciplinary research conducted is a type of continuous research subjected to a study based on the perpetual possibility of discovering new documentary and archival sources and old images related to these lost gardens, both from local and national sources, and also from European sources. These new sources may bring further clarification regarding important historical, urban, architectural, and landscape elements, but also social and anthropological (Crăciun 2009a, b:89–101) elements that can contribute to shaping the atmosphere of past ages (Pic. 3).

Beyond the scientific research component, the project has found over time a special place in the consciousness of the residents and of the general public, revealing itself also to be a cultural and exhibition project, four exhibitions having been organized as a result of new archival information surfacing.

The main positive experiences during the implementation of the project refer to the interaction of the team with the urban actors and members involved, as well as finding new information and research sources in the landscape and natural heritage field.

The partners involved in the debates were members of the Faculty of Urbanism of the "Ion Mincu" University of Architecture and Urbanism, Bucharest, the Union of Romanian Architects, the Register of Romanian Urban Planners, and the Order of Architects of Romania as well as other university professors who study, research, or are interested in the field of landscape studies, urban planning, history, and anthropology, who contributed to the surveys made for research purposes in this study; members of the local administration involved in the field of heritage, environmental protection, and the management of green areas, who contributed to the analysis of the current situation and to providing data; the residents of the areas studied or those who in the past lived in the researched areas and who provided interesting information about those areas, as well as about the importance of the

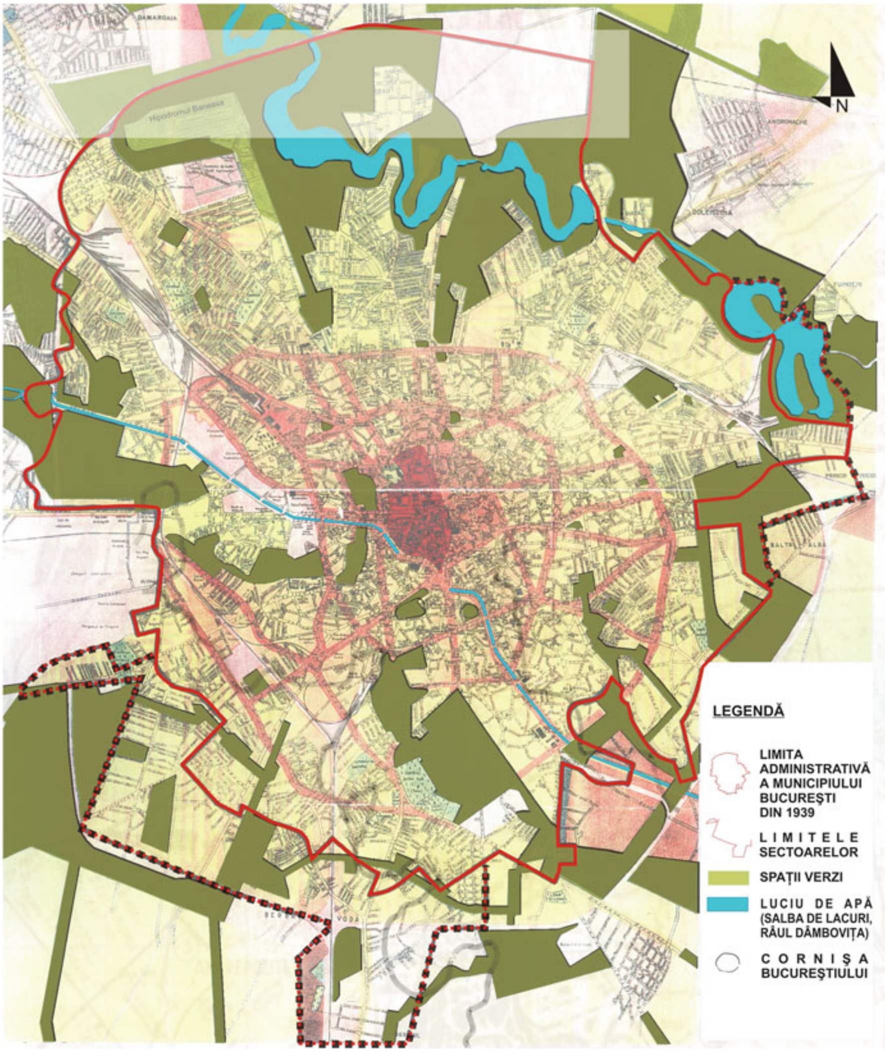


Pic. 3 The city of Bucharest: its system of parks, gardens, and waters in 1920. (Plan processed on the basis of historical information by Arch. PhD Cerasella Crăciun and by urban planning and landscape studies students Irina Luchian and Anca Ionescu, on the basis of the *New Plan of the City of Bucharest*, official edition, by Captain Mihail C. If. Pantea, from the Army General Staff)

topic; NGOs and civil society representatives interested in the environment and the protection and preservation of green areas who were consulted during the drafting of the project.

From *the results of the research* supported by the exhibition projects we can mention the following.

- Signaling to the direct and indirect beneficiaries regarding the phenomenon of acute extinction of the cultural heritage, as well as regarding the decrease and degradation of the landscape, the green space, and the implications this phenomenon entails, both on the natural environment, on the microclimate specific to the capital, and on the level of the city's health seen as an urban organism and on the health of its residents
- Raising awareness among all categories in the target group and the urban actors: members of the local and central public administration (decision makers), representatives of the civil society, higher education and research institutions, members of the Romanian Academy, and specialists (professionals and students in the fields of landscape planning, architecture and urbanism, horticulture, geography, history, anthropology, and so on)



Pic. 4 The city of Bucharest: its system of parks, gardens, and waters in 1935–1938. (Plan processed on the basis of historical information by Arch. Cerasella Crăciun PhD and by urban planning and landscape studies students Irina Luchian, Irina Ciobanu, Eliza Georgescu, Iulia Sarb, on the basis of *Bucharest*'*s Regulatory Plan*)

– Creating a viable interface for ensuring communication between different generations (different age categories, students, teachers)
– Understanding the phenomenon of gradual historical and urban development, sometimes followed by irrecoverable losses such as those seen at the level of the landscape heritage and the decrease of green areas and implicitly of the metabolic urban phenomenon and of urban and human health (Pic. 4)

The main achievements of the research conducted via the Lost Gardens project are:

- The materialization by means of this study of the acute need to perform integrated transdisciplinary research and studies in the field of landscape and natural heritage that are scarce or nonexistent at the moment, as well as the need to catalogue the historical information in archives and libraries regarding the historical evolution in the field of green areas and the natural, anthropogenic, and cultural landscape of the city of Bucharest
- Raising awareness among the population, among specialists, and among the administration regarding this type of landscape exercise
- Starting the interactive forum that led to the establishment of connections and new contacts, which in turn led to new information and important documents to research regarding the historical evolution of the research conducted, as well as supporting positive opinion trends in this sense
- The participation of local and national media in supporting the project
- A large number of visitors and participants in the exhibition, the roundtable, and the public debate that generated a discussion group with different urban actors

Apart from the gardens researched in the first stage, namely the Lost Gardens located in the central area of Bucharest: Rasca, Universitatii/Universala, Baratiei, Domneasca, Otetelesanu, Blanduziei, Gradina Cu Cai, Union, and Sutu, data regarding other gardens were also assessed (Bacalbasa 2013; Potra 1981; Iorga 2008; Stahl 2002; Harhoiu 2001; Majuru 2003; Zamani 2007; Dorin 2012).

The research continued with the Lost Gardens found in the area located in the vicinity of the city center, such as Procopoaia, Zdrafcu, Laptev, Gramont, Belvedere, Sarindari (Creanga), Sapte Nuci, Livedea Gospod, Varar, Mitropoliei, and Bellu.

The study may be completed by a different research stage of the lost gardens located in the old slums, initially found at the outskirts of Bucharest, but now a part of important urban areas, such as the following gardens: Orfeu, Scufa, Dudescului, Ivascu, Eliad, Grand, Campul Elefterie, Ateneului, Heliade, Grad Vilei Suter, Grad palatului Bragadiru, Gradinile taberelor de infanterie, Via Gherase, Grad Palatului Ghica, Gradina cu Tei, Gradina seminarului central, and therapeutic gardens of health areas (for the following hospitals: Filantropia, Odobleja, Military Hospital, the Tuberculosis Sanatorium, Colentina, etc.).

The research also uncovered information regarding many other lost gardens with an uncertain location from the existing historical plans, such as Gradina cu duzi, Gradina lui Matei, Gradina Frunzaresti, Gradina Rudenilor, Gradina Mavrocordatilor, Gradina Mavrogheni, Gradina Herasca, Gradina Banului Nicolae Brancoveanu, Gradina Boierului Vacarescu, Gradina Zugravului, Gradina Spirea, Gradina cu Tei, the gardens located northwest of Sf. Vineri Church, southwest of Olari Church, southwest of Delea Noua Church on the Boulevard Calea Rahovei, and so on.

Also, the project revealed possibilities of future development by the subsequent expansion in the area of the old ideal proposed by the Green Belt,[6] in Ilfov County or in other areas of the country, where there are a large number of historical Romanian palace and mansion gardens.

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[6] Promoted at the beginning of the twentieth century by Cincinat Sfinţescu (1887–1955), considered to be the founding father of urbanism in Romania.

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Lost Landscapes: In Search of Cartographic Evidence

Gabriela Osaci-Costache and Iuliana Armaş

Abstract This chapter aims at retrieving the old landscapes which are currently 'lost' in time, as well as in space, by comparing maps dating from different historical periods. The traces of old landscapes are gradually disappearing, especially because their existence was not linked to the present inhabitants' concrete experiences. Based on the large-scale historical maps (1:25,000–1:57,600) dating back to 1769–1980, six case studies in Romania were analysed (in a GIS open source environment) covering several types of landscapes: rural, urban, agricultural, forests, and vineyards. Ada-Kaleh Island and Orşova City were flooded after settling the Iron Gates Lake (1970–1971). Eteni and Lăteni villages disappeared following the floods produced by the Someş (1970) and Danube Rivers (1942). The well-groomed cemetery still bears witness of the existence of Eteni village. The painful history of the villages in Bărăgan where people were deported for political reasons, did not last long in Lăteşti village (1951–1976), but it was intense. In order to find out how interested young people nowadays are in past landscapes, but also how they relate to old disappeared landscapes, a questionnaire was given to first-year students at the Faculty of Geography within the University of Bucharest. Their responses proved that 85% of the students are interested in past landscapes, but at the same time, 58% were unaware of the fact that Orşova City had been covered by the Iron Gates Lake, 69% hadn't heard of Ada-Kaleh Island, and 92% were not familiar with the cause of its disappearance. Forty-nine percent of respondents didn't know that a great part of Vlăsia Forests (Codrii Vlăsiei) had disappeared from Bucharest's metropolitan area by the beginning of the twentieth century, being replaced with urban, rural, or agricultural landscapes.

Keywords Diachronic cartography • Historical maps • Open source GIS • QGIS • Emotional landscapes • Memory space • Visible landscape • Virtual landscape

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In memory of Professor Lucilia Gregori (*Università degli Studi di Perugia*, *Italy*)

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Somewhere, Sometime. . .. . .

'*Places* are signs indicating not only the relationship between human culture and the land, but also the way in which *time* is perceived and represented by each culture' and 'when we consider the *place* as a sign, we are flooded by an emotional wave, we relate that sign to our existential sphere . . . we are not interested in researching the meaning of the *place* throughout *time*, rather focusing on its value in the present *time*' (Vallega 2006, p. VII). Nowadays, some places (used in the sense of landscape) no longer exist, but were valuable in the past (not only emotionally), and their disappearance, the event in itself, triggered individual, as well as collective, emotions, some remaining in the collective memory to this day (let us only mention the city of Pompeii or the Berlin Wall, which is no longer part of the city's urban landscape). Others silently disappeared from what Vallega (2006 p. 149) used to call the 'visible landscape', being slowly transformed by human activity, for instance, by replacing forests with agricultural land.

Landscapes evolve and are continually transforming, as they coincide with the economy, acting as a mirror of civilisation (Lorenzi 2007, pp. 145–146). Following the pace of human intervention, they overlap in time on the same space, through 'stratification' (De Vecchis 2004, p. 710) whose traces were lost in the last hundreds of years. Old landscapes leave certain material 'prints' on the visible landscape, and based on them we can recover a 'lost' landscape: traces of pollen, old abandoned riverbeds, and so on. In order to investigate time, one can use material, as well as immaterial, signs which are part of cultural legacies (Vallega 2006 p. 149) such as toponyms. The more distant in time the loss of a landscape, the more difficult it is to recover it.

Why recover a lost landscape? One of the reasons would be the fact that getting to know old landscapes is essential to the process of territorial planning, so as to be able to conserve, protect, and manage the lands and in order to respect a region's values and cultural specificity (Scanu and Podda 2014, p. 503). Another reason relates to getting acquainted with the history of a territory, human interventions, or extreme natural phenomena of the past that have led to the disappearance of landscapes. Knowing the effects of the latter (natural phenomena) might allow their avoidance in the future.

How do we know that within a space, there was at some point in time a completely different landscape compared to the present one? In some cases, the current landscape offers clues (geomorphological, pedological, etc.) on the past existence of a different landscape. In other cases, the toponymy or the testimonies of the elderly locals can be helpful (the latter only apply to landscapes which have a relatively recent disappearance), but sometimes the visual comparison of historical maps is the only one that can shed light on the old landscape (for instance, the settlements flooded by artificial lakes), in the form of a virtual landscape that can differ completely from the current one.

How can we recover a 'lost' landscape? Their recovery needs to be made in space (where), as well as in time (when), by harnessing any documentary sources coming from a moment in time where the landscape was different from the current one. There are different sources of information for the recent past, including aerial and satellite images, but concerning the previous centuries, the map is the only one that can help visualise the space in different moments in time.

Although maps are the most useful sources, because they locate past landscapes in time and especially in space, that is to say geographically, they cannot constitute the only basis of documentation in geohistorical studies. The diachronic study of the landscape needs to be based on the confrontation and integration within many other contemporary sources (Rombai 2010, p. 85).

Thus, depending on their importance, the first category would be traditional sources used in geographical studies: historical cartography (heritage included in the historical cultural goods; Gatta 2011, p. 42), iconography (postcards, old flyers, etc.), historical photos, aerial images, written documentary sources (monographs, articles, newspapers, old magazines, travel notes, etc.), and toponymy, 'the memory of the land' (Piacente 2003), which expresses 'photos and images of the environment in the names of places' (Cassi 2014, pp. 400–407).

Another category is represented by nontraditional, atypical sources, such as films, oral testimonies of the elderly, and personal photo archives, for geohistorical research regarding more recent transformations of a territory (Vitale 2014, p. 419). Vitale (2014, p. 420) noticed that, unfortunately, films, products of the seventh art, are not considered true elements of reliable information or support in research within the academic world, despite rendering photos of the places where the action takes place. One can also add paintings, poetry, literature, art in general, music, local gastronomic traditions, 'the rocks of the city' (the ones the buildings are made of), all these contributing to the creation of an 'emotional context that allows everyone (. . .) to get closer to a landscape and not only physically' (Gregori 2009, p. 512), as well as to the formulation of nontraditional hypotheses of paleo-environmental reconstruction (Gregori 2009, p. 514). An 'emotional landscape' can thus be perceived (Gregori 2007a, b, 2009) as being generated by the people's emotions and feelings related to a certain place: 'this is where emotional geographies are born, their object being emotional territories and the landscapes of sensations and feelings' (Persi 2010, p. 3).

Field surveys can be included in another category: sedimentary, archaeological, historical, and ecological (Cevasco 2014, p. 386), paleo-geographical, and paleo-geomorphological.

By briefly analysing these categories of sources, we believe that historical cartography is the only one that can render visually and precisely locate a past landscape in space and time and on large surfaces. Aerial and satellite images are the exception, but these are missing for the past centuries.

Vallega (2006, p. VII) showed that the representation of places (on maps, in paintings, in a musical score) is based on innate ideas of space and time (as proven by Immanuel Kant) and thus 'the sign of the place contains a double nature: it is a sign that evokes the innate idea of space and at the same time, the innate idea of time'. Different authors have justified the importance of historical cartography for geohistorical studies, where it re-creates territorial processes in time (Rombai 2010,

p. 71), as well as for current studies, where it identifies ‘the legacies of the past in current images of the environmental landscapes’ (Rombai 2010, p. 71). It has been stated that ‘managing reality involves its geographical expression, that is cartographical’ (Farinelli 2009, p. 29), due to the fact that the map locates old landscapes in space and time, some of these having disappeared nowadays, and Gregory (2005, pp. 62–63) emphasised the importance of cartographic support and the diachronic analysis in identifying the regional development factors. Historical cartography maintains the structural components of past landscapes, the cultural values of the territory, being ‘a treasure which still needs to be dug up and interpreted’ (Rombai 2010, p. 69). There are numerous already published studies which covered different spatial analyses based on the transformations of the territory in time (Osaci-Costache 2009a, 2010, 2011a, b, 2014; Osaci-Costache and Ene 2010; Pacheco Angulo et al. 2011; Săvulescu and Mihai 2011; Armaş et al. 2014, etc.). By comparing old maps in different historical periods, one can analyse the changes undergone by the territory in time (Cantile 2004, p. 196).

Maps are not photos of the territory and ‘no maps can perfectly depict reality, but this is far more useful. The only perfectly faithful representation would be the identical copy of reality itself’ (Board 1967; *apud* Lodovisi and Torresani 2005, p. 417). Maps are therefore visual images of the real landscape, transmitted throughout symbols, which gain certain significance. Each historical map renders elements of the landscape in a certain moment in time, which the geographer interprets by restoring landscapes. In fact, ‘this is the miracle of cartography: the fact that from a limited number of very precise and carefully chosen measurements and observations, it is possible to create a map from which an unlimited number of highly precise geographical facts can be extracted’. (Toulmin 1960, p. 111).

In Search of Lost Landscapes

Starting from the truth in Vallega’s words (2006, p. VII), who found that ‘we are not interested in researching the meaning of the *place* throughout *time*, but in its value in *present time*’, the current survey aims at retrieving certain ‘lost’ places – in the sense of landscapes – which no longer have value nowadays, given that they don’t refer to a here and now. By retrieving them, the memory of those old identities is not lost, as this gives meaning to the changes which occurred in time (Morri and Maggioli 2009, p. 175). All this because the space inhabited, beyond the visible and material reality, is also a space of collective and individual memory, where different identities overlap and where, in time, different particularities that define and structure ‘cultural landscapes’ are formed (Vallega 2003; *apud* Morri and Maggioli 2009, p. 175). If we are interested in the place’s current value, as Vallega put it, this is also due to the fact that ‘a place can belong to you in the same way as your other belongings, or you can belong to a place. The sense of belonging is largely given by memory: in order to belong to a place, you need to keep it in your memory; in order to link your memories to a place, you need to go through memorable experiences in that place', as filmmaker Wim Wenders stated in an interview (Casu and Steingut 2000, p. 144). However, recovering certain landscapes lost long ago, with no concrete connection to what the inhabitants experience nowadays, can create 'caricature' representations in the form of 'virtual landscapes' (Guarrasi 2008). This effect can be counteracted by their cartographic depiction, in order to achieve a correct perception. Cartographic depictions of lost landscapes can fall in what Gregori called 'emotional cartography' (2007b, p. 16), referring to vineyard landscapes, and is done through an 'emotional map' which can be a classical thematic map that conveys tangible as well as intangible values.

From the multitude of documentary sources which can be used in studying the time–space dynamics of landscapes, large-scale historical maps are the most useful for past centuries and, as a result, by drawing their comparative analysis, we aim:

- To retrieve old landscapes dating back to 1782–1980, based on some Romanian case studies (Fig. 1) which refer to different types of landscape that no longer exist: rural, urban, agricultural, forestry, pastoral, vineyards
- To check the utility of large-scale historical cartography in between the eighteenth and twentieth centuries, in order to retrieve lost landscapes, by using overlapping maps, with good geometrical and planimetric qualities, which can be georeferenced, as well as pregeodetic maps

Although the purpose was retrieving old landscapes as temporal and spatial sequences within the stratification of landscapes and not explaining the causes of

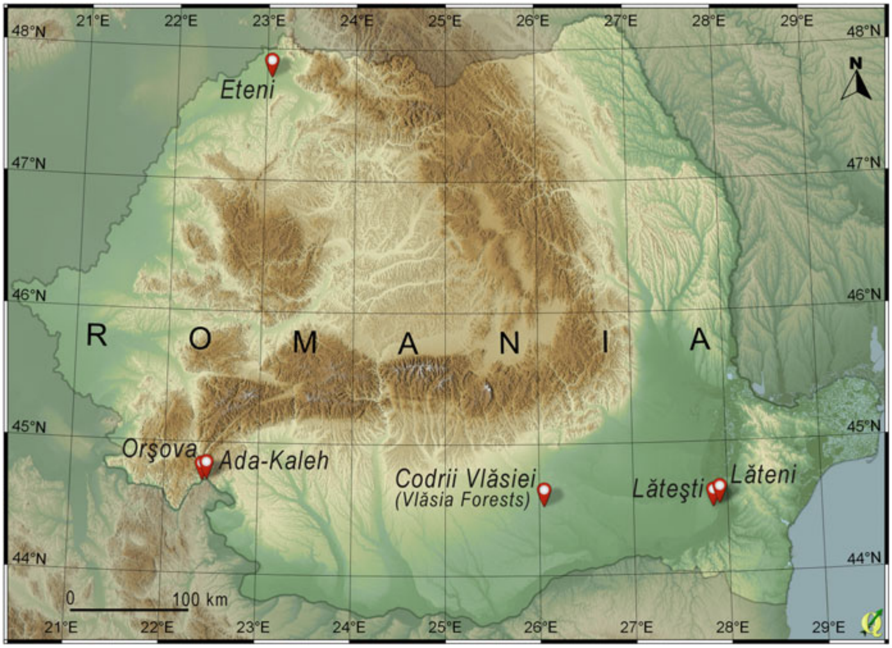

Fig. 1 Locating the analysed lost landscapes in space

these disappearances or highlighting their dynamics, we didn't limit ourselves to the comparative diachronic analysis of large-scale historical cartography (Table 1) for a period of over 200 years; instead, we harnessed other documentary sources to a limited extent. We only used large-scale maps due to the details they offered.

Given the emotional side in identifying lost landscapes, the survey's second objective was to get to know the way in which young people relate to territorial realities that no longer exist and to what extent some old landscapes remain in the collective memory. This objective involved the application of a questionnaire to first-year students at the Faculty of Geography within the University of Bucharest (in February 2015), on a sample of people thought to have a higher affinity towards the perception of spatial reality. The desire to check if geography students are

Table 1 Historical maps used in the analysis

Map	Land surveys	Scale	Format	Data source
Historical maps of the Habsburg Empire – The First Military Survey[a] ('Banat of Temes' and 'Hungarian Kingdom')	1769–1772, Banat of Temes	1:28,800[b]	Digital	http://mapire.eu/en/map/firstsurvey/ (Accessed April 24, 2016)
	1782–1785, Hungarian Kingdom			
Specht's Map	1790–1791	1:57,600	Digital	Romanian Academy Library
Historical maps of the Habsburg Empire – The Second Military Survey (Hungary, 1819–1869; Wallachia, 1855–1857)[c]	1819–1869	1:28,800[d]	Digital	http://mapire.eu/en/map/secondsurvey/ (Accessed April 24, 2016)
Historical maps of the Habsburg Empire – The Third Military Survey	1869–1887	1:25,000	Digital	http://mapire.eu/en/map/hkf_75e/ (Accessed April 24, 2016)
Szathmary's Map[e]	1855–1859[f]	1:57,600	Digital	http://charta1864.ro/ (Accessed May 2, 2015)
Topographic map in the Lambert–Cholesky projection ('Planul Director de Tragere')	1897–1956	1:20,000	Digital	http://www.geo-spatial.org/harti/download-planuri-tragere.php (Accessed May 2, 2015)
Topographic map in the Gauss–Krüger projection	1968–1970	1:50,000	Analog	The University of Bucharest, Faculty of Geography
Topographic map in the Gauss–Krüger projection	1974–1980	1:25,000	Analog	The University of Bucharest, Faculty of Geography

[a]Known as Josephinian Survey (Timár et al. 2006, p. 4) or Josephine Map
[b]Molnár et al. 2014
[c]Known as Franciscan Military Survey (Timár et al. 2006, p. 2)
[d]Timár et al. 2006, p. 5
[e]'Chart of Southern Romania'/'Charta României Meridionale' – copy of Marshal Fligely's Map of Walachia (Buchholtzer and Rotaru 1937, p. 89; Popescu-Spineni 1978, p. 232), which corresponds to the map of 'Wallachia' in the Second Military Survey, 1855–1859 (Bartos-Elekes et al. 2014)
[f]Bartos-Elekes et al. 2014

interested in past landscapes was somewhat animated by the words of the great Romanian historian Nicolae Iorga (1904) who wrote that 'we are a people that doesn't know itself or its country; if we did know them, we would cherish them and gain confidence in the future, which we actually lack'.

Method and Data

Although the information in the old maps can be harnessed through classical cartography (Osaci-Costache 2002, 2004, 2008), as well as in the digital environment, due to GIS (geographic information system) programmes (Azzari 2010), thus offering historical and geographical surveys a high level of precision (Osaci-Costache 2009a, b, 2011a, b, 2014), problems do not fail to arise when integrating new and old information, as historical maps are often difficult to compare to the current ones and even to use in a GIS environment (Mastronunzio 2010, p. 1311), having an inferior geometrical and planimetric accuracy (Mastronunzio 2011, p. 50). The main limit invoked is the geometrical distortion (Mauro 2010, p. 109) which affects maps that weren't based on precise topographic surveys. Although it is considered impossible to georeference 'a cartographic representation with no geometrical characteristics that allow a correct positioning without excessive deformation', precious information can still be gathered from such documents which, when redesigned, can place themselves on the georeferenced cartography (Azzari 2010, p. 218). As a result, the working methodology was different depending on the geometrical characteristics of each historical map. Maps were obtained in a digital format or printed on paper (Table 1).

By using overlapping maps, the current cultural landscape can be compared to the past reality, which allows the recovery of some lost landscapes, as well as their dynamics in time and space. The changes in the use of lands in different historical periods constitute an important indicator of the landscape dynamics (Nardin-Patroescu 1996), which is why we granted them a special importance, not only because they prove the characteristics of spaces with a maximum level of human impact, where natural vegetation was strongly modified by man (Nardin-Patroescu 1996; Osaci-Costache 2009b, p. 109), but also because they allow retrieving lost landscapes.

The recovery of information contained in historical cartography was done in several stages: (a) acquisition (converting the map in a digital format), (b) visual analysis, (c) georeferencing, (d) digitising (only for the maps with good geometrical and planimetric qualities), (e) analysing the geographical content of the vector or raster layers, and (f) elaborating thematic maps (Osaci-Costache 2011b, p. 65).

(a) Acquisition. The maps printed on paper (Table 1) were scanned with a minimum resolution of 300 dpi and saved in a .tif format. Some of the maps were directly downloaded in a digital format (Table 1).

(b) The comparative qualitative visual analysis of all the maps was done in order to notice the great changes which occurred over time.
(c) Georeferencing was made in the Open Source QGIS programme (http://www.qgis.org/en/site/) and was aimed at obtaining overlapping maps, by bringing maps in a common reference system (Dealul Piscului 1970/Stereo 70). The most recent map used (the topographic map in the Gauss–Krüger projection, dating back to 1974–1980) was georeferenced in the original projection, the Helmert transformation being chosen based on the neighbouring points (the nearest neighbour resampling algorithm), and then redesigned in the Dealul Piscului 1970/Stereo 70 reference system (EPSG: 31700).

Some surveys proved that before georeferencing an old map, a cartometric analysis of deformations is necessary (the Open Source MapAnalyst programme being suggested for this purpose, http://mapanalyst.org/) in order to assess the geometric and planimetric accuracy of the map, as only some maps can be geometrically rectified (Mastronunzio 2011, pp. 50–51; Gatta 2011, pp. 45–46), that is, the ones with a high geometric and planimetric accuracy.

Many control points were chosen for georeferencing older maps (GCP, ground control point), which were identifiable on the old map, as well as on the more recent one: crossroads, churches, isolated crosses, bridges over small waters, peaks, and the like (Fig. 2).

Two successive georeferencings were proposed in the literature for historical maps with great distortions (Gatta 2011, pp. 47–48; Mastronunzio 2011, p. 52): first, a global transformation for the entire image (map), then a local one, for small areas on the map, when the map has local distortions. Thus, in the current survey, maps were initially georeferenced through the global Helmert

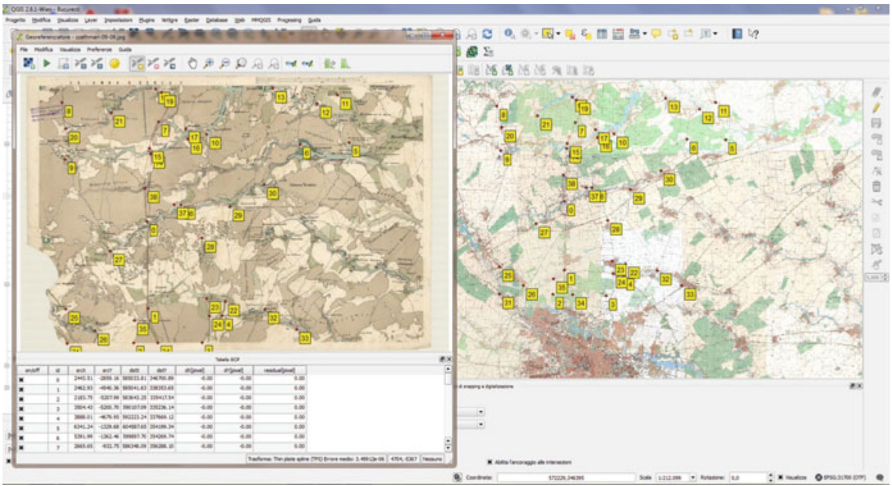

Fig. 2 Georeferencing a sheet of Szathmary's Map in 1864, north of Bucharest (*left*), based on the common control points (GCP) with the topographic map in the Gauss–Krüger projection in 1977 (*right*). Screenshot from the QGIS programme (2.8.1. Wien)

transformation, then new control points were added and the local thin plate spline (TPS) transformation was applied on all maps, except for the topographic map in the Gauss–Krüger projection (1:25,000, 1974–1980).

(d) Digital elaboration in the QGIS programme of the thematic vector layers in .shp format, containing digitised geographical data, was done only for the maps (or spaces) where the georeferencing was satisfactory.

(e) The qualitative and quantitative analysis of the geographical content of vector or raster layers was done in QGIS and GRASS. (http://grass.osgeo.org/).

(f) Elaborating the sequences of historical or thematic maps, in QGIS, with final processing in GIMP and Inkscape.

Open Source programmes were chosen for economic reasons, as well as for being trustworthy, their performances being proven.

In order to achieve the second aim of the research, that is, getting to know the way in which geography students relate to lost landscapes, a questionnaire composed of seven questions with closed and open answers was conceived:

(1) Did you ever wonder what used to exist on the plot of land where your house currently lies? (yes/no)
(2) In the eighteenth century, part of the first sector in Bucharest was covered by forests? (yes/no/I don't know)
(3) Are there cemeteries without villages in Romania? (yes/no/I don't know)
(4) Give an example of a cemetery without a village (open answer)
(5) The eighteenth century hearth of Orşova City is currently covered by the Iron Gates Reservoir Lake. (yes/no/I don't know)
(6) Where was Ada-Kaleh Island located? (location – open answer /I haven't heard of this island/I heard of the island, but I don't know where it was located)
(7) Why did Ada-Kaleh Island disappear? (cause – open answer/I don't know).

The questionnaire was given to a sample of 86 first-year students from the Faculty of Geography, within the University of Bucharest.

Retrieved Landscapes

Cartographically Recovered Landscapes

We recovered a few different types (urban, rural, forest, agricultural landscape, etc.) of lost landscapes (Table 2) with the support of large-scale historical maps, analysed over a period of maximum 205 years.

Based on the historical and cartographical data we disposed of, it could be established to what period the retrieved landscapes dated back (Fig. 3) and in what area they were located.

Georeferencing was strenuous in the areas where the changes had been highly significant, and for very old maps, due to the difficulty in finding common control

Table 2 Lost Landscapes (the case studies)

Location	Lost landscape	New landscape	Initial map analysed (Land surveys)	Final map analysed (Land surveys)	Time slot (Years)
Ada Kaleh Island	Rural	Lacustrine	1769–1772	1974	205
Orşova City	Urban	Lacustrine	1769–1772	1974	205
Eteni Village	Rural	Agricultural	1869–1887	1976	107
Vlăsiei Forests	Forest	Urban, rural, agricultural	1856	1977	121
Lăteşti Village	Agricultural	Rural, then agricultural again	1790	1980	190
Lăteni Village	Rural	Aquatic and wet landscape	1790	1980	190

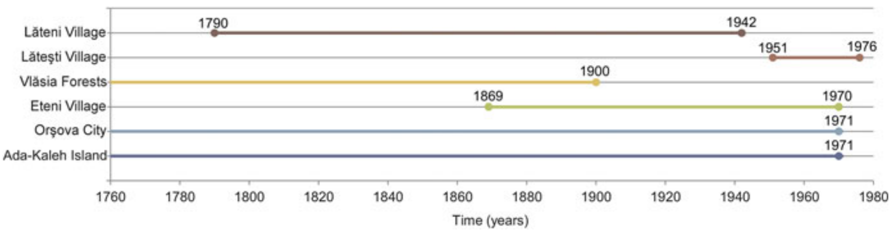

Fig. 3 Locating the analysed lost landscapes in time

points (GCP). The Iron Gates Reservoir Lake was one of these areas. In such areas, georeferencing was made starting with the most recent map and going back to the past. For instance, the topographic map in the Lambert–Cholesky projection dating back to the beginning of the twentieth century was georeferenced based on the topographic map in the Gauss–Krüger projection (1974–1980); then the historical maps of the Habsburg Empire from 1869 to 1887 were made based on the topographic map in Lambert–Cholesky projection, and so on. When common control points were found with the aid of the most recent map, they were preferred.

Ada-Kaleh, the Sunken Island

'Ada-Kaleh Island rises in the middle of the Danube as a green and red landscape' (The story of Ada-Kaleh Island, in the publication *Realitatea ilustrată – Reality illustrated*, year VIII, no. 390, July 15th, 1934, *apud* Anghel 2013), also described by Herodotus as Cyraunis Island 'full of olive trees and wild vineyards' (Iordache et al. 2012, pp. 34–35). In ancient times, it was called Erythia; in 1520 the Turks

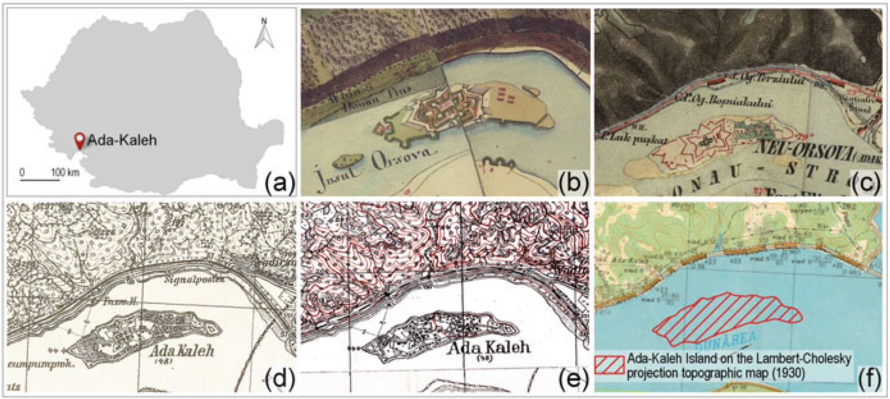

Fig. 4 Retrieving Ada-Kaleh Island on historical maps: (**a**) locating the study area; (**b**) the First Military Survey, 1769–1772; (**c**) the Second Military Survey, 1819–1869; (**d**) the Third Military Survey, 1869–1887, (**e**) the topographic map in the Lambert–Cholesky projection, 1930; (**f**) the topographic map in the Gauss–Krüger projection, 1974. The source of the maps: http://mapire.eu/en/map/fms-banat/?zoom=14&lat=44.70621&lon=22.42461, accessed May 2, 2015 (**b**); http://mapire.eu/en/map/mkf_hun/?zoom=14&lat=44.70791&lon=22.43961, accessed May 2, 2015 (**c**); http://mapire.eu/en/map/hkf_25e/?zoom=14&lat=44.70631&lon=22.42858, accessed May 2, 2015 (**d**); http://www.geo-spatial.org/harti/download-planuri-tragere.php, accessed May 2, 2015 (**e**); University of Bucharest, Faculty of Geography (**f**)

took hold of it and renamed it Ada-Kaleh (*Ada* – island; *Kaleh* – citadel), and in the eighteenth century it was also known as Carolina Island (Ghinea 2000, pp. 16–17).

The island (including the citadel in its middle, begun in the fifteenth century) appears on all the topographic Austrian maps (Fig. 4) as 'Jnsul Orsova' in the First Military Survey ('Banat of Temes', 1769–1772), 'Neu-Orsova (Adakalessi)' in the Second Military Survey (1819–1869), and 'Ada Kaleh' in the Third Military Survey (1869–1887). On the topographic map in the Lambert–Cholesky projection (1930) the isle is 1.4 km long, 365 m wide, it covers 35.3 ha, and is 44–50 m high (Fig. 4). When looking at the current maps, it is hard to imagine that approximately 20–25 m into the depths of the lake (the difference between the altitude of the island and the water level in the lake, which doesn't reach the 70-m contour line above the Baltic Sea) used to be the old island. The technical data reveal that the operating levels of the water in the Iron Gates dam is located between 63 and 69.5 m above the Adriatic Sea (Ioniţă 1997, p. 492). The differences in level between the two seas are insignificant for the current survey.

Ada-Kaleh Island, covered by the waters of the Iron Gates artificial lake in 1970 and officially abolished as a location much later, on October the 29th, 1977 (Ghinea and Ghinea 2000, p. 12), had been documented on 22 February, 1430, as Saan Island with 216 inhabitants, and on the day of the flooding (and blasting) it had 600–800 inhabitants, most of them Turks (Iordache et al. 2012, p. 35), being renowned for its fortifications, which are very easily noted on the historical maps analysed (Fig. 4). There was a project carried out by academician Constantin S. Nicolăescu-Plopşor which stipulated moving these artefacts to Şimian Island

(Ţone 2011) before filling the artificial lake. Although part of the citadel was moved downstream by the local authorities, on Şimian Island, near Drobeta-Turnu Severin, the inhabitants were scattered, refusing to move (Plesa 2005). Most of the inhabitants left for Turkey, part of them built houses on the lands granted by the communist authorities in Schela, near Drobeta-Turnu Severin, and others left for other cities (Ţone 2011) where they received houses from the state.

Once the Iron Gates artificial lake on the Danube was filled, the island disappeared, including from the maps, being forgotten nowadays (69% of the geography students interviewed hadn't heard of it) and only its former inhabitants can remember it. For instance, villager Gheorghe Bob said in an interview in 2011 that the island 'was like a family, a huge yard with several houses': 'I look for all sorts of reasons to push the memory of this island as further on as possible, at least until our departure (. . .) because one of these days we'll become history as well' (Ţone 2011).

When the exhibition 'Ada Kaleh – Island of Dream and Forgetfulness' was organised by the Romanian Peasant Museum in Bucharest in 2013, a journalist noted that '[Y]ou don't take joy when seeing photos' of Ada-Kaleh Island, because you feel the sorrow of the people evacuated before the flooding of the island (Anghel 2013). Knowing the history of the island, which used to be a true Eastern paradise, 'a green orchard on the Danube, an enchanted aquatic oasis, a garden of fig trees and roses suspended in the water, an island of cypresses and almond trees' (Mikó 1973) that surrounded the old citadel, the sorrow will surely prevent you from enjoying even the old maps that depict it (Fig. 4).

Orşova, the City Beneath the Waters of the Iron Gates Lake

Orşova City is located approximately 3 km upstream of the former Ada-Kaleh Island. It was declared a city in 1923 (Ghinea and Ghinea 2000, pp. 380–381), and became a municipality on October the 23rd, 2000. During 1966–1972 (Tălângă et al. 2005, p. 552) it was moved to the current location, together with neighbouring towns (Jupalnic, Tufări, Coramnic, which also appear on the Josephine Map in 1769–1772) once the works started on the Iron Gates energy and navigation system. Filling the lake resulted in raising the Danube level approximately 33 m above its average level and in flooding the old city and ways of communication – road and railroad – from the Danube Gorge (Ghinea 2000, pp. 990–991).

In the old hearth of the city, traces were found of the Dacian settlement Tierna, turned into Dierna in the Daco–Roman period, gaining the rank of municipality at the end of the second century AD (Sârbu et al. 2011, p. 12) and which, during the Roman period, was represented on Tabula Peutingeriana under the name of Dierna (Radu et al. 2013, p. 206). However, the name Tierna was kept on some maps up to the sixteenth to seventeenth centuries and Orşova citadel (as fortification), surrounded by a small number of houses, was depicted on maps during the tenth to seventeenth centuries, until the liberation from Ottoman rule (recorded by the Peace of Sistov in 1791), but not on the maps created after 1800, which is when the

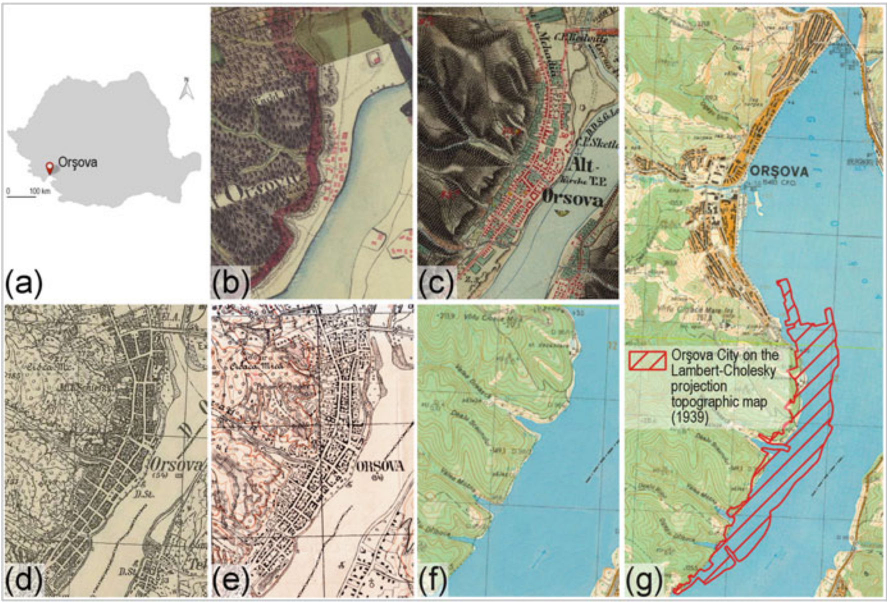

Fig. 5 Retrieving Orşova City on historical maps: (**a**) locating the study area; (**b**) the First Military Survey, 1769–1772; (**c**) the Second Military Survey, 1819–1869; (**d**) the Third Military Survey, 1869–1887, (**e**) the topographic map in the Lambert–Cholesky projection, 1939; (**f**), (**g**) the topographic map in the Gauss–Krüger projection, 1980. The source of the maps: http://mapire.eu/en/map/fms-banat/?zoom=14&lat=44.70621&lon=22.42461, accessed May 2, 2015 (**b**); http://mapire.eu/en/map/mkf_hun/?zoom=14&lat=44.70791&lon=22.43961, accessed May 2, 2015 (**c**); http://mapire.eu/en/map/hkf_25e/?zoom=14&lat=44.70631&lon=22.42858, accessed May 2, 2015 (**d**); http://www.geo-spatial.org/harti/download-planuri-tragere.php, accessed May 2, 2015 (**e**); University of Bucharest, Faculty of Geography (**f**), (**g**)

Habsburgs left it in ruins (Radu et al. 2013, pp. 206–208). Instead, the First Military Survey (1769–1772) renders two guard posts (of border guards) in the city, marked by the inscription 'Wacht Haus' (Fig. 5), which was natural in a border area. There are also written documents attesting to the fact that in 1774, the settlement was a customs and navigation control point, and in the nineteenth century, it was the most modern port on the gorge (Sârbu et al. 2011, p. 14).

By analysing the georeferenced historical maps, it turns out that the old location of the city covered approximately 0.09 km^2 on the Josephine Map (1769–1772) and the Third Military Survey (1869–1887) and approximately 1.24 km^2 and 55 m in amplitude on the topographic map in the Lambert–Cholesky projection (1939), being placed between 50 and 105 m of absolute altitude (including the agricultural lands around the houses, because at the time, the city had rural features). However, the built space of the settlement which covered around 1 km^2 in 1939, only exceeded the absolute altitude of 55–57 m in a few places (among isolated houses). As a result, the water of the artificial lake (which reaches the 65 m contour line on average) totally covered the constructions (with the few above-mentioned exceptions) by around 8–10 m. On the topographic map in the Gauss–Krüger projection

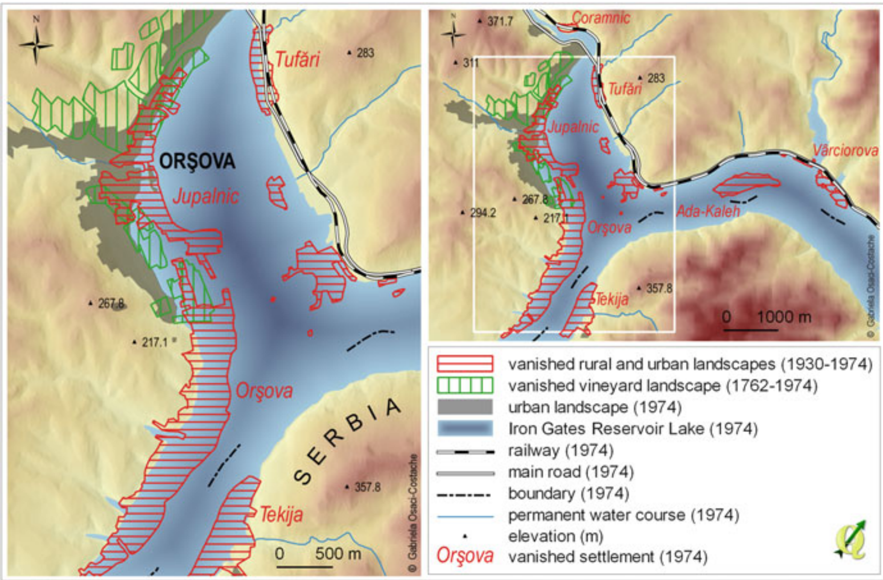

Fig. 6 Lost landscapes in Cerna (Orşova) Golf area. Personal elaboration in QGIS based on the historical maps: the First Military Survey, 1769–1772; the topographic map in the Lambert–Cholesky projection, 1930–1939; the topographic map in the Gauss–Krüger projection, 1:25,000, 1974

(1974), the new city covered 1.593 km^2 and 115 m in amplitude, being placed between 70 and 185 m of absolute altitude.

Comparing overlapping historical maps allows the observation of towns which were covered by the water of the lake at the same time as Orşova City (on the Romanian bank: Ogradena Nouă, Ogradena Veche, Ieşelniţa – nowadays Eşelniţa, Tufări, Jupalnic, Coramnic, Vârciorova, etc.; Fig. 6).

Although it is said that Orşova City retains nothing from the old city nowadays, it seems the only thing left is the current building where the Research Laboratory of the Faculty of Geography within the University of Bucharest lies in the Graţca neighbourhood (Sârbu et al. 2011, p. 19), which started to develop in the past 25 years towards the old hearth of the city.

Statistical data attest to the growth of the population after relocating the city, from 8112 in 1966 to 13,701 inhabitants in 1977 (Radu et al. 2013, pp. 209–212). However, on the topographic map in the Gauss–Krüger projection (1974) 15,403 inhabitants are mentioned in the relocated city, more than in 1977. The new construction done on location (schools, cinema, hospital, hotel, blocks with over 1000 flats, etc.) replaced other landscapes which existed at the beginning of the twentieth century (meadows, forests, orchards). The latter had, in their turn, led to the partial disappearance of the forests depicted in the Second Military Survey (1819–1869) and the vast vineyards covered in the First Military Survey (1769–1772), the Eastern slope of the Old Man's Hill (Dealul Moşului), and the eastern slopes of Ţârlui Creek, which were partially kept until the beginning of the twentieth century, being depicted on the topographic map in the Lambert–Cholesky projection (Fig. 6). Nowadays, a city street located where there once was a vineyard, is called Vineyards Street, and 1 km north from the former Coramnic Village, on a slope on the left side of Cerna, covered by vineyards in the eighteenth century, the name of 'Coasta Viilor' (Vineyards Shore) appears ever since 1869, which is, to this day, a reminder of the lost viticultural landscape.

Abandoned Rural Landscapes. The Eteni Village Case

A title ('Cemeteries Without Villages', Mortan 2013) caught our attention and made us search for this village on historical maps, where houses no longer exist, but there is a very well-kept cemetery depicted on the topographical maps dating back to 1968–1976, even after the physical disappearance of the village. Finding a cemetery outside a village, in the field, as well as on historical maps, has a strong emotional impact on the onlookers who immediately ask themselves: why did the village disappear?

Although it was first covered by statistics in 1913 (Ghinea and Ghinea 2000, p. 208), we found it on the topographical historical maps of 1869 (Fig. 7), on the right bank of the river Someş, about 12 km upstream from the city of Satu Mare.

On the Third Military Survey (1869–1887) three inhabited nuclei are depicted under the name Etény. Also, several nuclei appear on the topographic map in the Lambert–Cholesky projection (the village area covers four map sheets, which were created and updated in different years, during 1924–1953), but only one was named Eteni. The topographic map in the Gauss–Krüger projection (1:50,000, based on the surveys made in 1968) is the last map we disposed of, depicting the village (with 67 inhabitable buildings) before the floods in 1970 (Fig. 7), with the main nucleus found on the location mentioned on the topographic map in the Lambert–Cholesky projection, at the beginning of the twentieth century (Fig. 7). On the topographic map in the Gauss–Krüger projection (1:25,000) based on the 1976 survey, the city no longer appears. On this last map, one can notice the embankments made on the Someş River meadow after the 1970 floods, one of the new flood protection dams (3 m high) passing by the place where there once was the hearth of the village (Fig. 7). All the cartographic clues give the following answer to the previously addressed question: the village was destroyed by a flood.

The written documents complete the cartographic information: this rural landscape in Odoreu commune (Satu Mare county) was destroyed by the overflow of the Someş River on May the 14th, 1970, and the ruins of the households were removed by using bulldozers, during the communist regime (http://www.satmareanul.net/2015/02/26/patru-sate-din-judetul-satu-mare-pe-harta-localitatilor-fantoma-din-romania/, accessed March 8, 2015). Then, in the context of a rainy year, the flow of the Someş River reached the impressive value of 3400 m^3/s in Satu Mare, whereas the average flow for the same post was 114 m^3/s (Iacob and Savu 1992, p. 100).

Fig. 7 Retrieving Eteni village on historical maps: (**a**) locating the study area; (**b**) the Third Military Survey, 1869–1887; (**c**) the topographic map in the Lambert–Cholesky projection, 1924–1953, (**d**) the topographic map in the Gauss–Krüger projection, 1:50,000, 1968; (**e**) the topographic map in the Gauss–-Krüger projection, 1:25,000, 1976. The source of the maps: http://mapire.eu/en/map/hkf_25e/?zoom=15&lat=47.79057&lon=23.02417, accessed May 2, 2015 (**b**); http://www.geo-spatial.org/harti/download-planuri-tragere.php, accessed May 2, 2015 (**c**); University of Bucharest, Faculty of Geography (**d**), (**e**)

Although the village no longer appears on maps, and during the 2011 population and housing census, no inhabitants were registered (http://transilvaniareporter.ro/satu-mare/cimitirele-fara-sat/, accessed April 3, 2015), administratively it still exists.

Vlăsia Forests (Codrii Vlăsiei)

Looking at a current map which depicts the forests around the Romanian capital, it is difficult to imagine how wide the forest landscape was in past centuries. The city

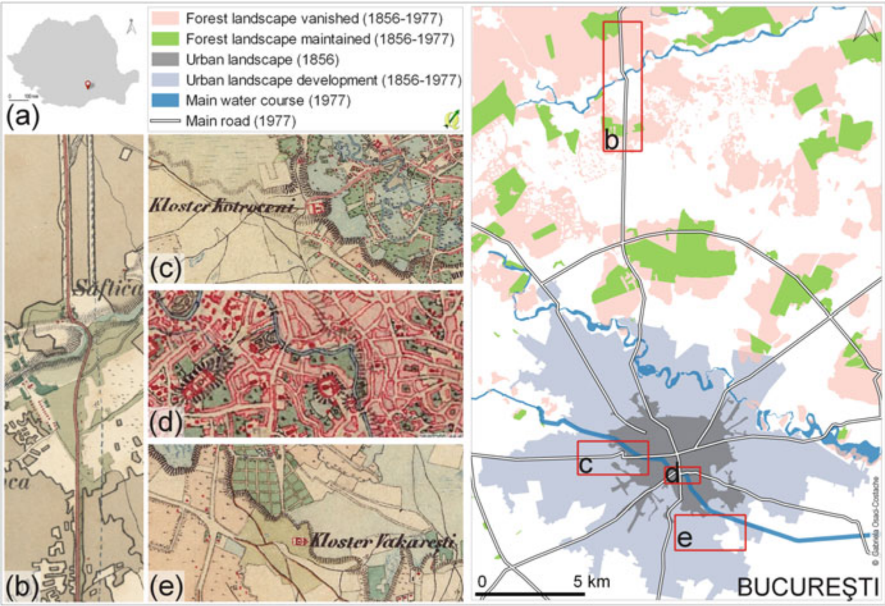

Fig. 8 Retrieving Vlăsia Forests (sample around Bucharest) on historical maps: (**a**) locating the study area; (**b**) the road to Ploieşti on Szathmary's Map, 1856; (**c**) Cotroceni Monastery in the Second Military Survey – Wallachia, 1856; (**d**) Bucharest city centre with the former Olteni neighbourhood in the Second Military Survey – Wallachia, 1856; (**e**) Văcăreşti Monastery in the Second Military Survey – Wallachia, 1856; on the right: the dynamics of forest and urban landscape around Bucharest (1856–1977), personal processing in QGIS based on historical maps. The source of the maps: http://charta1864.ro/, accessed May 2, 2015 (**b**); http://mapire.eu/en/map/mkf_wall/?zoom=14&lat=44.4216&lon=26.09916, accessed May 2, 2015 (**c**), (**d**), (**e**)

of Bucharest, still surrounded by remnants of oak forests (*Quercus robur*), developed in 'full forest area' (known as 'Codrii Vlăsiei') which separated Bărăgan Steppe from Burnas Steppe, and 'the further we go back in time, the larger these massifs and the more they surround the city on all sides' (Giurescu 1966, p. 16). In the eighteenth century, the forest spread 'up to the city gates' and continued towards the Danube (Cinà 2005, p. 30), but the city has broadened a lot ever since (Fig. 8), a contributing factor being the absence of fortifications, a condition imposed by the Ottoman power in the past (Cinà 2005, p. 32).

Vlăsia Forests used to cover Vlăsia Plain between Bucharest and Ploieşti city, spreading over 60 km from north to south, as well as from west to east, and covering around 360,000 ha during the preanthropic period, only 5% of it remaining to this day, that is, 18,000 ha (Doniţă 2011, p. 17).

By the second half of the nineteenth century, these forests mostly belonged to the Metropolitanate of Bucharest and to some manorial families, but when the monastic estates were secularised in 1864, they became state property (Carcea and Seceleanu 2011, p. 26). In the seventeenth century, part of the forests on the city outskirts were declared forest reserves, which meant cutting down trees was prohibited, same as for mowing hay (Giurescu 1966, p. 23), but the change in the property regime, which became private after 1989, favoured the deforestation and degradation of the forest landscape, which had already been greatly reduced. Although the intense exploitation of Vlăsia Forests began during the Ottoman ruling, it deepened (becoming uncontrollable and affecting large surfaces) in the second half of the eighteenth century by extracting huge quantities of oak to pave the streets in Bucharest and as raw material in construction for artisans (wheelwrights, carpenters, etc.), the production of luxury furniture, to make way for farming, and so on (Carcea and Seceleanu 2011, p. 26). In the absence of rock, Bucharest was a 'wooden city', where a fire almost completely destroyed its centre in 1847 (Cinà 2005, p. 34).

The extension of the urban landscape was made to the detriment of forest landscape from the previous centuries. Giurescu (1966, p. 23) notes that there are written documents reporting on the 'neighbouring' forests of the Văcăreşti area (nowadays part of the city; Fig. 8e) in 1632 or Olteni Slum in 1821 (nowadays in the city centre, Union Square area; Fig. 8d). Victory Avenue in the heart of Bucharest, previously named Mogoşoaia Bridge (bridge: a street bridged by planks) 'was once bordered by the forest, one of the forests emerged from the rich soil of the drained swamps around the city, and the clay ravine of Dâmboviţa river' (Iorga 1972, pp. 310–311). Later on, the Russian general Pavel Kiseleff (1788–1872) 'built the road in the forest' (Iorga 1972, p. 312) which extended Victory Avenue towards Ploieşti (nowadays Kiseleff Road, continued with Bucharest–Ploiești Road and the first national road; Fig. 8b). In 1679, Prince Şerban Cantacuzino raised the Cotroceni Monastery in the middle of Cotroceni Forests, which were mentioned in the seventeenth century together with Grozăveşti and Lupeşti Forests (Giurescu 1966, p. 258). At the time, on the right bank of the Dâmboviţa River (Fig. 8d) these forests 'continued up to the waterfront (. . .), climbed up the hill and scattered widely to the right and left, spreading the miasmas of swamps during hot times and blowing cool breezes on the heated plain' (Iorga 1972, p. 331; Fig. 8d). 'The former forest (. . .) what was left of it by the end of this innovative century' (the eighteenth century) was turned into Cotroceni Park and the Botanical Garden (Pântea 1919, p. XVI). Even the Old Saint Eleutherius Church, found near the Romanian National Opera and the Faculty of Law (1.3 km east of Cotroceni Monastery), was built in a clearing from these forests (Fig. 8c) and a forest (called Procopoaia Grove) existed ever since the second half of the nineteenth century between Plevna Avenue and the Dâmboviţa riverbank, up to the Faculty of Law (Giurescu 1966, p. 23). In fact, in Bucharest, during the eighteenth to nineteenth centuries, 'the vegetation hid many houses and the spatial coordinates remained bell towers and church figures' (Cinà 2005, p. 33), remaining 'full of trees' up to the beginning of the twentieth century (Le Corbusier, Viaggio in Oriente, 1984, pp. 137–140, *apud* Cinà 2005, p. 65).

On the sheets corresponding to Wallachia from the Second Military Survey, but also on Szathmary's Map (printed in 1864) the forests on Ialomiţa Plain (Vlăsia Forests) are depicted according to the 1856 topographical survey (Bartos-Elekes et al. 2014, p. 4). At the time, settlements not only covered less space than nowadays, they were also farther apart. On the long roads that linked them, frequently passing through the forest (Ştefăneşti, Dascălu, Afumaţi Forests, etc.), there were also inns, called *ospătării* (hostelries) on Szathmary's Map and they were marked through the initials W.S. (Wirtshaus) on the original map dating back to 1856 (Marshal Fligely's Map). A great part of these forests were kept until the first years of the twentieth century, as proven by the topographic map in the Lambert–Cholesky projection. For the sample of 671.19 km^2 analysed in Figure 10, forests covered 171.78 km^2 on the 1856 map, and in 1977 they only covered 50.17 km^2, that is, 29.2% of the forests that existed 121 years earlier. In the same period, the percentage of forest landscape from the total surface decreased from 25.59% to 7.47%, being replaced with the rural landscape (for instance, the villages emerged where there once were forests: Săftica, Dumbrăveni, Runcu, the Eastern part of Corbeanca), urban landscape (Băneasa neighbourhood in the first sector of Bucharest municipality, the northern part of Otopeni city, the southern part of Voluntari city, part of Colentina neighbourhood), and agricultural landscape.

Villages of the Deported. The Lăteşti Case

'Throughout many centuries, the deserted Bărăgan was homeland to high, frequent weeds, small forests whose weak trunks and abundant leaves are wiped out by the destructive autumn. (...) Pastures remained the green abundance for the cattle coming from other places, but next to them, the plough opened up plains of fruitage. (...) Shaggy sheep wind through the yellow stubble where they nearly merge' (Iorga 1972, p. 399). Specht's Map (1790–1791) or Szathmary's Map (1856) also attest to the fact that the Bărăgan area was 'deserted', as they depict few settlements that were very far apart. For example, in Southern Bărăgan, villages lined up along the Danube, but were far apart inside the plain, being separated by tens of kilometres (Fig. 9).

During the communist period, this deserted Bărăgan area, 'stretched between the tender Ialomiţa and the sulky Danube' and where 'as far as you can see, there is only thistle, the endless multitude of thick thistle (...)' like 'sheep with steel wool' (Istrati 1974, pp. 228–229), was the place where a significant number of people were deported. The latter were considered 'class enemies' (those who were opposed to the communist regime and collectivisation of agriculture and who had been convicted for political reasons), *chiaburi* – kulaks (a term which designated wealthy peasants who owned fortunes and land), and supporters of Josip Broz Tito's regime. According to some sources, over 40,000 people from the Banat region were deported here, to 18 centres created around 'state agricultural households' (in order to ensure the necessary workforce in agriculture), 12 new settlements being created (Gheorghe 2013, p. 36), among these, Lăteşti village (also called Borduşani-Satu Nou and Lădeşti), founded in 1951 in the Borduşani commune, currently in Ialomiţa county (Ghinea and Ghinea 2000, p. 300).

The village was established around the Borduşani state agricultural household, between Făcăeni, Borduşani, and Movila cities, around 2 km from Borcea Channel

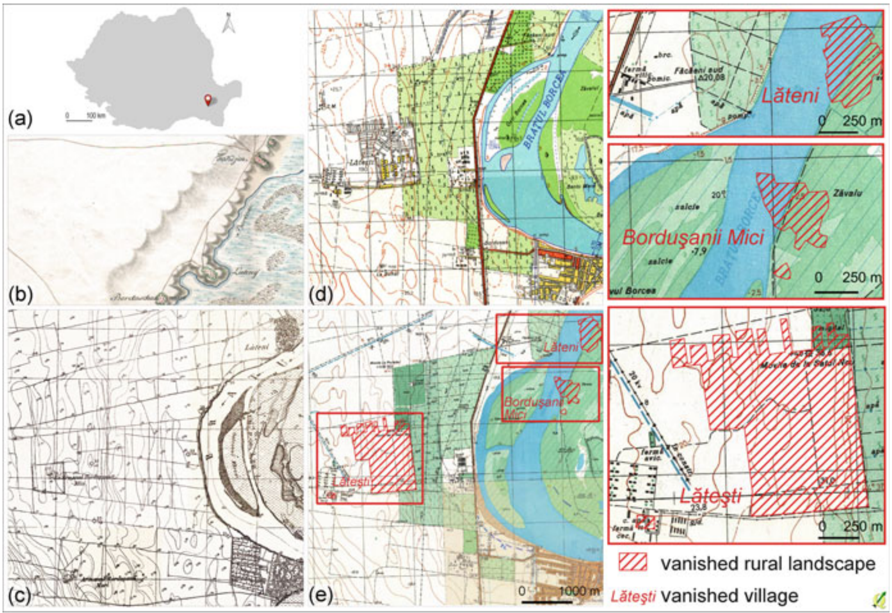

Fig. 9 Retrieving Lăteşti, Lăteni, and Borduşanii Mici villages on historical maps: (**a**) locating the study area; (**b**) the Specht's Map; (**c**) the topographic map in the Lambert–Cholesky projection, 1930; (**d**) the topographic map in the Gauss–Krüger projection, 1970; (**e**) the topographic map in the Gauss–Krüger projection, 1980; (**f**) locating Lăteşti and Lăteni lost villages overlapped on the topographic map in the Gauss–Krüger projection, 1980; personal processing in QGIS based on historical maps. The source of the maps: Romanian Academy Library (**b**); http://www.geo-spatial.org/harti/download-planuri-tragere.php, accessed May 2, 2015 (**c**); University of Bucharest, Faculty of Geography (**d**), (**e**)

(on the Danube) and 15 km from Feteşti, on wheat, barley, and cotton crops, including 616 families with 1740 members (V. Chiţan, Epic of the deployed. Fundata, Editura Star Tipp, Slobozia, 2001, pp. 54–57, *apud* Gheorghe 2013, p. 37) who were here on their so-called house arrest. On the topographic map in the Lambert–Cholesky projection (1930), immediately to the west of the place where the village was to be established, there was an enclosure including a few buildings (Fig. 9), which bore the inscription *La Armanul Borduşanii-Mici* (Borduşanii-Mici Manor), which meant it was a place on the field where cereal was carried and threshed, but it also referred to a mansion where the farm administrator lived and where the harvest was stored (DEX 2009).

Among the deported was writer Paul Goma, who was under house arrest for five years. When he arrived in Lăteşti, in 1958, 'the village was seven years old', and 'its age could only be deduced from the height of the acacia and apricot trees around the houses. But not from the houses: made of clay (rarely made of adobe), with no foundations, covered in straw, sometimes in cattail, if they weren't taken care of and repaired at least once a year, the ground walls melted like biscuits in tea. Then: an abandoned home constituted. . .a warehouse with construction materials for other houses' which were the deportees (Goma 2005, p. 248). Apart from the first houses of the deportees, 700 houses were built by the new deportees after 1960 (Cogean 2013, p. 42).

On June the 26th, 1964, the ban on leaving house arrest was lifted in Lăteşti (most of the political prisoners choosing to leave the village), and in 1974, the communist regime started to eliminate the traces of political oppression by demolishing the village, the last house being demolished on August the 1st, 1976 (Cogean 2013, p. 42), but the official dissolution occurred later, on October the 29th, 1977 (Ghinea and Ghinea 2000, p. 300). Based on the 1970 topographic survey, the topographic map in the Gauss–Krüger projection on a scale of 1:50,000 reflects the partial abandonment of the village due to the departure of some deportees, through the blocks of destroyed or semi-destroyed buildings, representing most of the village (around 68%), as well as the existence of buildings which were still inhabited, a total of 190 (Fig. 9). The entire village covered a surface of 1.4 km^2.

Lăteşti village disappeared. And it wasn't the only one. Specht's Map (1790–1791), Marshal Fligely's Map (1856), but also the topographic map in the Lambert–Cholesky projection (1930) attest to the existence of another village that no longer exists: Lăteni (Fig. 9), 'the hamlet which is mirrored in Borcea Channel' (Istrati 1974, p. 231), that was completely destroyed by the Danube floods in 1942. The inhabitants were relocated to Făcăeni and Borduşani during 1942–1947 (Ghinea and Ghinea 2000, p. 300), and most of the old village hearth is now covered by the Borcea Channel (Fig. 9). Thus, both villages, found around 4 km apart, disappeared, but due to different causes: the old Lăteni no longer exists, 'having been swallowed by water; the new Lăteşti no longer exists, having been swallowed (plowed) by the Communist State Security's bulldozers' (Goma 2005, p. 248). The cemetery was the only reminder of Lăteşti village, being depicted in the field on the 1980 topographic map, not far from a poultry farm (Fig. 9), and then it also disappeared. In 2013 there were wheat crops on the former location of the village and the cemetery (Cogean 2013, p. 41), which was also confirmed by the Google satellite images in 2014. The last sign left by the Lăteşti village in time and space is the toponym of the mound that marked the northern boundary of the former settlement (*Movila de la Satul Nou* – the New Village Mound). This toponym, together with the image of the village on the other historical maps, can contribute to the creation of a virtual rural landscape.

Another village, found 700 m south–southwest of Lăteni, had the same fate. That village is Borduşanii Mici, which appears on Specht's Map (1790–1791) and on Marshal Fligely's Map (1856) between Lăteni and Lăteşti. We consider this location to be correct, because when georeferencing Marshal Fligely's Map – through the Helmert transformation – we reached an average error of 26.42 m (for this area). We can deduce that the village was destroyed through the erosion of the Danube shore, as on the topographic map in the Lambert–Cholesky projection (1930) Borcea Channel appears to flow where the village was located (Fig. 9).

Places in Memory

In order to test the subjective value of these lost landscapes in Romania through their level of impregnation in the collective memory of the youth, we used a quantitative survey. In this respect, a standardised questionnaire was given to a sample of 86 first-year students at the Faculty of Geography within the University of Bucharest. First-year students were chosen on purpose, in order to test a population with less geographical knowledge. The structure of the sample by age groups was the following: 91% were between 19 and 20 years old, 5–21%, 2–18% and 2% over 21. Filling in the questionnaire was done voluntarily and anonymously. Because the survey was limited to a single faculty and to a rather small number of subjects, the results cannot be conclusive; they are only illustrative.

The first question in the questionnaire (Did you ever wonder what used to exist on the plot of land where your house currently lies?) was addressed in order to find out how interested students are in the old territorial realities which no longer exist. The answers showed a significant interest in the latter, only 15% of respondents not wondering what used to be on the plot of land where their house is located, and 85% were interested in past landscapes which are 'lost' nowadays (Fig. 10).

Concerning the past existence of forests where there are now buildings in the first sector (where the administration of the Faculty of Geography is also located), nearly half the respondents (51%) knew that in the eighteenth century, part of the

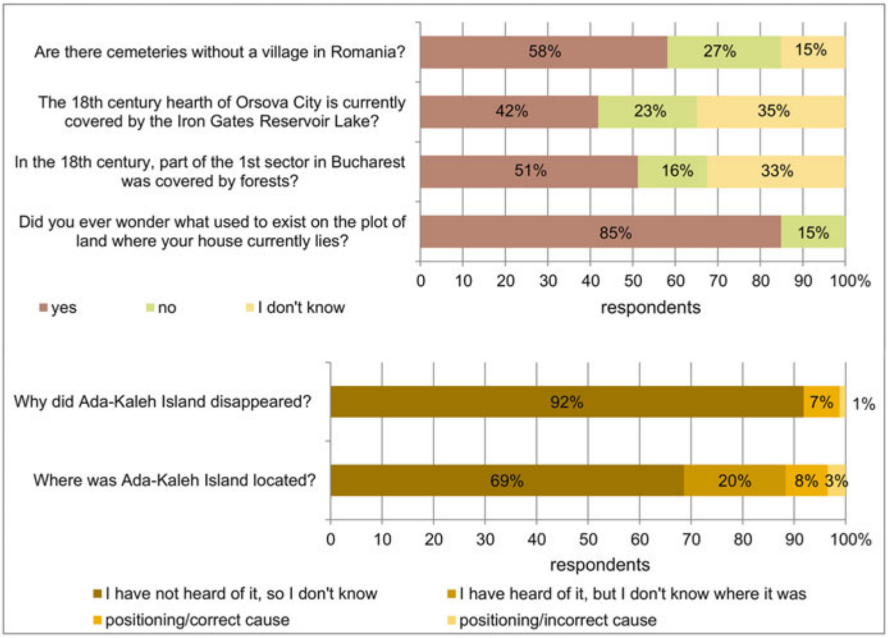

Fig. 10 The students' answers to six queries in the questionnaire

first sector was covered in forests, but 16% of them were convinced these forests didn't exist, and 33% didn't know how to answer (Fig. 10). Thus, nearly half of the respondents (49%) were unaware of the existence of these forests in the past, although they were part of the famous Vlăsia Forests which were frequently discussed (including by the media) given that their surface was greatly reduced in recent centuries.

A discussion held with the students after filling in the questionnaire revealed the fact that they were aware Bucharest had been surrounded by Vlăsia Forests and that it had been extremely reduced in the past centuries, but they hadn't seen any maps showing how much the Romanian capital had extended to the expense of these forests, as they had imagined that the forest landscape was found somewhere far outside the city.

Although 58% of respondents stated that in Romania there are cemeteries without villages (which is a correct answer), none of the 86 respondents could give an example. Twenty-seven percent answered that these cemeteries don't exist, and 15% didn't know how to answer (Fig. 10).

Less than half the students (42%) knew that the old hearth of Orşova city was covered by the waters of the Iron Gates artificial lake on the Danube, whereas 23% stated the hearth hadn't been flooded, and 35% didn't know how to answer (Fig. 10). As it turns out, 58% of them were unaware of the disappearance of the old city, which is somewhat understandable, as during the communist regime, the city's relocation wasn't highly discussed, because the emphasis was placed on the construction of the new socialist city, with modern facilities. Subsequently, the event was forgotten. Additionally, it was a phenomenon which had an emotional impact especially at the local level.

A large number of students (69%) hadn't heard of Ada-Kaleh Island. Twenty percent stated they had heard of it, but they didn't know where it was located. Only 8% pointed to the correct location (on the Danube, downstream of Orşova city), and 3% located it incorrectly (in Turkey, the Pacific Ocean, the Black Sea).

The answers to the last question showed that an overwhelming percentage of the students interviewed (92%), don't know the cause which led to the disappearance of Ada-Kaleh Island. One percent stated a wrong cause (earthquake) and only 7% mentioned the correct cause (coverage by the Iron Gates Reservoir Lake).

Corroborating the answers to the two questions concerning Ada-Kaleh Island, it turns out that most of them were unaware of its existence, despite its having disappeared in 1970, which is quite recently. It is surprising that only 31% of respondents knew of the past existence of Ada-Kaleh Island, whereas 42% of them had heard of the relocation of Orşova city, although both events are linked to the establishment of the Iron Gates Reservoir Lake, and the island and the city were only around 3 km apart. We can explain the forgetfulness of the island through the avoidance in discussing the event by the communist regime, on its occurrence. Moreover, the island's inhabitants have all left for other cities, which made the event difficult to keep in the local collective memory (only in the memory of the inhabitants from neighbouring settlements).

Conclusions

The diachronic territorial analysis based on retrospective cartography in a GIS Open Source environment proved through the case studies chosen that historical maps are essential in retrieving lost landscapes, first of all because it locates them in space. They are useful in surveys harnessing the historical and environmental heritage, as they allow the evolution of landscapes to be restored (through overlapping maps), even when no trace of the old landscape is left on the ground. Although maps also render the temporal dimension of landscapes, in order to establish precisely the period in which these landscapes existed, additional documentation resources are needed (reports, testimonies, statistics, photos, decrees, or laws, etc.), due to the fact that two successive maps are too far apart in time.

In order to locate precisely lost landscapes in space, maps with good geometrical and planimetric accuracy are needed, so that they could be exploited in a GIS environment. Their georeferencing involves finding many common ground control points (GCP) with the current map.

Recovering lost landscapes, their extraction from underneath the current layer of visible landscape creates a virtual, as well as emotional landscape, which needs to be based on a thematic cartographic representation (sometimes, an emotional map), in order not to become a caricature, in the case of subjects who had no concrete connection to it.

Recovering lost landscapes would satisfy one of the wishes mentioned by 85% of the students interviewed, especially because in all the cases investigated through the questionnaire, most of them were unaware of the existence of lost landscapes.

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Towards a New Design and Teaching Methodology for Large-Scale Landscape Design in the Era of Digital Overload

Pia Fricker

Abstract In this era of progressive digitalization, the precise choice of tools from the area of information technology poses a great challenge. Through simplified access to highly specialized software and hardware, one can make out a trend towards highly complex and often no longer controllable and realizable forms. Which methodologies and workflows within landscape architecture are suitable in order to react to the specific requirements of a place and the growing challenges of the discipline? Global urban questions and tendencies towards urban sprawl require strategies for solutions that integrate geographical, ecological, sociological, and infrastructural factors into planning. The integration of these parameters within design, however, often requires training specifically aimed at honing the skills needed to be able to sift through the existing data overload and find the useful data within.

In order to develop new approaches to solve these problems, the Chair of Professor Girot (ETH Zurich) within the Landscape Visualization and Modeling Lab (LVML) has pinpointed application areas for the academic education of landscape architecture that reveal practice-oriented workflows and methodologies.

Keywords Digital design methodology • Landscape design • Parametric workflows • Data visualization

Within the past 15 years, access to information technologies has become incredibly simplified. The interfaces between CNC-steered machines and CAD programs function seamlessly, visual programming languages enable parametric designing without special programming knowledge, and one can conjecture that in the near future the final step of the digital chain, or fully automated production, will be completed through the increased use of robots. However, if one critically observes the integration of information technologies within the study of landscape architecture, one notices that the consequent and methodological implementation of a

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Fig. 1 Generated data visualization image. Combination of pointcloud data from airborne and terrestrial laser scan. Image by Pascal Werner

broad-based spectrum of applications is for the most part not at the same level as its advanced development and use in professional practice.

There is a need for action! The current development of the profession of landscape architecture demonstrates a high demand in the area of technical expertise. Practicing landscape architecture offices often criticize that university graduates are more and more incapable of understanding and visualizing complex landscape designs. In addition to addressing this conjecture, the use of specific IT-related design tools that can be directly integrated into the design process has to be addressed in the curriculum.

For the past 8 years, the Chair of Professor Christophe Girot (Institute for Landscape Architecture, ETH Zurich) has committed itself to the development of a trendsetting range of applications of CAD/CAM technologies within teaching and research (Fig. 1).

The postgraduate MAS LA Program (Master of Advanced Studies in Landscape Architecture) of the Chair of Christophe Girot is aimed to function as an interface between research and professional practice. The thematic orientation of the program is based on the linking of specific tools from information technologies, which may be applied as future-oriented design directions furthering experimental analysis regarding the local problems of a place and innovative design, visualization (Fricker & Kaufmann 2015), and communication methods within the field of landscape architecture. The unique program is in a position to distill successfully the potential of a site by integrating the most modern technologies and technical expertise into landscape architectural practice.

This allows for a comprehensive study of complex elements grounding founded results that can show solutions at different scales, demonstrating the specific atmospheres during the seasons and integrating the challenging aspect of time.

Fig. 2 Rendered visualization: testing the generative vegetation components by using Laubwerk 3D plants on a complex landscape. Illustration of the focal point of their project for different seasons and times of day. Project by Angelos Komninos and Argyro Theodoropoulous

An important component is the immediate linking of visionary technical questions and developments from the area of information technology with theoretical questions and the possibility of the practical implementations within design. The combination of advanced parametric and analogue methods in modeling and design opened up a broad palette of possible heuristic iterations (Fig. 2).

Program Structure

The Master of Advanced Studies in Landscape Architecture (MAS LA) is a 1-year program divided into themed modules, workshops, and a concluding synthesis module. To this end, the learning of new software does not stand in the forefront but rather the integration of current modeling and illustration technologies as design tools for landscape architecture (Girot et al. 2010).

The chosen CAD programs are especially appropriate for the illustration of large-scale landscape designs and can be exported to computer-steered modeling machines. In conjunction with RAPLAB (Rapid Architectural Prototyping Laboratory) of the Department of Architecture, 3D physical models are created using the CNC milling machine, 3D printers, a laser cutter, and the CNC cutting machine.

Practical experience with rapid prototyping machines constitutes an essential didactic lever. Following an introduction in the use of the machines, each student can independently use and integrate them actively as tools in the design process and not only for illustration and representation purposes.

Teaching Methodology: Teaching Materials

Each module lasts around 5–8 weeks and begins with a phase where new techniques are learned. In this phase, individual exercises are connected to current issues in landscape architecture. In the second part of the module, participants grapple with complex problems, which are discussed during a concluding presentation within the framework of a panel discussion with a group of experts.

The module sequence ends with an individual synthesis seminar. This seminar allows the participants to go more in depth in an area of their choice among the completed modules. The students are challenged to go beyond the boundaries of conventional domains and test the tools in analysis, design, and visualization. The programs and different CAD/CAM techniques, which they have become acquainted with in the different modules, complement each other and should be applied and recombined to explore new design methodologies in the final project (Fricker et al. 2011).

The didactic concept is made up of an alternation of input, in the form of lectures and coached exercises and the implementation of new knowledge within the framework of a design task. The theme of the design task is already introduced within the first module and builds the backbone of the entire year. All modules and workshops find their applied problems within the design task. Step by step the students build their technical, theoretical, and design knowledge and integrate these in their design, which is concluded in a final synthesis module. During the individual modules, the students are given handouts, tutorials, and texts. The tutorials are made up of several levels, each including all of the relevant points so that the themes can be worked through independently. In addition, they also show outlooks and possible applications through references and links, which also include related fields such as design, art, or conventional engineering in order to convey and encourage critical thinking and evaluation of the content. The collective reflection on the individual learning steps presents an important didactic component, as each module ends with a student presentation in front of the teaching team and external guests. At the same time, the students train their communication skills both verbally as well as visually.

The students are challenged to go beyond the boundaries of conventional domains and test the tools for all areas of a landscape design. The programs and different CAD/CAM techniques, which the students have become acquainted with through the different modules of the MAS LA program, complement each other and should be applied and recombined to explore new design methodologies in their final project. The concluding final synthesis module of the postgraduate program acts as a test case for the questions or agenda, which have been defined throughout the teaching year.

The generally discussed question and often also fear that the designer loses control over generated design decisions must be refuted and, on the contrary, one must show methods and possibilities that give the designer back the control over the creative process and, at the same time, be open to technical developments and attempt to implement these in innovative ways.

The complexity of current architectural form language is also influencing trends in landscape architecture, which boils down to the issue of the choice of the right tool at the right point of time.

The basic idea is to use existing parameters from the site as design tools in an iterative process controlled by the designer. Information is translated into concrete design proposals that react to and respond to environmental constraints, sometimes in unexpected ways. This is a valuable resource whose full potential can only be harnessed using state-of-the-art software and technology, which is steadily becoming the norm in the highly technological reality.

The phenomenal growth of urban areas today combined with the environmental instabilities they in part induce require enlightened solutions combining the wealth of information from numerous fields. At the same time, the boundaries between urbanism and landscape architecture continue to disappear. With the massive increase in scale that is involved, traditional design tools too often cannot take advantage of the wealth of information at our disposal. For example, we are now able to control and understand the design proposal fully by integrating state-of-the-art technology as shown within the attached MAS LA final synthesis projects, in order to be able to calculate the immediate impact of a proposed development on the surrounding landscape.

The development of innovative tools within CAD/CAM technologies cannot be viewed in isolation, but rather always in direct relation with the design task at hand (Fricker et al. 2013a). These two fields are often separated from one another in landscape architecture, thereby losing valuable synergies and potentials. Integrative, transdisciplinary processes in large-scale landscape architecture are not only essential components on the technical side. Landscape architecture is able to create a bridge between architecture and urban planning. In many European countries, there is a tendency to rapidly growing agglomerations and suburbia, which cannot maintain a lasting imprint if the landscape architecture, simply said, is only concerned with the design of the in-between spaces. The discipline has to enter an open discourse with transdisciplinary planning, which requires a new definition of communication strategies and areas of responsibility. The main challenge is to design a landscape together with the dynamic spatial and temporal processes to be found in suburban sites.

The technical implementation of appropriate tools is already introduced at the beginning of the studio with the creation of the necessary data. Within the MAS LA program we tested different technological implementations; for example, through the use of a terrestrial long-range scanner, data can be gathered and simply and quickly supplemented by the pointcloud data of drones or from photos. In a next step, the first design hypotheses can be tested in 3D within these pointclouds at various scales. At the same time, the testing can take more of a semblance of reality through haptic sand models and milled models. Through this process, an understanding of scale is honed.

The next step is the transformation of the design hypothesis to design development, where intuitive and inductive thinking is supplemented with appropriate analyses. The direction is influenced through the defining of the various aspects

Fig. 3 Simultaneous landscapes. A MAS LA final synthesis project by Effrosyni Laskari and Marina Tsintzeli. A dynamic new parkland is created in the existing cultural landscape, one that responds to the future transformations of the area. The area is confronted by the onset of floods caused by topographical water dynamics. For this reason a flood protection infrastructure system is integrated in this reinvented cultural landscape

of design, the integration of development over time and the development of a strong and critical communication strategy. Throughout the process, the necessary technical skills are to be maintained.

The students were given a design task in Erstfeld – Altdorf (Switzerland): “Water Meets Infrastructure.” The task of each MAS LA student was to generate a large-scale vision for the future Reuss valley. This challenge demanded the transformation of the various infrastructure, integrating future flooding, living, and ecological patterns. The development of the Reuss valley at Erstfeld, Uri is a complex mix of infrastructural systems, including the local, regional, and European transport networks. The recent opening of the northern entrance to the Alp Transit tunnel project is the latest transformation to the valley system, creating large shifts in the future use of the valley. Within the MAS LA design studio, students work alone and in groups to react to the complex issues facing Erstfeld and its surroundings with a holistic approach to the future vision for the valley (Figs. 3 and 4).

Coding Concept: Development of Specialized Tools

The difficulty in teaching lies not in the lack of equipment, but rather it is seeing this digital overload as a new challenge in a positive sense.

What are the tools that adequately serve current landscape architectural trends and how can they be conveyed? The past years have shown us that programming within architecture has become as commonplace as CAD drafting. Within landscape architecture, urban planning but also building construction, for example, parametric designs, are often the only solution to dealing with complex form language. To this end we would like to use the computer to realize projects that would not be possible using conventional methods (Fricker et al. 2013a). This requires the further development of digital tools which allow for the subsequent design and working with the extracted information.

Programming has the advantage of solving complex tasks, accompanied by the risk of sacrificing the intuitive abilities of a designer. Our goal is to reduce the a

Fig. 4 (**a**) Waterscape section. (**b**), (**c**) Conceptual diagrams: urban evolution, pathways, water management system

b

Fig. 4 (continued)

c

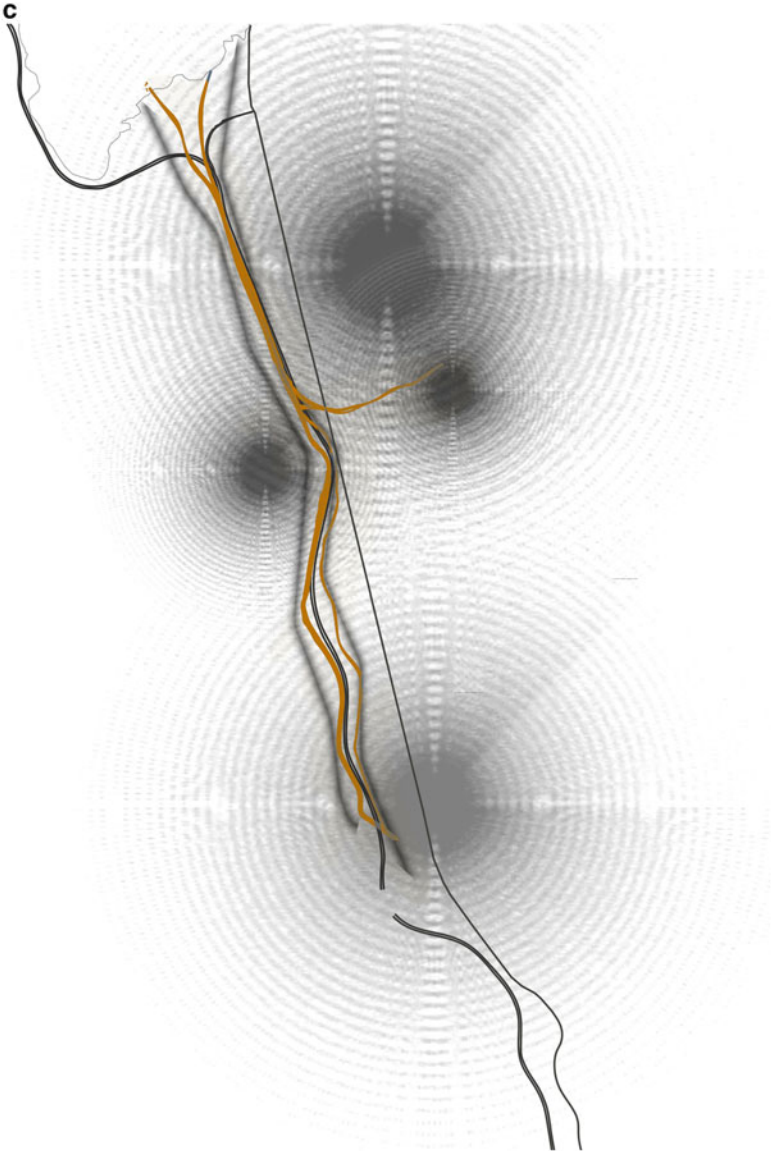

Fig. 4 (continued)

technical hurdles and apprehension towards programming in order to first reach an understanding of its necessity.

In this step, the use of computational design is expanded through the acquisition of structural thinking. Experiments using programming expand the scope of design. The students are asked to formulate their design routines as algorithms, to code their concepts. Instead of blindly applying existing software, the students learn to design landscape architecture through customizing their own scripts. Within the MAS LA program over the last years, we have gained successful results through the use of open source software, Processing. Processing, developed at MIT, has a steep learning curve and great functionality as well as variety of input and output.

Conceptual objectives include the following:

- Develop appropriate tools for physical design and modeling
- Work with specific landscape dynamics: permanence, growth, transformation, and decline
- Learn to design new spatial structures and topographies developing over time
- Integrate the potential and content of related disciplines to design
- Consider design-relevant material from the selective analysis of biotic, abiotic, and societal aspects of context

Explorative Data Mapping

Which methods are necessary in order to identify relevant information within the design process from the myriad available datasets? How is it possible to visualize these data in order to be able subsequently to derive meaningful decisions for the design? We experimentally researched this theme within the MAS LA module: "Programming Landscape."

Although traditionally statistical representations have the main task of communicating complex ideas in a clear, precise, and efficient way, we currently find ourselves in a phase where the nearly limitless access to data can be seen as relevant to the design. Through the simple use, for example, of a Quadrocopter (radio-controlled aircraft) in combination with sensors, we could record many different kinds of data that deliver site-specific conditions in real time. Data that especially in landscape architecture can be used to generate "datascapes" supplementary to conventional GIS Information, can be used at different levels as design tools. The experiences with our students, however, show us that the databases often cannot be completely understood and therefore influence the wrong parameters of the design. The designs tend to become exceedingly complex and no longer controllable.

For the past 3 years we have dedicated the MAS LA program to researching new areas that sound out the margins of programming with respect to the visualization of real data (sensor data) as a design tool. Our previous experiences were based on the use of Processing, the open source programming language with direct visual output. The main goal of the course is to gain a creative relation to complex relationships. At the beginning stand the elementary understanding of the data, then new strategies are explored, which are then visualized in order to gain design-relevant decisions from them (Fricker & Munkel 2015). When one looks at the generally used software packages for data visualization, often the process of

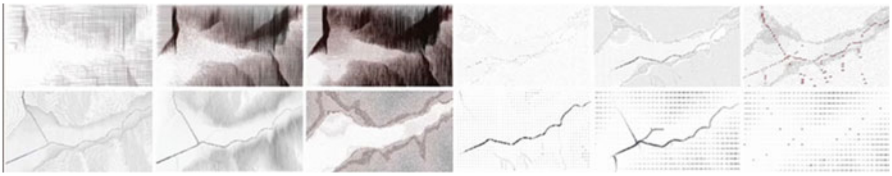

Fig. 5 Student project by Ana Krstulovic and Effrosyni Laskari, "Natural Elements: Extraction-Interpretation." The program is comprised of three main actors: the mountains, the valley, and the river. These actors were programmed with their own visual language. In the illustration of the mountains, the rotation of the lines was regulated in relation to their actual height. The valley and its boundaries were determined through a dot matrix algorithm. In this project, the students placed the focus on the interplay of graphical elements such as text, lines, and surfaces. The result of the program is an animated visualization and gives a visual feedback on the topographical interventions of the designers

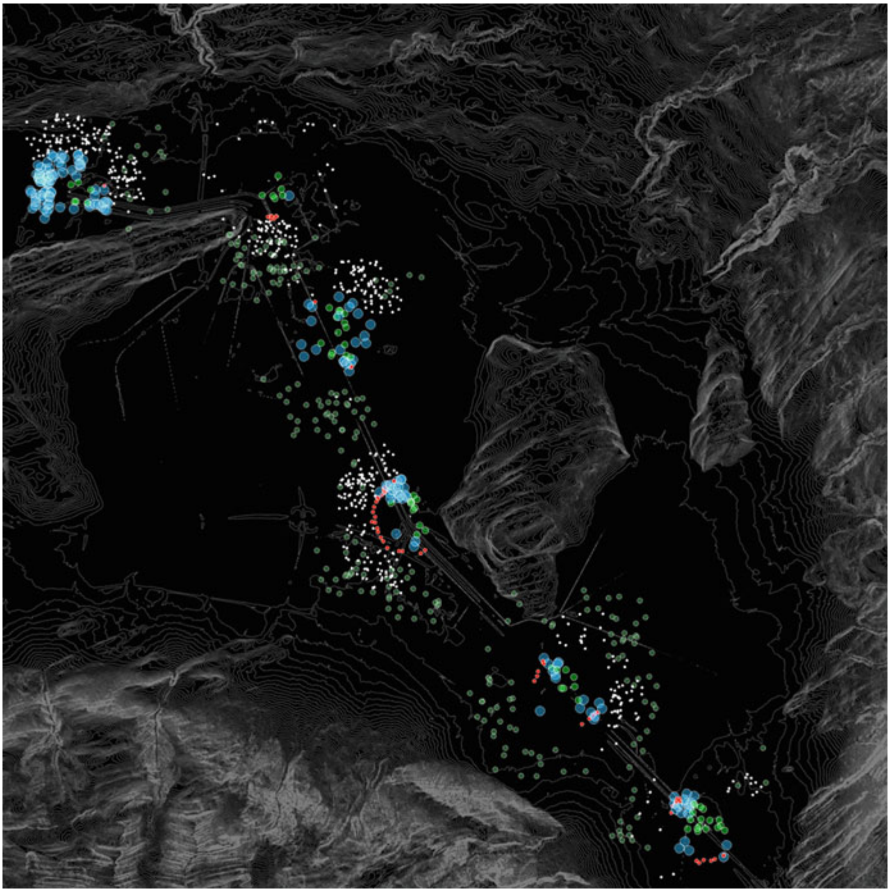

Fig. 6 Student project by Angelos Komninos and Argyro Theodoropoulous: "I Explorer." The program visualizes a "visual map" along a newly designed path. The central theme of the program is how visual references corresponding to an individually determined importance can be appropriately represented. This presentation technique allows the students to test decisions within the design process and adjust the parameters accordingly

reflection is forgotten. The visual representation, whether as a model or drawing, is often very similar to a spatial condition or a design solution and one runs into the danger of mistaking one for the other. Our experience shows that "Big Data Visualization" in landscape architecture requires not only a certain basic understanding of the data, but also a certain basic understanding of programming, in order to be in the position to control the use of these data independently. Rapid technical developments currently allow an almost limitless use of arbitrarily complex datasets, either created oneself or by open source sources. These, on the other hand, require a methodic and didactic continued development of the design tools by the institutions of higher learning.

In the concluding project of the module, our students write a program that draws a map from the design area of former modules. In so doing, the programming team follows the intent to focus on the decisive aspects of the site for their design. These aspects are represented in the smallest possible determining factors and as a result, separated from precisely qualifiable parameters. These are, for example, the grade, the distance to rivers, the visibility of other defined places, or the slope of the site. These values can be determined for every place on the map and will be translated in drawing style and methods. In so doing, drawings are created that mirror the interplay of the investigated parameters for the entire planning area (Fig. 5 and 6).

Acknowledgments MAS LA teaching team. Professor Christophe Girot, Pia Fricker (Director of Studies). Ilmar Hurkxknes, Philipp Urech, Magdalena Kaufmann, James Melsom, and Georg Munkel. www.girot.ethz.ch/masla

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Part II
Digital Art History

The Social Network behind an Architectural Style over Space and Time

Yanan Sun

Abstract This research aims to provide a sociological approach to studying architecture. With the help of social network analysis, it is not only possible to visualize the distribution of buildings of a particular style through time and space; it is also achievable to reveal the underlying social connections that enabled the transmission of the architectural style. Taking Chinoiserie architecture as an example, this chapter explicates the procedure from obtaining historical data to applying them to social network analysis in order to detect the social structure behind the diffusion of the Chinese taste in the early modern period in Europe.

Keywords Chinoiserie • Royal kinship • Style diffusion • Two-mode network • Network structure

Introduction

The influence of Chinese culture on the Western world is a topic that draws wide attention in many fields of research. A fascinating aspect of this topic is the Chinese influence on the Western arts between the seventeenth and the nineteenth centuries, collectively known as *Chinoiserie*, a French word denoting “Chinese-esque.” Although Chinoiserie repeatedly alludes to themes related to China, it is, in nature, European, for the intellectual creation of the European artists endows it with a kind of artistic effect that is nowhere to be found in the original Chinese arts.

This chapter is organized as follows. The first part generally introduces architectural Chinoiserie architecture and why its ubiquity over space and time becomes a great challenge to study the development of this style. The second part briefly introduces the methods of approaching this challenge with a sociological network perspective. Parts 3 and 4 detail the procedure of applying the network approach to seven selected historical sites in Germany, which enables us to construct a social network of architects and patrons and helps us to understand the development of Chinoiserie architecture from a nonfeaturistic analysis.

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As early as in 1670, the French King Louis XIV commissioned a "Chinese" building, *Le Trianon de Porcelaine*, in the Park of Versailles. This edifice was not the ephemeral whim of an eccentric nobleman, but the natural outgrowth of a time infused with information about the Far East, which provoked the European sense of aesthetics and curiosity. Recognizing that Chinoiserie appeared in various forms of arts, the focus of this research is architectural. Other forms of Chinoiserie, including wallpapers, porcelain, and lacquer, are an equally significant embodiment of Sino-European artistic interaction, yet they exhibit disparate patterns of development. To study architectural[1] Chinoiserie raises a different set of questions. The reasons are two. First, creating Chinoiserie architecture demands more resources than other art forms. Although small objects of decorative arts in Chinese taste, such as porcelain and paintings, became widely admired and increasingly available from the seventeenth century, the possession of a "Chinese" building was still restricted to the wealthy and influential, because to construct a building, one should be sufficed with financial and material resources as well as technical and artistic support. Moreover, compared to other forms of Chinoiserie, only a small number of Chinoiserie buildings have survived to today. The small, movable, and less expensive artifacts can be secured, relocated, and restored with less effort and cost. Architecture, in contrast, is frequently left to the mercy of war and financial crisis.

Nevertheless, the number of the known Chinoiserie buildings is astonishingly large. Preliminary research shows that over 300 Chinoiserie buildings were recorded from the 1670s to the 1840s[2] in Central Europe, one third of which are located in Germany. This number does not even include those after the 1840s, as the Chinese mode was no longer regarded as fanciful as previously. Vogel estimates, around 1800, almost every park and garden in Germany possessed a pavilion in the Chinese taste (Vogel 1932, p. 335). Not only the large number, but also the great diversity becomes an enormous challenge to the researchers who want to have a structural overall understanding of the development of Chinoiserie architecture, because each building would like to demonstrate its own Chineseness with innovative design elements and methods. Moreover, the location of these buildings is widely spread and dispersed. Particularly in Germany, before the North German Federation formed in 1866, the region was a loose association of independent states, the Holy Roman Empire. The time and manners that Chinoiserie settled in each territory varied greatly. All these factors make it difficult to detect the overall development of the style only based on featuristic analysis.

[1] Whereas in broader sense the art of architecture includes nonstructural design of buildings, such as interior design, furniture arrangement, and ornament, this research uses the term in its narrow sense and studies the issues that are generally not overlapped with other forms of arts and regards a building as a unit to study.

[2] The earliest one was probably Le Trianon de Porcelaine in Versailles, designed for the French King Louis XIV in 1670. The latest ones can be in small private gardens such as the three open pavilions built for the merchant family Uhlich from Trieste after 1840 in Zdravilški Park.

Methodology

How did the style of Chinoiserie succeed in crossing geographical boundaries over time? To answer this question, this research resorts to the methods of social network analysis (SNA) and focuses on the relationship among the patrons and architects of the Chinoiserie buildings. SNA studies social relations with network theory by taking the prepositions of graph theory and applying them to the social world. In its basic form, a social network is a network consisting of nodes, representing actors, and ties, representing a form of social relationship such as friendship. SNA uses sociometrics to note pairwise relations, which is indexed by the set of originating actors (for its rows) and the set of receiving actors (for its columns), and gives the values of the ties from the row actors to the column actors. In its graphic form, actors are represented as nodes, whereas lines symbolize relations among them.

Site Selection

Although more than 300 Chinoiserie buildings have been found on record, due to the limitation of time, only a part of them can be included in this chapter. To bring the wide reach of the topic to a manageable scale, 42 buildings on seven historical sites in Germany were selected: Nymphenburg and English Garden near Munich, Sanssouci and New Garden in Potsdam, Pillnitz near Dresden, Ludwigsberg in Saarbrücken, and Mulang in Kassel-Wilhelmshöhe.

The reasons for choosing these sites are mainly two. First, this selection allows investigating the specific meanings that Chinoiserie architecture took within the individually delimited cultural milieu of Germany. Second, it includes a broad area of social, political, and geographic units, examining similarities and difference in adopting Chinoiserie in various sub-German cultures.

Research Strategy

This research follows two steps: historical research and network analysis. Historical research is treated as a process of data collection, in which the relevant persons and their relationship are identified. The network analysis regards these persons as nodes and recognizes two types of ties among them: the personal relationship recorded in historical documents and their common association with a site. The second type of ties is indirectly obtained, that is, anticipated from some facts that the actors share some common properties, which is termed the “mode” in SNA. The key step of discovering unrecorded ties is to infer connections between two persons from the historical fact that they contributed to the same site. This fact can insinuate

Table 1 Contributors to Selected Historical Sites

Site	Owners	Planners	Buildings	Architects or Craftsmen
Nymphenburg	Maximilian II	Girard	Pagodenburg	Effner
	Maximilian I	Sckell	Badenburg	Cuvillies
	K Theodor			Effner
English Garden	K Theodor	Thompson	Chinese Tower	Frey
		Werneck		Lechner
		Sckell		Erlacher
				Raedl
				Me Leithner
				Mi Leithner
				Streitner
				Zietsch
			Chinese Wirtschaft	Streitner
				Erlacher
				Homann
				Hilger
Sanssouci	Friedrich II	Knobelsdoff	Chinese Tea House	Buering
	Wilhelm II			von Hildebrand
			Chinese Kitchen	Buering
			Chambers' Bridge Design	Chambers
			Chinese Bridge	Chambers
			Dragon House Design	Buering
				Gontard
			Dragon House	Gontard
				Krueger
New Garden	Wilhelm II		Chinese Parasol	
			Gate House	Gontard
				Krueger
			Schindelhaus	
Pillnitz	August S		Riverside Palace	Poeppelmann
	August III			Longuelune
			Upper Palace	Poeppelmann
			New Palace	Schuricht
			Bridge Pavilion	Schuricht
			Chinese Pavilion	Schuricht
Ludgwigsberg	L. v. Saarbrueken	J Köllner	Chinese Roof Bridge	B Stengel
		H Köllner	Affenkaserne	B Stengel
		Sckell	Chinese Bridge with Swan Boat	B Stengel
		F Stengel	Three Stream Bridge	B Stengel
			Adolfsfreude	B Stengel
			Clock Tower	B Stengel

(continued)

Table 1 (continued)

Site	Owners	Planners	Buildings	Architects or Craftsmen
			Chinese Gate Design	B Stengel
			Chinese Lattice Bridge	B Stengel
	8 Family		Garden Pavilion	Knipper
Mulang	F v Kassel	Schwarzkopf	Chinese Pagoda	
	Wilhelm IX	Du Ry	Dining Hall (Chinese Hall)	
		Jussow	Milchkammer	
			Chinese Kitchen	
			Bagatelle	Du Ry
				Jussow
			Hall Keeper's House	
			Milk House	
			Cow Shed	
			Supervisor's House	
			Windmill	Arhnholz
			Herder House	
			Sheep Pen	
			Barn	
			Connection Gallery	Jussow

the transmission of the Chinese taste from one person to another, even though the personal relationships, such as friendship, were not found in old records.

Historical Research

Unlike historiographical research, this research focuses on the records about the people related to the sites and their mutual relations. Then the information is reconceptualized into a graph-theoretical data format, by answers to the question: Who (architects) contributed to the construction of Chinoiserie buildings for whom (sponsors or patrons) at where (historical sites)? The answers to this question are summarized in Table 1.

Nymphenburg, Munich

Nymphenburg has been the summer residence of the Bavarian rulers since 1664. The 200-ha park, once an Italian garden (1671) which was enlarged and rearranged in the French style by Dominique Girard (ca. 1680–1738), was finally redone in the English manner during the early nineteenth century by Frederick Ludwig von Sckell (1750–1823), on behalf of Prince-Elector Maximilian IV Joseph (1756–1825). The two Chinoiserie buildings, Badenburg and Pagodenburg were crafted by Joseph Effner (1687–1745) between 1716 and 1721. Their owner, Elector of Maximilian II Emanuel (1662–1726), may have been influenced by his exile years in Versailles and sketched the ground plan himself and let Effner carry it out. Already in 1767 François Cuvilliés (1695–1768) started to revise the building for the Bavarian ruler Charles Theodore (1724–1799) (Honour 1961, p. 111; Vogel 2004, p. 149; Reichwein 1967, pp. 59–60).

English Garden, Munich

The construction of the English Garden in Munich was begun by Sir Benjamin Thompson (1753–1814) in 1789, and succeeded by Reinhardt von Werneck (1753–1842) and Frederick von Sckell (1750–1823), who had been counseling the project from the very beginning. The Garden is functionally different from other sites, because although it was commissioned by a nobleman, it was intended to amuse the public, not the princely family privately. In addition to the famous Chinese Tower, the English Garden once possessed a group of buildings in Chinese style, for example, the Chinese Restaurant, a Chinese Temple, a Gothic Temple, and two wooden summer houses, as well as a few bridges in oriental style. Except the Chinese Tower and the Chinese Restaurant, all other buildings have disappeared (Hallbaum 1927, pp. 183–184, 189; Schmid 1983, p. 44).

Sanssouci, Potsdam

Chinoiserie in Sanssouci began with the well-known Chinese Tea House in 1754 by Frederick the Great (1712–1796). In the time that followed, other Chinese-style buildings were added. Sanssouci declares the advent of Rococo Chinoiserie, differentiating itself from the previous Baroque Chinoiserie in Nymphenburg and Pillnitz which are serious in form and large in mass. Most Chinoiserie buildings in Sanssouci have survived (Dorst 1993, p. 30; Giersberg 1993, pp. 35–36; Harksen 1993, p. 52; Huth 1929, p. 14; Kopisch 1854, p. 100; Manger 1987, pp. 12, 239, 266–267, 342; Nicolai 1769, p. 529; Tack 1993, p. 46; Wacker 1993, p. 11; Vogel 1932, p. 324).

New Garden, Potsdam

The land of the New Garden in Potsdam was bought and had gone through some primitive construction already when King Wilhelm II (1744–1797) was still the Crown Prince. Like his predecessor Frederick the Great, he was also an enthusiastic proponent of Chinese fashion. He had been intensively involved in advising the design and planning of the Chinese village of Mulang. In 1796, he even personally visited Mulang. Compared to Sanssouci, Chinoiserie architecture in the New Garden appears to be less fantastical. Here dominates Neoclassicism (Laske 1909, p. 83; Reichwein 1967, p. 61; Vogel 1932, p. 326).

The Pillnitz, Dresden

The Chinoiserie in Pillnitz, the summer residence of Saxony rulers, was successively sponsored by two patrons, August the Strong (1670–1733) and Frederick Augustus I of Saxony (1750–1827). The Riverside Palace, the Upper Palace, and the New Palace boast to be the largest Chinoiserie construction in Germany. The former two were built for August the Strong by Matthäus Daniel Pöppelmann (1662–1736) between 1720 and 1723. The latter one was commissioned by Frederick Augustus I to Christian Frederick Schuricht (1753–1832) after 1818, who also added other new Chinoiserie designs to the site, bringing Pillnitz from the Baroque to the Neoclassical era (Erdberg 1936, pp. 174–175; Reichwein 1967, p. 60; Vogel 2004, pp. 147–149; Welich 2010, p. 218).

Ludwigsberg, Saarbrücken

Ludwigsberg began to boom under the regency of Louis of Nassau-Saarbrücken (1745–1793), Prince of Nassau-Saarbrücken, who fostered several "family dynasties" of architects and garden masters, for example, the Köllners and the Stengels. Contributions from other artists can also be seen; for instance, Frederick von Sckell had also drafted a renovation plan for Ludwigsberg. Although most of the site was destroyed during the French Revolution, historical documents show it was once rich in Chinoiserie buildings. Bridges, tents, or pavilions, at least nine Chinoiserie structures can be identified with historical images (Trepesch 1999, pp. 14–16; Hannwacker 1992, p. 54; Skalecki 1999, p. 225; Paul 2009, pp. 9, 21–22, 37, 45, 49, 94, 184, 211, 257–258; Lohmeyer 1937, pp. 91–118; Leonardy n.d., pp. (I).16).

Mulang, Kassel-Wilhelmshöhe

The ambition of constructing a Chinese village was begun by Frederick II of Hessen-Kassel (1720–1785) in 1781. After his death, the task was continued by his son, William IX of Hessen-Kassel (1743–1821) in 1785, who gave the name "Mou-lang" to the previously called "Chinese colony" in 1791. It is not known who actually laid the first plan for Mulang. Several candidates are suggested: Daniel August Schwarzkopf (1738–1817) and Simon Louis du Ry (1726–1799). It was also not impossible that Frederick II came up with the idea himself. The participation of Heinrich-Christoph Jussow (1754–1825), who in 1801 succeeded du Ry as the court master builder, could only occur in the later construction phase of Mulang.

Mulang was once rich in Chinoiserie buildings. Except the Pagoda, the Chinoiserie features of other buildings have faded away through multiple rehabilitations. Although many architectural drawings have survived, they are mostly not signed or dated. It is hard to identify specific architects for individual buildings (Dötsch 2006, p. 7; Paetow 1929, pp. 36–37; Steinhauer 2003, pp. 23–25, 28–29, 47; Holtmeyer 1913, pp. XLV, XLVII, LXXII; Holtmeyer 1910, pp. Tafel 173).

Social Network Analysis

The information from historical research is reconceptualized into graph-theoretical data format: actors and ties.

Actors

Two types of actors are defined based on historical research: persons who contributed to the design and construction of architectural Chinoiserie, and the seven selected historical sites. In the terminology of SNA, they are two modes. The first mode includes royal owners and their architects. Including royal owners might be one of the most significant ways of taking an insight of the diffusion of Chinoiserie. It has been often taken for granted that it was the architects who brought the artistic styles into life. Although their contribution should not be denied, the inspiration regularly imbued by the patrons can also not be neglected. For instance, on the court of Potsdam, the masterpiece of the Chinese Tea House is ascribed to the architect, Johann Gottfried Büring (1723–after 1788), yet the primary sketch was made by Frederick the Great himself.

The second mode includes the seven selected historical sites, to whose Chinoiserie style the actors in the first mode have contributed. The sites provided space for the development of the Chinese style.

Table 2 Recorded Personal Relationship

Person	Person	Relationship
Me Leithner	Mi Leithner	Family membership
August S	Frederick II	Friendship/acquaintance
Frederick II	William II	Family membership
August S	August J	Family membership
J Koellner	H Koellner	Family membership
F Stengel	B Stengel	Family membership
F v Kassel	Wilhelm IX	Family membership
du Ry	Chambers	Friendship/acquaintance
Wilhelm IX	Wilhelm II	Friendship/acquaintance
Knobelsdoff	Frederick II	Friendship/acquaintance
Pöppelmann	Longuelune	Apprenticeship
Effner	Cuvillies	Apprenticeship
Thompson	Charles	Friendship/acquaintance
Max II	Effner	Friendship/acquaintance
Max I	Charles	Family membership
Cuvillies	du Ry	Friendship/acquaintance

Ties

Ties in the First Mode

Historical research discovers various interpersonal relations among the actors, for instance, kinship among royal owners and cooperation among architects. We regard such relations as one type of tie, because they are related to the personal interactions about the actors in the first mode and can be found in historical records. They include friendship/acquaintance, apprenticeship, and family membership[3] (Table 2). These relations are not exclusive and can overlap. For instance, cousins can also be good friends. The graph of the recorded relations (Fig. 1) is very sparse, which may either be due to the historical truth that German courts were relatively independent of each other or the lack of historical records.

Ties Inferred Through the Second Mode

Meanwhile, there is another type of tie that connects the two modes of actors: the relation between the persons and the sites. For instance, Frederick the Great financed the Chinese Tea House in Sanssouci and Büring worked as architect for

[3] It should be noted that distant kinship among the noblemen is not included in order to avoid ties that are meaningless to the diffusion of Chinoiserie. A genealogical investigation shows all the noblemen in this research had some kindred relation. However, it does not guarantee a substantial interaction among them, which is meaningful to the spread of the Chinese taste.

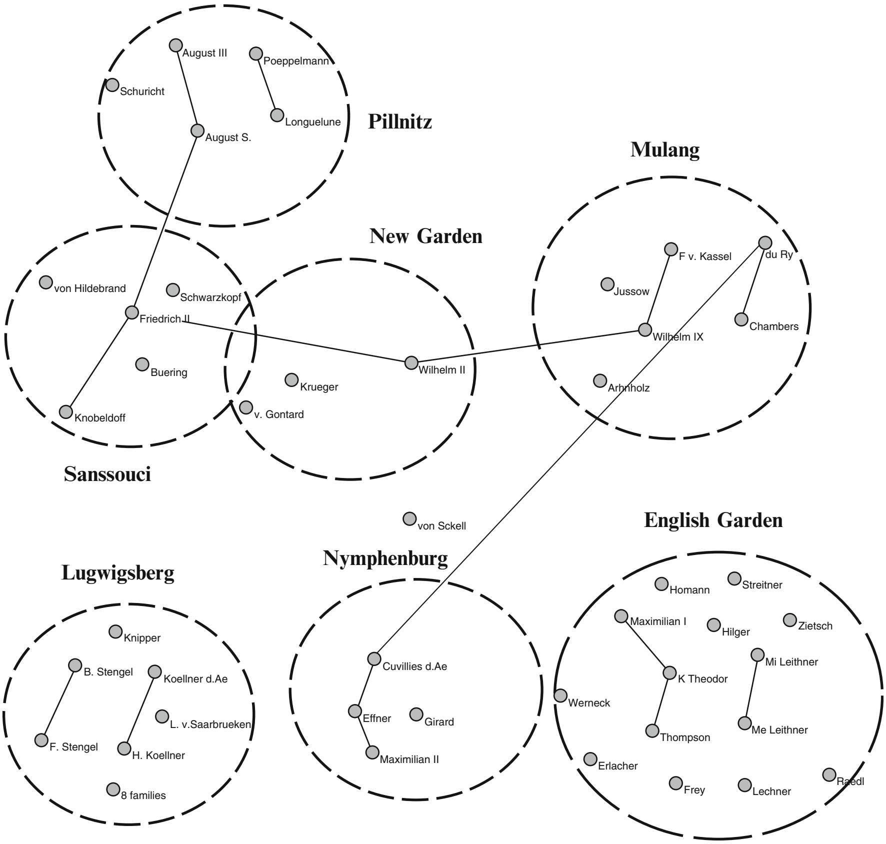

Fig. 1 Graph of recorded personal relationship

the House. In this situation, even if no records about the personal relationship between the two can be found, the fact that they both contributed to the same building or site can suggest a mutual association. This kind of relation seems to be obvious and simple at first sight, but can be very powerful, when it is difficult to find sufficient historical records.

It corresponds to the focus theory of Feld (1981), which proposes a group's activities are organized by a particular focus to the extent that two individuals who share that focus are more likely to share joint activities with each other than two individuals who do not have that focus in common (Feld 1981, p. 1016). Foci may be many different things, including persons, places, social positions, activities, and groups. They may actively bring people together or passively constrain them to interact (Feld 1981, p. 1018). In other words, if two persons are around the same focus, for instance, going to the same school or grocery store, it is very likely that they will develop a kind of personal interaction organized by the focus. In this research, historical site is regarded as the focus.

However, Feld also noted, all individuals who share a focus do not necessarily interact with each other very much or very often. For the foci where everyone is forced to interact much and often (e.g., families), all of the individuals associated with that focus will be tied to each other; but for the foci that are less constraining on interaction (e.g., city neighborhoods), only a slightly higher proportion of individuals will be tied than would be tied in the general population. In general, the more constraining a focus, the greater the likelihood that two individuals associated with that focus will be tied (Feld 1981, p. 1019). In the situation that construction is regarded as activities organized by the foci of historical sites, the constraining force turns out to be strong and can bring the participants into some form of communication. For instance, from documentation research, we know Joseph Frey (1758–1819) had designed the Chinese Tower for English Garden. Because he was still in Mannheim as the tower was built, Johann Baptist Lechner (1758–1809) may have also been involved in the actual construction of the tower (Schmid 1983, p. 43). Although no records show a personal relationship between Frey and Lechner, only based on the fact that the two architects have been working for the same building at the same time, we should not hesitate to assume some kind of communication happened between them, probably through post. Even in the case where two persons contributed to the site in different periods of time, it can also be assumed the Chinese taste was transmitted in less visible forms such as in the process of reviewing designs or rehabilitation of the predecessor's buildings. Feld's theory provides, essentially, a tool to infer channels that enabled the transmission of the Chinoiserie style among the contributors who are missing in historical documents. This inference is to discover (or rediscover) ties among actors of the first mode through the second mode.

Figure 2 shows who contributed to which historical sites, a two-mode network. By connecting nodes in the first mode who share a common node in the second mode, a new graph of the first mode can be obtained (Fig. 3). However, it should be noted ties in this graph are partially directed, which means the diffusion of the Chinese taste can only take place in one direction. It is due to the fact that some contributors have already passed away, when others made their contribution to the same site later. For instance, Joseph Effner and Frederick von Sckell both contributed to the site of Nymphenburg, however, it is only possible that von Sckell learned the designs and drawings of Effner during his renovation of Nymphenburg, not the other way round.

Diffusion

By combining the two graphs (Figs. 1 and 3), a graph of the diffusion channels of the Chinoiserie style can be drawn (Fig. 4). This well-entwined network reveals an important social pattern behind the development of the architectural style over time. It demonstrates the phenomenon that Chinoiserie buildings were widely constructed on different political territories was not a coincidence but a natural

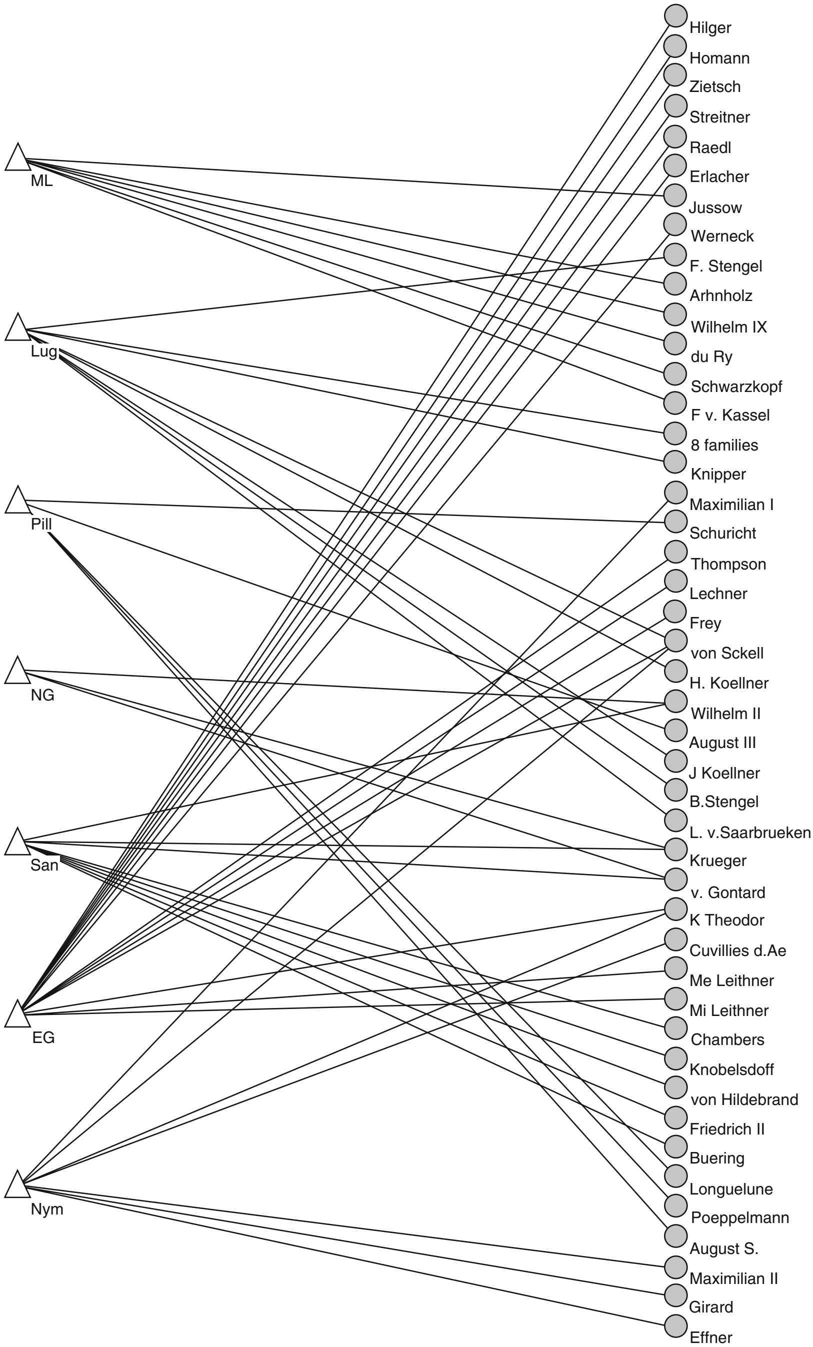

Fig. 2 Two-mode network: persons contributed to historical sites

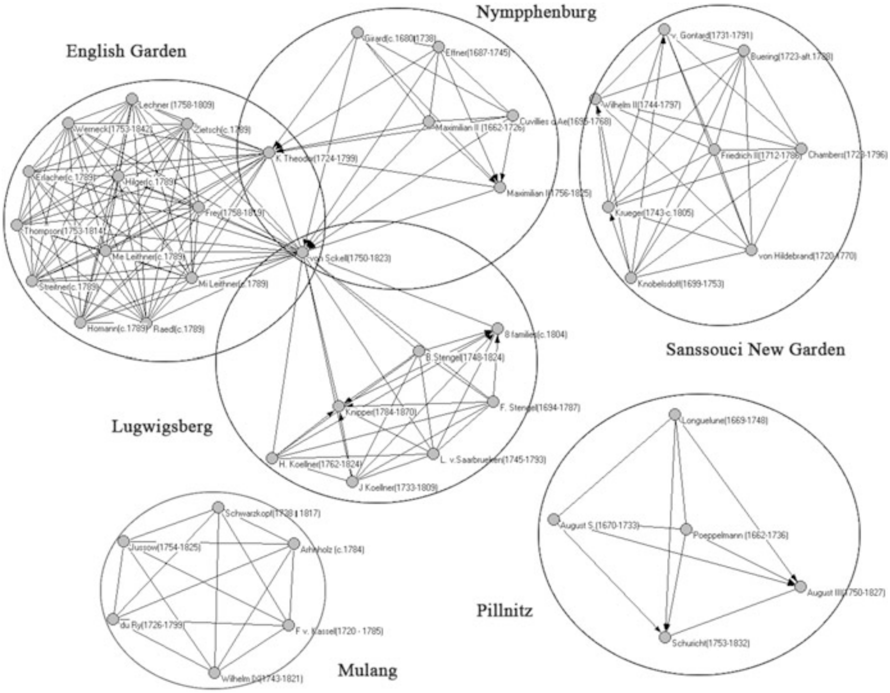

Fig. 3 Inferred ties from the second mode (directed)

outcome of a certain social structure. The graph can also provide support to specific historical interpretations.

The primary results of the network analysis correspond to the social mechanism in Europe of the early modern period, in which noblemen were the main sponsors of arts. They did not only finance the construction directly but also sponsored the study of the architects and provided recommendations to their employment. As the Chinoiserie architecture was born in this period of time, it is not surprising to observe that the connections of European gentry and aristocracy and the architects under their sponsorship provided channels to diffuse the Chinese taste. Meanwhile, this graph indicates the network of noblemen was not solo dominant in the diffusion of the Chinese taste; the networks of architects and craftsmen have also played an important role in the transmission of the taste in space. Having studied and practiced together, styles of architects became akin to each other. Afterwards, when working on various sites, they could transmit similar styles from one place to another, such as in the case of du Ry and William Chambers (1723–1796), who studied with Jacques-François Blondel (1705–1774) at the same time. The networks of architects became more contributing from the second half of the eighteenth century, when architects began to practice independent of permanent royal employment, which allowed them to provide designs even to international or civil patrons. Sometimes, the kinship of architects was equally influential for style diffusion. For

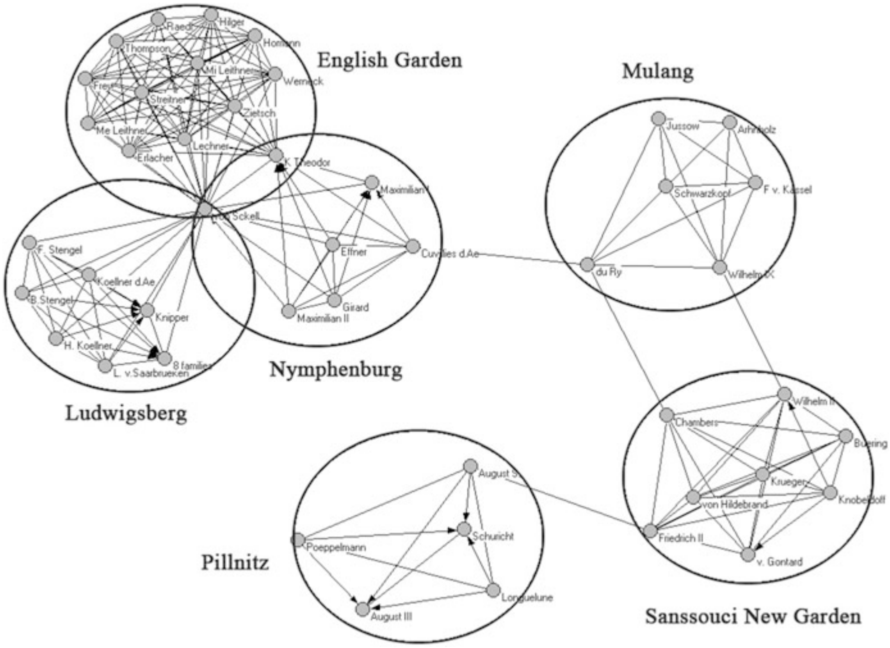

Fig. 4 Social association of contributors to the selected sites

example, the elder Friedrich Joachim Stengel (1694–1787) had two sons. One son, Balthasar Wilhelm Stengel (1748–1824) followed his father's footsteps and took over the post in Saarbrücken as Master Construction Director. The other son, Johann Friedrich Stengel (1746–1830) responded to the call of the Russian Czar Catharina II and became her Court Architect.

Moreover, the association of German Chinoiserie with French Chinoiserie can also be observed on this graph. The majority of earliest Chinoiserie contributors had personal experience in France. For instance, Maximillian II spent his exile years in the French court, and architects Joseph Effner, François de Cuvilliés, and Simon du Ry received their professional education in France.

Network Structure

After disclosing the social network behind the diffusion of Chinoiserie architecture, it can further inform us about features of the social structure beyond architectural innovations in the period.

There are different structures of networks. One extreme is a regular network such as mesh- and tree-graphs, in which the probability of any two randomly chosen nodes to be linked together is very low or zero. The other extreme is a random

Table 3 APL and CC of Chinoiserie network and random networks

	Average path length	Clustering coefficient
Chinoiserie network	3.378	0.829
Theoretical random network with the same size and density	1.828	0.178

network, typically, the ER (Erdos–Renyi) graphs, whose degree distribution is a Gaussian bell-shaped curve. In the real world, however, most networks display patterns of connection neither purely regular nor purely random, and therefore are complex networks. Two well-known complex networks are small-world networks and scale-free networks.

A small-world network is a type of network in which most nodes are not neighbors of one another, but most nodes can be reached from every other node by a small number of hops or steps. That is, the average "distance" between any two randomly chosen nodes is small, compared to the size of the network. Moreover, small-world networks contain many tightly connected small groups, which is called the "clustering effect."[4] The calculated results (Table 3) show that the network of Chinoiserie contributors has small degrees of separation averaging less than six steps. And the actual clustering coefficient is significantly higher than that of an equivalent random network. These measures suggest that the network is a small-world network.

A scale-free network is defined as a network whose degree distribution follows a power law; the vast majority of nodes in the network have few ties, whereas a small number of nodes have significantly many ties, which are normally recognized as "hubs."[5] Trying to fit the degree distribution of the Chinoiserie network to a power-law distribution, one can get $\alpha = 2.5568$ and $x_{min} = 5$ (Clauset et al. 2009, pp. 665–676). However, the distribution plot suggests that the data do not fit the power-law distribution very well (Fig. 5[6]). Moreover, the *p*-value for the goodness-of-fit is as low as zero, which agrees with the distribution plot and indicates that the Chinoiserie network does not show a feature of scale-free topology.

In a nutshell, the structure of the Chinoiserie network indicates that although the Chinese taste is not difficult to diffuse from one contributor to another, there are highly cohesive clusters of the contributors probably with homogeneous connoisseurs about the style. The short path length also indicates the existence of weak ties (Granovetter 1981) providing boundary-crossing channels for the taste to flow from one cluster to another. The absence of features of scale-free networks seems to correspond to the historical fact that Chinoiserie architecture was not extensively

[4] For a mathematical model, see test Watts and Strogatz (1998).

[5] For a mathematical model, see test Albert and Barabási (2002).

[6] Points represent the cumulative density functions P(x) for the dataset distributed according to a discrete power law, with $\alpha = 2.5568$ and xmin = 5. Solid lines represent best fits to the data using the methods described by Clauset et al.

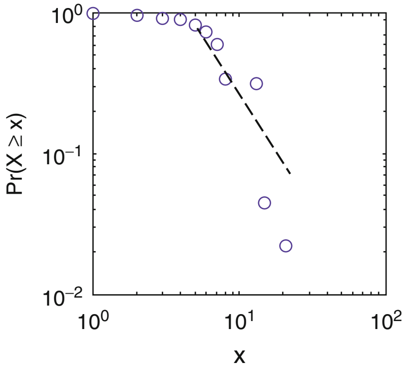

Fig. 5 Power-law distribution, Chinoiserie network

built and no contributor possesses a "hub-like" position in diffusing the taste. Therefore, the structure of the Chinoiserie network suggests the Chinese taste was embedded in a social structure where fashions could be transmitted easily among actors with relatively small distance. However, due to the high clustering and the lack of hubs in the network, the taste could not spread to the whole network in a very short period of time. This provides one explanation for the diversity and the duration of development of Chinoiserie architecture.

Conclusions

Taking Chinoiserie architecture as an example, this research shows how the historical research of architecture can benefit from the theories and methods of the social network analysis (SNA). It not only helps to establish connections among buildings of the same style in various locations and periods, it also discloses the social structure behind the development of the style and helps to interpret this development historically, which adds a social dimension to the architectural style beyond featuristic analysis.

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Essay: Archives (Building in Time)

Augustin Ioan

Abstract The text works on time representation in architecture, arguing in favor of the building-as-process attitude towards construction, as a way to incorporate time into the making and the unmaking of edifices. The phenomenology of composing and decomposing the built matter comes into being—with a whole range of procedures explained in the text—as a way to give time to our lives and places them as co-present archives against the background of the time–space continuum, which, in its turn, becomes visible when built into architecture.

Keywords Process • Co-presence • Post-occupancy evaluation • Archives

> Thus the oldest traditions were saved. Everything that we know by word of mouth about what was beautiful, grandiose, or in any other way special, be it with you, here, elsewhere, all this was noted down here with us and kept from time out of mind, in temples. And when with you and with other peoples, whenever it happened that things be somehow ordered as regards writing and everything that is needed in cities, there comes over you at precise times, just like a disease, the heavenly flood that spares only the uncultivated and those deprived of the gifts of the Muses. So that you become again ignorant, like youths, without any idea of what happened in the times of old, here or among yourselves.
>
> (Plato, *Timaeus*, 23a–b)

> As for the race of men (*genos anthropon*), the Egyptian priest of Timaeus assigns "places" to it: there are the places propitious for memory, or the conservation of archives, for writing and for tradition, these temperate zones which provide protection from the destruction by excesses of heat and cold (22e–23a).
>
> J. Derrida

> . . . to stay here, to die with these houses, to grow old with them.
>
> Emil Cioran[1]

[1] Letters to Jeni and Arshavir Acterian, Paris, 15 January 1940.

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Time Before the House

It was only after I had been in Oxford for a while that I noticed something downright shocking: the alley leading from the main yard to the church and library of my College, St. Edmund Hall, crossed the old graveyard of the church and the slabs making up the path were tombstones. I trod on inscriptions into which the living had carved their sorrow at losing those buried there. That manner of diverting stone from its basic purpose never ceased to send shivers down my spine, especially as I had no alternative route to take: custom bans walking on the perfectly manicured lawn close by. All of a sudden, by reading the inscriptions, the path I trod on acquired a temporal see-through character that seemed truly unbearable, as if those stones were actually windows to a past that had tumbled down from its commemorative purpose. I was treading on painful time made visible.

A shift in the relation with walled matter can be seen close to my home at Densus, where the building materials used to construct the Romanesque church entwine bits and pieces included from the ruins of the Roman constructions that must have been available at the time when it was erected. This is nothing new: to "phoenix" one building into another, the substance of the first being used in a new configuration of space seems to be rather the rule than the exception, namely the rule which considers that houses are subject to becoming, just as living beings are. If you can use something from an old house—a privileged location,[2] or merely the building stone—so much the better; formerly, this act had nothing of the impiety which today strikes those who look at houses through the glasses of modernist timelessness, but was rather a natural celebration of the process-like nature of building. We condemn such actions because we tend to endow the constructions that we celebrate as monuments with a sense that they are "without end" when we halt their becoming at an arbitrary point in time, one which merely happened to be contemporary with this—powerfully conditioned from an ideological standpoint—modern view of their destiny. The falsely reverential attitude vis-à-vis monuments as objects stunted in their becoming and mummified in one of their life-stages is more recent than we might think. It is from this taxidermic standpoint that we criticize, inventing fallacious theories of conservation and restoration on which I dwell a little later.

The Time of Making

For now, let us return to living architecture, which, more than any other of the so-called "spatial" arts, does not have a beginning or an end that can be clearly defined as regards its making, seen from a temporal perspective. A gesture, an

[2] The understanding of the sacred as it refers to places and constructions is beholden to the repetition of founding rituals on the same site, that which somehow instills in the ground the spirit celebrated by the ritual that "makes room" for it.

object, a perfume, or maybe a trauma can sometimes cast a cone of light back in time, extracting therefrom what might seem forgotten and which thus becomes part and parcel of the present, over and again. This is the manner in which memory, always nostalgic, operates. The archives of architecture are no exception to these mechanisms of remembrance.

The zero-moment of an architectural undertaking precedes and the final one postpones the conventional moments of building and demolition. This pre-usage[3] of the material and of the site turn the "birth" of the house into a rather vague moment. In the numerous makings there exist prior makings, and sites often appear to be palimpsests, layer upon layer, erasure upon erasure. This manner of approaching the question of the temporal "sponginess" of architecture recalls the question concerning the beginnings of architecture. In this chain of fertile blackouts, the origin of architecture ceases to be the inaugural moment still sought to this day: in a making there exist prior makings, and in an unmaking there endures the chance of future lives, at least in principle. Moreover, the question "When?" deserves another, probably more fertile for the economy of this text: "For how long?"

We all know stories about the long periods needed for the construction of particular cathedrals. This lengthy process, to which a considerable part of the community contributes, seems compensated by the temporal "stability" of architecture. It gives time back, withstanding not only the poorer aspects of reception (changes of style), but also physical aging. How is this possible? After only a short time practicing architecture I have come to realize there is nothing esoteric about this view. The fact that in design you can step back and sleep on an idea, giving it time to settle; the fact that you can test the idea together with the customer, with the builder; endows the building with an ever greater air of concreteness, even if you can perceive in it, new as it is, hesitations and changes of mind, scars of the conflicts which arose on the way, or the marks of past winters that would be clearly seen were they not camouflaged by the finishing touches.

Such a traumatic coming into the world on the part of the architectural object we often see in the case of Italian churches begun in the Romanesque and finished in the Baroque style. This makes the object of architecture less prone to change because it already includes in its substance a multitude of decisions, some only partial, and of variants, even if not consummated; in other words, virtual stages through which the building has gone. Such an object is no longer only its final form, but also all the stages it went through before it was ready. It is not a question of whether such a building–palimpsest is necessarily "better" than any of the "what ifs"" that it went through, as long as the final decisions also exude either a partial air—which, be it only for that reason and nothing else, calls into question

[3] At the upper limit of the amount of time accumulated before the translation into fact lies prefabrication, which can, in fact, reduce the creation of a building to an ensemble of "nearly ready-made" subassemblies: fitted bathrooms, complete rooms, or living units which are affixed to a central trunk (as in the case of Kurokawa's tower). In those instances, the house no longer has a different rank from the matter that it organizes in a superior manner; what difference does characterize it is all the more insignificant ontologically the bigger the degree of prefabrication.

Gadamer's optimum solution—or one that looks like the outcome of incomplete decisions. In any case, I know for certain that the real effect of such a house is superior to the houses made without using any remains, after a single design, according to a single decision, no matter how well informed and/or authoritative it may be.

The example of the Sagrada Familia Cathedral in Barcelona is enlightening in this respect. In the final years of his life, Antonio Gaudi worked on it almost alone. Since his death, the construction work seems to be advancing no more rapidly than it would have done if its author were still the sole builder. This pushes the completion of the cathedral into a future that cannot be defined because, in parallel with new construction, the issue of restoring previous stages has arisen in order to conserve and perhaps to give them the chance of temporal cohabitation with the new. On the other hand, the manner in which the Sagrada Familia is being "completed" is not taking on board the supplementary contribution of ideas that a new epoch can inject into a building whose making it inherits; on the contrary, the new construction work is markedly different from Gaudi's original in terms of its (intentionally) more imperfect construction: Gaudi's fractal-like geometries of detail are being simplified to a significant extent so that the new is explicitly, deliberately, and visibly inferior in execution as compared to the "original".

However, one thing is certain as far as building in time is concerned: such a house, erected at leisure, if not deliberately put off (which calls to mind a possible connection with Derrida's *différence*) will continue to bestow time, even when its construction is finished. How? First, by means of its capacity to provide dating indices, under the aegis of both its own slow becoming and the built-up context. The first Gothic choir can be identified in connection with the still Romanesque nave of the same church, just as the successive chapels of Westminster Abbey push the building farther to the east and at the same time into the Gothic: ever more lacy, ever more detached from gravity, up to the flamboyant and perpendicular. Crossing the threshold, one notices this very movement in time of the house itself, and with it, of oneself as an observer of this anamorphosis. But what one sees is the compression of century-old changes in a matter of a few minutes. In attentive observers of this accelerating change in forms this causes a dizziness comparable to watching a movie whose successive frames are rendered sufficiently fast so as to capture the blossoming of a plant and its wilting. In other words, what would otherwise be inaccessible in a lifetime becomes comprehensible by a mere crossing of the church from east to west.

The co-presence of constructions dating from various periods offers something more than mere visual diversity, namely, a contextual situation in time, the dating of our lives. *Our house goes back to the time when a particular edifice was being erected; it precedes or is subsequent to it.* The possibility of stating that our house was built before or after some edifice, district, or street inserts it into historical time, but not only our houses, our lives too. This is one reason why cities established on a pre-established plan (such as Brasilia or Chandigarth) or massive reconstruction projects in a city, especially when the "new" architecture is archaic, of which

Stalinist architecture or Bucharest's "Victory of Socialism" Boulevard are privileged examples.[4]

Time to Use the House (Post-Occupancy Evaluation)

Post-occupancy evaluation has existed in the West for quite some time, but it has not yet emerged in Romania (although there are indications that in the 1970s there were sociological studies that somehow resembled it). As I have already written about it in more detail elsewhere, here I only address its relationship with time. Post-occupancy evaluation makes observations concerning what happens to a house under the tenancy of different occupants over different periods of time. The purpose of this is to try to identify how it is best used, in keeping with the design and the construction and architectural solutions applied. In other words, post-occupancy evaluation seeks to discover to what extent it is a "happy solution" (Gadamer). Moreover, any alterations made by a particular occupant or by a succession of occupants, are recorded and subsequently examined, for the purpose of improving future design.

It is clear why modern architecture desperately needs such a discipline and why an architecture based on *vague space* does not. If, from the beginning, one allows a house to adapt over time to various—even opposed—ways in which it might be used, post-occupancy evaluation can evaluate their adequacy in accordance with what vague space offers. Moreover, a large part of the data that post-occupancy evaluation makes available can be simulated on the computer before or during design so that it becomes unnecessary to resort to empirical data; this is the case, for instance, with the behavior of houses during earthquakes, which can now be simulated with considerable precision. The results of such simulation can be taken into account in structural and architectural design calculations, just as the simulation of aerodynamic tunnels or of impacts provides vital data which make it possible to do without testing in "real" wind tunnels or using crash-test dummies.

Time to Unmake

In other words, houses—built at different times—date our lives, offering us location in both space (through the variation of its intensity vectors in relation to a home, the

[4] To these I am afraid soon will be added the consistent interventions of historicist post-modernism—in the genre of the Antigone Complex of Montpellier by Ricardo Bofill—a privileged model of the Bucharest Boulevard, a thing acknowledged by some of the architects whom I have consulted on the matter, such as the now vice-president of the International Union of Architects, Mr. Alexandru Beldiman who used to be in charge with a part of the Boulevard of the Victory of Socialism's architecture.

most intense of all), and time. Houses do something else for our lives, which are much more perishable than their own: they embody memories for us. The volume *The Story of Houses*, published by the Union of Architects at the Simetria Publishing House, clearly shows how much individual and family memory is associated with dwellings, and often with their loss. The intensity of such stories about houses and streets is without comparison: the house acts as a condenser of these founding myths or myths of family continuity, just as exemplary edifices solidify the great narrative of ever larger communities, justifying them both in their own eyes and in the eyes of the others, of strangers. It condenses—because the intensity of each story grows with the addition of a new one—and acts as a fixed point of memory. The house settles these great narratives, whether they belong to the individual or family, or to the collective, or even the nation.

Another problem related to the temporal dimension, on top of the making or unmaking of a house, is its interpretation. The perception of an edifice is not necessarily related to a temporal sequence, as in the case of a piece of music in which the order and time in which the work unfolds grow together in the act of reception (because that is how it is conceived).

Naturally, the perception of the object of architecture takes time, but the manner in which this time is *earmarked* does not condition the understanding of the whole. No privileged course exists, nor does an optimum duration. One can start from the city or from a stone detail, from the interior space to the exterior ambiance or context; we can cover colonnades and end with the study of the shells held captive by the geological eras in the travertine of the facade. At the same time, things can very well happen the other way round, without damaging in any way the process of drawing the object closer to architecture. Some discover *it* without the initial wonder of those who see the masterpiece or with the quiet admiration of those who inhabit *it* throughout their life. Others perceive it for a moment and preserve the *lightning* "flash of that moment of grace..." memory of that moment of grace which I have had the privilege of experiencing several times in my life, first in Venice and more recently before Fallingwater by Frank Lloyd Wright.

The Timeless House

This potential for accumulating time and giving back history has been challenged by modern architecture with considerable force. Time potential, which acts as a bonus function of the house in relation to its explicit (denotative) role, to provide shelter, disappears in three ways: (i) with the use of materials that do not decompose over time,[5] and which therefore do not *express their* aging and death, canceling out in the process the analogy with the body/organism, probably the most persistent

[5] More precisely, which do not do so at a pace that makes obvious the degradation effect in the consumption of materials, in the decline of the house.

metaphor with which architecture has ever been associated; (ii) by means of temporal, ephemeral, or disposable architecture;[6] and finally (iii) by disengaging the decoration from the economy of the edifice (the enemy of modern architects, by which location in time is achieved) and, *by emphasizing*, the privileged position of the carrying structure.[7]

Reduced to its functional and structural essence, the house is deliberately extracted from time, under the pretext that this bare structure is the endpoint in architecture's process of becoming. The moderns have suppressed the context in order to present a house in its integrity, untroubled by comparisons and contradictions, yet in this way they have diminished it, almost to the point of mutilation, as Venturi noted as early as 1966. Dating is no longer necessary; it disappears as a problem in an environment where only "pure" architecture exists. The absence of situating landmarks in time creates an uneasiness that has attracted comment from the sociopsychological studies carried out with respect to dwelling in instant milieus, where there is no temporal before and after. The dislodgment from historical duration and, consequently, the loss of collective memory, are, as a matter of fact, effects to be expected from modernist cities in general, not only those of totalitarian regimes; the disintegration of a community perched in an apartment-block city from which historical landmarks have been erased can be considered either the deliberate gesture of a diabolical mind or the unintended effect of the utopian idea of communisation. Examples are easy to find in post-communist Romanian towns. The dislodging of time here doubles the alienation produced by the disfigured site: all the towns and cities in the country look terribly alike because they were all badly constructed from the same set of designs.

But even when its execution is flawless, modern architecture seems not so much timeless as deprived of time, frozen in a moment that it tries to turn into a continuous present. If we look at the designs of Sant'Elia in the early twentieth century *or at* the Futurama building and exhibit at the New York World Exhibition of 1939 we may see that the same modern architecture was admired by differently dressed people in cars that seem funny to us today; everything has changed in the meantime, yet this architecture still seems topical. No wonder, because in its essence it is decomposed into primal factors, cleansed of elements that might have rendered it obsolete—above all, ornaments—it appears somewhat muted in respect of time.

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[6] This is not constructed with a view to endurance and, as a consequence, its making does not take up time in the way a perennial house does; a disposable house does not have to be remembered and, with the exception of photographic or video testimony, it is not. Not even the buildings that replace it make any reference to it, because it leaves no trace. *Disposable architecture* calls into question everything that is not "useful" in a building and in doing so it "un-founds" it, reducing it to a shelter, possibly a poorly decorated one but definitely a shelter.

[7] The creation of the dichotomic relations between decoration (peripheral, marginal, added: a surplus) and the carrying structure (central, essential, simple, and pure) is an explicit (sub)product of architectural modernism.

The Intoxicating Nature of Time

Retrospection, the house looking back and, nostalgically, allowing itself to be impregnated by time and history, is a privileged method of renewing architecture. The rediscovery of antiquity after the Gothic episode (itself not inured to the ancient heritage that it interprets against a background of amnesia in respect to *its own "built archives"*) represented a renewing shock situated, paradoxically only at first sight, in the remote past. More exactly, it was sufficiently remote to become new once more. The moderns operate in the same way, rejecting tradition (i.e., historical heritage) in order to take inspiration from the "origins" (peri-Mediterranean or African primitivism). In Romania, there is an equivalent of this rejection of history as something too burdensome: orthodox architects of the prewar period, which downgraded the medieval episode as unsatisfactory because of its diversity of sources and the *allogenous*. This separation from the past is done in the name of origins, both religious (i.e., Byzantine) and ethnic (i.e., Latin). Architecture oriented towards the past is an interpretive and selective reading of the archive. What is visible from the past is preserved, intensified, or even modified. *The Roman colonnades took on a kind of colossal order from Palladio, whereas with Speer, Piacentini, or, closer to home, with Duiliu Marcu and Contantin Joja, they became a row of pilasters stripped to their essence and with an austere geometry*. The elements caught up in a system with its own rules of coherence are "released and allowed to fly freely on the wings of memory." Roman arcades acquire the *right of citadel* and came back in fashion in the *stille littorio* or in the Carol II style (Victoria Palace by D. Marcu), in each case for different reasons, naturally. The first case is an exclamation of the imperial vocation of the fascist regime: for the Romanian architect, over the Roman source floats the memory, monumentalized, of the vernacular autochthonous. The belief that the architecture of 1930s Romania is massively influenced by local folk tradition remains an uncritical commonplace among historians of the period (cf. Machedon-Scoffam, *Romanian Modernism*, MIT Press, 1999). This says more about the role of culturally formed archives in shaping our collective memory than about the "real" sources of influence of the architects in question.

How are the past and its archival layers seen by way of the object present at hand? Sediment can float and resurface as cultural memory in the long series of consecutive remakings of the same program or the same town. The successive remakings of a sacred site will, for instance, in the form of a votive plaque, at least imply the presence, a mention, of what was replaced. The ghost of what has vanished returns to the collective memory: London or Chicago before their great fires; Bucharest before the successive waves of demolition. This glimpse into the past is not necessarily a deliberate action, but belongs to the normal mechanisms of site stratification. The layers are never perfectly superimposed; they do not cover up the past perfectly, leaving no remains. In other cases, we are dealing with unintentional unearthings. You dig to make room for a new house and stumble upon vestiges or traces of the old one. This thing, especially of late, means a change of plans, moving the house or even halting its construction; the archive regains its *status of citadel*.

At the extreme, this unearthing of the archive can become deliberate and, through its effects, aggressive vis-à-vis memory. Unearthing or incomplete covering, in short, partial or iceberg-like visibility, is a procedure quite frequently used in the post-bellum reconstruction of cities devastated by bombs: for instance, the reconstruction of Buda (the hilly half of Budapest) features such shards, fragments of ruins left as such in places and positions that make them visible as "not belonging there" (in fact, *what is new differs from the ruin which is "original"*). Archive fragments surface in this way, and, by way of contrast, in their relationship with their situation they elicit the question, "What is this ruin that obtrudes in this way?" Even this inconsequential question can trigger the unfolding of the archival story, which thus becomes somehow active and is brought up to date.

Another procedure is the incorporation into a new house of what is old *on the spot*, as testimony of its continuity. What is added to the restoration of the old is marked out as new in relation to what is original. In these benign forms, the preservation of a trigger capable of unleashing the archive—or at least of invoking its physical presence or absence—is beneficial both for remembrance and for inserting the new in historical time, so ennobling the new house, which wears the old fragment as it were in its buttonhole. The new is no longer absolute, inaugural. It becomes blurred, falls into filiations, acquires a patina. As in the case of a marriage of convenience contracted by the newly rich (or, until not long ago, top communists) and the declining aristocracy, this is a mutually beneficial alliance. The former (or their descendants) acquire a certain social visibility, whereas the latter escape misery, poverty, or even physical extinction. Similarly, a symbiosis of this kind which, as pure and tough modernists would say, "contaminates" the new house, postpones the evaporation or loss of the archive. I call these forms of new/old symbiosis the *active archive*.

Digging for a buried or invisible archive can account for a discontentment with the present, surface archive. In such radical cases we can say of the archive that it is rather aggressive than active. G. M. Cantacuzino, in his 1947 book, *On an Aesthetics of Reconstruction*, criticized the way in which the Italian architects of the Fascist period made the Roman ruins participate in the political propaganda of the system. The effort to uncover such vestiges and to reconstruct them sometimes entailed deliberate destruction of the existing city, and so of the surface archive, which were minor in comparison with the relevant propaganda goals. The present or the recent past, both unworthy of the heroic future, had to make room for the excavation of a more suitable past. What I have in mind here is, to quote Cantacuzino, "the *presence* of ruins and monuments that over the centuries found a setting that had become integrated into the artistry of the Renaissance" (Cantacuzino, 1947, 37), the way veterans exhibit the stumps of their violently crippled limbs in order to justify their heroism. Cantacuzino speaks of the "awakening from the lethargy of ruins" (in other words, from the neutrality of their stance or position as *ground layer* of the living city). This procession of the unburied must march along with the living: "the ruins have been taken out of their vegetal, picturesque scenery, the columns have been washed and scrubbed, entire walls have been rebuilt, the tomb of Caesar Augustus has been reconstructed to become a political document . . . Everything has been ravished and put in a false light" (Cantacuzino, 1947, 37).

Naturally, Italian architects were not alone. The German plans were on an even larger scale, geographically at least, and included Greece, Asia, and northern Africa in their search for "Aryan" vestiges to justify present grandeur. By comparison, the efforts of the Romanian mayor of a Transylvanian city to dig beneath a medieval past which does not serve his ethnic argument in order *violently* to bring to light (*agressively so*, that is) Roman ruins might seem ridiculous. These are invested, despite their original neutrality, with the same propagandistic role as the Roman ruins of the Eternal City in the Fascist period. This is not only a question of monuments or edifices, that is, buildings the original intention of which was display, public visibility, or the embodiment of a desired collective image of such and such a community. In the Transylvanian city in question an accidental instance of the archive is being mauled by being unearthed, the one that happened to be under the "foreign" square. Consequently, it cannot prove anything, or at least nothing of what the ultranationalist mayor might imagine. It is an uncovering of the bones of the long dead. The unearthing of vestiges in this way is, to a considerable extent, just as shocking as the disinterment of the dead. In the village of my birth, inhabited by Rasnov peasants from Dobrogea, there is a tradition of disinterring a grave after 7 years. The bones are recovered, washed with oil and wine, covered in a white cloth, and reburied. The moment, which I witnessed several times during my childhood, is overwhelming. It brings to light, "here", what ought to have stayed in the perpetual darkness of the "beyond". The remembrance of those who have passed away in this way becomes newly traumatic by the revisiting of their remains, after a period that would normally have softened the impact of the demise proper. My father refused to perform this 7-year disinterment on my grandparents, willing to risk offending against the local custom. Instead, he preferred that a sermon be said at their graves, perhaps because there is something immodest, unbearable in the unearthing of the archive, in its aggressive bringing up to date. I remember that when my grandfather died we had to dig up the grave where my cousin, only a few months old when she passed away, lay. All that was left of her were the few plastic toys that had been placed in the coffin.

The aggressive silence of a dislodged archive, in modern architecture, is doubled by the violence with which the archive is *left open*, like the white bones of a dead man who can find no rest, in totalitarian architecture. The way in which American restoration, for instance, makes possible the reconstruction of an archive as if it could live one more time (as at Knossos) has something of the harshness—though with the *reverse as meaning*—of this disinterment. The living-dead is, in the case of architecture too, a strange way of manipulating the archive.

There is, however, another form of survival of the archive which is, in fact, never buried, namely continued practice of the trade that created the previous layers of "sediment". Identical repetition (or with only a small degree of variation) of what once was *goes before* innovation, at least in what regards the activity of guilds. A particular way of treating the material, of decorating it, becomes the trademark of *a certain team of medieval builders* and leads to their being given the reason they are further called on to build. They are able to erect a monastery which is "much more beautiful and much brighter," yet still in accordance with the model that consecrated them. Against a prevailing background of redundancy, there are as few variations as possible; information or the "new" is reduced. It is virtuous to remain piously in the shade of one's forerunners; following in their footsteps guarantees one's grandeur. The past instills quality in present deeds: the more indistinct in relation to the archive, the greater the chances of the new edifice being fit for an archive and therefore of lasting. One becomes part of the past because one is already "old"; because one is part of an undeviating filiation.

Another manner of using the archive is the quotation. By means of quotation the new building invents for itself a pedigree or even *invents an entire archive with the burden of justifying the new presence* to justify its presence now. This is the reverse of the new–old symbiosis, in which the new is, if I may put it like this, the newcomer. On the contrary, in the case of the quotation what is invoked is the old brought into the new as a partner in its respectability. The quotation (which, as postmodernism teaches us, has an aesthetic function) operates against a background of difference between the new and the quoted object, which is somehow *shortcut* by the gesture of quotation. This short-circuits a prolonged amnesia. It is seen as endowed with the gift of eliminating the alienation between the new and the old edifice; thus, it is a form of "healing". This holds not only of historicist postmodernism, which uses the archive as a source of quotations without really believing in their role as a bridge between periods, but also of the recovery to the archive of individual sources of prestige. In other words, it is not a way of practising architecture which is recovered here (or continued, as in the case of the guilds), but of an individual thing, one of its final products. I quote such and such a monument, or one of its details, without repeating the process that made it possible.

Palladio's example provides us with an interesting means of understanding the *différence*: his manner of building (highly combinatory in relation to the recent archive of the Renaissance and also the deep archive of the Roman world) had an amazing career in Britain, from where it crossed the Atlantic to become almost the vernacular. American colonial architecture is almost entirely a reading (to a considerable extent unfaithful) of Palladianism. On the other hand, against this backdrop we might also consider the separate career of the Villa Rotonda in the work of Benjamin Latrobe or T. Jefferson. It became the ultimate example of a "democratic" house, an edifice that could in itself embody the values of the new American state. A particular manner of practicing architecture attains excellence in an edifice. By using it again and again, one can call again into presence: this very prestigious monument or style which is being quoted, the social rank of the customers who ordered it, the political, cultural, and religious environment that allowed it, the city or state where many others simply copy the excellent example of the mastery or collective state of grace in question. The Pantheon, the pyramids, the Hagia Sophia, the temple in Jerusalem, all these knots of intensity in the archive are revisited again and again because they have the ability to draw on the entire archive.

Co-Presence: The New Archive

There is a contemporary manner of starting a dialogue with *the built-in time of a new object*. Can a space be jointly inhabited; in other words, can we erect a new building without thereby eliminating the states through which the site has already passed and without relegating, in the process, the time they contain? Deconstructivists have come up with part of the solution; the other is provided by a postmodern view of restoration. I combine them under a sole generic term, "co-presence," a term I introduced in my book *Khora* (published in Romanian in 1999). Co-presence refers to the possibility of making now and then coexist in a single house or building. "Then" is not a specter, a good genius watching over and justifying the new building, but an indissoluble part of it.

The first manner of co-presence is represented by a new building on a given site that is equally "now" and "then". Co-presence implies the presence at the same time, at the same location, and, what is much more important, in the same undertaking (new building, urban arrangement, conversion of an existing building, restoration) of as many as possible of the significant *incarnations* through which the site—and, as the case may be, the building—has passed. In the case of Derrida's and Eisenman's *La Villette*, the authors, as inferred from Derrida's quote about the *khora*-grid, actually intended the joint existence of all the layers on the site. As a matter of fact, Eisenman is a sort of trailblazer of co-presence; see, for example, his Wexner Center in Columbus, Ohio. Built on the site of a former armaments factory, the new construction reminds us fragmentarily, as befits all memory, of what went before, somehow recovered as the meat of the present. Finally, the same Peter Eisenman turned the extension of the DAAP (the Design, Architecture, Arts and Planning College in Cincinnati, Ohio) into an architectural "Nude Descending a Staircase." The *imprint* of the existing building was moved to the site and the new house records as it were "stroboscopically," superimposed, the *successive stages* of this tectonic displacement. In the end, what we have is not a new building overlapping an old one, but rather an ensemble in which generating and generated form coexist in the same territory, explaining each other.

Co-presence is thus not only desired but even imperiously necessary, being a manner of the "saturation with being" of the place or the house subject to transformation. The new instance thus no longer represses or replaces the other spatial–temporal spaces, but is merely one of those concomitantly present. The old is not superior to the new (the traditional view), nor is the new superior to the old (the modern view). The two ages have the same axiological status. Of the two wings at DAAP Cincinnati, the new building needs the previous one the most. Here the past is more than a pretext of the design topic, growing into the new construction. The latter is woven organically, or perhaps Siamese-twin–like given that the old body also belongs to the modern repertory, to the other, to such an extent that a façade of the "old" body has become the interior façade of the atrium described by the new wing. The final ensemble looks like a body *with two different ages: it is both new and old*; something entirely new is added to an existing (or disappeared but brought back into life) building or fragment; the new one, after the joining, takes over the task of rewriting the entire organism. This radical hermeneutical approach to the matter of simultaneity presupposes the absence of a (sole) "text" that celebrates itself in favor of a contextual continuum and, especially, of an uninterrupted, constantly updated age. No house can, in fact, be actually present, being "always already" (Heidegger) submerged in the history of its own becoming.

This becomes obvious in the case of conversions, the second manner of co-presence. The house subject to conversion is "then", a "then" interpreted from the vantage point of the present, but used "now." It reveals its original age or successive ages, but makes no secret of having undergone a facelift, following which, even if it had been a successful solution (Gadamer), it becomes nonetheless something entirely new, often a mere carcass for an entirely new content.

The rewriting of old buildings to accommodate new roles (sometimes fundamentally opposed to the original one) is seldom easy. The contrast between what is visibly old but just as visibly renewed or even updated is what generates these tensions, more than the difference between the roles. As a fellow of Collegium Budapest I had the privilege of working for 5 months in the former city hall of Buda, on Szentháromság Square, opposite the Mathias Cathedral. The interior of the Renaissance building (in the local sense of the term) has been turned into a modern environment of hi-tech electronic apparatus and office furniture, with computers everywhere, naturally. The contrast between the stone framework on the one hand, and the avant-garde lighting fixtures and the Internet cables, at first spark off a certain tension, but this is quickly offset by the charm of the place. But contrasts of this kind can be even more dramatic: elsewhere in Budapest, reminiscent of similar interventions in the United States and Western Europe, a mill on the eastern bank of the Danube, facing Gellért Hill, is soon to become Gizella Court, a center for yuppies offering high-standard housing, offices, and an adequate restaurant. Other examples of co-presence in conversions come from the historical areas of Western cities: whisky distilleries in Edinburgh converted into dwellings, and churches in the same area converted into housing and industrial buildings turned into unreal, involuntary sculptures or modernist installations, surrounded by parks. More recent London examples include the transformation of the Bankside electricity plant (situated on the Thames across from St. Paul's) into the new Tate Gallery or that of another power station in Chelsea (Lot's Road) into a housing ensemble (arch. Terry Farrell).[8] There is a certain Gothic air about these worrisome conversions, but this is doubtless to be preferred to the scorched-earth tactics presupposed by modern architecture.

This phenomenon is probably even more visible here than in the United States where the *centers of skyscrapers of modern downtowns* make room for the unprecedented development of what is left of the historical areas, which are brought up to

[8] See *Financial Times* (20 May 2000, A5), "Converting power stations is not an easy way to earn a crust . . . but they can provide the most dramatic spaces, as visitors to the new Tate Modern Gallery at Bankside realize."

date by cosmetic and interior reshaping. These urban gestures often resolve—as an alternative to demolition—the problem posed by old warehouses and factories, and the ruins of industrial society in general. In summer 1999, I visited two cities fully engaged in recovering their inner-city areas so that they would be more in relation to the downtown area: Rochester, New York and Cincinnati, Ohio. Both are revealing examples because, being relatively small, the skyscraper district has not managed to devour the old one entirely (as a rule, the latter dates from the nineteenth century when it, in turn, eliminated the competition). The process of restructuring and bringing back to life what 5 years previously had been in ruins and a bad neighborhood is amazing and indicates, it is hoped, a change of direction on the part of the American city towards the recovery of the downtown area which, in a contorted way, is also a pilgrimage to its own past: the space of collective memory.

Layers, Scars, and Folds: The Painful Archives

The archive often becomes a problem (and co-presence difficult) in the case of the restoration or reconstruction of historical sites when a choice has to be made between layers or between the layers in time and an entirely new house. The incorporation of the surviving fragments of the old layers (in other words, not their reinvention, as in the case of Eisenman's co-presence) seems to become an ever more fashionable tendency in the case of the construction of historical sites, as if the new house *would perpetuate* the "flesh" or substance of the old. The continuation of the cankered logic of the first disappearance by marking the *scar tissue* or the growth of the tumor, which does nothing but make more visible the intrinsic plague of destruction, seems to be the specialty of Lebbeus Woods. His projects for Sarajevo and Havana could provide a few lessons which, I am afraid, we may grasp only with difficulty and are unlikely to accept. Nevertheless, they follow the internal logic of destruction.

The question posed by Woods is: Why do we persist in camouflaging the traces of urban dramas when that is one of the causes of their repetition? In other words, Woods invites us to meditate on our attitude to the inconvenient archives of the immediate past: we bury them by camouflaging them under layers of reconstruction and new things, or, on the contrary, we preserve them as something living and therefore painful. Is there an intermediate space between these extremes? The artist himself seems to think so, although he opts for a variant closer to the extreme of the living archive—a healing without cosmetic surgery—where once there was a wound, let the scar be seen, no matter how "ugly." The Warsaw variant of Stare Miasto, just as politically loaded, constitutes the opposite case: healing without a visible trace (other than collective memory) of the extermination to which the city was subject. Budapest, likewise prey to a process of violent extermination during the Second World War, chose a more moderate variant: the preservation, sometimes, of the ruins in the new flesh of the houses or the preservation of the type of houses pulled down in the architecture of the new ones. The German cities left without a center sometimes put up a modern one in a desperate attempt to avoid the physical presence of the archive, especially when it was inconvenient. On the contrary, in Dresden, with a gesture just as ideologically loaded as the one which produced it, the ruin of the sacred space bombed in 1945 was preserved “alive” until recently, like the memory of a wound in the body of the city to remind us of the past and to prevent it from descending undisturbed into the depths.

Bucharest is not an example to follow either for the way in which it managed its prewar archive or for the manner in which the archive as it stood right up until 1989 was revisited in the following decade. Why should we believe that an international competition or, indeed, any other solution could erase the drama which occurred in downtown Bucharest in particular? Furthermore, why should we want it? To use tall buildings to camouflage the House of the Republic is a dramatic form of co-presence in which the new hides the “tumor,” but in such a way as to suggest that, in the midst of this concealment, there is something that must be swept under the carpet. By making this gesture of covering a canker with a new texture we do not heal the city; in fact, as a result of this it might perhaps no longer be susceptible to healing in the sense that it might be able to return to the patriarchal serenity it enjoyed before the destruction; but perhaps it can come to terms with its handicap and live, psychically at least, at peace with its presence, the way the deaf put up with their hearing aids or others with draining pipes in their abdomens. This is no longer normality, but at least it is a life in possession of the decency of its own infirmity, in which the being survives, accepted by society, without pretending to be a fashion model if it is a paraplegic. Perhaps I have overextended my allegory, but the message of Woods’ work, insofar as it addresses (post)communist cities, is this: If the canker is metastatic, let the patient know: don’t pull the wool over his eyes!

In other words, co-presence is a field in which the ingenuity of the architect puts into, sometimes violent, contact the past and the present, if not the (unwanted) future as well. Yet this violence engenders memories, conserving and attracting to itself the memory of the place. By ceasing to make room for their houses by eliminating the adversary, architects seem to understand that past time is essential in architecture and therefore in the life of the houses they create. The archives of a site’s layers are therefore involved in a symbiotic process. The old houses continue to exist and to lend what they have accumulated as a consequence of their longevity, always a quality associated with wisdom, seriousness, and, in art, also with aesthetic value, to the new houses which are added to them or into which they themselves are transformed. In turn, the new edifices make visible and present (also in the sense of duration) the old house near or in which they sit.

Memories and the City, Heritage and Urbanity

Space and Time Visualization as Advocacy Tool for the Importance of Heritage to Urban Development in Bucharest

Daniela Calciu

Abstract Working with the *already-there* is still debatable and difficult to substantiate in most urban settings, and especially in a country still struggling with a strong Communist legacy. Despite the foreigners' appreciations for the bizarre complexity of Bucharest, its structures are continuously being threatened by the authorities' systemic ignorance and indifference towards urban heritage. This mindset is largely supported by the inhabitants, whose awareness of the value of urban heritage has been biased by Communist slogans and by the poor conditions of these buildings and places. Germinating for the way Bucharest has developed from then on, the late nineteenth- and early twentieth-century buildings are being particularly threatened by this seemingly perverse continuation of the Communist demolitions, which holds heritage preservation in opposition with urban development in simplistic capitalist ways. Considering the multiplicity of memory, the erosions and sedimentations that make up our cities, this chapter brings to the fore and discusses the added value of *urbanity*—understood as mutual determinations between built forms and patterns of habitation—for defining and keeping the intertwining of conservation and development. Using ICT methods and tools such as GIS, 3D reconstruction, or digital images to illustrate the tales of old buildings and sites might open up the imagination and enhance urban engagement, thus offering more solid grounds for dialogue between inhabitants and politicians, the better to substantiate one particular decision or another, when working with the *already-there*.

Keywords Urbanity • Heritage • Communication • Advocacy • Urban engagement

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Prologue

On Monday, April 4, 2011, the news website HotNews.ro reported that "because their voice wasn't heard in Romania, a group of NGOs concerned with heritage conservation in Bucharest notified the European Parliament about the local administration's decisions to demolish an old area for opening the new Buzești-Berzei Boulevard." This situation is symptomatic of the authorities' systemic ignorance and indifference towards urban heritage, and of their lack of communication with citizens in the decision-making processes. To some extent, this mindset is also shared by a large part of the inhabitants, whose awareness of the value of urban heritage has been biased by Communist slogans and by the poor conditions of these buildings and places.

Buzești-Berzei is a very interesting case, as it managed to coagulate all the possible actions and reactions in the city, maybe for the first time in the last two and a half decades. It has a highly complex and entangled history, for which this entire chapter would not be enough. The very condensed story goes like this: the City Hall decided to implement an older idea of closing a traffic ring in the city by piercing a boulevard between Piața Victoriei (the government) and the People's House (the parliament). However, instead of following all the standard procedures for such an operation, it went ahead and expropriated and demolished a series of valuable buildings (for the local community, foremost) without the proper legal grounds. The NGOs contested, and the Court ordered the project be stopped. This was the first big victory of the civil society against public authorities in the last two and a half decades. The City Hall was mandated to negotiate with the Ministry and with the civil society, to define the legal and operational mechanisms for such a strategic intervention in the Romanian context. It generated the most debates and encounters between urban actors and stakeholders, and probably animated more professionals than any other cause.

The symbol of the résistance became Hala Matache (the Matache Market Hall), if not for its inner value as a building, but as an anchor of the entire marketplace and neighborhood. After numerous protests (flash-mobs, human chains, blog entries, petitions, public debates with foreign guests, manifesto projects, alternative solutions, exhibitions, publications, etc.), the situation seemed finally to be heading towards a more democratic and up-to-date approach, supported by a spatial planning which fit the functional demands of the City Hall and also kept the Market in place, until the spring of 2013, when the City Hall decided it was less expensive, therefore more pertinent, to "move" the market hall than to deviate the sewer system.

The hall was eventually demolished completely, and the formerly vivid community seems to have already scattered away. The last standing piece of memorabilia of the nineteenth-century neighborhood, the "Matache Restaurant," has just been rebranded under a different name (in Spring 2015). There goes the final act of one of the most powerful civic actions in post-Communist Bucharest, alongside other historic places being destroyed by the desire to "build anew."

A close look at this case exposes the entirety of power plays and relationships, as well the early stages of what we would like to call participatory urban planning, when conflict still seems to be disappearing under oppression, and small victories of the civil society are still provisional and ultimately rendered irrelevant for the course of action.

Furthermore, this case reinforces the timely need to reach out to the inhabitants, especially in a poorly understood city, with a rather unknown and neglected history, and with no real care towards its structures. This coincides with the overall need of architects all over the world to reinvent themselves and their practice, as well as their instruments, to better face the forces of current upheavals, and to be more able to respond to the new challenges and needs of our society.

In this context, the reflections that follow first touch on the nature of the contemporary urban project, then question the place and role of built heritage, therein. The text builds on two main ideas: that the stakes of the contemporary urban project are relational rather than formal, embodied by the concept of *urbanity*; and that heritage is a valuable resource for (re)establishing these relationships. The purpose of the text is to set forth the need to use the new advances in virtual reality and imaging technology to generate a visual support for reconstructing heritage and memory, with a user-friendly interface, in order to communicate heritage values effectively to the nonspecialized public, in an effort to promote public participation and knowledge-based urban policies.

Notes on the Contemporary Urban Project

Constructing contemporary cities, both in discourse and in practice, has ever less to do with building anew, and ever more to do with resuming, resignifying, and reusing what is already there. The reflection on urban development has long replaced the dominant model of conquering new territories with the more subtle one of inventing new dwelling skills (Choay 1988), in the sense of assembling new meanings in spaces with no apparent significance to urban life, and new building skills, in the sense of reconfiguring already built areas.

Following the reflections of the 1980s, many of which were directed towards “investing the urban with urbanity” (Habermas 1981; Cohen 1984; Virilio 1984; Choay 1990), the approaches of the “RE-generation of the 1990s” (Ellin 1999) embraced the strategies of re-evaluation and revaluation, and promoted the model of the city growing over itself, through emotional reconnections to the old: regeneration, recycling, revitalization, rehabilitation, restoration, and so on, of what was left from former urban moments, overlaid in time, on a same territory.

In consequence, the postmodern project has had a rather condensed route over the last five decades, from the solitary architect’s vision to a process outlined by disciplinary transgressions and crossbreeding, and then to increasingly involving citizens at the different levels of decision making. As a result, the conceptual instruments of this “humanized urbanism” require constant questioning and redefinition, seeking reconciliation between men and cities. One of the best examples could be the French concept of *maitres d'usages*, which is the acknowledgment of the inhabitants as main actors in the urban project, and which follows the already consecrated categories of *maitre d'ouvrage*, the one who defines the project, and of *maitre d'oeuvre*, the one who carries it.

No matter what concepts we choose to create or use, they all embrace the need for collaborative processes to define the values and principles of our ideal place of life. From this point of view, as well as considering the nature of the issues and approaches it raises, the contemporary project can be called, without much reserve, a "project of urbanity".

In 1956, Josep Luis Sert led the way to a new academic discipline, of urban design, intended to bridge the gap between urban planning (bureaucratic approaches, mainly quantitative and unrelated to the spatial dimension of the problems, founded solely on the theories and methods of social sciences) and the exclusively spatial concerns of functionalism. After five decades of practical and methodological formulations, but also of searches to delineate its purpose and scope, urban design meets an appealing definition in the same home of the Harvard Graduate School of Design, through Rodolfo Machado's words, reported by Alex Krieger (2004): "Urban design is the process of design that produces or enhances urbanity." Adopted by the urban discourse towards the late 1990s, urbanity is often invoked, but still very little conceptualized. Therefore, how to operate with this notion is still an open question, as is its content.

Urbanity

In the Latin and Anglo-Saxon languages, "urbanity" comes from the Latin *urbanitas, atis* defined as life in Rome, manners of the city, civility, bon ton, *savoir-vivre*, *usage du monde*; politeness (of language), elegance, grace, good taste; fine spirit, presence of mind (Gaffiot 1934). Urbanity is, primarily, as Choay also writes, "a moral quality of that which belongs to the city." She then continues by writing that urbanity is "a quality of individuals or societies, which cannot be reported to physical agents [but which] we use, however, by abuse, as a synonym for refined urban ambiance" (Merlin and Choay 2000). Indeed, "urbanity" belongs, traditionally, to the philological and humanistic domains, as Edwin Ramage defines it: the "outward manifestation of an inner culture acquired from residing in or at least having contact with an urban center" (Ramage 1973). It entered the discourse on city building together with the lexical and semantic whirl produced in recent decades around the "urban" and its cognates, agents and victims alike of the criticism and (over)theorizing of architecture and urbanism.

However, urbanity appears to be more than a linguistic ornament in the discourse and approaches to understanding and working on the urban physical space. The hope attached to this concept seems to be related to its potential power of leading towards a new, complex, and highly problematic responsibility of urban design, of aestheticizing the relation of the subject to urban space.

According to Merlin and Choay (2000), civility and urbanity have become fundamental values of urban societies over the last decades, confronted with the separation from modernist aesthetics, and in the context of the explosion of human sciences. Despite their similar meanings of politeness, order, respect, courtesy, manners, and the like, "civility" has kept the nonfigurative character, referring only to social rituals, whereas "urbanity" is precisely the link between these rituals and urban spaces, in two ways: it nominates certain conduct (with)in the city; and, on the other hand, it raises the question of the spatial-figurative conditions that favor the definition and growth of such conduct. These two sides of urbanity are actually in correspondence with the main challenges of our urban policies today, dealing with the (re)construction of the metropolis as a place of urbane manners and attitudes. How to define a new figure of the city, or of the urban phenomenon, and how to reinvent social practices associated with its spaces?

Looking at the modern history of the city, urbanity appears to be invoked mainly in moments of crisis. The first one corresponds to the birth of the industrial city and the need to accommodate all the changes brought on by the passage from the *Ancien Regime* to the modern states. Haussmann's project for Paris starts from the question, "What municipal bond can hold together two million inhabitants?" It is, in this sense, a project for a new urban life, according to the new social forces and economic energies put into motion. Today, the postindustrial city has not only suspended the modernist model of urban growth, but it is also denouncing the loss of marks in relation to the traditional city, up to the radical separation of the two forms of human settlement: the traditional city has often taken the form of "museum-islands" in the urbanized territory, as historical centers.

The call for urbanity and for redefining its content is a reflection of at least two symptoms of the break from tradition: the gap between the pace of social and economic phenomena and the possibility to conceive the urban fabric accordingly; and the shifts that the meaning of the concept of urbanity has undergone, from something that used to be appropriated through education and insertion in a certain natural continuity, to something which has to be produced by architects as external agents. The same questions that had determined Haussmann's project in the nineteenth century have been reappearing in the last years. "What makes a city continue to exist economically, socially and politically, despite so many differences and fragmentations? What makes a city, despite the often chaotic appearance, have a meaningful order, which some people love and identify with, while others reject as source of multiple evil?" (Zijderveld 2009).

To Zijderveld, urbanity (a synonym of urban culture) is the symbolic infrastructure of a city, overlapping the technical infrastructure. It is what gives meaning to the word "collective," and what allows us to talk about urban identity. The contemporary discourse has turned the urban into a noun, dissociated it from urbanity and opposed it to the city. Today's "urban" is the result of an urbanization deprived of urbanity: the spread of technical infrastructure, unaccompanied by the symbolic infrastructure. In terms of cultural or symbolic dimensions, the urban has no content of its own, but is a condition of possibility (of urbanity). Because the roots of our current urban crisis are associated with the discrepancies between the sprawling infrastructures and the underdeveloped ways of life, the invention of urbanity is an effort aiming to retrieve urban experience by finding new meanings in the existing infrastructures. "Inventing new types of settlements invested with urbanity is our only defense against the destruction of landscapes by the sprawl" (Choay 1994).

Used with the meaning given by Choay, of "mutual adjustment of a certain form of urban fabric and a form of conviviality," the notion of urbanity is a conceptual tool that can accommodate the successive crossings between lifestyles and built forms. At the same time, this operational definition is open to the plurality of figures of urbanity, and can integrate the wide range of features and differences within the metropolitan territory, which are indispensable to our urban society:

> What I think of as urbanity is precisely making use of the density and differences in the city so that people find a more balanced sense of identification on the one hand with others who are like themselves but also a willingness to take risks with what is unlike, unknown... it is this kind of experiences that make people find out something about themselves that they didn't know before. That's what urbanity is at its best... To me, how to privilege the notion of difference that is what urbanity is all about. (Sennett 1994)

Despite the cautious acknowledgment of urbanity's role within the discourse formation of urban design in the last few decades, in retrospect, it did act as a catalyst for the retrieval and diffusion of a refined spirit, seeking out new technologies of the self (Foucault 1988), concerned with the beauty of the individual existence and of the common life among the others. It can also be argued that the contemporary experience of this concept has led to new norms of conduct, guided by the precepts of sustainability, and generative of new models of education for awareness empowerment, and participation to constructs such as ethical governance, sustainable development, or solidarity in urban policies. The contemporary message of urbanity is that the experience of the city cannot be complete without the responsibility and the informed exercise of civility and citizenship; the concept can also be read as a synthesis of the premises of a certain type of sociability, based on cosmopolitism, cultural relativism, and social tact.

First, the contemporary experience of urbanity is about the way in which we define ourselves as urbanites, namely about the way in which we learn how to feel at ease traveling the diversity of worlds that the city has to offer, and to take a stand with regard to their contours. Second, it is about the way in which we define our civility, namely the rituals of our interactions and dialogue with the others, no matter how they might be different from ourselves. Third, it is about the way in which we define our citizenship, and about how we participate in the political life of our community. Finally, it is about the way in which urban space responds to, and affects, these modes of the definition of subjectivity. This would be the starting point of urban design, as the geometrical place of the concern with the aesthetics of the relation between the subject and urban space.

These observations lead towards new methods of the architect, methods that emerge from the union of research, design, and pedagogy, and develop circularly between the need to participate in institutional changes, and the need to encourage mentality changes. Some of these methods are: advocacy and debate (through the written or spoken word, as well as through visual representations); involvement and attraction of others in actions and events to raise awareness of, to explore, and to take a stand regarding the subtle realities of the city, interpellation and exposition, translation and dissemination of technical/expert information, and so on.

To sum up, the professional experience of the concept of urbanity starts with the interest for the multiplication of occasions and circumstances that favor the definition of the individual as the subject of one's own urbanity, and continues by confirming the need to preserve its ambiguity, as well as the opportunity of taking it on as the geometrical place of the concerns with urban common sense and with fair action on and within the city fabric.

Starting from the pursuit of new dwelling skills (*savoir-vivre*) and new building skills (*savoir-edifier*), our ideas of development of the city are constantly reclaiming reinventions and redefinitions of the principles and methods of (re)assembling and (re)articulating the *already-there*, placing the legacy of the past within the topical issue of inventing the new urban commons.

"Humanized" Heritage

Consequently, heritage holds an increasingly important position in political and administrative documents, from the European level down to the local governance agencies: it is an extremely valuable resource, not only for preserving local identities, but also for community development and local economies, as an asset or premises for creative business ideas.

However, this is still not clear in Bucharest (or Romania), where heritage preservation and urban development are still perceived as opposing one another. The very few exceptions are too small-scale to shift the paradigm, despite having been promoted within several attempts to increase the inhabitants' and the creative entrepreneurs' role and engagement in heritage management. At the same time, the authorities' efforts at preserving the past are mostly directed towards the legal and technical issues of heritage processes, and far less towards creating the mechanisms and the processes that could actually support the balance between conservation and new development. The civil society's struggle to save one building or another is regarded as an act of cultural elitism, as a fad or a luxury that should not be gratified until economic growth has been ensured. These attitudes reflect an approach to heritage in terms of an act that freezes the city and blocks its development, and not as a dialogue between the memories of places and the new dynamics seeking to increase the quality of the various urban ways of life.

At this point, any operational tactic to subvert this dominant perception needs to start from the observation that the site's present is not just a pellicle, but the entire depth of the narrations embedded in the traces and remnants from the past; upon their readability lays the construction of new stories. The general acceptance (in Europe) of the multiple forms of urban existence today has paved the way towards the acceptance of the plural and various forces and mechanisms that have been shaping the city figures and memories throughout its history. Still far from sharing the principles of pluralism, Bucharest is a fertile ground for complex approaches to heritage conservation and urban development, which could make use of the (still extant) multiplicity of traces (and memories) of often incompatible layers, without claiming to preserve either one at the expense of the others. In other words, Bucharest does pose a challenge in working with concepts such as the palimpsest or sedimentary accumulation.

To look at the city through the palimpsest metaphor is to understand it as a complex layered structure and to be able to expose the overlapping urban moments. The palimpsest has a time of writing, one of correction, one of erasure, and then of rewriting, which provide a sense of duration and open up a manner of reading the city as condensed memory, with its continuities, ruptures, and discontinuities. The palimpsest flattens the past and updates the layers, making them visible and giving clues for the rewriting of the present. The sedimentary city metaphor, and the implied (geologist-like) delving into the depth of layers, thicken the present and help explain it, providing clues about the nature of the different slits, still present or faded away.

One way or another, both metaphors inspire new methods of (re)writing urban histories that are more useful to the contemporary project, in a double mirroring between the look towards the past and the look towards the future, between urban shape and collective memory.

The look towards the past. Looking to understand the city doesn't mean choosing between continuity and change, but capturing the articulation of the two, grasping for inflections or intensifications of certain tendencies rather than radical breaks. The old may fall apart, but it never goes completely away. Hence, layers are never accurate or sharp, but rather fringed. The historical depth settles the successive memories. Reading the city as an immense archive, one can decipher intentions, projects, and concrete actions: layered, overlapping, distorted, and conflicted. Many of the surprising effects of the city today are the result of long processes of cumulative selection.

The look towards the future. The urban experience cannot be dissociated from the duration engraved in the city forms, condensed presence of all past layers. The coexisting urban contrasts offer the possibility of different patterns of dwelling. However, this potential depends on our ability to remember, to listen to the multiple memories echoing in the diversity of spaces and places. Looking for the sources of meaning of the city, Göran Sonesson writes that urbanity is not conditioned merely by the contiguity of a large number of homes, but by the publication of space:

> The meaning of the city is not to be found in its buildings. Or, at least, it is not exhausted by them. It is not in the interstices, nor even exclusively in the passage-ways leading up to famous landmarks. It is elsewhere. And yet it is no doubt spatially grounded. (Sonesson 2011)

Looking for meaning in architecture, the semiotician tells us, begins with drawing the limits of a portion of space (urban landscape) which tends to cause a certain behavior, and to identify the potentialities for action that it opens up. Under the influence of these practices, the city gives itself back to erosion, decantation, and resedimentation, in a process of selective accumulation.

The French geographer Marcel Roncayolo (2002) suggests reading urban layers by leaning on the notions of landscape, "relations between society and urban form," and social practices, those of the daily life, but also the exceptional ones, in times of crisis, maybe the "most revealing for the state of social forces and relations." In this respect, urban histories tell stories of the "succession of experiences in a same place," thus finding similarities with the approaches of archaeology or geology. However,

> it is less useful to reconstruct the successive stages in their integrity than to identify the conditions in which they occurred, historical processes unevenly spaced in time, but whose role we can see today in the fabric of our cities. (Roncayolo 2002: 181–197)

As stated above, the contemporary project lies on the premises of the city as a relational construct, as a place of multiplicity of lifestyles, respectively, as a place of copresences of all the remains and echoes of each sequence in the long process of its becoming. The innovation is rather the invention of relations between fragments, than their mere formal redefinition or reconstruction. To be in line with, and useful for the contemporary project, layers ought to be regarded as moments of urbanity, as frames or instances of the relation between the subject and urban space, regarded as a venue of experience (*foyer d'expérience*) in Foucault's terms: as the venue of possible knowledge, of normative matrices of behaviors, and of virtual modes of existence of the subject (1983).

Regarded as a moment of urbanity, the heritage object could be considered to the contemporary project similarly to what Foucault considers the document to be to history: neither a passive material, nor a trace that supports the reconstruction of past events. On the contrary, just as history is trying to organize the document, to define unities, totalities, series, or relationships right within the document, the project of urbanity places the heritage object right at the heart of reflections on the present; not as a mere articulation of new and old, but rather as the update and revalorization of the old itself, and its release towards new developments. In this sense, we can remember Leon Krier's approach (1980) to urban history, as an archive of spatial typologies, subject to critical reconstruction, meant to mitigate the relation between the old and the new, at the architectural and urban scales.

Foucault (1969) writes that, compared to traditional history, which salvaged the monuments of the past and turned them into documents, contemporary history is turning documents into monuments, aspiring to the condition of archaeology, drawn to its possibility of intrinsic description of monuments. A similar mechanism could be described through the progressive broadening of the categories of heritage: from buildings to protected areas, to tangible and intangible heritage, to cultural landscape and historical urban landscape. However, the designation as heritage can cause deep contradictions between preservation and development, as is often the case outside the Western European countries, and proven by the Romanian case.

As long as the aspirations of urban thinking go, they would probably be less inclined to seek the conditions of archaeology in its traditional sense, dedicated to silent objects, passive and separated from their context, than to seek the condition to which contemporary archaeology is aspiring itself: meant to retrieve a historical discourse around the heritage object, in its double hypostasis, as relic of the past, and mark for recomposing the present (through research and questioning, through integration in the relational system that is the city today, etc.).

In Guise of a Conclusion

To Choay, our need to preserve everything, or as much as possible, is actually the symptom of a profound ailment among autonomous technical objects produced by contemporary architecture; it is a symptom of our desire, however, to invent a new type of human settlement that will last, and a recognition that historic heritage might be "the only extant memory of those skills:"

> Why preserve heritage at all cost? Especially in an era when artificial memories can preserve the exact image, together with all physical characteristics? The reason might have to do with the built heritage being in fact the physical support of an endangered anthropological memory: it reminds us of a building skill, *savoir-edifier*, and of a dwelling skill, *savoir-habiter* (the two being inseparable) which the development of our new civilization is about to erase. (Choay 2008: 213–214)

Urbanity, as a concept and embedded mode of action (still to be explored), can hold together the meaning and the complexity of heritage, by its very composite nature, which gathers objects (as explicit traces) and inferred values. Hence, addressing heritage from the perspective of urbanity might open new avenues of interpretation and construction of use-values.

Conversely, heritage is one of the pillars of understanding the nature of contemporary urbanity, and contributes to its construction. By taking on the numerous strategies of working with(in) the *already-there*, heritage itself is put in the service of the new project, as a catalyst for inventing new urban skills and practices.

The monument is a relic of the past. The heritage object is the visible (tangible) part of the memory of a layer of urbanity, of a moment in the urban world. As any artifact, it opens pathways to anthropological knowledge, but also to urban history inquiries; in addition, as anchor of personal memories, it is a key to access a world of the probable, of the myth involved in the construction of meaning:

> the art of memory is based on the image of a place to remember an event that happened there. The place serves as container of memories, it triggers anamnesis, it anchors memory, and it is an antidote to oblivion. A place, a feeling, that's convenient, right? Proust's Madeleine! Starting from the image of a place, the imaginary is set into motion. It invents a story. The place turns into dreamt, experienced, hoped, unfulfilled plot; its characters get improvised lines, or even in complete accordance with the writing. In the end, the outcome

> matters very little; what is crucial is the correspondence between place and story. The story grows roots, feeds on the place then detaches itself from it; it makes it grow, it transfigures and mutates it. (Paquot 2008)

In cases such as Bucharest, ICT methods and tools could act as a very powerful tool in our search of lost time, and also in our attempts to advance democracy through risen awareness, awakened interest, and multiplied engagement to integrated urban development. In cases such as Bucharest, where monuments have lost their power to act as the madeleine of Proust, virtual representations of past lives and tales could very well be the last resort in triggering creativity around a derelict building or place.

The monument is a mark for recomposing the present. The heritage object belongs to our urban world of today; it is a resource for local development, economically and socially. However, the mere archiving can only turn cities into museums, collections of objects. For heritage objects to be truly a part of the current urban processes, they have to provide the freedom and the possibility to produce use-value. And to produce use-value, they need to become objects of this world, thus able to undergo processes of updating the values they embed or refer to, knowing that the perception and assessment of these values are subject to multiplicity of urban actors as of generations (Araoz 2011).

In cases such as Bucharest, monuments often need mediators to help redeem their discourse, their image, and their future.

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Part III
Digital Art

New Media in Architecture: Media Façades

Oana Andreea Căplescu

Abstract A new phenomenon emerged and it is called media architecture. What has started out as a form of advanced advertising on buildings is now changing how buildings are designed and to some extent how they perform in public space; from urban screens to media façades and onward to something quite unique and ever changing. This chapter discusses projects that investigate the relation between architecture, urban space, and media from technical aspects to aesthetic ones in an attempt to define the tools and the language of this new hybrid of media and architecture. Following the emergence of Web 2.0 and social media the buildings are infused with a lot of technology enabling them to shift the control of their behavior to the users thus becoming more adaptable and "social". A new generation of urban manifestations is beginning to form with experiments that span from entertainment to social awareness. Projects from URBANSCREEN's 3D projection mapping that are short-lived and nonintrusive to REALITIES:UNITED's Crystal Mesh or ART + COM and Ateliers Buckner's refurbishment of the BMW Museum with a permanent media display fused with the building show not only the customized approach specific to the digital culture but also the potential of using new media in the built environment. The language of media architecture is one of variability, mass customization, and complexity, and is in resonance with the current information society. The conclusion of the chapter stresses the need for architects' involvement in media architecture designs from the early stages underlining that media architecture is not just a trend in advertising but has the potential to form new urban spaces and intelligent custom buildings.

Keywords Media façades • Media architecture • Hybrid spaces

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New Media and Its Transition Into Physical Space

The term “new media” is defined by the *Oxford Dictionary* as a means of mass communication using digital technologies such as the Internet and was explored at large in Lev Manovich’s 2008 “*The Language of New Media*.” One aspect in particular is relevant to architecture: new media is the aesthetic layer of the digital revolution and because our culture has become increasingly visual, this influence played a part in the changes in art and architecture.

With computers entering in every domain, the practices have been rearranged and architecture is not an exception; not only has it changed the way we design, but an entirely new kind emerged: digital architecture. Exploring the new possibilities, such as complex shape modeling, algorithmic and parametric design, and digital fabrication, a new language is formed in architecture that responds to the new paradigm shift.

The way architects and designers approached this paradigm shift shows a large variety of responses: from Robert Venturi who treats media installations as an ornament, a highly advanced billboard, but just a decor for architecture, to Toyo Ito who considers that architecture today must be a form of media suite in relation to natural and informational environments, or to Lars Spuybroek’s vision of a metamorphosed ambient, an architecture “swallowed up by technology so that it becomes completely capable of absorbing and enhancing the body’s rhythm” (Zellner 1999).

Once the display and fabrication technology became available, digital architecture and its experiments started to leave the virtual realm and began to populate the physical one. Visions of the future city from movies such as *Blade Runner* or *Minority Report* do not seem so far-fetched anymore and reality seems to resonate more with science fiction. The city has become a mixture of architecture and media, all sorts of displays appear in and on buildings, in public and private spaces; a constant flow of data is inserted in everyday life through a large array of displays (TV, computers, tablets, mobile phones, billboards, urban screens, media façades). The physical space becomes augmented and the city receives a new media infusion. If the mass media are associated with the industrial era, with Ford’s assembly line and standardization, the new media represent the logic of mass customization, where anyone can choose his or her own way of life from a large array of options.

But no matter the method or techniques employed, the common ground is the belief that physical build space is variable, adaptable, and to a certain degree flexible and liquid. The media façades can be considered one of the ways architecture responds to the ever-growing need of change, adaptation, and interactivity; buildings are expanding through new media.

Dynamic Images in the Urban Space

> Of course, physical space has long been augmented by images, graphics, and type, but replacing all of these with electronic displays makes it possible to present dynamic images, to mix images, graphics, and type, and to change the content at any time. (Manovich 2006)

The need for messages in the urban space can be traced to ancient times, when people used carved wood plaques or wall inscriptions to enhance commerce or draw attention to different aspects of city life. Once regulations appeared it has become clear that the position of these messages is very important: places with high traffic gained more attention for advertising purposes. Billboards were born. Electricity transformed the cities and was soon adopted by the advertising and entertainment industry. Animation using the effects of on/off alternations of lights has spread and light shows have become the attractions of the city at night. Tourism and cultural programs used *son et lumière* shows to promote historical sites and monuments. But most of these were limited to the night time. LED (light-emitting diode) lights, now bright enough to compete with natural light have extended the reach of these events while raising questions about their presence in the urban scenery.

Dynamic images have accompanied us in the city for some time, so what's new? Their abundance, perhaps, but high density is not really something new; places such as Times Square in New York, the Las Vegas strip, and their counterparts in Japan, Singapore, Hong Kong, or Macao have functioned like this for quite some time. What's truly new is the fusion with the buildings. What started out as highly evolved billboards, the urban screens, have fused with the buildings they were attached to and produced an interesting hybrid. The media façade has become a phenomenon.

At the first Urban Screens Conference (Amsterdam 2005), Mirjam Struppek defined the urban screens as

> various kinds of dynamic digital displays and interfaces in urban space such as LED signs, plasma screens, projection boards, information terminals but also intelligent architectural surfaces being used in consideration of a well-balanced, sustainable urban society – Screens that support the idea of public space as space for creation and exchange of culture, strengthening a local economy and the formation of public sphere. Its digital nature makes these screening platforms an experimental visualization zone on the threshold of virtual and urban public space. (http://urbanscreens.org/2006/10/who-is-architect-of-this-media-facade.html)

But the media façades are not screens on a building; they are something more than that: they are an extension of architecture, a complex exhibit of contemporary art and technology whose manifest is just at the beginning. The media façades can be considered one of the ways architecture responds to the ever-growing need forchange, adaptation, and interactivity; buildings are expanding through new media. The social and economic demand of the moment requires companies to be in perpetual change, providing new content and products to be competitive and within this trend, architecture found a means to have an adaptive skin, in perpetual motion. Much like the Web 2.0 logic where the content is user generated, the city now provides buildings with interactive façades.

Behaviors: Passive, Reactive/Interactive

One of the most controversial aspects of the media façades is the content they disseminate into the public space. Because most media façades have been developed for commercial purposes, cultural content is seldom scarce. Nonetheless, conventional advertising is rarely used, most of them having custom media content specially designed for their displays. The technical aspects of the media façade dictate the content, its abstraction level, or artistic and cultural significance. Here resides the biggest difference between urban screens and media façades: urban screens have a tendency to emulate a TV screen or a computer monitor, whereas the media façades take a step back, orienting their content to more abstract and timeless content.

Most of the media façades have predefined content to display; much as with television or other mass media, the content is curated, a selection of clips or images is made and it runs in a loop. In the case of higher resolution displays the narrative becomes even more important, because they can run movies and images with a higher level of detail. A repetitive content becomes tiresome and obsolete in a short time, even when the loop is very big, therefore algorithms are used to create the randomness of the display. All these are passive behaviors; the program is predefined and the input is controlled by the curator.

Starting with Blinkenlights (http://blinkenlights.net/) in Berlin in 2001 interactive or reactive behavior has been explored. The power shifts from a curator or administrator of the façade/building to virtually anybody. In the case of Blinkenlights anyone could send images, messages, or short animations to be displayed on the façade from their mobile phone or computer; even play a game of pong.

In the case of the project *Touch* (http://lab-au.com/#/projects/touch/) developed by *Lab*[*au*] for the Dexia Tower in Brussels in 2006, anyone passing through the square could change the color, patterns, and movement of the lights making her own show over the city night sky.

Another interesting example of reactive behavior is the AAMP – Wilkie Edge (http://www.realities-united.de/#PROJECT,140,1) in Singapore done by *realities:united* in 2008 where the display is based on an algorithm that hacks into the main conventional LED screen signal creating a chromatic and sequential response to what's going on the main screen. Not user generated but not controlled by a curator either, the façade responds differently even if the same commercial runs on the main screen.

Resembling the developments of social media (such as YouTube, for example), the reactive/interactive media façade is a support for user-generated content; it becomes more than a database of dynamic images and it reflects the choices of a lot of users. Playing with a building is becoming an option. “An architectonically designed public space makes communication possible between people whereas a mediatectonically conceived public space becomes part of the communication” (Christoph 2010).

Technologies

The technical aspect has significant implications over the quality of the media façade, but surprisingly not in the same manner that we are used to with other displays; that is, higher resolution, brighter LEDs, or a wider range of colors does not equal a better quality of the façade. Different technologies apply for different purposes: although a temporary pavilion in an expo might successfully use a high-resolution display, a building in a dense urban area might use a much more subtle and less obvious one. Media façades employ a large variety of technologies, from mechanical moving components to projection mappings, but the most common and widely spread are the light-emitting ones. Depending on the type of building and the existing façade (in the case of later interventions) the façade can be opaque, translucent or transparent, layered or integrated, and more or less sustainable.

The light source also differs, depending on the desired effect and the dispersion medium: fluorescent lights with different shapes, halogen elements, and LEDs, placed behind clear or satin glass, Ethylene tetrafluoroethylene (ETFE), or other transparent and translucent materials. In the case of the Allianz Arena by Herzog and DeMeuron, the exterior is covered in over 2500 ETFE pockets containing three fluorescent lights (red, white and blue) displaying the colors of one of the resident football teams when a game is held, thus sending a message to the city and passersby of what is taking place inside it.

Sustainable approaches have been made combining a media display of LEDs with photovoltaic panels, as in the case of the Greenpix Zero Energy Media Wall (http://www.greenpix.org/) in Beijing or the Balance Tower (http://www.ag4.de/index.php?id=46) in Barcelona where a water tower's entire exterior surface is used for the display.

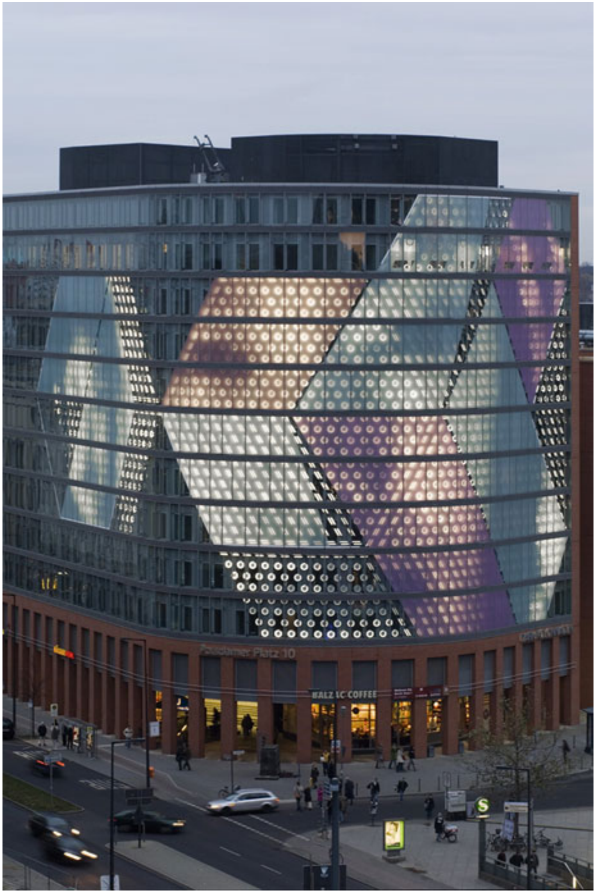
Some unique approaches have been made by *ag4 mediatecture company* in developing the transparent media façade using a steel mesh with small LEDs inserted in it, obtaining an effect of dialogue between the media content displayed and the space behind the mesh; a constant back and forth with vision, layers of visibility interchanging in a dynamic way. Also from *ag4* came an innovative idea of using wax as a dispersion medium for the LEDs generating a sensation of tactile need.

All these solutions push the media façades to a tailor-made approach to their designs, both in content and in shape and technology, further distancing them from the typical advertising billboard.

The Many Shapes of a Pixel

> The artistic possibilities for architecture that arise from this are still hard to grasp. Therefore many architects see the integration of pixels into the façade as a threat to architecture instead of seeing it as an expansion of architecture. (Tscherteu 2010)

Some of the most interesting approaches have been made by those who question the display and treat the pixel as an architectural element. The projects done by *realities*:*united* show a pursuit of deconstructing the display and questioning every element, from the rectangular frame of a screen to the shape of the pixel and the solidity of the façade. Among their first media façades is the BIX installation on the Graz Kunsthaus in 2003 where a low-resolution mesh of pixels made of fluorescent circular tubes covers a large part of the spatially curved building. A more elaborate version of the BIX was SPOTS in Postdamer Platz, Berlin (http://www.realities-united.de/#PROJECT,81,1), a temporary installation mapped on the curvature of the façade with different shaped pixels and colored films placed on the glazing.



The Crystal Mesh on UEC Iluma in Singapore, 2009 (http://www.realities-united.de/#PROJECT,138,1) offers a different image, that of a shattered screen that has shaped around the light sources thus generating crystal pixels of different shapes and sizes on the entire building. The latest project of the studio realities: united (C4 Espacio de Creación Artística Contemporánea in Cordoba 2011) presents a building with a massive façade where the pixels have cut into the dense thick skin of the screen at different angles, deeper than before, becoming hidden in the concrete and giving an indirect light.

These projects show, in addition to the custom-made solution and high level of abstraction, a deep aesthetic concern for the building and its installation when the lights are turned off, when the façades are unplugged.

Temporary Versus Permanent

Most of the media façades are now developed as permanent installations, but not the same can be said about the interior public space, where we usually find conventional displays.

The refurbishment of the BMW Museum in Munich aims at offering an "outside experience" while visiting the exhibit. The main design idea was to continue the outside street indoors by using the spiral ramp. The core of the exhibit is a permanent installation done by ART+COM and Atelier Bruckner called the BMW Square (http://goo.gl/Xqb8T) which spans across 700 m^2 using more than

1.7 million LEDs. The walls are covered by the monochromatic LED display over which are mounted two layers of satin white glass for light diffusion. The effect is a dematerialized, translucent, dynamic, and highly atmospheric space. The media content is made of more than 30 possible scenes, more or less abstract, evoking technical and poetic environments. The monochromatic images have a surreal effect over the exhibition, reflecting in the cars displayed, transforming the architecture in a soft skin with an inner glow, responding to the presence of visitors and making them part of the scenario. The dramatic scenery makes the entire exhibit seem in motion.

At the other end of the temporal range of media façades are the projection mappings with their short-lived existence, a technique patented by the *urbanscreen* studio. This very particular type of media architecture is noteworthy because it allows a nonintrusive approach to urban space, especially when monuments are involved, and allows a playful reinterpretation of the building. One of the best examples is the 555 Kubik project (http://www.urbanscreen.com/usc/41) where the projections completely transform the stone grid of the façade, giving it various depths and textures while accompanying the process of transformation with sounds of moving stones. It can be argued that these manifestations could hardly be considered media architecture, but considering that they are site specific, mapped to perfection on the architecture of the building and are made possible by the digital technology of surveying and modeling and precision projection, I consider them a part of the new media phenomenon in architecture.

The presence of dynamic images in the urban space gives a major advantage in drawing attention; we are a society fascinated by the visual and the new media have become a constant in our lives (be it on the computer monitor, a smartphone, the TV, or in a bus station, on or in buildings); digital images have become ubiquitous. In the case of cinema and television the public is required to focus their attention almost exclusively for a determined time while given the option of choosing the program to watch. Not the same can be said for the media façades, especially the permanent ones. Temporary media façades have a precise purpose (a sports event, a festival, an exhibit, etc.) and usually have well-structured media content, much as do the TV programs or cinemas. The content issue must be stressed when approaching a permanent media façade because their presence in the urban public space makes them a part of the social sphere, people coming in contact with them on a constant basis. For these kind of media façades are not suited as a conventional advertising program therefore alternative means must be developed.

It's Not (Only) About Advertising

> In principle, media façades have nothing to do with classical advertising. They are employed to give a building and, very often, the company behind a building an unmistakable public face. (Kronhagel 2010)

Utilizing new media in architecture will not replace the way architecture is understood and practiced. It just gives an alternative much as all media technologies that appeared did not mean the end of previous ones: television did not permanently replace radio or the written press, the Internet did not mean the end of books, and synthesizers were not the end of classical music. The effect is to open new ways of thinking, new approaches and a reconsideration of the old. It presents the challenge of redefining the things we used until then, be they spaces, telephones, or design techniques.

The media façades come in a lot of different shapes and sizes, evolving from the premise of fusing an urban screen with architecture. This variety cannot be examined as a whole, but contextualized, from one case to the other. We must always consider that more, bigger, brighter, and higher definition is not always better and usually damages the architecture. What kind of a media façade is optimal for a building depends a lot on the context of that building and on the abstraction level supported by its desired media content. One key aspect of the media façades is their size; because of this size they can facilitate new experiences in the public space, share experiences and new ways to socialize, and to associate these experiences with landmarks. The media façades promote the shaping of new urban spaces. New media-augmented spaces are now used in exhibitions and commercial buildings, indoor and urban public spaces, addressing the passersby and are almost vacant in residential spaces. Nonetheless, the technology tends to become invisible and it is quite possible to witness the proliferation of intelligent objects in our homes. Under such circumstances it becomes vital that architects collaborate with media and interface designers to ensure the desired behavior of such smart spaces. The potential of architecturally integrated electronic media to augment spaces (indoor or outdoor) is to generate interfaces towards virtual worlds.

> In 1960s, M. McLuhan said that our clothing and shelter are the extended form of our skin. From old times, architecture has served as a means to adjust ourselves to the natural environment. The contemporary architecture needs to function, in addition, as a means to adjust ourselves to the information environment. It must function as the extended form of skin in relation both to nature and information at once. Architecture today must be a media suite." (Toyo Ito, interview for *designboom.com* – http://www.designboom.com/eng/interview/ito_statement.html)

No matter how future spaces will be configured, the integration of new media in them will have to answer key questions: what are they used for and what purpose do they serve, and what kind of message do they disseminate in these hybrid spaces, and the least important answers given should be the advertising one.

For architects, this presents a new challenge, the seduction of a new technology where "the medium is the message" (McLuhlan 2001) and on the other hand, the need to understand and control a different language: the one of new media. Architecture deals with subtlety and a certain degree of secrecy (this is a rough and debatable generalization but it is useful in making a comparison) whereas new media are quite frank and explicit: one is solid, stable, and lasting; the other is evanescent, active, and very fragile but both are meant to achieve an emotional response and maybe this is why they can be blended to various degrees (resulting in different levels of abstraction). But no matter how concrete or abstract the media content of augmented public spaces is, the effect is dramatization of architecture. Of course it can be easily argued that architecture has developed its own tools for dramatic achievements, but the result is still static; animation is suggested, not displayed.

> Beyond the statics of the normal facade or simple light-facade a la Las Vegas with their rather stereotypical patterns, the contemporary, digital-technology-based mediatic facade allows of more and indeed subtler means of expression. (Wasserman and Buhlmann 2010)

But what about the long-term implications of this expanding phenomenon? The risk is an overflow of information and an oversaturation of stimuli that in the long run leads to an indifference towards both information and space. The cases of Times Square in New York or Shibuya Crossing in Tokyo with their overcrowded displays stand as proof that collages of screens (and commercials) if not attuned create only white noise and discomfort. Of course, these places function now on a very different premise; they have become attractions precisely because of this congestion and continue to draw attention (not to individual elements, but as an ensemble).

Another (quite different) risk to which augmented spaces are exposed is the misuse of their installation. A faultly media content can determine discomfort and angst in the way space is experienced. To avoid this as much as possible, architects and media artists must collaborate and the information stream must be designed in strong relation to the needs of the space in order to have control over the effect. "Images and fixed image sequences can quickly become subject to mental wear-out, and repetition can rapidly lead to oversaturation and repulsion from the viewer" (Lusche 2010).

In Conclusion

The presence of dynamic images in the urban space gives a major advantage in drawing attention; we are a society fascinated by the visual and new media have become a constant in our lives (be it on the computer monitor, a smartphone, on TV, or in a bus station, on or in buildings); digital images have become ubiquitous. Utilizing new media in architecture will not replace the way architecture is understood and practiced; it just offers an alternative, much as all media technologies that appeared did not mean the end of previous ones: television did not permanently replace radio or the written press, the Internet did not mean the end of books, and synthesizers were not the end of classical music. The effect is to open new ways of thinking, new approaches and a reconsideration of the paradigms; it presents the challenge of redefining the things we used until then, be they spaces, telephones, or design techniques. New media-augmented spaces are now used in exhibitions and commercial buildings, indoors and in urban public spaces, addressing the passersby, and are almost nonexistent in residential spaces. Nonetheless, the technology tends to become invisible and it is quite possible to witness the proliferation of intelligent objects in our homes. Under such circumstances it becomes vital that architects collaborate with media and interface designers to ensure the desired behavior of such smart spaces. The potential of architecturally integrated electronic media to augment spaces is to generate interfaces towards virtual worlds. The architecture's native "virtuality" is amplified by the use of new media and leads to the development of new expressive techniques; in other words, the need arises for coordination between architecture and media, not only on a technical level but also to study the effects of these hybrids on human perception and to avoid an oversaturation with stimuli of our environment.

Augmenting interior or outdoor spaces, with or without a commercial end, is another way contemporary architecture breaks from the modernist tradition. What is seen by some as an ornament and by others as a means of adapting to the demands of the digital society, has brought a new approach in design: interfering and blending time variables, dynamic adaptable behaviors, interactivity, communication, and architecture transforming stability in movement and dematerializing solids. To some extent this is the promise of the early digital architecture experiments, reaching for changing every constant with a variable and creating adaptable environments.

The digital revolution has touched every aspect of contemporary society. The technology has yet to reach its maturity and it is difficult to predict when that will happen. Under these circumstances it is hard to grasp the long-term effect of new media, but one thing is certain: the possibility of configuring new spaces, virtual or physical, public or private, indoor or urban ones, cannot and should not be ignored.

The way these spaces are devised, manifest, evolve, and relate to users and society in all their complexity is the challenge facing the media-architecture. I believe we are witnessing the forming of a new discipline at the border of architecture, media, art, technology, sociology, communication, philosophy, and image science. We, as architects, have to understand the language of new media and how to work with it not only because it is part of our everyday life but because the hybridization of spaces is just at its beginning.

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Digital Art Conservation: Review of the Book and an Itinerant Exhibition Resulting from a European Project

Maria Boştenaru Dan and Alex Dill

Abstract "Digital Media Art in the Upper Rhine Valley. Conservation – Restoration – Sustainability" is a European project that ran from January 2010 to December 2012 by ZKM (Centre for Art and Media) and five partners from France and Switzerland in the upper Rhine valley. The exhibition, entitled, "Digital Art Conservation. The Challenges of Conservation," curated by Bernhard Serexhe, Chiara Marchini Camia, and Arnauld Obermann was presented to various partners. It featured the 10 case studies from the project, from iconic media art pieces such as Jeffrey Shaw's Legible City to contemporary Macromedia Director works such as Antoine Schmitt's "still living". Older works display the problem of hardware that became difficult to preserve, sometimes of analogue signals, which drew attention to the future of the contemporary. Some works were updated in the framework of the project. A book was published afterwards, with the same title, on the theoretical background.

Keywords Digital art • Conservation • Software • Art exhibition

Introduction

"Digital Media Art in the Upper Rhine Valley. Conservation – Restoration – Sustainability" (short title "Digital Art Conservation") is a European project that ran from January 2010 to December 2012 and was cofinanced by the European Union's INTERREG IV Upper Rhine program (http://www02.zkm.de/digitalartconservation/index.php/en/). Participating partners were Conseil Général du Territoire de Belfort – Espace Multimedia Gantner, Ecole supérieure des arts

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décoratifs de Strasbourg, Haus für Elektronische Künste Basel, Hochschule der Künste Bern, Vidéo les Beaux Jours, Strasbourg, ZKM|Center for Art, and Media Karlsruhe. Project activities included symposia, case studies, survey, teaching, exhibition, and publication. The exhibition, entitled, "Digital Art Conservation. The Challenges of Conservation," was presented at:

– ZKM|Zentrum für Kunst und Medientechnologie Karlsruhe (29.10.2011–12.02.2012)
– Espace Multimédia Gantner, Bourogne (25.02.–28.04.2012)
– CEAAC, Straßburg (16.06.–23.09.2012)
– House of Electronic Arts Basel (18.01.–31.03.2013)

The exhibition was curated by Bernhard Serexhe, Chiara Marchini Camia, and Arnauld Obermann.

In May 2013 a book was published with the results (*Preservation Of Digital Art: Theory And Practice. The Digital Art Conservation Project*, B. Serexhe (Ed.), 2013, Ambra V, Vienna, 665 pages, 174 images in color, 30 images b/w, in 3 languages: English, French, and German). The book layout is an artistic one, with full page images.

We visited the exhibition at the House of Electronic Arts in Basel on the 2nd of February 2013, and read the book on our subsequent visit to Karlsruhe in 2014.

The Exhibition

The exhibition in the House of Electronic Arts Basel (Fig. 1) features the 10 case studies in the project. It is organized on two floors: the ground floor and the basement. On the ground floor there are the works that are running on a computer monitor, and the basement features those which come closer to projections on wall-like screens, because of darkness, with one exception, the one that is conceived as a wall projection itself.

In the following the exhibition pieces are described, along with the conservation measures that are explained on boards next to the works.

1. Nam June Paik: Internet Dream, 1994 (from ZKM|Center for Art and Media), a wall consisting of 52 monitors displaying images from three separate video sources. Such "videowalls" characterized the work of the artist from the 1980s on, focusing first on television, but in this work on the then new Internet. Special conservation works were required for this work based on an analogue splitting system, different from the other digital work case studies, but, through conservation, it is likely that the work will become digital, and thus the exhibition.
2. Herbert W. Franke (German artist): ORCHID, RAHMEN4, TROPIC, ABROLL3 1884–1992 (from ZKM|Center for Art and Media) are four artistic computer programs, from which the unnumbered ones were created on a DEC

Fig. 1 Exhibition entrance (Photo: M. Bostenaru 2013)

Professional 350 microcomputer, and the other two on a 386 PC. These are a donation from 2007, and the preservation was developed together with the artist, including that a software emulator on a contemporary operating system was employed, according to the exhibition documentation.

3. Hervé Graumann: Raoul Pictor cherche son style (Fig. 4) 1993 (from FRAC Alsace) is a Macromedia Director 4 movie, in which Raoul creates unique paintings, which are printed, and can be taken by the visitor, but never repeated again. According to documentation today, the artist created a new version for the iPhone (2009). A hardware preservation was made possible by availability on secondhand market.
4. Antoine Schmitt (French artist): still living, 2006 (from Espace Gantner) shows three (H, I, J) of a series of ten works by the artist: graphics generated by the world of business (pie charts, bargraphs, etc.), animated by the artist. It is yet another movie done with Director, in Director 10, and thus running on the most recent versions, being one of the newest works in the exhibition. From the experience with older works, the artist opted this time for an executable program.
5. Samuel Rousseau (French artist): Untitled (Video Wallpaper) 2003 (from FRAC Alsace) are playful animations projected on wall surfaces, to which they adapt. In Basel, the wall is opposite the entrance on the ground floor (Fig. 2). Here only a backup strategy was employed.
6. Marc Lee (Swiss artist): TV-BOT 2004 and 2010 (from plug.in) shows two versions, 1.0 and 2.0 of dealing with the information on the World Wide Web to

Fig. 2 Projection on the wall (Photo: M. Bostenaru 2013)

broadcast it as in television news. The original was done in RealPlayer and needed to be updated because of dependence on the Internet to Adobe FlashPlayer, which ran together with an update of the content, for example, including Twitter. The original version exists today just as a video record of a certain time. See in this book that Marc Lee also developed an art work for the e-installation by Munoz et al (2016).

7. Jeffrey Shaw (Australian artist): The Legible City (Fig. 3), 1989–1991 (from ZKM|Center for Art and Media) is not displayed as such in Basel, as the original was already available at that time at the ZKM. It is a milestone of media art. Riding a bicycle, the exhibition visitor can explore Manhattan, Amsterdam, and Karlsruhe, which are represented as 3D city models consisting of letters. The letters form words connected to the displayed history. The exhibition booklet informs us about the origins of interactive art works of Jeffrey Shaw coming from the "expanded cinema" movement. In this case ZKM adopted an expensive hardware preservation in order to be able to transmit the analogue signal of the bicycle to the digital city models, and a long-term solution is still looked for.
8. Michael Naimark (American artist): Karlsruhe Moviemap 1991 and 2009 (from ZKM | Center for Art and Media) is a new form of cinematographic local urban landscape, with an interactivity reminiscent of computer games of the time. A more contemporary version creates a 3D illusion with stereoscopic glasses and a touchscreen. This transformation went along with preservation, of

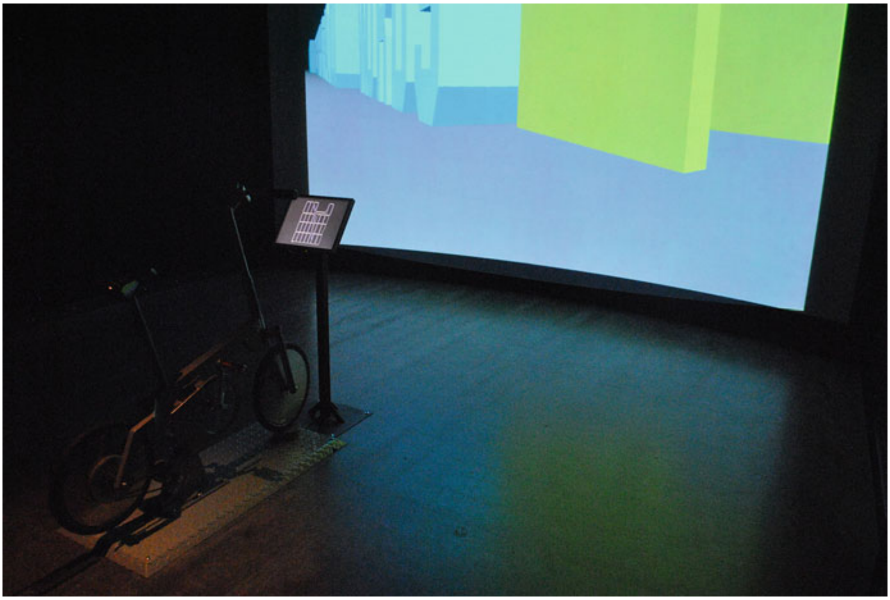

Fig. 3 Legible City (Photo: M. Bostenaru 2013)

hardware from the original analogue laserdisc to digital QuickTime. This new version was done by ZKM in accordance with the artist, and using digital photography instead of the film in the 1990s. Although this reinterpretation was done, the hardware migration is also valuable because of the historical record of the city 20 years ago.

9. Jodi (Joan Heemskerk and Dirk Paesmans): OSS/**** 2005 (from Espace Gantner) is a work exploring the screen, the mouse, and the keyboard as elements of the computer. It was updated in 2005 by the artists reworking it into the newer Director version, with some loss. The option in the exhibition by Espace Gantner was to distribute the CD ROM, a medium obsolete today, despite having the rights for the (https://oss.jodi.org/), much more contemporary online version.
10. Nicolas Moulin (French artist): Viderparis 1998–2001 (from Musée d'Art Moderne et Contemporain de Strasbourg) shows a compilation of 50 images of Paris void of any human traces, shown in alleatory order. They are projected with a digital video projector. The conservation strategy is information-preservation strategy and data backup.

The conservation challenge with which these works dealt is the fact that the hardware and software environment for which the artworks were conceived changed since the time they were developed, for some of them almost 25 years ago. Herefrom come the preservation solutions, for both software and hardware. For some of the works, such as Karlsruhe Moviemap or The Legible City, the hardware doesn't include just the display screen of the computer but also the

Fig. 4 Printing of Raoul Pictor (Photo: M. Bostenaru 2013)

navigation items (e.g., for Legible City it is a bicycle; Fig. 3). But also for other works preserving the hardware was essential, such as in case of “Raoul Pictor cherche son style,” designed for another shape of the screen than today’s (Fig. 4). Additionally, early Director movies such as this one cannot be displayed on today’s MacOS. It is not the only Director movie displayed; another one is OSS (Jodi) for which CDs were available, or the still living pieces, showing the glory time of Director for multimedia work.

The conservation works followed the steps of identification of the characteristics of the work, artistic classification, technological findings, existing damage, interview with the artist, conservation concept, editing protocol, and other problems, according to a table at the entrance. The interviews can be listened to on a computer in the exhibition.

From the case studies the majority (almost half) are from the ZKM, which is the leading museum in the world in media art. Therefore also the reference of the works at the location: Karlsruhe.

The Book

The book was conceived at one of the partners, the ZKM (Centre for Art and Media in Karlsruhe, Germany), who initiated and led the project, and edited by Bernhard Serexhe (2013).

The first part of the book contains an introduction to foster the international debate on conserving digital art (four papers).

The next two parts contain selected papers from the two symposia that took part in framing the project. The first symposium was entitled, “The Digital Oblivion. Substance and Ethics in the Conservation of Computer-Based Art” (11 papers). This symposium took place in Karlsruhe, November 4–5, 2010. Theorists and curators discussed the changes introduced by a new form of materiality in the digital age. The symposium featured 12 speeches, apart from the introduction and panel, grouped in four sessions, “Cultural Memory in the Digital Age,” “Paradigm Shift in Cultural Heritage Transfer,” “Artist Statements,” and “Producing and Preserving in Everyday Exhibition-Making.” The papers range from approaches in traditional disciplines (cultural memory, monument) to those related to digital art. The second symposium was entitled, “Digital Art Conservation. Practical Approaches: Artists, Programmers, Theorists” (10 papers). This symposium took place in Strasbourg, November 24–26, 2011. The symposium featured eight talks on each of the 2 days, from these a selection was made. Particularly interesting are the practical problems on equipment and other technical issues of conservation. These were encountered in the experience of artists and programmers present at the symposium, but a special focus was given to the problems encountered with the case studies. Both symposia aimed at a practical view, not only a scholarly perspective. The selection in the book, and the editor, mirror the multidisciplinary background of the experts participating. The videos of the talks are also accessible on the project webpage. The third part of the book is dedicated to the 10 case studies presented above. After an introductory paper, for each project there was a paper presenting the project followed by an interview with the author (except Internet dream). The presentation of the case studies included a photograph of the installation in the exhibition, a technical sheet of the data (hardware, software, conservation strategies, concept, and measures, as well as documentation), as presented in the exhibition as well, an abstract, a work description, art historical context, and conservation. The interview was enriched with further photos, in the original collection from where they were selected for the exhibition, and in different stages of the exhibition. Finally, in line with this, the following part of the book presented the exhibition. The last part of the book dedicated two articles to teaching in the field of preservation of digital art.

Conclusions

There have been previous articles in e-conservation dealing with digital art preservation (L. García, P. Montero Vilar, “The Challenges of Digital Art Preservation”, *e-conservation magazine*, No. 14 (2010) pp. 43–53, http://www.e-conservationline.com/content/view/884). One of the artists featured there also authored one of the case studies. The project was about to start when that article was written, and we hope that the research did progress in what is needed to preserve such works.

We visited the exhibition with support of a grant from the Network for Digital Methods in Arts and Humanities (NeDiMAH), funded by the European Science Foundation (5454). To our feeling digital arts are not represented in the network as much as humanities are, and such research projects, animated by unique locations such as the ZKM, might increase awareness. Additionally, conservation of digital works gives a unique encounter of the direction towards history of the humanities scientists within the network and the creation in the arts.

Nevertheless, it also gave us an impulse to see again critically our works created in 2000 with Director 7 and later Director 8.5 as potential testimonies of multimedia history.

Right now we are performing a postdoc in the field of digital means for catastrophe representation, and looking forward to visiting the next exhibition in the German space dealing with this, Artlantis in the Mannheim REM museum, dealing with "Images of Disasters," but also to present our Director 7 multimedia works in its framework, dealing with the image of Köln.

Acknowledgments Photos by the author.

Descriptions of the technical details and conservation measures from the exhibition documentation.

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Part IV
Virtual Reality

Lost Cities in the Digital Era: The Case of Pre-Earthquake Lisbon

Helena Murteira and Paulo Simões Rodrigues

Abstract Lisbon was ruined by a major earthquake on November 1st, 1755. The seismic shocks, the tsunami, and the fire that followed massively destroyed its urban and architectural fabric, and its written and iconographic memory was seriously curtailed. There is a significant historiography on pre-earthquake Lisbon, particularly dating from the last 30 years. However, it was vital to convert this knowledge into a global outlook on the city which was lost. Virtual archaeology provided the necessary tools, from a technical and a methodological perspective. *City and Spectacle: A Vision of Pre-Earthquake Lisbon* was thus devised as a virtual re-creation/simulation of all the area of Lisbon destroyed by the 1755 earthquake and on which the new city was built. Developed at the Centre for Art History and Artistic Research (CHAIA), of the University of Évora, this project aims to re-create the physical, social, and cultural dimensions of Lisbon on the eve of the earthquake, through the use of Second Life®/OpenSimulator technology. The documentary sources available, either primary or secondary, are being tested in an interactive and immersive model and in a collaborative real-time environment, so as to give the project an innovative laboratory dimension. Also, the fact that users are able to interact with the model as well as with other users in realtime transforms the data itself and, as a result, the object of study. The Lisbon that is being re-created/simulated is not just a working hypothesis presented as a glimpse into the collective memory, but is also a means for contemporaneous fruition of this memory.

Keywords Lisbon • 1755 earthquake • Architectural history • Urban history • Virtual archaeology • Virtual heritage • OpenSimulator

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Introduction

On November 1st, 1755 Lisbon was devastated by an earthquake with a magnitude estimated today between 8.5 and 9.0 on the Richter scale. A tsunami and an intense fire completed this destruction. The old city center disappeared and was replaced by a new city built on the same location, although with a regular layout of streets and architectural units.

A significant part of the history of Lisbon before the 1755 earthquake was buried in its ruins. The damage caused by the catastrophe in the city's physical structure, the loss of a large number of valuable documents, and, ultimately, the decision to rebuild on the same location according to a new plan truncated the memory of the old city.

However, not all was lost. From the late nineteenth century, the history of pre-earthquake Lisbon has played a significant role in the Portuguese historiography.

The surviving documentary sources scattered throughout various libraries, archives, and private collections have generated an important field of study on the history of Lisbon, known in Portugal as *Olisipografia* (from *Olisipo*, the Roman name for Lisbon). Travel literature has also been an important source of information on pre-earthquake Lisbon, notwithstanding its highly subjective nature.

Since 1965, with the publication of *Lisboa Pombalina e o Iluminismo* (*Pombaline Lisbon and the Enlightenment*) by José-Augusto França, the study of Lisbon witnessed a significant boost.[1] This study opened the way for an architectural and town planning perspective on the history of Lisbon. Both from an urban history or architectural and town-planning approach, the historiography of pre-earthquake Lisbon is now going through considerable development.

The scarcity of reliable sources and images of Lisbon prior to the 1755 earthquake has hindered a global vision of the lost city. However, virtual archaeology and cyberarchaeology have recently been changing this reality.

The project *City and Spectacle: A Vision of Pre-Earthquake Lisbon* aims to re-create the Lisbon destroyed by the 1755 earthquake through the use of virtual worlds technology.[2]

A team of diverse experts, ranging from the fields of art history, architecture, and landscape studies, to IT resources and virtual worlds, is developing an immersive and interactive re-creation of the city's physical, social, and cultural dimensions in the years that preceded the earthquake.

Through the use of the open source, multiplatform OpenSimulator, this project is allowing us to test the available documentary sources, as well as the formulation

[1] The book had two extended and fully revised editions in 1977 and 1983, respectively.

[2] *City and Spectacle: A Vision of Pre-Earthquake* is being developed by a team of researchers from the Centre for Art History and Artistic Research (CHAIA), of the University of Évora, in partnership with the company Beta Technologies. See http://lisbon-pre-1755-earthquake.org/ and http://vimeo.com/lisbonpre1755.

and the visualization of a comprehensive working hypothesis on pre-earthquake Lisbon.

City and Spectacle thus becomes a research laboratory on urban history and, therefore, a case study on the methodological and epistemological impact of the digital era on historical research.

Historical Research on Pre-Earthquake Lisbon

The devastation caused by the 1755 earthquake in Lisbon was extensive. The city center, an area of approximately 385 square miles, was completely destroyed, causing the death of approximately 12% of the city's population.[3]

Houses, streets, goods, money, and a significant amount of the city and the country's artistic and cultural heritage vanished.[4]

The rebuilding process was guided by efforts to modernize and regularize the city and, therefore, a new plan displaying regular and uniform building blocks was developed on the site of the old city (França 1983).

On the morning of 1st November 1755, Lisbon could be seen as a medieval urban maze, afflicted by the same evils that plagued other premodern European cities: insufficient building control, deficient or inexistent sanitary, lighting, and policing systems (Murteira 1999). However, efforts towards modernization were being felt since the sixteenth century, particularly after the end of the Restoration War with Spain, in 1668 (Rossa 1998; Murteira 1999; Carita 1999). Streets were opened and enlarged, quays and public buildings were constructed or refurbished, and legislation aiming for a more controlled and regular building process was issued by the Crown and Lisbon's City Council (França 1983; Rossa 1998; Murteira 1999).

The seventeenth-century austere architecture, heavily influenced by military engineering's formal solutions, was briefly interrupted at the beginning of the eighteenth century, due to the architectural program implemented by King D. João V (1689–1750) (Ayres de Carvalho 1962; Bottineau 1973: 341–353; Mandroux-França 1989; Calado 1995; Delaforce 2001; Pimentel 1991, 2002, 2012; Pimentel and Henriques 2013).[5] This can be seen in some of the pictorial representations of Lisbon in this period as well as in descriptions in contemporary accounts related to the city. It is precisely this Baroque Lisbon, embellished during

[3] Contemporary estimations of the death toll range from 10,000 to 100,000 people in Lisbon alone. The lack of reliable census or demographic records in Lisbon at the time and the instability that followed the earthquake make this information hard to ascertain. Today historians believe that between 10,000 and 20,000 people may have perished in Lisbon as a result of the 1755 earthquake.

[4] On the 1755 earthquake see Sousa (1919–1932), Estorninho (1956): 198–233, Davison (1938), Boxer (1956):113–129, Kendrick (1956), Buescu and Cordeiro (2005), Araújo et al. (2007), and Murteira (2004).

[5] On the nature of seventeenth century Portuguese architecture, see Kubler (1972).

the sovereignty of King D. João V, which has mostly vanished and whose memory is more fragmented and unclear.

The documentary sources related to this period are scarce and thus not able to provide us with a consistent image of early eighteenth-century Lisbon. The traces of the old city center are also rare inasmuch as the rebuilding plan demanded the leveling out of the surviving buildings. Although the two main squares of the old city, *Rossio*, at the north end and the *Terreiro do Paço*, at the south end, were kept, albeit according to a regular layout, the existing architectural elements of the ruined city are few and embedded in the new plan.

The old neighborhoods on the Castle hill shed some light on the urban character of the old city. These areas were not as damaged as the city center and were not included in the rebuilding plan. However, since the early sixteenth century, this area was no longer within Lisbon's city center, where the main squares and the royal palace, the political and economic heart of the city, could be found (Carita 1999; Senos 2002; Caetano 2004).

The main documentary source related to the destroyed city is the *Tombo Pombalino* (Pombaline Survey) requested by the State Secretary of Foreign Affairs and War to King D. José I (1714–1777), Sebastião José de Carvalho e Melo, the future Marquis of Pombal.[6] This major survey registers the location and size of all the properties ruined by the earthquake as well as the identity of their owners. Due to the detailed nature of this work, it has not yet been extensively studied.

Maps and plans of pre-earthquake Lisbon are scarce. Essentially, there is a well-known mid-seventeenth–century plan of Lisbon signed by the Portuguese military engineer João Nunes Tinoco and a 1730s plan of part of the city center signed by the military engineer Manuel da Maia (Figs. 1 and 2).

Regarding the architectural and social aspects of pre-earthquake Lisbon we have revealing pictorial representations of the city, particularly of its main square, the *Terreiro do Paço* (Palace Courtyard), where the royal palace and the most significant public buildings were located (Figs. 3 and 4). Another fundamental historical source is the collection of engravings representing the ruins of six of the most noteworthy buildings in Lisbon, by the French engraver Jacques Philippe Le Bas. It represents the only known depictions of the baroque urban and architectural units of the Patriarchal Square and the Royal Opera House, although they were depicted when already in ruins (Figs. 5 and 6). There is, however, a detailed plan of the Patriarchal Square, which is kept at the National Library of Portugal (*Biblioteca Nacional de Portugal*). This document was crucial for the re-creation of this area of Baroque Lisbon (Fig. 7).

Decades of research provided a substantial body of information for the study of Lisbon. Nonetheless, a global vision of the city was still missing. It was thus crucial

[6] The *Tombo Pombalino* is kept in the *Arquivo Nacional da Torre do Tombo* (Portuguese National Archives), in Lisbon. There is an abridged version of this survey, compiled in the nineteenth century by Valentim de Freitas, in the *Biblioteca Nacional de Portugal* (National Library of Portugal).

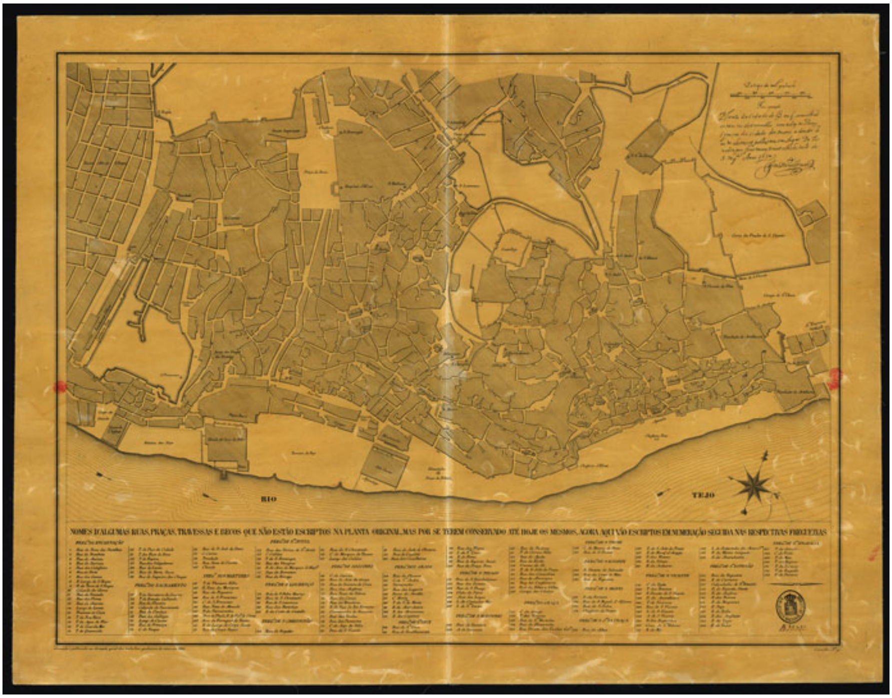

Fig. 1 João Nunes Tinoco. Plan of Lisbon (ca. 1610–1689). National Library of Portugal

to carry out a swift and reliable comparative study of all the existent data, written and pictorial, on pre-earthquake Lisbon.

Digital technology provided the necessary tools. The result exceeded our expectations. We were confronted not only with ground-breaking research tools but also with a new object of study, which led to questions on the scope and the ontological value of the research itself.

Pre-Earthquake Lisbon as Virtual Reality

In 2005, on the 250th anniversary of the 1755 earthquake, a team led by Alexandra Gago da Câmara developed a 3D model of the old Royal Opera House in Lisbon using Second Life® technology (Câmara 2007).[7] There is no known picture of this short-lived building, apart from the above-mentioned engraving of its ruins by Le Bas. The Royal Opera House was the first of its kind in Portugal, praised in contemporary accounts for its magnificence and opera programming (Câmara

[7] See http://operadotejo.org/.

Fig. 2 Manuel da Maia. Plan of the Lisbon city center before the 1755 earthquake. Drawing: watercolor on paper (1756). DGAIE, Lisbon

1993, 2006, 2007, 2013; Januário 2008; Gallasch-Hall 2012). It was built on the west end of the Royal Palace complex by King D. José I (1714–1777), according to a project signed by the Italian architect Giovanni Carlo Sicinio Galli Bibiena. The inauguration of this building took place on March 31st, 1755, six months before the earthquake ruined it. There is a plan and a cross-section of an Opera House in the archives of the Fine-Arts National Academy (*Academia Nacional de Belas-Artes)* in Portugal, which until recently was believed to portray the Royal Opera House. Recent studies have suggested that these documents are probably a draft and thus do not correspond to its final layout (Januário 2008; Gallasch-Hall 2012).

The re-creation of the Old Opera House was therefore a difficult task and required a reliable and low-cost technology. Second Life®/OpenSimulator technology was used to put forward a first hypothesis of a 4D model of the building. The success of the project encouraged us to widen the research scope so as to include the whole Lisbon area destroyed by the 1755 earthquake.

City and Spectacle: A Vision of Pre-Earthquake Lisbon was thus devised as a re-creation/simulation of the part of Lisbon devastated by the 1755 earthquake. The urban area that is to be re-created corresponds to the whole area included in the rebuilding plan (Fig. 8). However, this re-creation is not only urban and architectural in terms of its nature; it aims also to include aspects of the social and cultural life of early eighteenth century Lisbon through the simulation of the city's daily life

Fig. 3 Dirk Stoop. The Palace Courtyard in the seventeenth century (1662). Oil on canvas. Lisbon City Museum

and some of its major events, such as religious processions, bullfights, opera performances, and the infamous *autos de fé*.[8] Therefore, the model will also have an audio component, as well as text boxes with historical information.

The project combines the history of art, urban/architectural history, and cultural heritage studies with computer science and thus presents not only a scientific dimension but can also be used for education, leisure, and commercial purposes, that is, edugames, virtual tourist guides, and the film industry (Câmara and Murteira 2008, 2010; Câmara et al. 2009; Sequeira and Morgado 2013).

The first challenge that the research team faced was the selection of a reliable and an operational cartographic source for re-creating pre-earthquake Lisbon.

As mentioned above, plans of Lisbon before 1755 are scarce and, with the exception of the old layout inscribed in the plans for the rebuilding project, they do not represent the city on the eve of the earthquake. To make matters worse, the layout of the old city that appears in the sketches for the new Lisbon by the military engineer Eugénio dos Santos is not detailed enough to allow us to develop a comprehensive urban re-creation. On the other hand, the plan of Lisbon in the early eighteenth century does not represent the Lisbon that we hope to re-create: it does not include the Patriarchal Piazza (completed circa 1749) and the Royal Opera

[8] *Auto de fé* was the ritual of public punishment and execution of the condemned by the Inquisition.

Fig. 4 Francisco Zuzarte (attribution). The Palace Courtyard at the eve of the 1755 earthquake (n.d.). China-ink drawing. Lisbon City Museum

House (dating, as previously mentioned, from March 1755). For this reason, we decided to use a plan drawn at the beginning of the twentieth century by the engineer Augusto Vieira da Silva, an early and fundamental contributor to the history of Lisbon (Fig. 9). This plan uses some relevant information that the author selected from the plans already referred to as well as the Pombaline survey. Hence, the plan we used is not a primary source, but a working hypothesis itself.

Secondly, and given the ambitious scope of the project, it was necessary to establish the various phases of the re-creation.

We decided to work first on the most important area of the city, the old *Terreiro do Paço* (Palace Courtyard), which is the location of the *Ribeira* Royal Palace compound, including the old Royal Opera House and the Patriarchal Church and Square (Figs. 10, 11, 12, 13, 14, and 15).

Some written primary sources, namely the only known description of the old Royal Palace and the few surviving representations of Lisbon before the 1755 earthquake, were also used as relevant sources of information.[9] The extensive historiography on pre-earthquake Lisbon, and particularly the studies carried out during the past 30 years, provided the necessary theoretical context.

[9] There is a detailed description of the Royal Palace in the eighteenth century that was published in the nineteenth century by Camilo Castelo Branco, a renowned Portuguese writer. See Branco (1874). *Noites de Insomnia offerecidas a quem não póde dormir*. Porto: 10–11.

Fig. 5 MM. Paris, Pedegache and Jacques Ph. Le Bas, Colleçaõ de algumas ruinas de Lisboa causadas pelo terremoto e pelo fogo do primeiro de Novemb.ro do anno de 1755 debuxadas na mesma cidade por MM. Paris et Pedegache e abertas ao buril em Paris por Jac. Ph. Le Bas [n.d.]. Ruins of the Patriarchal Square. Engraving. National Library of Portugal

The process of setting up the model enabled us constantly to examine the validity of the information gathered in the various available documentary sources, both primary and secondary. OpenSimulator technology acted simultaneously as a technical and as a conceptual framework, inasmuch as it tested the workability of the information mentioned above and also its adequacy in responding to the demands of a visual and all-inclusive working hypothesis. All this was achieved through collaborative work carried out on the virtual model, in realtime.

The results of the research process are presented as an interactive image that needs to be filled in with information (Fig. 16). However, this information rarely reflects similar stages of research and equally consistent evidence. It was as if we were putting together a jigsaw puzzle with several missing pieces. In addition to this challenge, models are increasingly more complex in their interactive and immersive features and are thus open to a multitude of interpretations and to different inputs by users.

For the general public, the assertiveness of a visual working hypothesis is easily mistaken for an exact reconstruction. This has been extensively discussed during the last decades (Frischer et al. 2002; Beacham et al. 2006; Lopez- Menchero and

Fig. 6 MM. Paris, Pedegache and Jacques Ph. Le Bas. Colleçaõ de algumas ruinas de Lisboa causadas pelo terremoto e pelo fogo do primeiro de Novemb.ro do anno de 1755 debuxadas na mesma cidade por MM. Paris et Pedegache e abertas ao buril em Paris por Jac. Ph. Le Bas [n.d.]. Ruins of the Royal Opera House. Engraving. National Library of Portugal

Grande 2009; Denard 2012). Therefore, it was crucial to secure transparency and historical rigor, as well as facilitate access to all the information produced by the project. According to the guidelines of the London Charter (2009) and the Principles of Seville (2012) for virtual heritage visualization, we have meticulously documented our research process, referencing the various documentary sources that were used and highlighting the various re-creation choices made. A website was created providing information about the project and on how to access the 3D virtual model (http://lisbon-pre-1755-earthquake.org/). This included a virtual museum on the history of eighteenth century Lisbon and the development of the project itself (Figs. 17 and 18).

The purpose, the conceptual framework, and the various stages of the project were presented in different national and international conferences (Câmara and Murteira 2008, 2010, 2012; Câmara et al. 2009, 2010, 2011, 2012; Murteira 2012; Murteira and Rodrigues 2014; Câmara and Rodrigues 2014) and the project has generated studies on crowd simulation for virtual historical re-creations (Sequeira and Morgado 2013; Sequeira et al. 2014).

This was, of course, an innovative way of working for our research team. It was clear from day one that we were engaged with a simulation of the past. We were

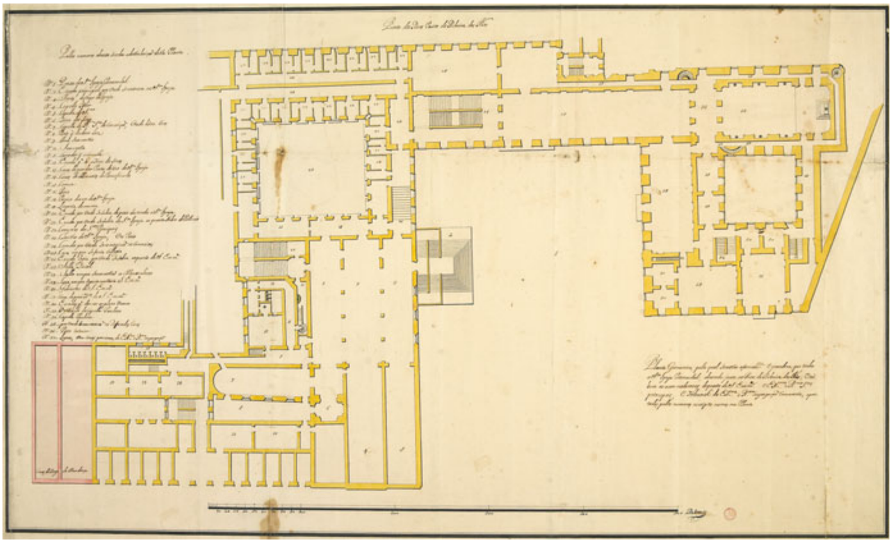

Fig. 7 Plan of the Patriarchal Church and Square. Drawing: China ink and watercolor on paper (ca. 1775). National Library of Portugal

Fig. 8 João Pedro Ribeiro. Copy of the adopted plan for Lisbon by Eugénio dos Santos and Carlos Mardel. Lithography (1947). Lisbon City Museum

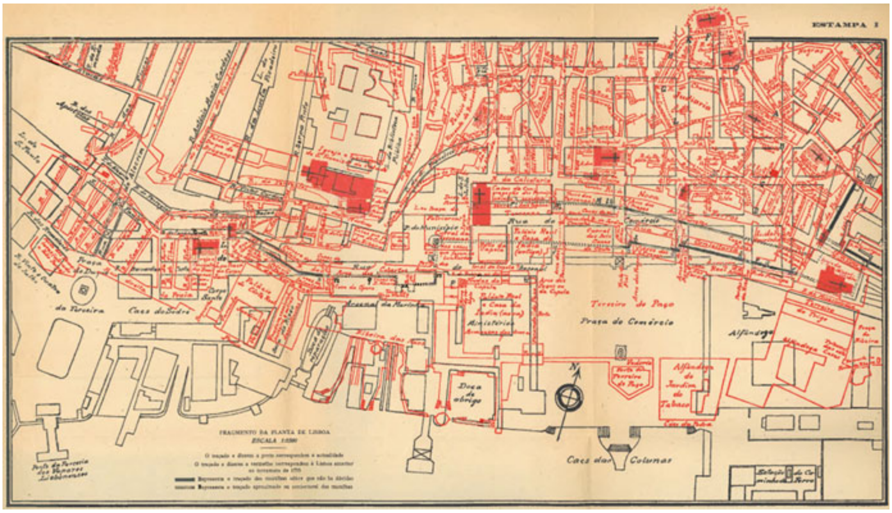

Fig. 9 Plan of the Lisbon city center before and after the 1755 earthquake. The plan shows the old layout in *red* and the new in *black*. A. Vieira da Silva. 1940. As Muralhas da Ribeira de Lisboa, vol. I. Lisboa

Fig. 10 Aerial view of the Royal Palace complex. City and Spectacle: a vision of pre-earthquake Lisbon, OpenSim version 0.7.5 Dev, November 2012

never attempting to produce a reconstruction, not only because we were dealing with scarce sources of evidence and information, but also because re-creation and simulation are the very essence of the historical scientific process. The fact that the results of the research were being translated as image reinforces the previous

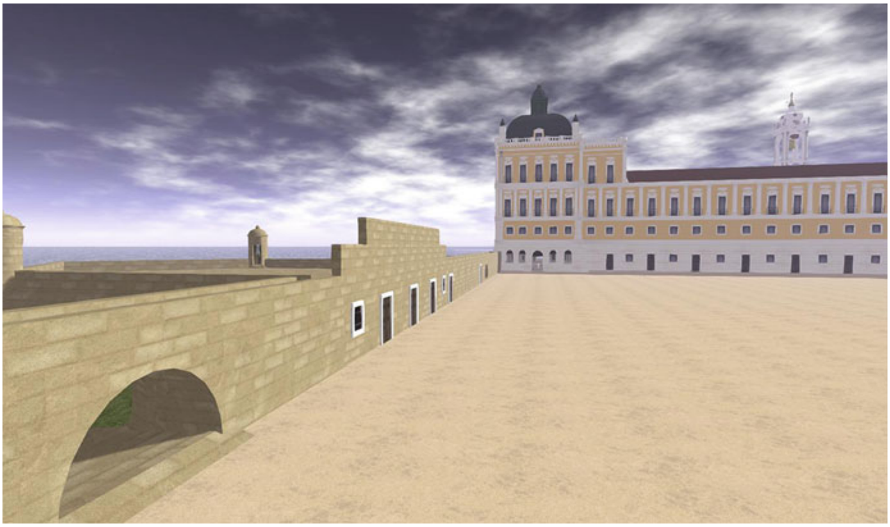

Fig. 11 The Terreiro do Paço (Palace Courtyard). City and Spectacle: a vision of pre-earthquake Lisbon, OpenSim version 0.7.5 Dev, November 2012

Fig. 12 The Royal Opera House, the Royal Palace, and the shipyard. City and Spectacle: a vision of pre-earthquake Lisbon, OpenSim version 0.7.5 Dev, November 2012

assertion. It was also clear for us that we were not only processing and testing pre-existing information but we were also dealing with data that the model itself was providing us. Thus the project acquired a laboratory nature that would not have been possible through the conventional process of historic research.

Fig. 13 The Patriarchal Square and Church. City and Spectacle: a vision of pre-earthquake Lisbon, 0.7.5 Dev, September 2013

Fig. 14 The Royal Palace and entrance to Chapel Street. City and Spectacle: a vision of pre-earthquake Lisbon, 0.7.5 Dev, September 2013

There is still a long way to go in terms of achieving the goals we have set up for this project. The model needs constant amendments as a result of the continuous character of the historic research. The animation of the model will be another significant challenge given the scarce and fragmented data available for the social and cultural aspects of early eighteenth century Lisbon.

Fig. 15 Virtual model of Chapel Street in the Royal Palace Compound. City and Spectacle: a vision of pre-earthquake Lisbon, OpenSim version 0.7.5 Dev, November 2012

Fig. 16 Virtual model of the Royal Opera House and the shipyard. Aerial view. City and Spectacle: a vision of pre-earthquake Lisbon, OpenSim version 0.7.5 Dev, November 2012

However, more important than the working hypothesis that we are putting forward is the fact that the model itself is able to interact with users in such a way that they become a part of it and as such, they provide a new variable to the historic research: contemporaneity through social interaction.

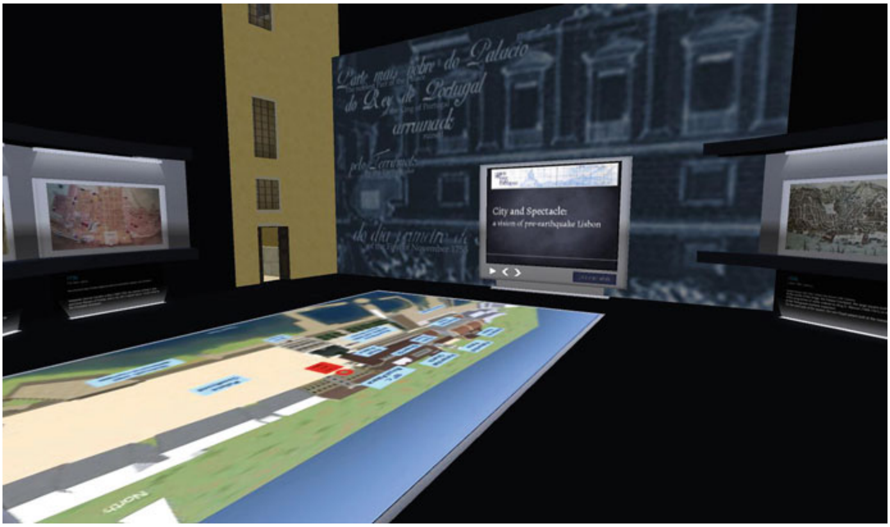

Fig. 17 Virtual Museum. City and Spectacle: a vision of pre-earthquake Lisbon, OpenSim version 0.7.5 Dev, August 2013

Fig. 18 Virtual Museum. City and Spectacle: a vision of pre-earthquake Lisbon, OpenSim version 0.7.5 Dev, August 2013

Conclusion: Towards a Novel Field of Research

Imagining has always been a crucial part of historic research and of the scientific process: "Once we appreciate the role of imagination as a standard means for evaluation conditionals and modal claims, we should be much less inclined to regard the use of thought experiments in philosophy (or natural science) as constituting any highly distinctive method" (Williamson 2016: 16).

In Marguerite Yourcenar's short story "The Salvation of Wang-Fô," an old Chinese painter (Wang-Fô) and his young assistant Ling escape from a death sentence declared by the Emperor, by disappearing into the sea waves in a landscape painted by the painter himself (Yourcenar 1938). Yourcenar's short story is a metaphor about the power of artistic imagination, through its ability to manipulate time and space in ways that conventional thinking could never achieve. This is because the past is something we can never fully obtain. As Larry J. Zimmerman accurately states revisiting Lowenthal's, *The Past is a Foreign Country*, "We incorrectly imagine that the past is relatively simple and understandable. We may travel to the past, and though we may know something of the foreign country's language and customs, we will never actually be part of it because we are strangers from the present."[10]

The past is a fragmented memory that we can only represent or portray as a distant landscape. Like painters, historians are also able to manipulate time and space. They can compress these dimensions, expand them, measure them, and even transcend them. The past is a landscape and history is the way we represent it (Gaddis 2004).

Virtual reality enhances the historian's ability to represent the past as a landscape. The representation of the past thus becomes a simulacrum, as models make visible what until then was only an idea, as a new dimension of existing but not perceptible space (Ferry 2003). Virtual Heritage Visualization requires imagination to play this unusual role in historical thinking, particularly when we are dealing with lost urban environments.

Scientific transparency and accuracy in Virtual Heritage Visualization require new methodological tools, which documents such as the Beacham et al. (2006), London Charter (2009) and the Principles of Seville (2012) attempt to provide.

However, we are not only in the presence of an exercise of converting existing data into a 3D or a 4D model. As previously mentioned, digital technology provides virtual environments, often immersive and increasingly receptive to interaction with users. Therefore, we are confronted with the novelty of the methodology in use and, on the other hand, with the ontological value of the model itself.

Virtual heritage should deal with these two aspects as one. Memory is transformed by the way we view it and by the way we are able to share it with others. Therefore, the process of building virtual models and the models themselves is not only processing and testing data in a way and at a rate never done before, but is also producing new data, digital from the start. From virtual archaeology we have evolved to cyberarchaeology (Forte 2009). With virtual heritage we are confronted with a nonverbal domain that we can experience and transform through our own experience, in a context of social interchange. From "the scenography of memory"

[10] Zimmerman. *The Past Is a Foreign Country* at https://www.usd.edu/arts-and-sciences/upload/Harrington-Lecture-Zimmerman.pdf. Accessed 9 February 2015.

(Bostenaru Dan and Panagopoulos 2014) we have evolved into living the memory, although in a new sensory environment. Therefore, the object of study is not just a conceptual exercise but also the continuous result of our own virtual experience, or, in other words, "the mind embodied in the environment" (Forte 2014).

The concept of cultural presence as defined by Erik Champion is paramount in order to understand what these models represent as scientific and as learning tools (Champion 2005). The feeling of being "there and then," instead of "here and now," according to each individual's cultural perspective acquires (Foucault 1984) a particular meaning within this project (Champion 2005; Forte 2014). In fact, visitors are not only able to take part in the simulation of the major events of baroque Lisbon, but they also become a part of it. Their experience of a past reality becomes part of the model itself and, as such, produces data that can be manipulated and reinvented both by the research team and by other users. Therefore, the memory of the past is experienced and changed by our own actions and experience. Quoting Larry J. Zimmerman once more, "'[T]he past' is something we create, it is a product of our present," which is absolutely true in the realm of cyberarchaeology.

Virtual models of past urban environments need to be open to continuous historic and technical updates and their methodological and epistemological framework should always be receptive to the demands of the constantly interchangeable relationship between past and present.

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e-Installation: Synesthetic Documentation of Media Art via Telepresence Technologies

Jesús Muñoz Morcillo, Florian Faion, Antonio Zea, Uwe D. Hanebeck, and Caroline Y. Robertson-von Trotha

Abstract In this article, a new method for the conservation and dissemination of media art through "synesthetic documentation" is presented. A "synesthetic documentation" is the description and reproduction of complex multisensory information that a work of media art produces. This new method is called "e-Installation" in analogy to the idea of the "e-Book" as the electronic version of a real book. An e-Installation is a virtualized media artwork that reproduces all synesthesia, interaction and meaning levels of the artwork. Advanced 3D modeling and telepresence technologies with a very high level of immersion allow the virtual re-enactment of works of media art that are no longer performable or rarely exhibited. The virtual re-enactment of a media artwork can be designed with a scalable level of complexity depending on whether it addresses professionals such as curators, art restorers, and art theorists, or the general public. An e-Installation is independent of the artwork's physical location and can be accessed via head-mounted display or similar data goggles, computer browser, or even mobile devices. In combination with informational and preventive conservation measures, the e-Installation offers an intermediate and long-term solution to archive, disseminate, and pass down the milestones of media art history as a synesthetic documentation when the original work can no longer be repaired or exhibited in its full function.

Keywords Media art conservation • Telepresence • Virtual reality

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Research Aims

The main aim of this research is to design a novel synesthetic documentation method for media artwork at risk under the perspective of "informational preservation" (Muñoz-Viñas 2011). For this purpose, advanced 3D modeling and telepresence technologies have been used, which allow a realistic immersive experience. This chapter is a first step to improve conventional media art documentation not only for re-enactment purposes but also allowing permanent access to the virtualized artwork. In this way, the multimodal limitations of traditional audiovisual documentation methods such as video or photography are overcome. The goals within the involved research fields (media art conservation, advanced 3D modeling, and telepresence) include the enhancement of media art documentation on a synesthetic (i.e. multisensory) level and the development of improved techniques for immersive representation and interaction. In addition, the transversal effects of this work have influence on relevant research questions including the change of the authenticity concept in art conservation theory and the use of telepresence as an art creation tool.

Introduction

Media art has existed since the early 1960s. However, compared to traditional genres such as painting or sculpture, the lifespan of a piece of media art is very short: the technology it needs to operate is also the cause of its caducity. Moreover, museums are faced every day with the inexorable decline of technology-based artwork. Works of media art not only require constant maintenance but also take up much more exhibition space than museums can provide. As a result, they are often dismantled for maintenance and repair, or remain in the museum depot for long periods of time. When this happens, these pieces of art are no longer accessible to curators, art theorists, and the interested public. In this case, a detailed documentation that mostly consists of construction plans, interviews with the artists, and audiovisual material such as video or photography is the only way to ensure that these works of art can be examined. However, this kind of documentation cannot entirely reproduce the synesthetic experience level that media artwork such as video, sound art, kinetic sculptures, or media art installations requires to produce meanings. Curators and art theorists can only speculate on the full aesthetic impact of an artwork on this basis, unless that artwork is reinstalled.

In the near future, art restorers will not be able to repair media artwork in accordance with satisfying authenticity criteria. Technical decay ageing or damage can originate a deviation from the original appearance of a work of media art, which may have importance for the meaning of the work (see e.g. Hummelen and Sillé 2005). The reason for this is above all the obsolescence of technical components that are no longer being produced, such as CRT TVs and RGB projectors, CCF lamps, or old data storage forms such as punched tapes or even old EPROMs. Given this scenario of a cultural heritage that is jeopardized and difficult to access, there is an urgent need for a new kind of documentation that allows, as much as possible, for a realistic representation of all the synesthesia levels implied in media artwork. Such documentation is necessary to protect and preserve the meanings and processes that might otherwise be lost along with the material work itself. Advanced 3D modeling and telepresence technologies can make a significant contribution in this regard.

As an anthropological category in the history of ideas, telepresence is a concept that can be traced all the way back to ancient times: the dream of an artificial life, an artistic tradition of virtual reality (e.g., life-size and immersive depictions), and the religious search for a disembodied conception of the human mind are the anthropological constants that converge in the idea of telepresence (Grau 2000). According to that, the human mind is naturally predisposed toward immersive experience without simultaneously being incredulous of such experiences. Nevertheless, the definition of telepresence used in computer science research follows a less epistemological and much more technical notion as formulated by Sheridan (1989), who, assuming the human predisposition for telepresent experience, describes it as “the extension of a person’s sensing and manipulation capability to a remote location.” This “remote location” can also be a virtual world. According to both definitions, a carefully designed telepresence system would allow realistic access to and interactions with virtualized works of media art, in particular with those that are temporarily not available to the public, or those whose continuity cannot be guaranteed through current curatorial and conservation practices. The development of this new documentation method and its dissemination requires an interdisciplinary cooperation between experts in modern art preservation and documentation, experts in 3D modeling, telepresence technologies, and long-term archiving, as well as art communicators.

State of the Art

Since the end of the 1990s, there have been several international projects on the conservation and restoration of media art that bring the importance of documentation into focus as the first step to conserve and archive this new heritage. Several well-known projects and conferences about preservation and conservation of media art are “Modern Art: Who Cares?” (“Modern Art: Who Cares?” was an interdisciplinary research project and an international symposium on the conservation of modern and contemporary art in 1995), “Seeing Double” (“Seeing double. Emulation in Theory and Practice” was a project on art emulation in 2004), “Inside Installations” (“Inside Installations: Preservation and Presentation of Installation Art” 2004), the activities of the DOCAM Research Alliance (“DOCAM – Documentation and Conservation of the Media Arts Heritage” 2005-2010), as well as newer projects on the conservation of artwork created with computer technologies, including “Digital Art Conservation” (“Digital Art Conservation” was a European research project for the conservation of digital arts in 2010).

All these projects have one very important feature in common: they all regard media art documentation as an integral part of conservation strategies. From this point of view, it can be affirmed that documentation is also an indispensable part of the media art conservation process itself.

Institutions such as the Daniel Langlois Foundation and the INCCA Network have already performed pioneering work identifying conservation issues, observing artistic and curatorial practices, and proposing conservation strategies for the preservation of compromised art forms such as media art installations, video sculptures, Net art, and game artwork. The value of documentation for modern art conservation is also a commonplace in art restoration (Gomes 2011). Good documentation requires well-founded knowledge about the piece of art in question focusing on conceptual and technological details and information about the intention of the artist and his or her expectations. In the year 2000, the art restorer Jon Ippolito published the “Variable Media Questionnaire” for ephemeral media art (Depocas et al. 2003). From today’s perspective, it was the first attempt to involve media artists in conservation issues following a standard questionnaire similar to Erich-Ganzert Castrillo’s detailed questionnaires and technical interviews with German painters (Castrillo 1995). Information about intention, future expectations of the artist, the optimal framework for exhibition, details about used technologies, and advice about how to preserve the artwork and what kind of replacements can be taken into account, help curators and art restorers in their decision-making processes, to respect crucial authenticity criteria during conservation practice and reinstallation. Sometimes it is no longer possible to exhibit a media artwork in its original medium. In this case, it can be migrated or emulated. Ippolito distinguishes both strategies: “To migrate an artwork is not to imitate its appearance with a different medium, but to upgrade its medium to a contemporary standard, accepting any resulting changes in the look and feel of the work. To emulate an artwork, by contrast, is not to store digital files on disk or physical artifacts in a warehouse, but to create a facsimile of them in a totally different medium” (Depocas et al. 2003, p. 51).

Making media art accessible to the public sometimes implies the need to vary some parameters of an artwork while still respecting the authenticity of its meaning. Migration and emulation are two documentation-based methods that allow the transmission of meaning at the expense of the original medium. In such cases, there is also often the need for a “reinterpretation” (Depocas et al. 2003, p. 52), that is, an adaptation of the art concept to the new medium. Both strategies can be included in the “informal preservation” model (Muñoz-Viñas 2011), that is, the preservation of meanings through documentation and migration, in opposition to the “preventive preservation” that tries to conserve all original parts of the artwork as long as possible with direct and environmental preservation measures. The “informational preservation” serves also as a frame for conservation strategies and as a starting point for the idea of virtualizing media artwork in order to create an e-Installation as a kind of “migrated” artwork.

In addition to the inclusion of the artist in the conservation process, there are also descriptive methods that allow a personal perspective on the art experience such as art depictions and video documentations. In combination with the technical and background information provided by the artist, it is possible to get a good idea of the whole artwork, although less intellectual effort would be needed and the findings would be more accurate with an intuitive experience of the artwork as is. Moreover, most video documentations with a conservation background tend to show a time-lapse recording of the set-up and dismantling of media art installations (Brake-Baldock et al. 2007), whereas the available video documentations for the public do not even cover the full time length of media artwork.

We have to differentiate between the conservation and visualization of digital-born and virtual art, and digitization as a conservation mechanism. Single projects including "Aire ville Spatiale" (see http://aire-ville-spatiale.org/) and the "Immaterial ArtStock Museum" (Herbert 2014) represent first attempts to collect and preserve digital-born 3D art in a digital space such as Second Life, OpenSimulator, or realXtend. On the other hand, digitization has become a way to preserve and make accessible the content from old video art tapes (Blase 2005) or to reconstruct archaeological finding places and reproduce historic buildings, pottery, or sculpture (Salgado et al. 2005; see 3D-COFORM; Koutsoudis et al. 2014; Sfikas et al. 2013).

As for art visualization, the common opinion is that immersive virtual reality technologies (VR) offer very effective means to communicate cultural content, and are also effective for educational and presentation purposes (Scali et al. 2000; Jones and Christal 2002). In the case of archaeology, the potential of 3D and augmented reality (AR) technologies for conservation issues have already been identified in the past (see 3D-COFORM). These kinds of technologies, such as VR, AR, and Web3D, have, over the last 10 years, mostly been used by science and archaeological museums that are interested in making their content attractive to the public (Styliani et al. 2009; Carrozzino and Bergamasco 2010). However, the so-called "virtual museums" are at best "content museums," that is, websites with enhanced information in the form of pictures or videos. Genuine immersive platforms remain an exception.

Immersive hardware applications for cultural experience such as the CINECA Virtual Theatre or the ReaCTOR of the Foundation of the Hellenic World also dedicate large exhibit spaces for their settings (Carrozzino and Bergamasco 2010). The ARCO platform (Augmented Representation of Cultural Objects) (St. Sylaiou et al. 2010) uses interfaces to exploit multimodal visualization, but most of the VR devices being used in museums are desktop devices. Moreover, external devices including CAVEs (Cave Automatic Virtual Environment) or panoramic powerwalls are being used in modern museums to visualize new art forms or to complement the real museum's activities, but they are not being used as media art archives or for conservation or documentation purposes.

Nevertheless, there are already some VR systems that can interact with art in museums on the basis of commercial hardware such as "The Museum of Pure Form" (consisting of a CAVE and an exoskeleton with a haptic interface) or "The Virtual Museum of Sculpture" (panoramic powerwall). The disadvantages of these systems are that exoskeletons are heavy hardware and cannot easily be controlled by untrained operators, and that panoramic walls are very large and thus need large exhibit spaces. Because the use of head-mounted displays is not possible in combination with these systems, the participants cannot move about freely. Moreover, most of these projects (including exotic theater experiments with holographic illusions such as "The Virtual Exploration of Turandot Stage" [Carrozzino and Bergamasco 2010]) offer a noninteractive stereoscopic installation with movement and proprioceptive limitations for the participants.

For most media artwork—which is either at risk or rarely seen—there are documentation and conservation strategies in practice that do not consider the virtualization of the whole artwork as is but prefer a step-by-step preservation in order to keep the media artwork operating for as long as possible.

The virtualization of material parts integrating all digital software components and audiovisual signals, as well as all kinetic and interaction patterns, in a consistently playable, dynamic, and interactive 3D model would enable a new documentation method that allows telepresent accessibility to rarely exhibited or destroyed artwork to save the synesthetic level of experience and its structure of meanings. The benefits of synesthetic documentation for the conservation of the meaning and experience level of a media artwork were brought up by Muñoz Morcillo in 2011 in an essay on the documentation of changing media art (2011):

> In this case study ["Dancing on Tables" by Stephan von Huene], one sees that the documentation of the change of a media artwork implies both a technical as well as a perception-related documentation. The interactive nature of "Dancing on Tables" can mainly be found in the descriptions, no photo can document this fact. [...] Accessing this work would be virtually possible today if we had, e.g., an interactive 360° view of the installation and the ability to integrate its functions into a multimedia application [...].

Our research continues and materializes this idea of the perception-related documentation, that is, synesthetic documentation in the form of photogrammetrically comprehended, 3D-modeled and programmed artwork, and a suitable telepresence-based visualization of the virtualized media artwork using, for example, head-mounted displays (HMD), body tracking systems, haptic interfaces, and "motion compression" algorithms, that are being developed (Packi et al. 2010a; Faion et al. 2012; Pérez Arias and Hanebeck 2009; Rößler and Hanebeck 2006) at the Laboratory for Sensor Actuator Systems (ISAS) at the Karlsruhe Institute of Technology (KIT).

e-Installation: Telepresence as a Media Art Documentation Method

Multimodal devices and telepresence systems already allow a lifelike experience of virtual scenarios in a new kind of immersive virtual reality that implies genuine telepresence research topics such as the plenoptic (Adelson 1991), plenacoustic

(Ajdler et al. 2006), and plenhaptic (Hayward 2011) functions. The fusion of these technologies with body tracking and motion compression algorithms allows a very high immersive level of virtual presence, with which established VR systems such as CAVEs and Panoramic Walls cannot compete. The high immersion in combination with realistic 3D documented media artwork is the reason why our research addresses telepresence technologies and also prefers this terminology instead of the widespread VR notion of "a simulation of physical presence." Indeed, in an e-Installation there is no simulation but rather a realistic interaction with a "living document" that re-enacts all features of the real artifact. Moreover, the chance to interact with and observe other remote visitors is a quality indispensable for perceiving the "blind spot" of one's own perception. In this way, the visitor can become a second-order observer of the art system, as in real life.

The e-Installation as telepresence-based documentation builds a new category of media art documentation and conservation. As a new method, it will take time to determine accurately what kind of media art can and should be documented with it. For this purpose, many experiments with different works of art will be necessary. Even more difficult is the standardization of measures and steps that have to be performed to re-enact a work of media art, because every artwork has its own very specific features and representation claims. For now, we can say that works of media art with kinetic and audiovisual elements as well as wide-ranging art installations such as land art are especially suited for conversion into virtual 3D art environments that can be visited with a convenient telepresence system. In particular, kinetic and sound artwork by artists such as Jean Tingely, Alexander Calder, Nam June Paik, Rebecca Horn, Jeffrey Shaw, and Stephan von Huene, but also temporary modern art installations such as Christo's wrapped buildings, Ólafur Elíasson's artificial waterfalls, or even Per Barclay's liquid installations come into consideration for e-Installation.

For every media artwork that has to be synesthetically documented, it is necessary to carry out a detailed investigation of its meaning, the artist's intention, its technical features, its construction plans, and so on. This investigation has to be performed following systematic data collection methods according to modern art conservation practices (e.g.,"Modern Art: Who Cares?" was an interdisciplinary research project and an international symposium on the conservation of modern and contemporary art 1995; "Seeing Double. Emulation in Theory and Practice" was a project on art emulation 2004; "Inside Installations: Preservation and Presentation of Installation Art" 2004; "DOCAM" – Documentation and Conservation of the Media Arts Heritage" 2005-2010; "Digital Art Conservation" was a European research project for the conservation of digital arts 2010; Depocas et al. 2003; Real 2001). The selection criteria depend on several aspects, which have to be determined by art experts and computer scientists. For the present research, we defined the following key aspects: (a) the artwork's relevance in terms of art history; (b) the artwork's level of vulnerability and accessibility; (c) access to a documentation of the artwork with detailed information about, for example, the artist's intention and the materials used, as well as the artwork's technological basis and its construction plans; (d) the technical viability of the documentation method; and (e) the conceptual and material suitability for the telepresence-based documentation method.

As in the conservation and restoration of modern and contemporary art, a "decision-making model" (see, e.g., Hummelen and Sillé 2005, pp. 164–172) is needed to deduce the conservation options, that is, the "virtualization and re-enactment options" in the case of an e-Installation. The "virtualization and re-enactment options" can be very different depending on the object and the artist's intention. Some artists attach a lot of significance to apparently trivial things whereas other aspects of an artwork are of much less importance to them. Knowing these details helps avoid mistakes and misunderstandings. The transmutation of the material conditions of an artwork through its virtualization can also change its meaning, so the relation of the physical conditions of an artwork to its meaning must be investigated before a virtualization treatment is proposed. If there is no connection between the material conditions of an artwork and its meaning, then it is possible to reproduce the basic structure of the artwork without laborious photogrammetric methods or the use of sensor data for textures. On the other hand, if the material conditions of an artwork are essential for its meaning, then it is necessary to reproduce it with high accuracy using textures, photogrammetric techniques, and so on.

The Telepresence System and the Case Studies "Versailles Fountain" by Nam June Paik and "10,000 Moving Cities – Same But Different" by Marc Lee

In order to explain how the virtualization and the visualization in a telepresence system work, two case studies were carried out. For the present research, we used the proprioceptive extended-range telepresence system (Packi et al. 2010b; Fig. 1) of the Intelligent Sensor-Actuator Laboratory (ISAS) at the Karlsruhe Institute of Technology (KIT).

The telepresence system at ISAS offers a broad and very adequate experimental ground for testing and developing realistic art scenarios. It consists of several basic components: (1) a server PC that runs the telepresence framework and streams audiovisual data to the user; (2) a visualization system worn by the user that visualizes the streamed data; and (3) a tracking system that allows the user to navigate and interact within the telepresence system. Here are more details about the three basic components:

1. *The server PC:*

The server PC is in charge of rendering the 3D scene from the user's point of view and streaming the resulting audio and visual data to the client. A programming interface for Python and C++ is provided to control the system's logic.

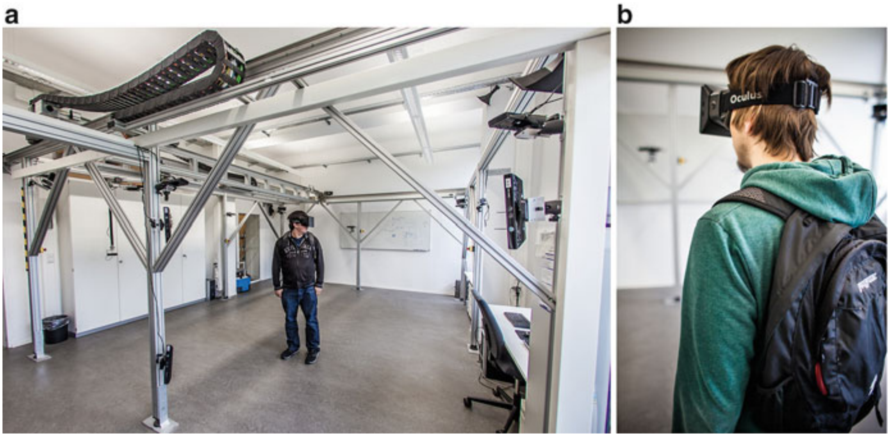

Fig. 1 (**a**) Telepresence system at ISAS (**b**) Visualization system: HMD and portable PC

2. *The client PC:*

The client PC, stored in a backpack carried by the user, displays the data streamed from the server PC. For visualization, the system uses an Oculus Rift Head-Mounted-Display (HMD) and surround-sound headphones.

3. *The tracking system*:

The tracking system consists of a room with an area of $5 \times 5\ m^2$, which is being observed by a network of eight Microsoft Kinect Devices. The captured data are used to estimate the user's head pose, that is, position and orientation, which determines the user's point of view for rendering.

In order to allow the experience of extended-range environments, a technique called "motion compression" (Rößler and Hanebeck 2006) predicts the desired walking path and adjusts the visual input of the HMD to guide the user on a slightly transformed path that fits into the telepresence system. As an example, if the predicted path is a straight line in the virtual environment, the algorithm would lead the user on a circular path. Figure 1 shows a prototype of the telepresence system used at the ISAS Holodeck laboratory. A specialized form of this system that minimizes invasiveness is being planned for use in museums and galleries, in which a user can experience the telepresence environment simply by putting on a mobile phone-based HMD. In the following, we discuss how e-Installations can be created and re-enacted in telepresence.

"Versailles Fountain" (1993) by Nam June Paik, depicted in Fig. 2a, is a two-channel video sculpture that can be visited at the ZKM | Center for Art and Media Karlsruhe. The lavish fountains of Versailles are used here as a metaphor for the entertainment system of our time. It consists of 30 neon and 38 CRT monitors in various sizes. The TV monitors are switched in two different circuits producing a

Fig. 2 (**a**) Video sculpture "Versailles Fountain" at the ZKM (**b**) Intermediate 3D model, manually created in Blender. (**c**) Virtualized version, as shown in the telepresence system

barely perceptible half-second time delay between UHF (ultrahigh frequency) and composite video connections.

The following criteria were taken into account in selecting this specific artwork as a case study:

1. Endangered artwork: The sculpture consists of old neon lamps and CRT televisions, and is not always accessible to the public due to preservation work being done on it.
2. Relevance: This is considered an important work by Nam June Paik, acclaimed as one of the "fathers of video art."
3. Accessibility: There is little audiovisual information (mostly just photos) about this artwork, and the work is not always available to art experts and the interested public. A temporary absence of this artwork due to maintenance or lending the artwork to other exhibitions could be bridged with the performance of its digitized version.
4. Indirect conservation: The availability of the artwork as a digital surrogate could increase the lifespan of the original.

Concerning "10,000 Moving Cities – Same but Different" (2012) by Marc Lee, depicted in Fig. 3a, the artist's intention to virtualize the artwork fully was the starting point for the case study. Furthermore, net art is a jeopardized form of cultural heritage because of its dependence on the World Wide Web, which brought about additional challenges for the case study, such as the creation of an encapsulated offline version.

For the identification of authenticity criteria and a decision-making model in Marc Lee's "10,000 Moving Cities – Same but Different," a questionnaire by Fabienne Blanc about a similar work (Blanc 2013) was enhanced for a detailed interview with the artist that focused on conservation issues and exhibit requirements, among other things.

With reference to "Versailles Fountain," the research on the art piece was complemented by the specific knowledge of the relevant curator and technical personnel at the ZKM Museum. Once information relating to art history, material conditions, technical documentation, and the artist's intention were carefully examined and contrasted, a treatment model for 3D modeling and telepresence re-enactment was designed with a focus on computational complexity reduction, while still respecting the requirements and authenticity criteria for digital re-enactment.

According to the experiences with "Versailles Fountain" (VF) and "10,000 Moving Cities – Same but Different" (MC), the technical process of generating an e-Installation can be structured into five essential parts:

1. Creating a basic geometric 3D model
2. Modeling details using captured information such as photographs and depth images
3. Incorporating existing digital content
4. Implementing the program logic

1. *Basic model*

Some parts of the artwork, such as the cubes (MC) and the body (VF) of the original installations, can be modeled as simple, basic geometric objects with the 3D modeling software Blender (http://www.blender.org/). For the "Versailles

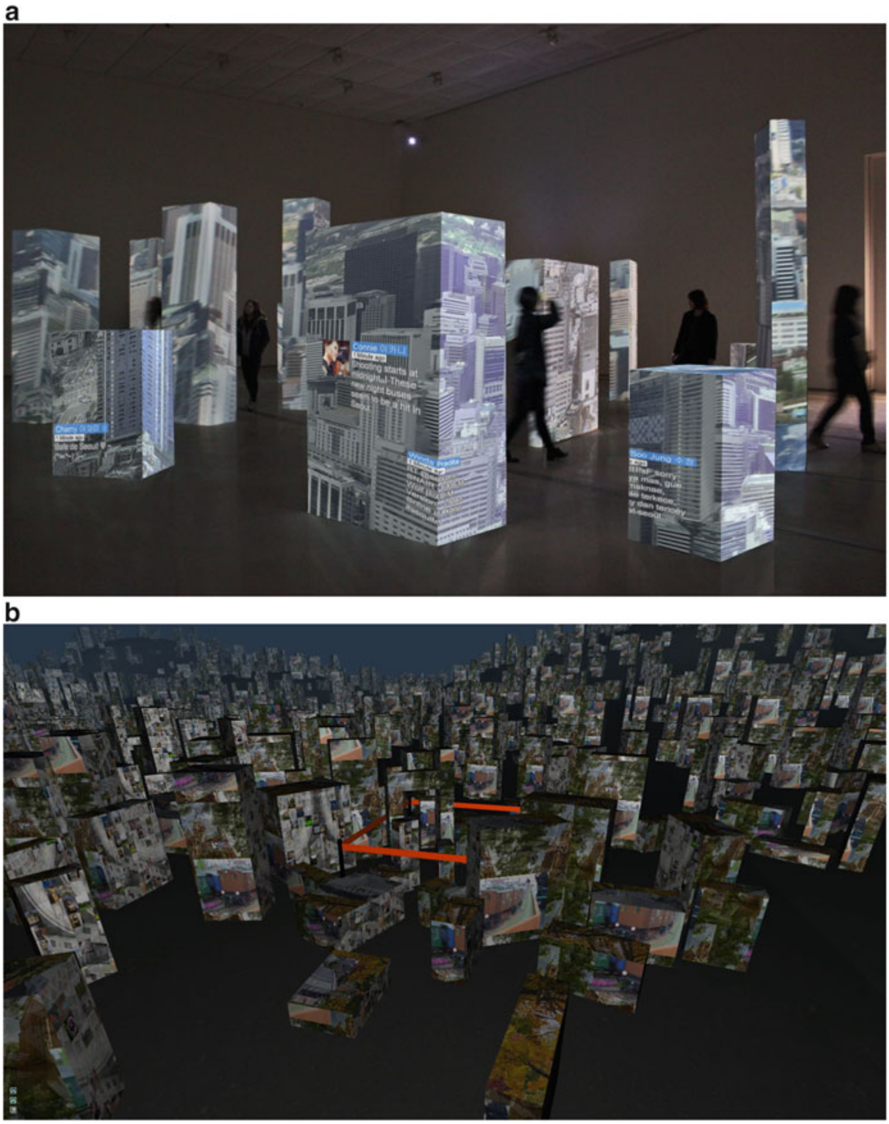

Fig. 3 (**a**) Net artwork "10,000 Moving Cities – Same but Different" at Seoul (**b**) Virtualized version in the telepresence system

Fountain," the complete body of the artwork was found to be simple enough to apply this type of modeling. In Fig. 2b, an illustration of the 3D model is given.

2. *Captured Data*

More detailed components, such as complex geometry and textures, were reconstructed using real data captured from the installation with a consumer digital

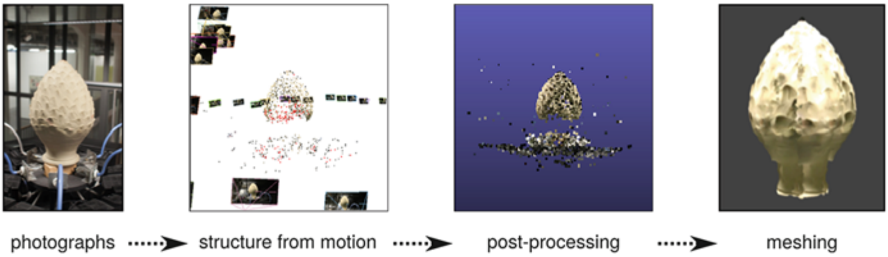

Fig. 4 3D reconstruction using Structure From Motion

camera. In particular, we applied Structure From Motion (Changchang 2011; Changchang et al. 2011) to reconstruct the 3D geometry of the pinecone on top of the VF artwork (see Fig. 4). For postprocessing and meshing, Meshlab (http://meshlab.sourceforge.net/) was used. This software tool was developed in the context of the 3D-COFORM project (see http://www.3dcoform.eu).

In addition to the Structure From Motion technique, a panoramic image of the surroundings was created in order to embed the VF into its exhibition environment at the ZKM.

3. *Digital Content*

Existing digital content, that is, video files (VF) and code (MC), was adapted and incorporated. In VF, two video files, stored on the hard disk of a PC, are played in a loop on the television sets. MC contains five browser applications written in PHP and HTML, which generate audiovisual collages of current Internet content that are then projected onto the cubes. Another application, which also requires a connection to the Internet, implements a menu with content taken from Google Maps.

4. *Program Logic*

We implemented the program logic for both e-Installations in Python. For the VF, the logic simply required displaying the video files in the form of video textures on the virtual televisions in the "Fountain". In the case of MC, implementing the logic was much more complex, as it required (1) displaying current browser windows as a video texture, and (2) allowing for interaction with the menu. This included implementing the menu for the selection of cities, as well as implementing virtual speakers and virtual projectors that project video textures onto the cubes. This has been challenging from a technical perspective, as all the digital content of MC is loaded online from the Internet, that is, from Google Maps, Twitter, YouTube, and other sites. Figure 5b shows the menu, as implemented in the telepresence system. For an intuitive interaction with the menu, the user equipment was extended by a handheld mouse (McClelland 2014). Figure 5a shows a user operating the device.

Once an e-Installation is created according to the scheme described above, it can be experienced using the telepresence system at the ISAS lab. As mentioned at the beginning of this section, in the telepresence system the user is equipped with a

Fig. 5 (**a**) User carrying the equipment for experiencing “10,000 Moving Cities” (McClelland 2014) (**b**) User interface of “10,000 Moving Cities” as seen by the telepresence user (McClelland 2014)

head-mounted display as well as headphones and can freely explore the e-Installation by walking and looking around. A server PC runs the application and synthesizes the multisensory impressions of the e-Installation according to the current user location and perspective. These impressions are then transmitted to the client PC and rendered to the user.

The synesthetic documentation of “Versailles Fountain” allows unrestricted access to a very realistic model of the sculpture and its meaning level for everyone everywhere. In this scenario, the virtualization and telepresence visualization of a static video sculpture with embedded original video signals was tested.

“10,000 Moving Cities” provided a different scenario with realtime data from the Internet and interaction with a search interface. The cooperation with the Swiss Net artist Marc Lee has shown that an e-Installation also offers a very attractive alternative for exhibiting immersive Net art beyond the conservation of synesthetic documentation.

Using the experience gained in creating e-Installations for these two works, we conclude this section by describing a general methodology for digitalizing works of media art. First, a detailed description of the artwork and its meaning has to be made. This information includes all technical data, art theoretical and conservation-related information available that is needed for a meticulous migration of the artwork respecting its originality and authenticity. Second, a base 3D model is created out of the physical geometry of the artwork. This task can be made easier by creating and reusing generic templates of common objects such as televisions, boxes, or video projectors, whenever this shortcut does not modify the meaning of the artwork. Third, the base model is enhanced with detailed reconstructions of specific aspects relevant to the work. For this, off-the-shelf reconstruction programs (such as the aforementioned Structure From Motion), which take photographs and depth images as input, can be used. Of course, the decision of which parts are deemed relevant needs to be taken with input from the artists and art experts that supervise the authenticity criteria. Fourth, digital, time-varying media content is digitalized and encoded. In particular, this includes video and audio data. Finally, the logic needs to be reproduced in the virtual model. This consists, for example, of modeling the dynamic mechanisms of how individual parts move and interact with the public, and re-enacting this behavior within the digital replica.

Challenges of Digital “Re-Enactment” Beyond Technical Issues: Curatorial Decisions and the e-Installation Paradox

During the digital re-enactment of a work of media art and its transfer into a telepresence system, some curatorial decisions must be taken. Curatorial input led to the implementation of specific environments as well as to relevant decisions concerning detail modeling.

Environment

In both cases, an environment was re-created in order to preserve contextual information: the real exhibition place in the case of VF, and an imaginary landscape conceived by the artist in the case of MC. This re-creation helps document the intention of the curator and the artist, respectively.

Modeling Detail

Ideally, the entire composition of the sculpture, including hardware, circuit, and wiring diagrams, has to be captured. The following questions regarding the level of modeling detail have therefore been addressed:

1. What level of detail has to be achieved in the modeling of hardware components?
2. Should unintended side effects such as a half-second time delay between the UHF and the composite video signals of VF be emulated?

After discussions with the curator and the ZKM technicians, it was clear that the position of the knobs of VF has no effect on the images. This means that the modeling of the rotation of the knobs can be omitted without the sculpture losing authenticity at the level of meaning. In the case of the half-second time delay between the monitors in VF, this was not originally intended by Nam June Paik and is only perceptible on closer inspection, so there was no need to emulate this.

The e-Installation Paradox

The creation of such a complex digital artifact, that is, an e-Installation, is an interesting paradox for the conservation of media art: the synesthetic documentation becomes an artwork itself, and needs, for its part, a preventive preservation framework in order to keep functioning when the software context and the hardware configuration change. In particular, the virtualization of physical components of digital-born artwork, as in Net art or game art, does not guarantee a long-term solution for the conservation of meanings and processes. For this purpose, continuous maintenance with regular updates and adaptation of all involved software components is required. Therefore, e-Installations are also a subject of study for long-term archiving experts.

Conclusions

In this chapter, a new synesthetic documentation method for the virtual re-enactment of media artwork was presented and tested. This new method, which is called e-Installation, can be integrated into modern art conservation practices as a form of extended documentation within the framework of an informational preservation strategy. In addition, it offers scalable access not only for curators, artists, conservators, and art theorists, but also for art communicators and the general public. An e-Installation also provides 3D modeling and telepresence experts a large field of research on human perception thresholds, which influence the complexity and resolution of the virtual re-enactment.

We have seen that a realistic and useful e-Installation implies a deep knowledge about the artwork and its authenticity criteria. This is only possible if systematic modern art documentation and conservation planning methods such as the "variable media questionnaire" and the "decision-making model" (section "e-Installation: Telepresence as a Media Art Documentation Method") are first taken into account. In this way, mistakes can certainly be avoided during the virtual re-enactment.

Two scenarios have so far been tested: the video sculpture "Versailles Fountain" by Nam June Paik and the Net art installation "10,000 Moving Cities – Same but Different" by Marc Lee. In both cases, five steps were followed for the technical implementation: (1) documentation of the artwork, (2) creation of 3D objects in Blender, (3) use of sensor data, (4) integration of existing digital content, and (5) the implementation of the art program logic. The resulting application runs on a server PC that synthesizes the sensory impressions of the artwork according to the current user location and perspective in a telepresence system.

The synesthetic documentation of works of media art at risk is still in its infancy. New scenarios are required to achieve new goals and define systematic decision-making models. As an example, kinetic art and land art are particularly suitable for the improvement of realistic proxemics, multiple-visitors interaction, and second-order observation. These art scenarios require further development of telepresence techniques such as haptics and motion compression.

The present research has also shown that an e-Installation can transcend current conservation thinking by creating an entirely new media artwork in collaboration with an artist. Finally, the use of an e-Installation within and beyond a conservation context has implications for the authenticity concept, which requires further study.

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Part V
Virtual Recording

A Remote Sensing and Geo-Informatics Approach in Watershed Planning of Irrigation Tanks Connected with Batticaloa Lagoon: A Case Study of Unnichchai Watershed

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Abstract Watershed land and hydrology are very important resources in agricultural development. Adequate and proper land use planning and management of these resources is of ultimate importance in sustainable development. Batticaloa lagoon is the most important of the three lagoons in the Batticaloa district that supports the people living around it environmentally and economically. However, negative anthropogenic activity elicits adverse changes in the natural system of the lagoon environment. In this study remote sensing and geographic information system (GIS) techniques were used to generate information on the current status and utilization potentials of the Unnichai watershed in Batticaloa district generating local specific micro watershed development plans for the area. One such anthropogenic influence is the impact of water that is expelled from the Unnichchai tank which is connected to the lagoon. This input of the water from the Unnichchai tank in the forms of issued and spilled water is suspected to be creating significant changes in the geophysical status of the lagoon that could induce dynamic changes in the lagoon system. The study revealed that about 59.92 % of the land cover is used for rainfed agriculture that lacks sufficient soil and moisture to support good yields. After the conflict and displacements and resettlement of the district the western part of the district land was utilized for several development activities. The

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intense agricultural practices along the streams pose a problem to the ecosystem which may affect the life of the inhabitants within the watershed. It became obvious that a developmental plan was necessary in order to enhance food security, livelihood development, economic development, and ecosystem repair.

Keywords Remote sensing • Geo-information • Land use planning • Sustainability • Watershed

Introduction

A watershed is a resource region where the ecosystem is closely interconnected around three basic resources: water, land (soil), and vegetation (Bruns and Sweet 2004). These three resources provide arable land for food production, water to support irrigation, fisheries, hydroelectric energy, and various biodiversity that regulates and controls the biophysical environment and generates sources of livelihood (Ibrahim 1997; Sharma et al. 2003).

Watershed management is fast becoming a blueprint for agricultural development and generally an aspect of natural resource management in most parts of the country today. The knowledge of the land use and hydrology of a watershed is important for its planning and management. Assessing the land use potential and conservation needs can help in planning for alternative uses that will maintain the quality of the land and water (Clark 1990).

Watershed management implies rational utilization of land and water resources for optimal and sustained production with the minimum hazard to natural resources and environment (Jain 2001).

The success in planning developmental activities of a watershed depends on the quality and quantity of information available on the natural primary production systems (interaction among the basic resources of land, water, and vegetation) and socioeconomic resources (Jain 2001; Perumal et al. 1997). This knowledge will allow efficient and effective generation of development plans showing new land use practices that would be suitable in the watershed (Sanchez-Azofeifa 1997). This will assist in achieving and maintaining a balance between resources development to increase the welfare of its population and resource conservation to safeguard resources for future exploitation and to maintain ecological diversity, both for ethical reasons and as an assumed prerequisite for the survival of mankind (Ifatimehin 2007).

Geospatial technology plays a significant role in the development of a digital terrain database in replacing the qualitative and nominal characterization of topography. The availability of satellite-based new topographic datasets has opened new venues for hydrologic and geomorphologic studies including analysis of surface morphology (Frankel and Dolan 2007).

Landform analysis with respect to their nature, extent, spatial distribution, potential, and limitations is very useful for evaluation and optimal utilization of

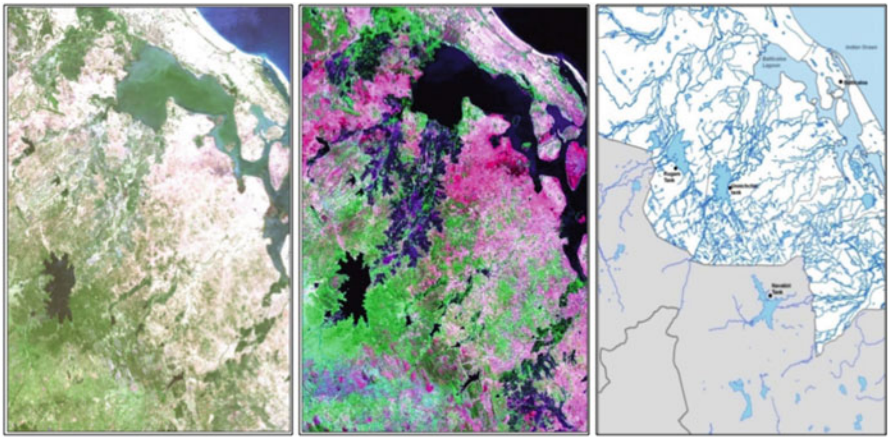

Fig. 1 (**a**) Landsat satellite image (natural color) of Unnichai watershed during Yala season. (**b**) Landsat satellite image (false color composite) of Unnichai watershed during Maha season. (**c**) Map illustrating how the issue and spillwater reach the Batticaloa lagoon

land resources. In the quantitative approach for landform mapping and classification based on high-resolution digital elevation models (DEMs), slope, elevation range, contours, and stream network pattern can be used as basic identifying parameters. High-resolution satellite data provide a reliable source of information to prepare a comprehensive and detailed inventory of landforms (Reddy and Maji 2003) and land degradation mapping (Reddy et al. 2004).

The Unnichai watershed resources such as land, soil, vegetation, and water are facing threats posed by unsustainable depletion, poor farming practices, indiscriminate utilization of resources, resource conflict between the resettled population and other neighboring communities. This situation can be addressed when proper understanding of the limit of these resources is acknowledged, how they can be sustainably used, adoption of good farming practices, and the delineation of resources to avoid conflict and other issues (Krishnayya Angira Baruah 2003). The development of an alternative land use may serve as the basis on which activities detrimental to the watershed can be resolved and checked.

This chapter concerns the problem of the Unnichchai tank input into the Batticaloa lagoon. Throughout the year the Unnichchai tank releases water to the Batticaloa lagoon at Makilavadduvan (North portion of the Batticaloa lagoon). Especially during the northeast monsoon, the Unnichchai tank releases a high quantity of the water, which leads to flooding. Therefore, if the water exceeds the holding capacity, the excess water will spread over the boundary of the Batticaloa lagoon (Fig. 2).

During the northeast monsoon period the Unnichchai tank releases the water through the sluice gate from where it spills out.

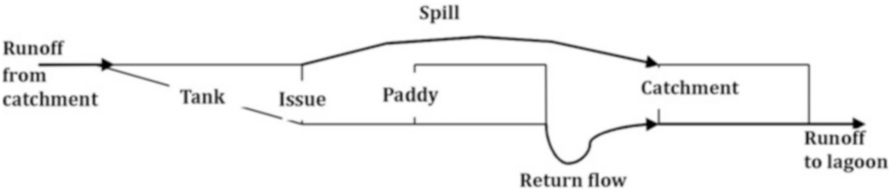

Fig. 2 Hydrological processes operating in different units of the Batticaloa Lagoon

On this note, this chapter adopts remote sensing and GIS techniques in generating an alternative land use plan for the Unnichai watershed for maximum utilization and returns.

The Study Area

The Batticaloa lagoon (7° 24′–7° 46′ N, and 81° 35′–81° 49′ E) is one of the most productive brackish water bodies in Sri Lanka. The lagoon is about 56.8 km (23 miles) long along the meridian axis, its width varies widely from 0.5 to 4 km (Jayasingam 2000), and the maximum depth is about 15 fathoms (Vinobaba and George 1996). The lagoon is the direct recipient water body of about 19 reservoirs, five major lakes, and 11 rivers, numerous irrigational channels, and many drainage basins and has become a dominant morphological feature of the watershed. The largest of these rivers is the Mundane Aru, which has a subcatchment area of 1280 km^2. In addition to these streams, there are numerous *villus,* which are low marshy depressions, and *Thonas,* which are brackish water intrusions of the sea and an occasional link with the lagoon(s) (Anon 1999).

The Unnichchai and Navakiri tanks connect to the north portion of the Batticaloa lagoon but the Rugam tank connects to the south portion of the Batticaloa lagoon. The catchment of the Navakiri tank is 70.00 mile^2. The water discharged from this tank reaches the Batticaloa lagoon at Mandur. The catchment of the Unnichchai tank is 106.00 mile^2. The water discharged from the tank reaches the Batticaloa lagoon at Makilavadduvan. The catchment of the Rugam tank is 35.00 mile^2. The water discharged from the tank reaches the Batticaloa lagoon at Karuthapalam.

Unnichchai is the oldest irrigation settlement scheme in the Batticaloa district. This was constructed by throwing an embankment across the Mahilavedduvan River and it is located in the Unnichchai village in Manmunai west divisional; secretary division in the Batticaloa district. This tank is reached by turning left at Karadianaru off Batticaloa–Badulla road and proceeding about 13 km along Karadianaru Unnichchai Road which terminates on the left bank of the tank bund.

The tank comes under the purview of the Irrigation Department of the Sri Lanka central government. The most recent proposed development of the reservoir includes its augmentation for the provision of drinking water to Batticaloa town by raising the bund by 2 m.

Unnichchai tank is an irrigation tank. It supplies the water during the *Maha* season for paddy cultivation but in the *Yala* season the water that exceeds the holding capacity of the tank is spilled out. The water-holding capacity of the tank is 41,500 ac.ft. These issue water and spilled water discharges into the north portion of the Batticaloa lagoon as shown in Fig. 1.

Materials and Methods

The materials used for the study are

- Landsat image data of Yala and Maha seasons 2007
- 1: 50,000 Topographic map of 1988
- Arc/Info Version 9.3
- For generating information on land and water resources Landsat data in the form of false color composite (FCC) prints at 1:50,000 scale acquired during 2005, and 2007 were used.

The digital analysis of the satellite data using Erdas 9 software was done to classify the imagery into different land use types using the maximum likelihood algorithm (Kolawole 2005). Limited ground checks and training data generated through the global positioning system (GPS) were carried out to improve the thematic maps and the identification of various land uses in the study area.

All the thematic maps were converted into digital form, using a scanner. The datasets were converted from raster to vector form using the Arc GIS 9.3. After preliminary editing, the data were imported into the Arc/Info (Version 9.3) GIS environment and the different thematic layers were edited to create an error-free

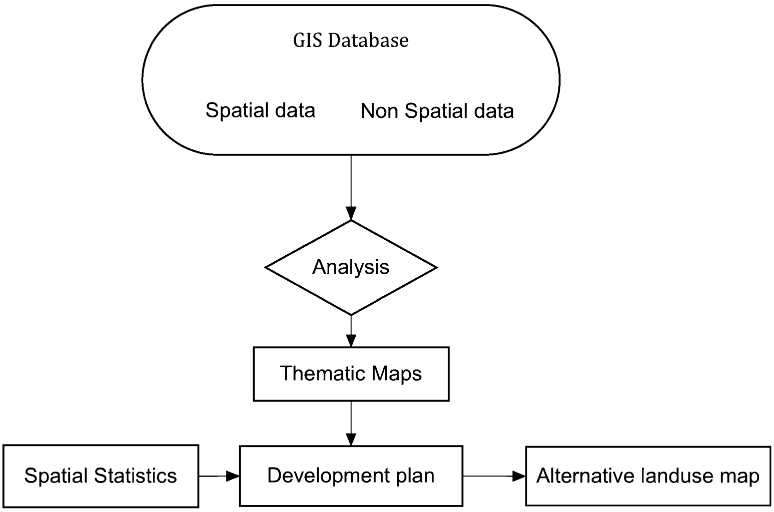

Fig. 3 Flowchart of the method

digital database. However, questionnaires administered to a systematically sampled population generated demographic and socioeconomic data of the region that helped in ensuring a locale specific to the development plan. The study design (Fig. 3) was used for the development plan.

Results and Discussion

Land Use Classification

Land use classification of the watershed from the satellite imagery shows the spatial distribution of the nine classes of land use. The land use statistics of the watershed are presented in Table 1. Agricultural land use both rain-fed and irrigated dominates the landscape of the watershed at about 44.10 % and forest cover is limited to the southern part of the tank with scanty shrubs of 0.13 % and 46.31 %, respectively. Although water bodies and others are represented by 4.38 % and 3.16 %, respectively, this suggests that the major occupation of the settlers is farming.

Soil Classification

The limited data collected from the field checks aided in deriving the soil types of the watershed from the soil map. The soils fall into the group of ferruginous tropical soils. Table 2 and Fig. 4a, b show the spatial distribution as derived.

About 53.8 % of the rain-fed agriculture is practiced on noncalcic brown soil and low humic gley soils. However, alluvial soils of variable texture also support various rain-fed crops along the riverbank. These soil types are shallow and poorly drained with little available soil volume for root extension and offer limited

Table 1 Present land use of Unnichcai watershed

Landuse	Area (km^2)	Area (%)
Forest	0.47	3.63
Home garden	13.64	1.20
Marshy land	4.52	0.54
Other plantation	2.04	39.91
Paddy land (rain-fed/irrigated)	149.95	0.73
Rock	2.75	46.31
Scrub, bare land	173.99	4.38
Water bodies (streams, tanks, ponds)	16.46	3.16
Others	11.89	3.63
Total	**375.72**	**100.00**

Source: Authors' computation 2013

Table 2 Present soil types Unnichchai watershed

Soil Types	Area (km^2)	Area (%)
Noncalcic brown soil and low humic gley soils	155.29	53.80
Solodized Solonetz Solonchaks and soils on recent marine calcareo	48.04	16.64
Alluuvial soils of variable texture and drainage; flat terrain	72.34	25.06
Erosional remnants steep rock land and various lithosols	12.97	4.49

Source: Authors' computation 2013

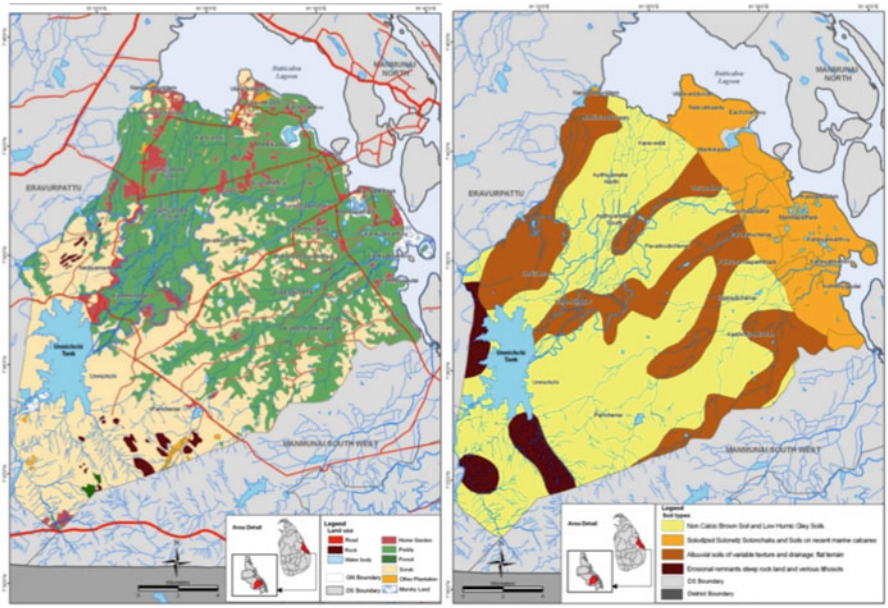

Fig. 4 (**a**) Land use patterns of Unnichchai watershed, (**b**) Spatial distribution of soil types at Unnichchai watershed

potential for crop plant growth. They support both rain-fed and irrigated agriculture.

Hydro: Geomorphological/Drainage Pattern Analysis

The drainage basin is frequently selected as an ideal geomorphological unit. The watershed as a basic unit of morphometric analysis has gained importance because of its topographic and hydrological unity. GIS techniques characterized by very high accuracy of mapping and measurement prove to be a competent tool in morphometric analysis. Drainage density and stream frequency are the most useful criteria for the morphometric classification of drainage basins which certainly control the runoff pattern, sediment yield, and other hydrological parameters of the drainage basin.

The geomorphologic parameters of Unnichchai watershed drainage are generated from the imagery. These parameters show the hydrological characteristics of the watershed. They show the linear, aerial, and relief properties of the watershed. The drainage density of 1.5 km per km^2 indicates that the soils are permeable, whereas the bifurcation ratio of 3.6 indicates the watershed's slight vulnerability to flood risk. Therefore, the land use of this watershed can withstand intense agricultural activities when proper agricultural practices and conservation methods are employed. This will enable farmers to use the land according to its capabilities and to treat it according to its needs.

An Alternative Land Use Plan for Unnichai Watershed

The natural resources of a country are the basis upon which all life depends. The rapid increase in population witnessed around the nation today drives each district towards seeking self-sufficiency in economic development and food production, which poses a great threat to the resource base, as it increases the risk of degradation. Certainly, changes in land use patterns provide many social and economic benefits and constitute a major developmental cost to the natural environment (Tanga et al. 2005).

After the Civil War the nation has been leaning towards sustainable development and also according to "*mahinda cinthana*," each district should focus on agricultural self-sufficiency. For that Batticaloa district has to seek possibilities to increase gross production. Thus, this is one of the alternative plans to increase production by planning land use appropriately with irrigation, rainfall, soil types, and the like. Remote sensing and GIS can be used to reassess the impact of these interactions between the natural environment and economic development in more systematic and holistic ways (Ifatimehin 2007; Ibrahim 1997; Jayasingam 2000) in order to provide proper resource management and alternative land uses (Clark 1990) suitable for maximum utilization and returns from these resources. Alternative land use plans for the study area became inevitable inasmuch as the resettled people are underutilizing the potentials of the watershed. Their agricultural practices with the increase in population are increasingly degrading the watershed ecosystem.

The alternative land use plan was generated through the overlaying of the various thematic maps coupled with the application of decision rules.

Finally suitable bare lands were identified, then depending on suitability of cropping, those lands were categorized as new land classes; these are fuel and fodder plantation, grazing land, forest plantation, other field mixed cropping land suitable for both seasons, and suitable for Yala season only.

The spatial statistics for suggested land use are given in Table 3 and the final development plan map is shown in Figs. 5 and 6. Comparing the existing land use types (Table 1), the alternative land use plan gives a considerable amount of growth

Table 3 Alternative land use plan

Land use	Area (km^2)	Area (%)
Forest	0.47	0.13
Home garden	13.64	3.63
Marshy land	4.52	1.20
Other plantation	2.04	0.54
Paddy land (rain-fed/irrigated)	149.95	39.91
Rock	2.75	0.73
Water bodies (streams, tanks, ponds)	16.46	4.38
Fuel and fodder plantation	15.13	4.03
Other field mixed cropping: Maha	73.76	19.63
Other field mixed cropping: only in Yala	20.37	5.42
Grazing land	21.28	5.66
Forest plantation	13.21	3.52
Scrub, bare surface	30.243	8.05
Others	11.89	3.16
Total	**375.72**	**100.00**

Source: Authors' computation 2013

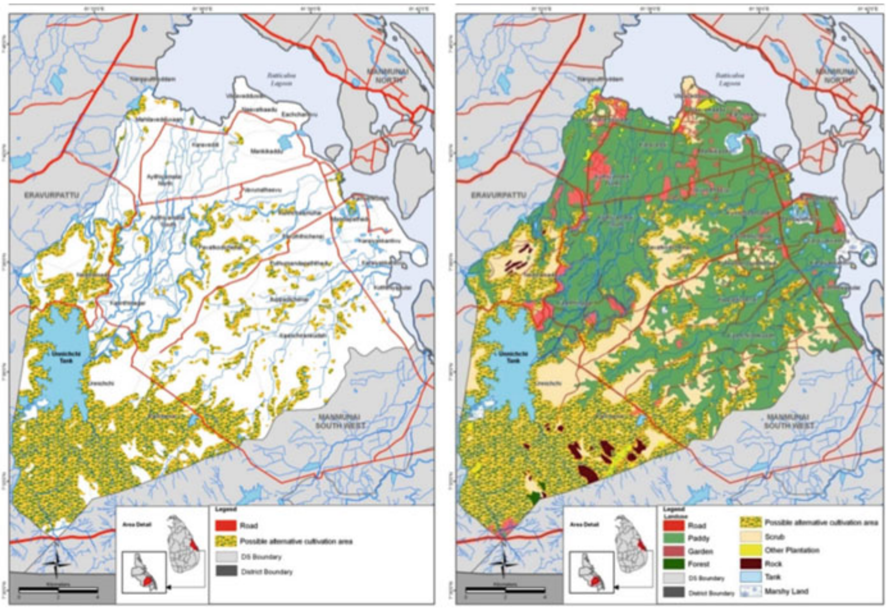

Fig. 5 (**a**) Identified suitable bare lands for agriculture, (**b**) Identified suitable bare lands for agriculture with existing land use pattern

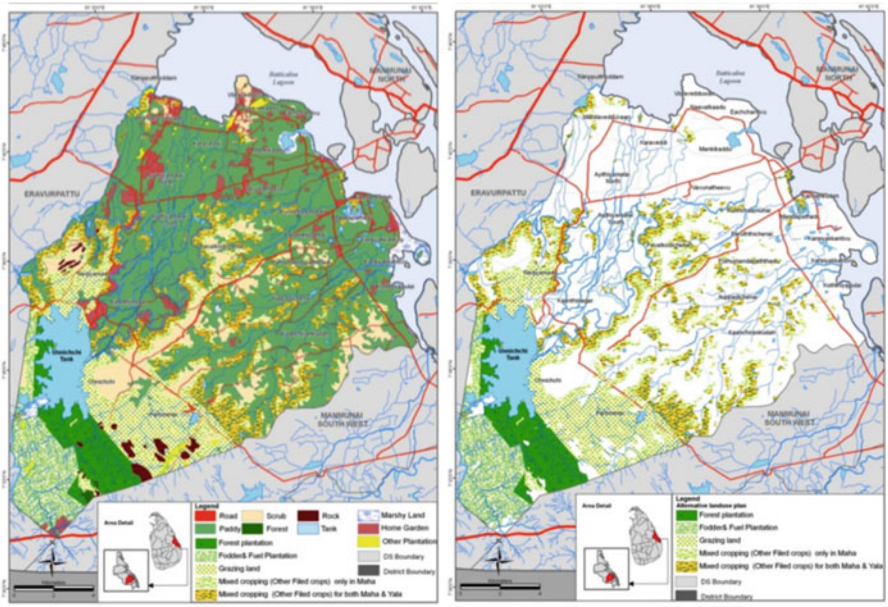

Fig. 6 (**a**) Alternative land use map at Unnichchai watershed, (**b**) Alternative land use map at Unnichchai watershed with existing land use pattern

in vegetation cover in the watershed. The bare surface and shrub land uses could be transformed to other beneficial different uses: forest plantation, fuel and fodder plantation, and mixed cropping.

These different land uses will enrich the soil by aiding soil depth development, increasing soil moisture, and checking excessive runoff and top soil erosion. The suggested grazing land will disallow indiscriminate depletion of vegetation cover by animals, most especially by herds of cattle. The fuel and fodder plantation will provide fuel wood to the population and as well save the riparian forest from illegal felling of trees. The bare surface and shrubs can serve as an area for further development either to meet the infrastructural needs of the settlers or for other purposes.

Policy Implication

The essence of this chapter is to suggest/recommend how land, water, and vegetation resources can be sustainably managed. The development plan depicts adherence to the management and conservation measures according to the suitable change in land use practices that will enhance the development of vegetation cover, retention of soil moisture, and provide economic opportunities which may help in the alleviation of poverty, wealth creation, and food security to the population and the nation at large.

The Unnichchai tank and Batticaloa lagoon can be adequately sustained when prospective sites for rainwater harvesting are constructed in order to augment irrigation water as well as recharge the aquifer.

The government can effectively employ the development plan of the Unnichchai watershed to other watersheds in order to achieve the Ministry of Economic Development and Development projects and Millennium Development Goals (MDGs). The various organizations and research institutions working within the Unnichchai basin can be charged to see how their activities (fishery studies, cropping, livestock, hydrology, etc.) could be tailored with the development plan to achieve maximum utilization and returns from the three resources (water, land/soil, and vegetation) of the watershed and opening a sustainable socioeconomic environment and a sustained biophysical ecosystem for all.

Conclusion

Sustainable development aims at maintaining the balance between often conflicting ideals of economic growth and nurturing environmental quality and viability. Remote sensing provides a suitable database for generating baseline information on natural resources, a prerequisite for planning and implementation, and monitoring of any developmental program.

A geographic information system offers an ideal environment for integration of spatial and attribute data on natural resources for formulating the developmental plan of an area taking into account social, cultural, and economic needs of the people. The digital elevation model generated from the measurements through a global positioning system using a digital photogrammetric approach enables further refining the developmental plans.

The employment of a watershed developmental plan may result in the sustainable land use management and proper utilization of inherent natural resources. The integrated approach of remote sensing and GIS techniques provides the major tool in the evaluation of all attributes of a watershed. The proper understanding of these attributes (geomorphological parameters, soil, land use, etc.) will provide the necessary information in the detection of problems and proffering solutions to the issues faced by the human population in their quest for survival.

Geospatial technologies can be effectively used in the generation of a digital terrain database, inventory and mapping of landforms, soils, land use systems, soil suitability evaluation, soil loss assessment, prioritization of watersheds, and watershed management.

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Building Survey System for the Representation of the Load-Bearing Structure

Gregor Bourlotos and Maria Boştenaru Dan

Abstract This work deals with the different methods of building surveys. Special attention is paid to the record of building geometry. But methods of investigation of building materials are also considered. First, the classic approach to surveying buildings is presented to the readers. Proven measurement techniques are explained on the basis of sketches; the instruments used in this case are presented with color images. In the later chapters of this work, the reader is introduced to modern building survey systems. The use of a standard computer allows numerical evaluations of photos and makes the interpolation between two points in space measured in situ possible in the office. The monitoring of onsite measurements and the (also associated) reduced personnel costs by using site-ruggedized laptops are also discussed. But especially, the mystical world of photogrammetry is entered. The mathematical background is explained for the most part and software developed at IMB shows how to master façade evaluations using a photo and everyday programming means (the source code is located in Appendix C). Investigation processes of building materials and the fledgling recording system "laser pantograph" complete the circle of modern building acquisition systems. The use of computers causes in every area of daily life an automatic increase in information density. This fact is taken into account by modeling considerations in the last section.

Keywords Building survey • Semantic enrichment • CAD programming

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Introduction

The building survey is a way to experience the environment. A building is recorded in the framework of a building survey through measurement, drawing, and description. The result describes its creation, history, and relation with the environment. For this reason it is necessary:

- To reproduce as exactly as possible the spatial object in the plans
- To understand the historical processes: design in the creation phase and transformation

The building survey became important for the preservation of historical buildings.

For more recent buildings the authorization plans are available and provide information on the interior of the building. For the older ones a building survey is needed. In this work the integration of modern technologies in the survey process is investigated.

Among the methods surveyed in this work is that of the laserpantograph (from Greek *pan*, everything, and *grapho*, write down). As part of the record, the way information is interpreted is also important. Observations on altering the historical substance provide semantic enrichment through text data to the geometric record.

The goal of this work was to create a model for the classification of existing buildings independent of the considered concrete cases, in which spatial elements and semantic data related to them can be integrated. The spatial elements adequate for the connection of semantic data are identified, considering the information needs of actors from the architectural, building technique, and building economics fields. A focus on the cooperation between different actors for seismic building retrofit is defined.

The work has the following structure.

- Introduction to the approach and expected results in the case of traditional and recent (3D scan) methods of building survey and measurement
- Identification of the spatial elements of the interface between construction and execution
- Investigation of the visual recognition means of these elements
- Development of a connection between concept data and spatial elements
- Development of a methodology for the recording, digitalization, and vectorization of the identified spatial elements

Bostenaru (2004) shows the role of the so-called "retrofit elements" that incorporate information from the building survey, information used in engineering simulations, in costs estimation, and which define the reals perceived by the inhabitants. This way they build the basis for the interaction between the actors in intervention on existing buildings. The interest groups in this regard are conservation of historic buildings, structural behavior and construction techniques, construction costs, and, more limited, user interests. The corresponding actors in the decision process are the architect, the civil engineer, the investor, and the user. As such, the information in the building survey is used in an integral process of planning of the retrofit intervention in decision making. Information from the archive (pre-existing plans) can be combined with this.

In the reintegration grant of the second author (http://bostenaru.natkat.org/) it was investigated how the drawings of the plans, be it from the archive or from the building survey, can generate ontologies. These can refer either to the façade, or to the interior of the building. Building elements constitute the basis of a structural engineering concept called macro-elements (Lagomarsino 1998), and this work aims to recognize geometric quantitative relationships in the façade between the contour of such macro-elements. In the urban images of destruction (Schweier et al. 2004), structure for motion methods are used to build the CAD model based on multiple photographs, a method proposed to be later used on drawing tablets (personal communication with the authors), which is in synergy with what is proposed here. Macro-elements are those elements that display damage patterns, for which retrofit solutions are suitable and which are characteristic for the structure (e.g., in rapid visual screening) as envisaged by the *World Housing Encyclopedia* (http://www.world-housing.net/) and as such, a development of the retrofit elements. Retrofit elements as an interface are also the interface for building information modeling programs. English Heritage, the University of Geneva, and Getty developed special ontologies for buildings that can result in such elements. Apollonio et al. (2010) presents a database of 3D elements based on style for the architect Palladio. Cignoni and Scopigno (2008) show instead a critical view. The other chapter in this book by the second author (Bostenaru 2015) shows their employment for structure. Libraries of software, for both CAD and structural simulation, permit additions of library elements that can be such retrofit elements. In building information modeling this is done via scripting, with Geometric Modeling Language. For this reason, in this chapter an extensive view on geometry is given, and how geometric relationships translate in perspective projections such as photographs. Even if today the computer takes over the task of drawing perspectives, the basics need to be known in order to be able to reverse-build from ancient images. In the chapter two programming approaches are shown: one with a built-in camera and one without. The one with a built-in camera can be used for augmented reality as in Schweier and Markus (2006).

Bostenaru (2011) developed an ontology for ordering photographs of disasters according to their technical and artistic information characteristics. In Bostenaru and Armas (2015) the ORA classification of their networking is presented. Photographs can serve, as shown by numerous projects (Snavely et al. 2006, 2008) and in this work, to build 3D models. Younes et al. (2014) use historical photographs. But the same need of ontology to order sites and artifacts can be used to create a database of 3D elements. In case of disasters this can be the database of macro-elements. Creating such models goes beyond the creation of meshes as in the software presented in this chapter, towards building elements as entities, which can be macro-elements from the point of view of structure or style. The alteration of a building in time can be shown with modifiers of macro-elements (through graphic codes such as color or transparency), be it a fast modification as in the case of disaster or one over time.

This chapter proposes a structure from motion (SfM) approach of gaining 3D models from photographs. This approach is not new (Rothganger et al. 2006). Archive images can be used as well, and these images can be collected through public participation such as PGIS and PPGIS (Lee et al. 2005). Some researchers proposed the method of the urban game to collect such images (Tuite et al. 2011). In Romania such an approach is employed by the project “Memorable City” for Braşov. Google Cultural Institute contains travel stories such as we find in literature (Stefan Zweig, Nicolae Iorga). Google Stories is a related project. The Google tools thus replace many pioneering software approaches from a decade or more ago. In Germany projects of this kind were done in Darmstadt and Schwäbisch Hall. The city is seen as a network of stories of houses and reading the city means reading the links between these, the “paths” according to Lynch (Lynch 1960). Heath (2010) proposes image webs as well. The COMOB method (Amoroso et al. 2013) was shown by Bostenaru and Dill (2014) as a way to connect photographs in order to create paths of the Magheru Boulevard in Bucharest, a boulevard of Modernist buildings, adequate for the software proposed in this paper. Then, in the same year, a workshop of the AESOP “Becoming Local” group took place in Bucharest to translate scenarios of urban development into real space. A path of this kind was translated to a map, of the successful cooperation between architect and engineer, two of the decision actors.

Building Survey: Definition of the Concept and Typological Classifications

The building survey is the record of the existence and the state of a 3D object and its reproduction in 2D scale plans and, as far as it is not possible in drawing, through verbal description. The building record should present the construction details and the style characteristics.

The phases of the building survey are:

- Onsite measurement
- Drawing reproduction
- Description of the building
- Representation of architectural history

In the digital realm the drawing reproduction results in geometrical virtual reality models, and the description leads to semantic enrichment of these. The representation of the architectural history should explain property changes, changes in the structure, state of materials, as well as the consequences of a certain architectural style in the façade and in the interior organization as reflected in the plans and 3D.

The scope of the building survey is:

– To document construction changes
– To contribute to the preservation of the built substance
– Selling, value estimation
– Construction research, conservation

The building survey can be a step in an integrated approach to economic efficiency calculations, because the same building elements (in a detailed view) or surfaces (in a general view) can be measured, investigated for structural change, and be used for the estimation of costs. These costs can be either the value of the building or the costs for an intervention in the existing substance. For conservation the building survey serves as documentation of endangered buildings and would allow their (partial) reconstruction when hit by a disaster. Structural and alteration problems can be first recognized in the building survey and initiate a call for corresponding measures to avoid further degradation. In both mentioned cases for application to disasters such as earthquakes, methods from general conservation of buildings affected by aging can be adapted.

Employment fields of the building survey are:

– Archaeology
– Construction research, conservation
– Rehabilitation, modernization
– Individual measures connected to an object

All these require specialist knowledge from the respective fields, and in the survey attention is paid to the information needed for further processing according to the discipline. In the particular case of rehabilitation and modernization we highlight the need of information for possible interventions for sound insulation, energy efficiency, or for structural upgrade. For the case of energy efficiency we review the special method of thermography, for the case of structural upgrade that of the recognition of steel reinforcement, both connected to characteristics of materials which can be represented geometrically through color and texture, not only through description. Individual measures can, for example, refer to living surfaces in housing. In this case actors such as sociologists and political science researchers come into question, who investigate housing quality but also compute taxes or take action regarding energy politics.

Types of building survey are:

– Sketches
– Photography
– Measurement by hand
– Photogrammetry

Although photography is more exact in representing the recorded artifact, the data content in photography is higher than in sketches. Sketches retain from the recorded artifact the essentials, and can through this build a key factor in the classification of elements of a building, as required by this work. With the capacity of computers to process a large amount of information, in order to obtain data it is required to make a selection through the computer operator. Sketches can help in measurement by hand. The measurement by hand, different from 3D scanning, also records the essential elements. In order to identify this, it is necessary to have a corresponding knowledge of the constructive structure and the architectural history typology of the building, in order to recognize the key building elements and spaces to be recorded. This record of building elements can even act as enrichment to existing authorization plans. Such building elements can be structural ones (columns, walls), but not only. For example, in this work a method to record the size of windows is given, which also can be used to measure the span of beams and columns if visible. These are useful for a quantitative dimension of the rapid visual screening for seismic purposes. Specialist knowledge is needed in the case of photogrammetry at another stage of the work, at the interpretation of the large amount of data. Architects, civil engineers, and art historians all have different needs of data for subsequent construction and architecture research based on the building survey. In the case of measurement by hand their necessity has to be known in order to know what to record, and can be communicated, for example, through sketches; in the case of a photogrammetric record this is necessary to evaluate the information when transforming it to data (e.g., the point clouds of the laser scan).

Regarding the systematics of measurement, for onsite measurement the steps are to measure the object and draw the results in so-called working drawings. For onsite dimension drawings two cases are to be considered: there are some existing plans (e.g., from the archives) or no existing plans.

In the case of existing plans only the dimensions of the given drawing are to be verified, as shown.

When there are no existing plans, first some sketches are done. A triangle method is used: every point is measured through three different distances, and the compass results in a single point from the three intersections. The distances are fixed from equidistant points on a measurement line. Although the working drawings are done with methods of descriptive geometry and exact (line, compass) with pencil, the "clean" drawing in ink is done by hand to take into account irregularities of ancient walls. Dimensions are written down. Because a 3D object is presented in 2D, more horizontal sections (plans) as well as vertical sections, façades, and details are needed. The section levels are represented. The measurement precision varies with the scale on which drawings are done: for S 1:100 1 mm represents 10 cm, the measurement precision is 1.0 cm and the error is between 1.0 and 5.0 cm. For S 1:10 it is 10 times less.

Measurement Instruments

Measurement instruments differ according to the measurement situation: conditions and methods used.

Simple instruments for measurement by hand are: scale (folding rule), leveling guide, tape measure, and leveling scale. A spirit level and tube level are used for keeping the vertical.

Geodetic measurement instruments are the angle prism, leveling, theodolite, ranging pole, hand slope measurer, compass, late directioner, and the frog. These instruments are used sometimes to ensure the horizontal as in the case of measurement by scale, but also to measure distances and angles. The measurement of distances and angles happens between fixed vertical markers, such as the ranging pole, but the measurement instruments can act as vertical markers at the same time as well.

From the drawing instruments we highlight the drawing frame. This is used for making sketches in the measurement by hand. Modern computer instruments replace the drawing frame with special laptops or notepads on which one can draw with special pencils, sometimes integrated with the measurement. This way the sketch is transformed into a building information model on the electronic drawing frame.

Measurement Procedure Technique

Measuring the Landscape

There are differences between measurement in the wide landscape (e.g., for cadastre) depending on accessibility. On a landscape with an overview it is different from those with hills and valleys (Fig. 1). In these cases geodetic instruments are used. First vertical markers are staked out. Then the straight lines are measured either with a tape measure, with a relay procedure, or with a reduction procedure. For the landscape without overview geometric computation is used to compute the distance using more reference points. With optical instruments the measurement of angles is of importance, and from geometry the tangent function is used. From the geometrical rules, with Pythagoras' theorem (Amoroso et al. 2013), the intercept theorem, also known as Thales' theorem (Apollonio et al. 2010), and Euclid's height theorem (Borzi et al. 2008) are used. The height can also be measured either geometrically or trigonometrically using angle functions.

$$\overline{AB} = \sqrt{\left(\overline{AC}\right)^2 + \left(\overline{BC}\right)^2} \tag{1}$$

$$\left(\overline{AB}\right) = \left[\left(\overline{BD}\right)*\left(\overline{BC}\right)\right]/\left[\left(\overline{CE}\right) - \left(\overline{BD}\right)\right] \tag{2}$$

$$\left(\overline{AB}\right) = \left(\overline{BD}\right)^2/\left(\overline{BC}\right) \tag{3}$$

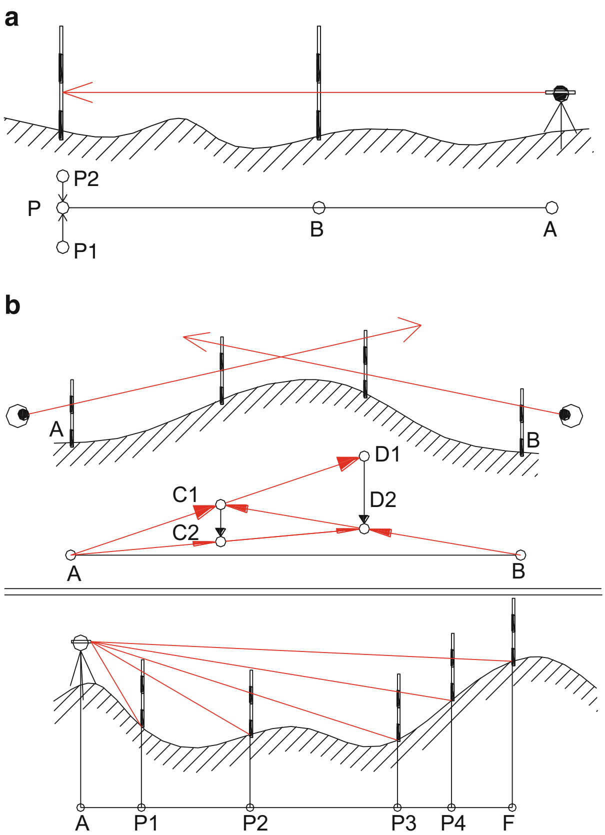

Fig. 1 Measurement in landscape with overview (**a**) and without (**b**) (Drawings: Gregor Bourlotos)

Measurement of Buildings

First the measurement of the perimeter of the building is presented. More variants of the orthogonal or the binding procedure can be used (Fig. 2).

For the interior of the building, measurement can occur as described with the help of triangles. These triangles can be arrayed on a stand line or not. Arraying on a stand line is a similar procedure to measurement by hand with the rolling tape or a similar instrument, and any of these can be performed with the laser distance measurer, a semiautomated method, between hand measurement and automated measurement. The thickness of walls has to be measured separately. The triangle method is also suitable for curved wall surfaces. Special attention has to be given to the reference points with the help of which floors are placed one above the other. In sections, it is important to measure the height of openings and the thickness of floors.

The measurement for views takes into consideration both that of the perimeter and that of interior sections.

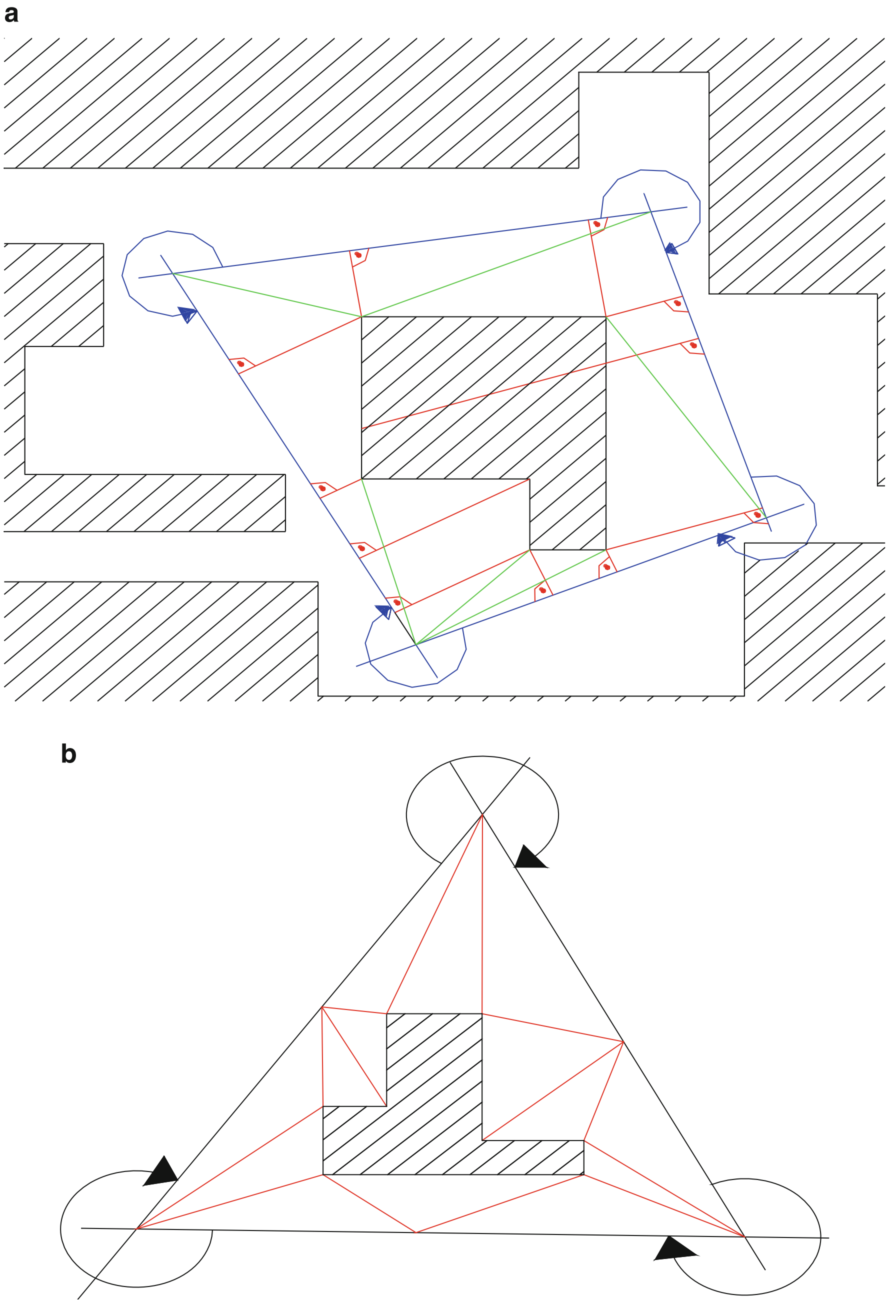

Fig. 2 Measurement of the perimeter of a building (Drawing: Gregor Bourlotos)

Modern Measurement Instruments and Procedures

The first employed modern instrument in this work was the DISTO laser measurer from Leica. Other companies produce similar instruments. The DISTO measurer includes a Pythagoras function that permits measuring the minimum distance between a point and a surface. The dimensions of that perpendicular surface can also be measured, as well as the diagonals. The measured data can be imported over software.

A scenario for measurement in the interior means first creating a sketch on the drawing frame. This is a qualitative plan. The measurement transforms this into a quantitative plan.

In case of the façade the same steps are used. The façade as mentioned is useful for rapid visual screening, and some quantitative relationships between façade elements may serve to determine the type of structural system. Style elements are also important to determine the age of the building from the usual typology, but the most important are the relationships between surfaces in different depths and of different kinds (openings, surfaces with different materials as determined by thermography or metal recognition), for which in a first step the laser measurer can be employed. Later in this work the photographic image is used for this through CAD investigation based on descriptive geometry principles.

Measurement results are the position of measured points, which can be edited in text software, imported in a spreadsheet. In the latter case surfaces can be computed based on triangles. In the case of surfaces in the plan, these can be used as mentioned for computations useful for a large category of actors, such as for computing indicators for housing quality, the volumes for energy computations, the costs of intervention, or the value of the building, and so on.

The digital tachymetry total station is more automated. In this case instead of the drawing frame the notebook can be directly employed in onsite measurement. http://www.theocad.de/eng/index.html presents an example of an application in which building survey measurements are directly introduced in a multimedia room book, that is, a building information modeling (BIM) system. The CAD software, archiCAD, has been a pioneer in shaping software according to BIM, but a direct measurement possibility is not connected. The principles are, however, those observed by hand measurement, that the wall and floor thicknesses are separately placed in the definition of the building, this being described through the building elements. The room book is defined for new buildings and for restoration projects. Bostenaru et al. (2013) discussed the possibilities of including data for different actors concerned with disasters in BIM. Such 3D building models attach semantic enrichment to the geometric data including classification in certain groups, for example, for the costs determination, or data about the material, and even the composite structure of such elements from other materials and elements.

The connection between the geodesy/surveying approach mentioned before and the architectural BIM models is now discussed. This discussion has its roots in the integration between CityGML and CAD models, or between GIS and CAD models.

These categories of software models are still compatible only to a minor extent. In our work (Bostenaru and Panagopoulos 2014) we tried to see to which extent CAD models are suitable for 3D city models and for this purpose reviewed the ways in which semantic information can be attached to CAD models considering the difference to GIS in the fully 3D nature as opposed to 2½ D in GIS of the CAD models, namely the mentioned superposition of floors. CityGML permits presenting the interior of buildings in adequate levels of detail, but work is still needed on semantic enrichment. The work of Thomas Kolbe gives a beginning (Kolbe 2008). For this reason certain standards (ISO), in the frame of IFC (Industry Foundation Classes), are developed to allow the exchange of building models. There is still a lot to be done, and it would allow building new models using similar elements from existing modeled ones in a common database. Europeana is a first step in this direction.

The Group on Earth Observations deals among others with mapping and surveying geohazards (including photo competitions on the subject, to which the second author contributed a stereo image related to the programming presented here), but recently included also cultural heritage into the work program (http://www.earthobservations.org/geoss_imp.php?smid=200). The parts on heritage conservation and risk investigation from this book are connected in this way. This is also in line with a newly established COST action on “Intelligent Management of Heritage Buildings.” This action investigates ways to document the buildings by digital means, and intervene consequently for their maintenance, preservation, and conservation. The second author is a member of the network. This way the previous work on digital methods from “Semantic Enrichment of 3D City Models for Sustainable Urban Development” and from NeDiMAH will be continued.

Data from Theocad can be exported in formats typical for CAD (DXF) and edited in other CAD software. For example, computations for the façade as proposed in this work can be done.

The Software Application

This chapter presents the design of a programmed add-on for the autoCAD software in order to measure relationships in the façade.

Photogrammetry Basics

First the descriptive geometry at the base of the proposed photogrammetry transformations is explained.

One of these is coordinates transformation: translation of a point, scaling around the origin (using a matrix relationship by scaling each corner; Bostenaru Dan 2004), rotation around the origin by a certain angle (Bostenaru Dan 2011), in the plane (new coordinates computed with trigonometric functions, which can be included in a matrix; Bostenaru Dan 2012) and in space around any of the axes (Bostenaru Dan and Dill 2014).

$$\begin{aligned} & x' = x + d_x,\ y' = y + d_y,\ z' = z + d_z \\ & x' = x - d_x, y' = y - d_y, z' = z - d_z \qquad P' = S + T \end{aligned} \tag{4}$$

$$\begin{bmatrix} x' \\ y' \\ z' \end{bmatrix} = \begin{bmatrix} s_x & 0 & 0 \\ 0 & s_y & 0 \\ 0 & 0 & s_z \end{bmatrix} * \begin{bmatrix} x \\ y \\ z \end{bmatrix} P' = S*P \tag{5}$$

$$\begin{bmatrix} x' \\ y' \end{bmatrix} = \begin{bmatrix} \cos\varphi & -\sin\varphi \\ \sin\varphi & \cos\varphi \end{bmatrix} * \begin{bmatrix} x \\ y \end{bmatrix} P' = R*P \tag{6}$$

$$\begin{bmatrix} x' \\ y' \\ z' \end{bmatrix} = \begin{bmatrix} \cos\varphi & -\sin\varphi & 0 \\ \sin\varphi & \cos\varphi & 0 \\ 0 & 0 & 1 \end{bmatrix} * \begin{bmatrix} x \\ y \\ z \end{bmatrix} P' = R(z)*P(\text{around Z})$$

$$\begin{bmatrix} x' \\ y' \\ z' \end{bmatrix} = \begin{bmatrix} \cos\varphi & 0 & \sin\varphi \\ 0 & 1 & 0 \\ -\sin\varphi & 0 & \cos\varphi \end{bmatrix} * \begin{bmatrix} x \\ y \\ z \end{bmatrix} P' = R(y)*P(\text{around Y})$$

$$\begin{bmatrix} x' \\ y' \\ z' \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & \cos\varphi & -\cos\varphi \\ 0 & \sin\varphi & \cos\varphi \end{bmatrix} * \begin{bmatrix} x \\ y \\ z \end{bmatrix} P' = R(x)*P(\text{around X}) \tag{7}$$

A coordinate system can be transformed in a homogeneous coordinate system through a supplementary dimension. Each point in an unhomogeneous coordinate system will be transformed in a line in a homogeneous one. This is a concept used in computer graphics. The matrix computations (Bostenaru Dan 2004, 2011, 2012) can be transformed into similar size matrices through this (Bostenaru Dan and Panagopoulos 2014; Bostenaru Dan and Mendes 2014; Bostenaru Dan and Armaş 2015) and in a single transformation (Bostenaru Dan 2015).

$$\begin{bmatrix} x' \\ y' \\ z' \\ w \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & dx \\ 0 & 1 & 0 & dy \\ 0 & 0 & 1 & dz \\ 0 & 0 & 0 & 1 \end{bmatrix} * \begin{bmatrix} x \\ y \\ z \\ 1 \end{bmatrix} (\text{translation}) \tag{8}$$

$$\begin{bmatrix} x' \\ y' \\ z' \\ w \end{bmatrix} = \begin{bmatrix} & (S) & & 0 \\ & & & 0 \\ & & & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} * \begin{bmatrix} x \\ y \\ z \\ 1 \end{bmatrix} (\text{scale}) \tag{9}$$

$$\begin{bmatrix} x' \\ y' \\ z' \\ w \end{bmatrix} = \begin{bmatrix} & & & 0 \\ & (R) & & 0 \\ & & & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} * \begin{bmatrix} x \\ y \\ z \\ 1 \end{bmatrix} \text{(rotation)} \tag{10}$$

$$\overline{\underline{|\mathrm{P}' = \mathrm{t}_2 * \mathrm{S} * \mathrm{t}_1 * \mathrm{R(a)} * \mathrm{P} = \underline{\mathrm{M}} * \mathrm{P}|}} \tag{11}$$

The projection of an object can be parallel (orthogonal), central (perspective), or radar. In the perspective projection a matrix relationship is created through the transformation of points on the projection surface (Fig. 3). The image point can also be calculated through a matrix (Bostenaru Dan and Dill 2015). The relationship between the object point and image point is given by (Cignoni and Scopigno 2008)

$$\begin{bmatrix} u_h \\ v_h \\ n_h \\ w_h \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 1/d & 1 \end{bmatrix} * \begin{bmatrix} x \\ y \\ z \\ 1 \end{bmatrix} \tag{12}$$

$$P_0 = \begin{bmatrix} x \\ y \\ z \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ -d \end{bmatrix} + \alpha * \begin{bmatrix} u \\ v \\ 0 \end{bmatrix} - \begin{bmatrix} 0 \\ 0 \\ -d \end{bmatrix} \tag{13}$$

Use Example for Visualization of the Photogrammetry Principles

Since the nineteenth century (John P. Soule photos of the Portland/Maine fire in 1866), pairs of stereo photographs have been used for obtaining spatial impressions; different devices to see the pairs with a certain type of glasses were developed later. Today 3D cinema brings this approach to a new revival.

However, to understand the way camera pairs work, the same principles of photogrammetry as explained above were used. Cases of camera errors, which are corrected when working with a single photograph as we show, were investigated (Fig. 4). The application shown here was built with Macromedia Director (now Adobe Director) and a script, Lingo, was also employed for programming. The 3D programming language of Lingo in the Director 8.5 version used is based on openGL principles. The excerpts below show how the modeling was done. Because Director has an implemented 3D engine, a different approach was taken as in the LISP script in the next passage. Macromedia Director had already incorporated the principles of camera view in perspective, therefore only the camera had to be used. The main 3D programming effort was to introduce the studied geometric objects in the camera and to change the relative position of the camera with regard to the image plane through rotation, translation, and scaling. A drawing sketch of the perspective principles was also included. This application was done with Macromedia Director 8.5, a version about 15 years old. For half a year the scalable

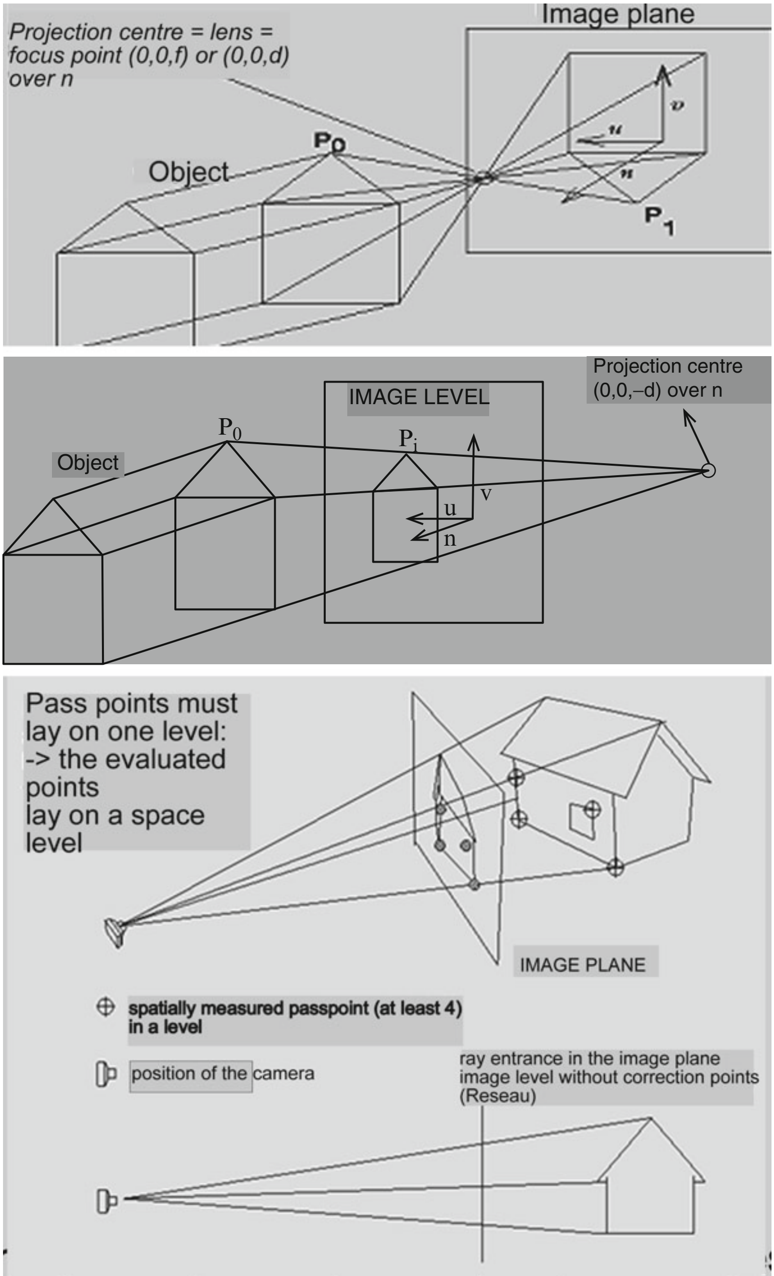

Fig. 3 Central (perspective) projection (Drawings: Gregor Bourlotos)

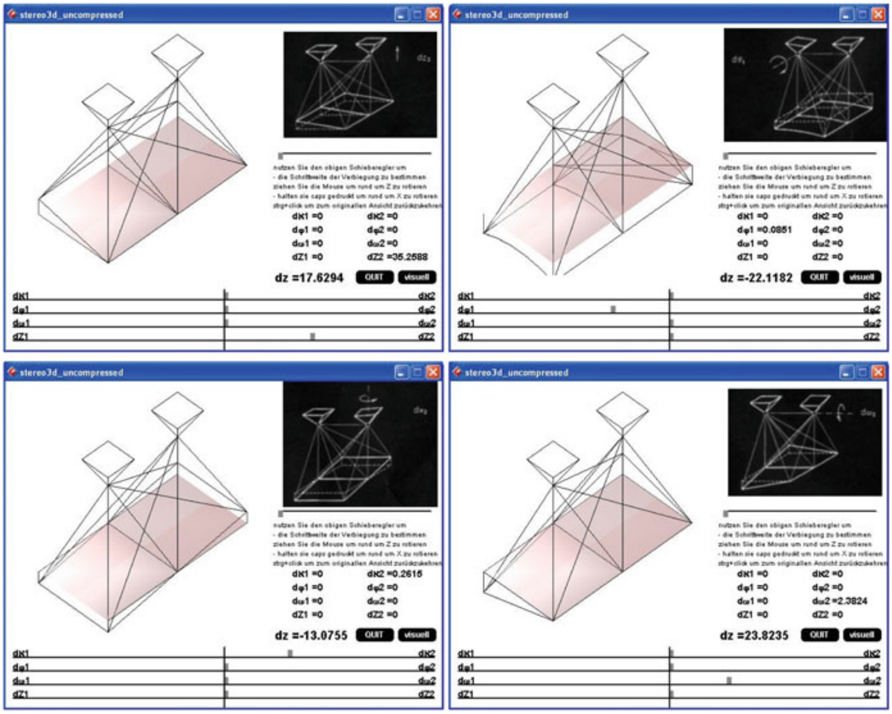

Fig. 4 Camera errors. Screenshots of programmed software by Maria Bostenaru

application in the Web browser ceased working because the plugin was not supported. Digital demonstration movies such as this one deserve conservation as in the dedicated article by Bostenaru and Dill (2015) in this book. The following script extras were published in Bostenaru (2012).

```
    member(1).newCamera("axonometrie")
    (member 1 of castLib 1).Camera(2).translate(0, 0, 100, #world)
    member(1).camera(2).rotate(45, 0, -135, #world)

    member(1).newCamera("camera2")

    (member 1 of castLib 1).Camera(3).translate(0, 0, 100, #world)
    member(1).camera(3).rotate(45, 0, -135, #world)
    member(1).camera(3).translate(20, 0, 0, #world)
on enterFrame

    global l
    member(1).resetWorld()
    member(1).bgcolor=rgb(0,0,255)

    l=20
    mymeshgeometry = member(1).newMesh("rhombicuboctaedron", 44, 24, 0, 4)

    tmpvertlist=[]

    tmpvertlist.add( vector(l/2,l/2,(l/2+l*cos(PI/4))) )
    tmpvertlist.add( vector(-l/2,l/2,(l/2+l*cos(PI/4))) )
    tmpvertlist.add( vector(l/2,-l/2,(l/2+l*cos(PI/4))) )
    tmpvertlist.add( vector(-l/2,-l/2,(l/2+l*cos(PI/4))) )

    tmpvertlist.add( vector(l/2,l/2,-(l/2+l*cos(PI/4))) )
    tmpvertlist.add( vector(-l/2,l/2,-(l/2+l*cos(PI/4))) )
    tmpvertlist.add( vector(l/2,-l/2,-(l/2+l*cos(PI/4))) )
    tmpvertlist.add( vector(-l/2,-l/2,-(l/2+l*cos(PI/4))) )
```

```
  mymeshgeometry.vertexlist=tmpvertlist
  mymeshgeometry.colorList=[ rgb(255,255,255), rgb(0,255,255) , rgb(255,0,0),
rgb(0,0,255)]

  mymeshgeometry.face[1].vertices=[1,3,2]
  mymeshgeometry.face[1].colors=[1,1,1]
  mymeshgeometry.face[2].vertices=[4,2,3]
  mymeshgeometry.face[2].colors=[1,1,1]
  mymeshgeometry.face[3].vertices=[2,4,17]


  mymeshgeometry.face[42].colors=[1,1,1]
  mymeshgeometry.face[43].vertices=[6,8,5]
  mymeshgeometry.face[43].colors=[1,1,1]
  mymeshgeometry.face[44].vertices=[5,8,7]
  mymeshgeometry.face[44].colors=[1,1,1]

  mymeshgeometry.generateNormals(#flat)
  mymeshgeometry.build()
  mymeshl = member(1).newModel("meshlinks", mymeshgeometry)
   (member 1 of castLib 1).Model[1].visibility = #both
```

```
  mymeshgeometryx = member(1).newMesh("tetraedru", 4, 4, 0, 1, 1)
```

```
  myboxgeometry = member(1).newModelResource("cub", #box)
  myboxgeometry.width = l
  myboxgeometry.length = l
  myboxgeometry.height = l
  mybox = member(1).newModel("cube", myboxgeometry)
  myboxtexture = member(1).newTexture("cubetexture", #fromCastMember, mem-
ber("bitmap"))
   (member 1 of castLib 1).newShader("rot",#standard)
   (member 1 of castLib 1).Shader[2].textureList[1] = (member 1 of castLib
1).texture[3]
   (member 1 of castLib 1).Model[3].shaderList = (member 1 of castLib
1).shader[2]
  member(1).model[3].translate(0, 0, (2*(l+l*cos(PI/4))) , #world)

  mymeshgeometryz = member(1).newMesh("tetraedruz", 4, 4, 0, 1, 1)
  mymeshgeometryz.vertexList=[vector(-((l/2)*cos(PI/4)),-((l/2)*cos(PI/4)),-
((l/2)*cos(PI/4))),vector(-
((l/2)*cos(PI/4)),((l/2)*cos(PI/4)),((l/2)*cos(PI/4))),vector(((l/2)*cos(PI/4)
),-
((l/2)*cos(PI/4)),((l/2)*cos(PI/4))),vector(((l/2)*cos(PI/4)),((l/2)*cos(PI/4)
),-((l/2)*cos(PI/4)))]
  mymeshgeometryz.colorList=[rgb(255,0,0)]
  mymeshgeometryz.face[1].vertices=[1,3,2]
  mymeshgeometryz.face[2].vertices=[2,3,4]
  mymeshgeometryz.face[3].vertices=[1,2,4]
  mymeshgeometryz.face[4].vertices=[1,4,3]
  mymeshgeometryz.face[1].colors=[1,1,1]
  mymeshgeometryz.face[2].colors=[1,1,1]
  mymeshgeometryz.face[3].colors=[1,1,1]
  mymeshgeometryz.face[4].colors=[1,1,1]
  mymeshgeometryz.generateNormals(#flat)
  mymeshgeometryz.build()
  mymeshx = member(1).newModel("tetraederz", mymeshgeometryz)
   (member 1 of castLib 1).Model[4].visibility = #both
  member(1).model[4].translate(0, 0, (3*(l+l*cos(PI/4))), #world)
```

```
mymeshgeometryx.vertexList=[vector(((1/2)*cos(PI/4)),((1/2)*cos(PI/4)),((1/2)*
cos(PI/4))),vector(((1/2)*cos(PI/4)),-((1/2)*cos(PI/4)),-
((1/2)*cos(PI/4))),vector(-((1/2)*cos(PI/4)),((1/2)*cos(PI/4)),-
((1/2)*cos(PI/4))),vector(-((1/2)*cos(PI/4)),-
((1/2)*cos(PI/4)),((1/2)*cos(PI/4)))]
  mymeshgeometryx.colorList=[rgb(255,0,0)]
  mymeshgeometryx.face[1].vertices=[1,3,2]
  mymeshgeometryx.face[2].vertices=[2,3,4]
  mymeshgeometryx.face[3].vertices=[1,2,4]
  mymeshgeometryx.face[4].vertices=[1,4,3]
  mymeshgeometryx.face[1].colors=[1,1,1]
  mymeshgeometryx.face[2].colors=[1,1,1]
  mymeshgeometryx.face[3].colors=[1,1,1]
  mymeshgeometryx.face[4].colors=[1,1,1]
  mymeshgeometryx.generateNormals(#flat)
  mymeshgeometryx.build()
  mymeshx = member(1).newModel("tetraeder", mymeshgeometryx)
  (member 1 of castLib 1).Model[2].visibility = #both
  member(1).model[2].translate(0, 0, (1+1*cos(PI/4)), #world)
```

```
  particleresource=member(1).newModelResource("particles",#particle)

  particleresource.emitter.minSpeed     = 40
  particleresource.emitter.maxSpeed     = 50
  particleresource.emitter.numParticles = 350
  particleresource.emitter.tweenMode    = #age
  particleresource.emitter.angle        = 90
```

```
  particleresource.emitter.direction    = vector(0.000,  -150.000, 0.000 )

  particleresource.emitter.region    = [vector(-50.000,  0.000, -50.000 ),
vector(50.000,  0.000, -50.000 ), vector(50.000,  0.000, 50.000 ), vector(-
50.000,  0.000, 50.000 ) ]
  particleresource.wind                 = vector(1.000,  -50.000, 50.000 )
  particleresource.lifeTime             = 5000
  particleresource.colorRange.start     = rgb(0, 255, 255)
  particleresource.colorRange.end       = rgb(255, 255, 255)

  particleresource.sizeRange.start      = 12
  particleresource.sizeRange.end        = 6

  particleresource.blendRange.start      = 25
  particleresource.blendRange.end        = 100

t = member(1).newTexture("tparticle", #fromCastMember, member "particle")
t.quality =#low
t.renderFormat = #rgba4444
particleresource.texture = t

  member(1).camera(1).addChild(member(1).newModel("particles1",
particleresource))
  member(1).camera(1).addChild(member(1).newModel("particles2",
particleresource))
  member(1).model("particles2").rotate(0,0,180,#parent)
end

create world
```

```
sprite(1).camera=member(1).camera("axonometrie")
  sprite(2).camera=member(1).camera("camera2")
  member(1).model[3].rotate(0, 90, 0, member(1).model[1])
end
```

Use Example for the Building Survey

In this work Gregor Bourlotos employed the presented principles for software (a script) in autoCAD Lisp. The matrices were used to solve an equation system in order to compute the real dimensions knowing those of the projection. Four pass points were computed in order to have a solvable system for the given number of unknowns (FEMA 2015) and the coordinates could be computed (Glaister and Pinho 2003).

$$\begin{bmatrix} x_1{'} & x_2{'} & x_3{'} & x_4{'} \\ y_1{'} & y_2{'} & y_3{'} & y_4{'} \\ 1 & 1 & 1 & 1 \end{bmatrix} = \begin{bmatrix} a_{11} & a_{12} & t_x \\ a_{21} & a_{22} & t_y \\ a_{31} & a_{32} & 1 \end{bmatrix} * \begin{bmatrix} x_1 & x_2 & x_3 & x_4 \\ y_1 & y_2 & y_3 & y_4 \\ 1 & 1 & 1 & 1 \end{bmatrix} \quad (14)$$

$$\underline{A} = \begin{bmatrix} X_1' & Y_1' & 1 & 0 & 0 & 0 & -X_1*X_1' & -X_1*Y_1' \\ X_2' & Y_2' & 1 & 0 & 0 & 0 & -X_2*X_2' & -X_2*Y_2' \\ X_3' & Y_3' & 1 & 0 & 0 & 0 & -X_3*X_3' & -X_3*Y_3' \\ X_4' & Y_4' & 1 & 0 & 0 & 0 & -X_4*X_4' & -X_4*Y_4' \\ 0 & 0 & 0 & X_1' & Y_1' & 1 & -Y_1*X_1' & -Y_1*Y_1' \\ 0 & 0 & 0 & X_2' & Y_2' & 1 & -Y_2*X_2' & -Y_2*Y_2' \\ 0 & 0 & 0 & X_3 & Y_3' & 1 & -Y_3*X_2' & -Y_3*Y_3' \\ 0 & 0 & 0 & X_4 & Y_4' & 1 & -Y_4*X_4' & -Y_4*Y_4' \end{bmatrix} \underline{l} = \underline{A}*\underline{x} \quad (15)$$

The steps to be followed are:

- Photography of the object
- Measurement of four pass points and a control point
- Identification of the pass point coordinates in the image
- Computation of the transformation coefficients
- Finding marking points on the photo
- Computation of the corresponding coordinates on the image
- Computation of the real coordinates
- Drawing of the results

The photo of a façade is imported in autoCAD. The script is loaded and started. Four pass points are marked. The software computes the pixel coordinates for these points and saves them for the computation of transformation coefficients. The four pass points are connected. The user introduces the coordinates of the computed pass points. Now the transformation coordinates are computed, and then the real coordinates of the four points. The rectangle is drawn. For the output a second script is employed. Now an arbitrary number of points on the façade can be drawn in a similar way, and the whole façade with its relationships results. Distances and surfaces can be computed.

The software thus removes the inaccuracies caused by the cameras. An extract from the first script can be seen below.

Recognizing pass points (example point 4)

```
(setq pbild4 (getpoint "\n pbild4 mit der Maus anklicken!..."))
(command ".line" pbild1 pbild2 pbild3 pbild4 pbild1 c)
```

Saving coordinates of pass points (example point 4)

```
(setq r4 (car pbild4))
(setq h4 (cadr pbild4))
```

Introduction of in situ measured values of the pass points (example point 4)

```
(setq RR4 (getreal "\n Geben Sie den Rechtswert des Pkt.4..."))
(setq HH4 (getreal "\n Geben Sie den Höchstwert des Pkt.4..."))
```

Setting the 8x8 matrix plus a 9th column for the plan transformation (example point 4)

```
(setq zeile7 (list 0  0  0 r4 h4 1 (* HH4 r4 -1) (* HH4 h4 -1) HH4))
(setq zeile8 (list r4 h4 1 0  0  0 (* RR4 r4 -1) (* RR4 h4 -1) RR4))
```

Computation of the transformation coefficients

```
(setq f1_2 (/ (nth 0 zeile2) (nth 0 zeile1)))
(setq f1_3 (/ (nth 0 zeile3) (nth 0 zeile1)))
(setq f1_8 (/ (nth 0 zeile8) (nth 0 zeile1)))

(setq hilfs1_2 (list f1_2 f1_2 f1_2 f1_2 f1_2 f1_2 f1_2 f1_2 f1_2))
(setq hilfs1_3 (list f1_3 f1_3 f1_3 f1_3 f1_3 f1_3 f1_3 f1_3 f1_3))
(setq hilfs1_8 (list f1_8 f1_8 f1_8 f1_8 f1_8 f1_8 f1_8 f1_8 f1_8))

(setq sub1_2 (mapcar '* hilfs1_2 zeile1))
(setq sub1_3 (mapcar '* hilfs1_3 zeile1))
(setq sub1_8 (mapcar '* hilfs1_8 zeile1))


(setq zeile8 (mapcar '- zeile8 sub1_8))
(setq zeile8 (subst '0 (nth 0 zeile8) zeile8))
 (setq zeile2 (mapcar '- zeile2 sub1_2))
(setq zeile2 (subst '0 (nth 0 zeile2) zeile2))

(setq zeile3 (mapcar '- zeile3 sub1_3))
(setq zeile3 (subst '0 (nth 0 zeile3) zeile3))
```

Saving the transformation coefficients (example point 3)

```
(setq a3 (/ (nth 8 zeile7) (nth 6 zeile7)))
(setq b3 (/ (nth 8 zeile8) (nth 7 zeile8)))
```

The second software employs the externally determined transformation parameters to draw lines in the plane.

```
;*************************************************************************

 (defun c:2p ()

(setq osmode_alt (getvar "osmode"))
(setvar "osmode" 4)
(setq pkt1 (getpoint "\n Markieren Sie den ersten Punkt!..."))
(setq pkt2 (getpoint "\n Markieren Sie den zweiten Punkt!..."))
(setvar "osmode" osmode_alt)

(setq x1bild (car pkt1))
(setq x2bild (car pkt2))
(setq y1bild (cadr pkt1))
(setq y2bild (cadr pkt2))

((setq zähler11 (+ (* a1 x1bild) (* b1 y1bild) c1))
(setq zähler12 (+ (* a2 x1bild) (* b2 y1bild) c2))
(setq nenner1 (+ (* a3 x1bild) (* b3 y1bild) 1))

(setq zähler21 (+ (* a1 x2bild) (* b1 y2bild) c1))
(setq zähler22 (+ (* a2 x2bild) (* b2 y2bild) c2))
(setq nenner2 (+ (* a3 x2bild) (* b3 y2bild) 1))

(setq x1real (/ zähler11 nenner1))
(setq y1real (/ zähler12 nenner1))

(setq x2real (/ zähler21 nenner2))
(setq y2real (/ zähler22 nenner2))

(setq p1real (list x1real y1real))
(setq p2real (list x2real y2real))

(command ".line" p1real p2real c)
```

```
)
;********************************ENDE**********************************
```

Further Employment and Discussion

For nondestructive testing of reinforced concrete elements in order to map the reinforcement, tools such as Ferroscan by Hilti can be used. The scale is smaller, but the same principle can be employed.

For larger-scale material investigation infrared photogrammetry is suitable. Temperature differences are created through the difference in thermal conductivity in the façade, for example, between reinforced concrete columns and beams and brick walls. Even if the façade is covered by plastering, thermography can differentiate these elements and recognize the floors and the walls from outside.

The above-designed software script can be used to draw these rectangular elements in the façade, be it small-scale reinforcement or the wall and floor elements. First the pass points are determined using the size of the whole façade or of certain windows, and then remaining elements of the façade from a thermographic image can be drawn.

Connecting to the other chapter we wrote in this book (Bostenaru 2015), knowing the span distance between load-bearing elements this way can be used in structural engineering computation such as the DBELA method, for both reinforced concrete (Glaister and Pinho 2003) and brick masonry buildings (Borzi et al. 2008). This goes beyond the rapid visual screening (FEMA 2015) for which the qualitative information might have been enough, into methods where quantitative information is needed, but still at urban scale.

In the case of 3D scanning systems, as mentioned, the interaction with the built substance does not happen onsite, but the geometric shapes have to be recognized from the point cloud. The CAD tools replace the measuring instruments.

In order to build a model, there are several ways to get from the model of the building survey to the CAAD model:

- Through digitalization of drawn building surveys (scanning and vectorization)
- Through interactive introduction of the numerical data on dimensions of the building using CAD tools
- Through obtaining CAD data from photographs of the building (mostly either the perimeter or the interior)
- Through digital tachymetry (laser scanning)

The difference between the first two, which are based on drawings, can be seen in the example of the 3D model buildings for the Esposizione Universale Roma, one of them using the authorization plans to build in virtual reality. The same approach was used in Romania for the Stirbey Palace complex virtual reality reconstruction of some of the now disappeared buildings. Authorization plans or historical surveys such as the ones scanned at the "Ion Mincu" University of Architecture and Urbanism thus can be used to reconstruct lost buildings, which laser scanning cannot do.

There are no universal pros and cons for which method should be chosen. Photogrammetric methods permit a fast collection of data on a remote site and their evaluation later in the office, wherease the onsite survey is more adequate for learning about the classification of a building, the relationship between spaces and elements that can lead to a BIM. Computer support can be included as we also saw in the onsite measurement. Alternatively to laser scanning, structure for motion can be employed as the example of the timber church in Pietrari-Anghelești (SALVart project; see Nancu and Barcan 2010) shows. Laser scanning can survey characteristics of buildings that are connected to their optical appearance, such as frescoes (at training school taking place at the Eighth European Commission Conference on Sustaining Europe's Cultural Heritage on "Multipurpose Laser Scanners for Cultural Heritage Diagnostics" https://www.uauim.ro/cercetare/chresp/en/), rather than to their technical semantic enrichment with material and economic data. For this the 3D scanning data should be connected with data from other sensors.

The software presented in the chapter is adequate for straight façades with little ornamentation, for example, those of the modern movement. For complex façades, laser scanning is more adequate than methods based on photographs or direct editing in CAD software.

The number of providers for measuring software with its own graphical core or as an application to a CAD system is high, as is the number of laserpantograph providers. In recent years the price for laser scanning or for infrared photogrammetry has decreased.

Conclusions

There is software on the market to draw façades from one image or from multiple images (Figs. 4 and 5). For example, PhotoModeller was employed both in Karlsruhe to model collapsed buildings (Schweier et al. 2004) and in Romania to make the survey of a timber church before translation to allow for its reconstruction (Nancu and Barcan 2010). In this work one image photogrammetry was used, and the geometric basics leading to software programming explained. The multiple image photogrammetry employs the above- mentioned structure from motion algorithms presented in the introduction.

For the survey of urban areas rapid visual screening (FEMA 2015) is an established means. The RVS method encompasses:

- Filling a check-list with qualitative information on the building
- Photographing the building

In the framework of the SFB 461 project in Karlsruhe, Germany, the second author performed such an analysis for the modernist boulevard in Romania

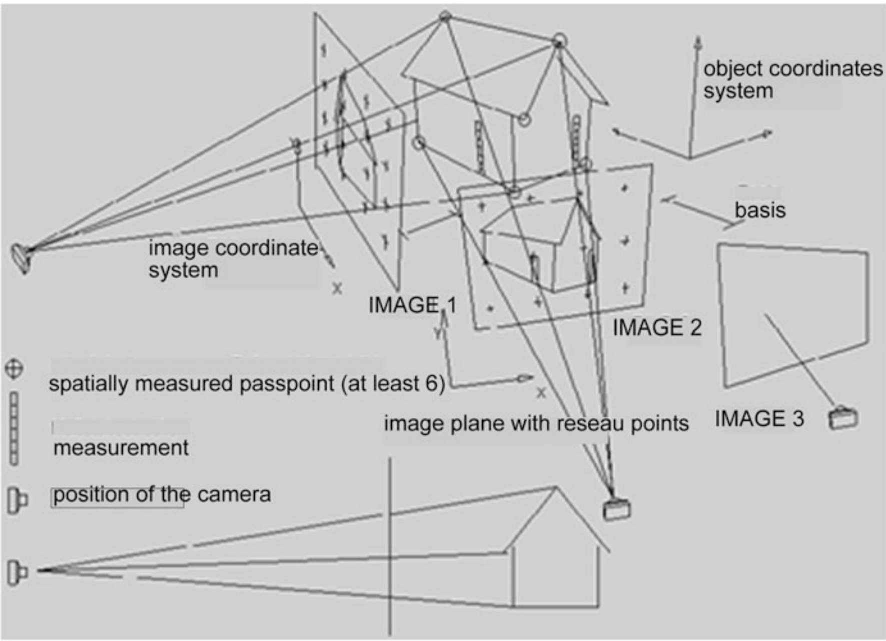

Fig. 5 Survey through multiple photographs (Drawing: Gregor Bourlotos)

mentioned in the introduction. Quantitative information is missing, although this is useful for post-evaluation of the vulnerability of the building stock. In order to do this, the post-processing on office computers of the photographs taken onsite has been considered to have potential. The building survey at urban scale done in SFB 461 provided a wealth of photographs suitable for this kind of post-processing. It was a survey at urban scale, but the editing of the information in exterior photographs taken in the RVS workframe can lead to a survey at the building level. This way the two scales, urban and building, are linked, as envisaged in the current post-doctoral project (Bostenaru and Armas 2015). CAD software can be used to draw quantitative relationships based on the building geometry. Particularly characteristics of load bearing or not in structures can be expressed in numbers: reinforced concrete beams are 1/8–1/10 of the span height. Recognizing the height of the beam in thermography may compute the span needed as in Bostenaru (2015). In a masonry system with concrete reinforcement columns are places at both sides of windows that have less than 1 m distance. The width of openings in unreinforced masonry load-bearing walls should be not more than 0.5–0.6 of the whole wall length of exterior walls. This way distance computations in the vector drawing may help. The same applies for the distance between two openings in bearing walls which should be not less than 1.2–1.5 m. Thus dimensions of thickness of building elements, height of floors and building (e.g., to determine the soft story), the span between load-bearing elements and openings, rhythm of bearing elements and openings, the proportion between opening and wall, and also other dimensions of architectural features may be measured. This way geometry gives information on material as well.

Other geometric characteristics in the façade are useful for computing conformation coefficients for seismic vulnerability, such as the recess size (recess width/ building height) and the mentioned change in the height of floors. But these coefficients are mainly related to the shape in plan, for which reason plan drawings are needed additionally for the façade, as shown.

The classical way to survey buildings was first presented in this chapter. The techniques and instrumentation are visualized in sketches and, respectively, photos. Then the modern survey systems are reviewed. Digital methods make it possible at this stage that post-evaluation and measurement add a quantitative dimension to the qualitative one. This can also be employed on building sites. This evaluation has a mathematical–geometric background, explained in depth, and along with it, translation to a computer language. Knowing both the structure and history of the building to choose relevant elements, as well as this mathematical background, key elements are retained for the model. Because a model M of a system S is a simplified system maintaining all characteristics of the system S is necessary for the simulation. With the increase of information in digital storage, modeling becomes more important than ever.

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Geographical Information Systems as Environmental, Landscape, and Urban Planning and Research Tools. Romania as a Case Study

Alexandru-Ionuţ Petrişor

Abstract Geographical information systems are decision support systems composed of hardware, software, data, methods, and users. Their main ability is to relate objects from different layers based on their spatial relationship. This chapter attempts to emphasize the goal-oriented definition of GIS in order to show when its use is a "must", when other tools perform better, and its main limitation, exploring planning and research, with a special focus on the Romanian experience. The results indicate that the use of GIS can be strengthened in conjunction with statistical tools, but this combination is more appropriate in research; in planning, participatory tools should be used instead. Also, a GIS is unable to prove spatial causality unless hypotheses have been stated before and the experiments control for extraneous variables.

Keywords Data base management system • Mapping • Geostatistical approaches • Decision making • Spatial integration

Definition and Features of a GIS

In order to discuss the "proper" use of a geographical information system (GIS), the concept needs to be defined. Two definitions are proposed and analyzed, to illustrate the most important points that make a GIS unique.

The first definition is an "organized collection of computer hardware, software, geographic data, and personnel designed to efficiently capture, store, update, manipulate, analyze, and display all forms of geographically referenced

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information. Certain complex spatial operations are possible with a GIS that would be very difficult, time consuming, or impracticable otherwise" (Ioniţă and Moise 2001). As can be seen, the definition states five key components: the computer, software, data, user, and specific methods (Dangermond 1991); the presence of all components is not absolutely required, as worldwide reputed geographers could perform the functions of a GIS without a computer (Petrişor 2011). In addition to them, the definition specifies the main functions of a GIS: collection, processing, analysis, and display of data. Nevertheless, the definition lacks a very important component. To understand it, it needs to be emphasized that GISs are systems. In defining systems, most authors focus on components and eventually their relationships (Botnariuc and Vădineanu 1982; Ianoş and Heller 2006), and very few on the goal-orientation functioning of systems (Ianoş 2000; Petrişor 2011); every system has an ultimate goal, and this goal is lacking from the definition. Without a "higher"goal, a GIS can be seen as simply some "mapping software", which performs better or easier.

The second definition is a "decision support system involving the integration of spatially referenced data in a problem solving environment" (Cowen 1988). This definition specifies the ultimate goal (problem solving), and also shows that what makes a GIS unique – although few users achieve the level of making use of this capability – is that it symbiotically combines (integrates) the functions of database management systems and mapping systems (Maguire 1991; Yeh 1999; Clarke et al. 1996; Unwin 1996; Richards et al. 1999; Segrera et al. 2003) to produce a new system. In addition to the first, a GIS allows for mapping; in addition to the second, a GIS can query a database. Of course, a GIS can be used restrictively for one of the purposes (in Romania, mostly for mapping). Nevertheless, only a GIS can spatially relate two objects from different databases (Petrişor 2011). In more detail, only a GIS has the ability to perform the following operations:

- Perform specific searches on objects in order to be displayed or not on the map, based on certain characteristics related to their attributes found in the database (e.g., display cities only if their population is over 100,000).
- Determine spatial relationships between objects, including limitations based on their attributes (e.g., find all cities within a certain distance from a highway, or find only the cities with a population over 100,000 situated within a certain distance from a highway).
- Identify objects that satisfy simultaneously certain criteria (see the second example in previous paragraph), including the option to assign weights to each individual criterion.
- Perform, using specific extensions, different spatial operations, resulting in the generation of new data (e.g., spatial interpolation generates a continuous surface starting from point data; another extension allows reducing a polygon to its center; others dissolve boundaries between features of the same kind or that have certain characteristics), or computations (e.g., determine the surface of polygons, length, or angle formed with the north vertical by a segment).

In addition to these situations, Goodchild and Longley (1999) consider that a GIS should be used:

- To deal with geographically referenced data when geographical references are essential to their analysis
- To deal with vector data, specific projections
- When spatial connections between objects are important to the analysis, or the visual display is important
- To analyze large amounts of data, objects with large numbers of attributes
- To integrate data from a variety of sources, requiring format changes
- When the background of the investigator is in geography, or a spatial discipline
- In multidisciplinary studies
- When the results of the analysis are used as input by other projects, or data are shared.

Moreover, Fotheringham and Rogerson (1993) believe that GIS-based spatial analyses should be used only for spatial problems and never for aspatial ones, whereas other authors found that their use in these "forbidden" settings could be productive (Ianoş and Heller 2006; Petrişor 2011).

Some authors provide definitions similar to the first one, describing components and functions (Densham 1991; Maguire 1991; Clarke et al. 1996; Vine et al. 1997; Ramachandran et al. 1998; Nelson et al. 1999; Richards et al. 1999; Graves 2008), whereas others perceive GIS as a management tool or decision support tool (Cowen and Shirley 1991; Densham 1991; Goodchild 1993; Jankowski 1995; Clarke et al. 1996; Ramachandran et al. 1998; Carver 2003; Power 2003; Zerger and Smith 2003; Malczewski 2006; Overall et al. 2008; Blaschke et al. 2012; Santana et al. 2013).

GIS needed a long time to start being perceived as a tool accessible to everyone instead of a realm belonging to specialists, facilitated by the "digital revolution", especially the interoperability and particularly the delivery of outputs via the Internet (Yeh 1999; Devillers et al. 2005; Santana et al. 2013). The process was paralleled by the understanding expanding also to require the consideration of the question "where" in addition to "how", "why" and "what is the cost" (Greene 2000). Fortunately, this change occurred at the same time as the expansion of GIS capabilities and availability of other tools, such as advanced remote sensing instruments and especially the global positioning systems (GPS). In the United States in particular, the management-based use of GIS was facilitated by a democratic system, for which information is its lifeblood (Greene 2000).

The use of geographical information systems by disciplines sometimes totally different from geography, and even without a spatial support, led to the emergence of a self-standing science (Blaschke et al. 2012), GIScience (from GIS: geographical information system, and science), defined by Michael F. Goodchild (1992, 2004) as "a multidisciplinary research enterprise that addresses the nature of geographic information and the application of geospatial technologies to basic scientific questions." Approximately 15 years after this definition, the National

Research Council of the United States Academy (2006) recommended the National Science Foundation to “recognize GIScience as a coherent research specialty.”

History

Even though it is obvious that the modern computer-based GIS could not appear before the computer, its functioning was possible without it. Therefore, some authors argue that the first GISs were the map of the 1781 Yorktown battle, creation of French cartographer Louis-Alexandre Berthier (because it involved the analysis of the spatial relationship between at least three layers – two opposing armies and environmental conditions – in a decision-making process); the 1819 map of illiteracy in France (first chloropleth map), made by Pierre Charles Dupin (Iosub 2008); or the 1854 map illustrating the connection between the source of contamination and addresses where cholera cases were recorded during the outbreak in London, produced by Dr. John Snow, analyzing a spatial phenomenon: clustering of cases around water sources, leading to the hypothesis that water could be the underlying cause, also under a decision-making framework (Gordis 1996).

Modern GISs appeared in 1969 in Canada and were the work of Roger F. Tomlinson, who finalized the implementation of Waldo Tobler’s principle “Map In, Map Out” (MIMO), started in 1959, and leading to the digitization of all paper-based maps (Coppock and Rhind 1991; Iosub 2008). In the United States these digitized maps were the start point used as a support for integrating other data, in a continuous update process. ESRI launched its first product (ArcView) in 1981 (Letham 2007). From this point on, the development of the GIS is marked by true revolutions; unlike other software, users were involved in its development by creating extensions. The process resulted in the emergence in ArcGIS 8 of a new concept, “interoperability”, consisting of many features: compatibility with other products and applications, possibility of being used in a network where users can modify data (documenting any changes), and delivery of final products (ESRI 2003a).

The first feature reached its apogee by creating GIS models importing and exporting data to other applications during the processing flow, performing the format changes automatically (ESRI 2003a). The second feature relies on the concept of “metadata”, meaning “data about the data”: file format, creation and change time, geographical projection, and other information useful for tracking any changes of the dataset (Devillers et al. 2005). The third feature consists of shifting from products that could be delivered only to users who needed the software to visualize them up to creating self-standing applications and finally via the Internet (ESRI 2003b), for example, the Yahoo and Google maps, that allow the people in the United States to obtain driving directions in both map and text format by simply entering the start point and final destination. It is important to note that directions were delivered in both map and text format, showing that the range of GIS outputs can be expanded far beyond mapping.

Spatial Versus Nonspatial Data

In analyzing Professor Cowen's definition (1988), the importance of "spatial data" has been emphasized. However, the border between "spatial" and "nonspatial" is a thin line. This is particularly true for a GIS because it has two components (the spatial support and the database associated with it). To illustrate the concept, Fig. 1 presents several maps based on 2006 data from Romania.

The top map shows the total population by administrative units; there are three classes, each covering one third of the distribution in ascending order. The middle map shows the number of employees, grouped in the same way. Even if the two maps (and underlying distributions) differ, the spatial data do not differ, because the boundaries of the administrative units are the same. The bottom map is derived from the top one using a spatial operation: dissolution of borders between neighboring administrative units with a population falling in the same class (low: <2630, average: 2630–4173, and high: 4173–1,931,236). Even if the distribution of the top and bottom maps is the same, the spatial data are different (the number of polygons within each class is changed; fewer polygons exist in the second map, inasmuch as polygons from the first distribution were joined through the dissolution of borders).

GIS as a Planning Tool

Even though worldwide planners have understood the benefits of GIS for a long time (Yeh 1999; Ikezaki et al. 2006), despite being constrained by law or not (Cowen and Shirley 1991), only recently many Romanian spatial and urban planning regulations, such as the normative acts subsequent to the Law on Authorizing Construction Works, started to require plans in a GIS format (i.e., shape format, used by older versions). Compliance with these requirements is not necessarily an issue, however, their implementation was not easy, as GIS was often used as a mapping or even drawing system, similar to Corel or AutoCad, disregarding its ability to integrate layers of information (Goodchild and Longley 1999; Smith 1992). The underlying cause was the lack, or better said, restriction (by administrative procedures and/or costs), of circulation and availability of data. Despite the difficulties in implementation, such requirements have been embedded in a national program focused on producing cadastral databases for buildings, utilities, and other components essential to urban and spatial planning (Petrescu et al. 2005).

Romanian GIS users are growing accustomed to its benefits, although many Romanian researchers still consider geospatial technology to be novel and cutting-edge, despite the first product appearing in the United States in 1969. For many people, a GIS is just another mapping product, perhaps not as user-friendly and easy to use; very few reached the level of using it as a research or analytical instrument. Nevertheless, managers were able to see its benefits immediately. The Chief

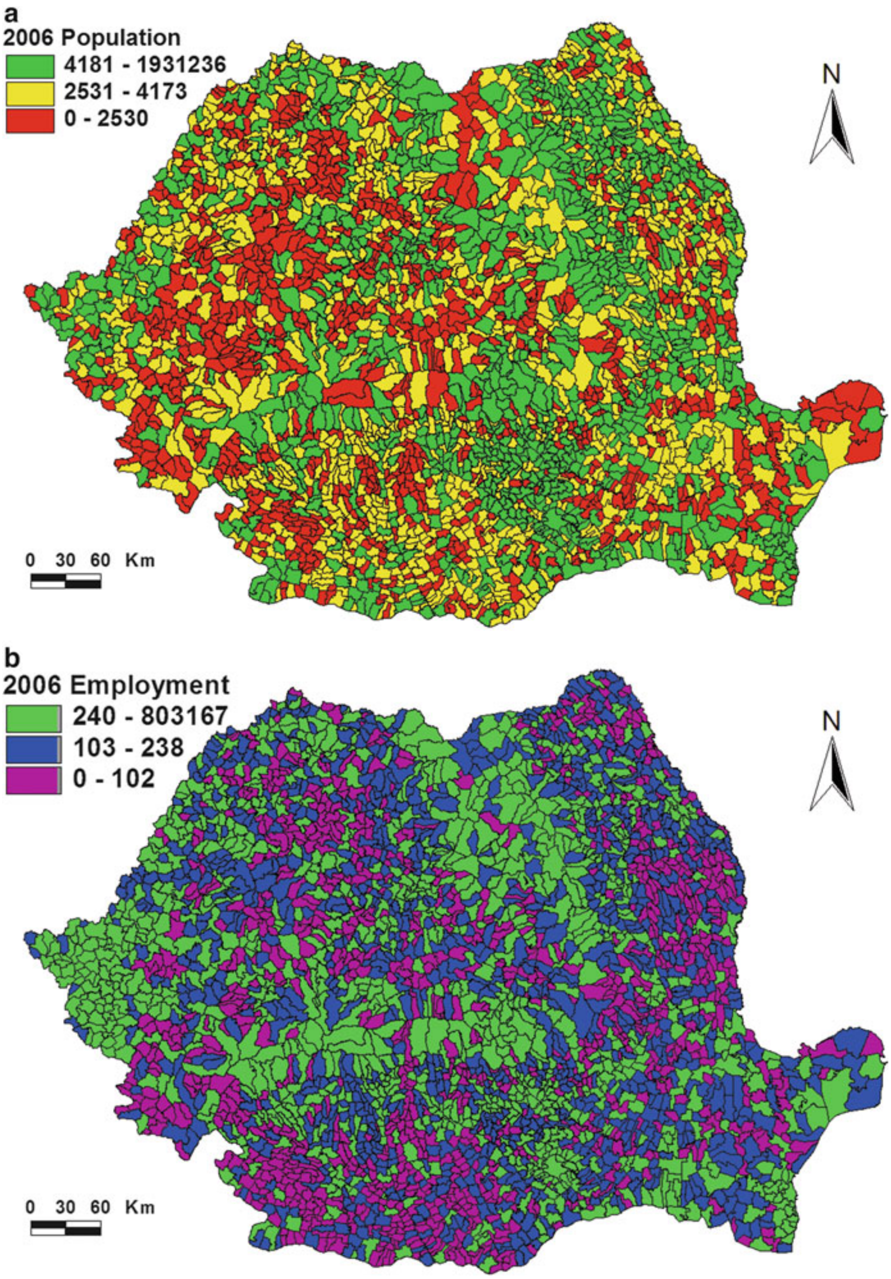

Fig. 1 2006 data on Romania: total population by administrative unit (**a**), number of employees by administrative unit (**b**), and population by levels (**c**). The "**c"** map is derived from the "**a"** one, dissolving the borders of administrative units with low (<2630), average (2630–4173), and high (4173–1,931,236) population

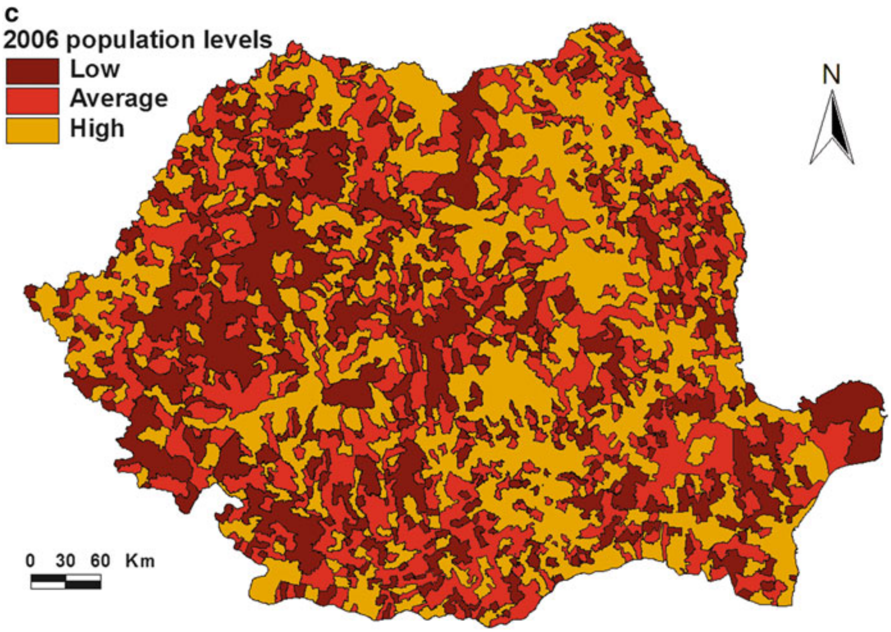

Fig. 1 (continued)

Architect of Satu Mare County is one of the pioneers, who realized the potential of GIS for being used as a planning instrument. After years of digitizing available information, which is updated permanently, building permits are automatically issued using GIS (Gheorghiu 2007). The application is a typical GIS example, because: (1) it is used as a decision support system, and (2) it integrates different layers of information (technical, economic, and juridical) to check whether a certain proposal complies with the specific zoning requirements. The platform is in place to embed other pieces of information. A similar situation is found in Oradea, where the benefits of using GIS for urban management and control purposes were obvious for the Chief Architect of the city (Luncan et al. 2010) and the commune Floreşti in Cluj County, where GIS has become a part of the information system used by the City Hall in the decision-making process (Haidu et al. 2006).

The main advantage of using GIS in planning is its objectivity; nevertheless, this could also be one of its main shortcomings. Urban planning approaches are as pragmatic as possible, not aimed at the elaboration of a conceptual model for sociospatial systems in general, but the concrete organization of each system through specific plans (Petrişor 2011). The approach used to reach this goal does not use preferentially quantitative and objective methods (except for at most econometric analyses or strategic planning), but mostly qualitative ones: urban composition, participatory, management, and communication urbanism (Lacaze 1990), which involve negotiation and public participation, eventually hindered by an objective approach (Cowen and Shirley 1991).

This dilemma answers the question related to the proper use of GIS tools. A GIS should not be used for mapping purposes only, unless data are available for this purpose. Using GIS to create data (via digitization) in order to build a map from the beginning is hard, time consuming, and obsolete; traditional urban mapping software (Corel, AutoCad) makes better candidates. Similarly, even though GIS can be used to create hierarchies (of units) this approach needs to be used cautiously. Two Romanian examples are offered below:

- Petrişor et al. (2012) developed an approach used to produce hierarchies of territorial units using data consisting of indicators covering all development sides (economy, society, culture, infrastructure, environment, etc.); principal component analysis is used to find the most relevant indicators and their weights, and is used to build up a compound index of development. This method is good for research purposes, but in planning the selection of indicators should rely on participative approaches (Carver 2003), expert consultation, or other approaches (Yeh 1999) used in conjunction with a quantitative approach (e.g., Delphi scenario) to derive their weights (Carver 1991, 2001; Eastman 1999; Yeh 1999; Jankowski 1995; Xiang 1997; Malczewski 2006).
- Petrişor (2013) discusses the different results yielded by different methods used to divide data into classes when drawing a chloropleth map. If this map serves decision makers, the planner must understand and be able to explain the rationale behind choosing a particular approach. Some of them (equal areas, natural breaks) are harder to understand and sound arguments must be provided for their selection (Goodchild and Longley 1999).

GIS as a Research Tool

On a similar note, different research projects developed in Romania involved the use of GIS technology to map historical monuments in Tulcea County (Bica et al. 2008; Topoleanu et al. 2009; Popescu 2011) and to identify and characterize barely accessible mountain areas exhibiting a high potential for tourism in order to include them in circuits (Popescu and Petrişor 2010). Ghiţuleasa et al. (2011) attempted to decide the path of national Romanian security corridors, allowing for a massive eviction in emergency situations, and proposed methods used to compare two routes (in the case of a disaster, evacuation routes) based on two parameters. The first looks at their path; the optimal one minimizes, by analogy with least square methods, the sum of squared distances computed using a N–S line drawn from the center of each accessible city to the path. A city is considered accessible based on the 45-min isochrone (Nordic Centre for Spatial Development 2005; Spiekermann and Wegener Urban and Regional Research 2007); that is, it can be reached within 45 min. The time can be converted to distance using an average speed (in the study, 65 km/h; for urban areas, 50 km/h). The second indicator is called "potential accessibility" and consists of summing up the population of accessible cities, defined again based on the 45-min isochrone. Again, the study transformed the time in distance based on the average speed. Each or both indicators can be used to compare the efficiency of routes. In hazard management, GIS was used in conjunction with data mining methods to assess urban seismic vulnerability (Leon and Atanasiu 2006), manage urban seismic risk (Atanasiu and Leon 2007), or visualize the spatial distribution of urban infrastructural risk (Toma 2010) in Iaşi. In the National Park Călimani, an in-depth study linked GIS-based risk assessment to private insurance; however, the research was mainly focused on technological risks (Mara and Vlad 2009). A research grant was focused on the assessment of seismic risk at the national level, embedding GIS in a software platform to pinpoint critical zones vulnerable to seismic events (INCERC Bucharest 2006; Craifaleanu et al. 2008).

Particular attention must be paid especially to the interpretation of results when GIS is used in conjunction with other tools increasing its analytical power, such as the statistical ones (Clarke et al. 1996; Unwin 1996; Varekamp et al. 1996; Nelson et al. 1999; Miao et al. 2007). Petrişor (2011) proposes a hierarchy of approaches situated at the intersection of geography and statistics: (a) "pure" mathematical methods, theoretical constructs: data are analyzed as if their nature were not geographic (e.g., longitude or latitude are analyzed using multiple regression, disregarding their geographical significance; Cheval et al. 2011); (b) very abstract geostatistical methods: the connection with the territory is ignored until the end, when the results are interpreted (e.g., ordinary kriging prediction of the Drane–Aldrich–Creangă test values; Ianoş et al. 2013); (c) area of interference: map data are used in statistical analyses to produce a new map, or the results of statistical analyses are mapped, but the results are correlated with the territorial reality (e.g., spatial interpolation techniques, representation of statistical or mathematical results, use of factor analysis to determine the weights of a GIS model); (d) less abstract geostatistical methods, connected to the territorial reality: starting from a map, a certain abstractness is obtained, even grouping data by categories (e.g., a GIS representation of the population of cities using different statistical tools); and (e) "pure" geographical, descriptive methods (e.g., a simple representation of the population of cities, based on the conventional size classes).

GIS in Research Versus GIS in Planning

The issues discussed before are particularly important when doing science and planning at the same time. A scientist knows that spatial interpolation is an exploratory research tool and will never interpret the results, particularly the class boundaries, as they were precise reality; in a similar way, a researcher is aware of the limitations of the methods and would never interpret the results of hierarchical classifications as precise and final, regardless of the number of variables used in this classification. However, when dealing with planning, GIS users must be aware of the potential conflicts generated by communicating such results to administrators (particularly when the message is negative), and be ready for questions such as "Why does this kriging map include my city in the 'low GDP' class?" or "Why is the level of development 'low' in my city and 'average' in the neighboring one?" For this reason, such approaches are not recommended to planners, unless they have the ability to explain the methodology or involve the public in choosing the parameters beyond spatial analyses.

GIS in Life and Health Sciences

GISs are the perfect tool to be used when the investigator looks at spatial relationships between individuals belonging to different species. Even though the set of spatial relationships is broader, including other specific relationships (inclusion, overlapping, etc.), most of the relationships of interest to ecologists can be assumed to be moving farther (suggesting avoidance) or closer (condition for their interactions). Proximity is reflected by Waldo Tobler's principle: "All things are related, but nearby things are more related than distant things" (apud Miller 2004; Goodchild 2007). It is hard to analyze avoidance; a minimal threshold can be established, but positioning behind this threshold does not necessarily imply avoidance, as it could be coincidental; in other words, if in some cases distances are known (e.g., a bird lines up at a distance where angry neighbors cannot reach it without the bird moving its feet or flying), in general it is unclear how far is enough to avoid. Similarly, proximity can be analyzed only for exploratory, not confirmatory purposes (Openshaw 1991; Pfeiffer and Hugh-Jones 2002); in this case, spatial analyses are a helper to other approaches (Graves 2008; Sundarakumar et al. 2012). Whereas causality implies proximity (i.e., in order to interact, the individual must come close), the reverse does not hold true (Openshaw 1991; Vine et al. 1997; Miron 1998; Gattrel and Senior 1999; Miller 2004; Herbreteau et al. 2005). If two individuals come close and their relationship is neutral, proximity is purely coincidental.

In Earth and life sciences, the main limitations related to the use of GIS include the following ones (Petrişor 2011).

- Due to the complexity and diversity, each ecological or territorial system is unique; possible comparisons and generalizations are hardly achievable. For this reason, the simple description is and remains a fundamental research instrument. Comparisons rely on the assumption that the analysis accounts for common and comparable parameters, imposing the simplification of their models and ignorance of parameters that could offer, in fact, the explanation of observed differences.
- Due to the lag in observing the effects, experiments are impossible in the format of other disciplines (chemistry, cellular or molecular biology, physics), and the causal mechanism explaining why a specific factor has certain effects on the dynamics of the system is often hard to determine.

- Because ecological and territorial systems are open, even though the influence of a given factor can be analyzed, other potential analyses cannot be excluded, inasmuch as research cannot be performed in isolation.
- Certain ethical constraints prevent the performance of intervention-based experiments (similar to those in fundamental research) performed over ecological and territorial systems, particularly if negative consequences are possible.
- Comparisons are, similar to other studies carried out at the population level, subject to "ecological fallacy": results on the associations seen in populations cannot be extrapolated to individual units, especially due to spurious associations and confounding (Vine et al. 1997). The latter is due to variables associated with both cause and effect, resulting in an apparent association of the cause and effect. More exactly, when looking at the correlation of variables measured in different units, the existence of a correlation does not necessarily imply a causal mechanism justifying its existence.

Dimensions of a GIS

A previous paper (Petrişor 2013) has shown that space can be interpreted anywhere from having one dimension up to an almost infinite number of dimensions. Nevertheless, most people perceive space as having three dimensions, at least the geographic space. The question is, "How can a GIS reflect these dimensions?" In order to be answered, the question must be rephrased in terms of resolution. Most authors agree that 2D and 2.5D GISs exist, and efforts have been made to the implementation of a truly 3D GIS (Van Oosterom and Vijlbrief 1994; Fritsch 1996; Schmidt and Fritsch 1996; Zlatanova et al. 2002; Santana et al. 2013). The 2.5D GIS is a 3D representation obtained by elevating a 2D representation, but lacking the same resolution on the third added dimension (i.e., it assumes that the base 2D shape of an object does not change at any continuous or discrete values of the third one).

Choosing the Appropriate Temporal and Spatial Scales in Environmental Planning

The key concept is diversity, understood in statistics quantitatively as scatter around a central trend (Dragomirescu 1998:37) and qualitatively as the different number of constituents and their different weights, evenness of distribution (Dragomirescu 1998:88; Magurran 1998, 37); and in ecology as diversity of structure, relationships between structural elements, and functions (Vădineanu 1998). Based on the discipline, diversity is called in geography *geodiversity*, and in ecology *bio*- and *ecodiversity*. Ecodiversity overlaps with geodiversity, and represents the diversity

Table 1 Correspondence of the hierarchies of systems in geography, ecology, and spatial planning and spatial diversity

Hierarchy of ecological systems	Hierarchy of geographic systems	Hierarchy of territorial systems	Spatial diversity
Structural and functional subunits of ecosystems	Nano- and micro-structures, house/ block, company/unit/section, street/ street segment	–	α, ω
Ecosystem	Geosystem, geofacies, geotope, local system	NUTS V (LAU II)	α, ω
Regional complex of ecosystems	Natural region, geographical region, regional system	NUTS III	ß, γ, ω
Macro-regional complex of ecosystems	Domain, zone, national/supranational, continental system	NUTS II, NUTS I, national territory, continent	γ, δ, ε, ω
Ecosphere	Geosphere, planetary system	Globe	ω

of natural and anthropic subsystems, including biodiversity. This chapter is based on understanding that geodiversity (equivalent to ecodiversity) includes biodiversity (Petrişor 2011:55). Functionally, biodiversity is reflected by the variety of food niches and trophic subunits of the biocoenose: trophodynamic modules, guilds, trophic levels, and the like (Popescu 2009). From a spatial viewpoint, different authors (Magurran 1998; Petrişor 2008, 2009; Pusceddu 2008) distinguish:

- α Diversity: Ecosystem level
- ß Diversity: Micro-regional complex of ecosystems
- γ Diversity: Regional complex of ecosystems, such as ecological regions or European biogeographical regions
- δ Diversity: Macro-regional complex of ecosystems, such as global biogeographical regions
- ε Diversity: Life environments (oceanic, terrestrial)
- ω Diversity: Global philogenetic diversity (included in the same category, even though the approach is structural)

Petrişor (2012) proposed, based on the spatial scale, a correspondence between the units (systems) used in ecology, geography, and spatial planning, including their corresponding diversity, shown in Table 1 (updated from the original version). It has to be stressed that geographically large scale (e.g., 1:50) means small coverage, whereas small scale (e.g., 1:5000) involves a large coverage.

In a different framework, time is accounted for in an unusual manner in the article published by Petrişor et al. (2011). Essentially, the article proposes a new approach for visualizing temporal data in a spatial manner. The method allows for pinpointing "hotspots" resulting from the cyclical repletion of phenomena or periodical trends, such as climate changes (seen as very dry or hot summers over consequent years) or trends in the dynamics of the diversity of species "visible" only at some moments of the year (dropdowns or increases of their population). In both cases, the two dimensions of space are represented by time variables (month and year) and continuity is obtained through spatial interpolation via kriging.

Conclusions

This chapter stressed the unique and defining features of a GIS: the fact that it exceeds the capacities of a database management system and mapping system, even though it combines both of them, becoming a decision support system. The uniqueness consists of the ability to analyze spatial relationships between objects belonging to different information layers. Therefore, the proper use of a GIS is especially related to these abilities: as a decision-making helper, and as a tool used to derive spatial relationships between different objects. Nevertheless, the second direction must be used with the caveat of being an exploratory and not a confirmatory tool. If all other extraneous variables are controlled for, GIS can be used to detect spatial relationships supporting an already inferred causality mechanism, but not to prove causality in the absence of underlying hypotheses. In planning, a GIS can be used in conjunction with participatory tools; in research, its abilities are strengthened when used in conjunction with statistical instruments.

In summary, a GIS is not about "steady maps". This means that the descriptive snapshot of the status of a system does not require the use of a GIS. On the other side, the GIS is about processes. Tracking, and especially measuring changes, needs the use of a GIS. Similarly, the GIS is about relationships. Analyzing and especially quantifying spatial relationships between different layers requires the use of a GIS.

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Part VI
Digital Representation of Hazards

GIS for Dam-Break Flooding. Study Area: Bicaz-Izvorul Muntelui (Romania)

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Abstract The objective of this chapter is to present a GIS-based application to visualise and analyse downstream flooding, following a hypothetical Bicaz dam failure on the Bistrita River, Romania. The assumptions of the dam failure scenario are: 50 % breach of the dam surface coupled with a 10,000-year flood. The inundation maps and the dam break flood wave characteristics (depth, velocity, and travel time) are obtained through numerical simulations using a hydraulic model (HEC-RAS) and the best available topographic data. Analysis of flood inundation maps by using GIS tools is crucial for risk assessment and for the emergency preparedness to protect against the loss of life and property damage. Vulnerability maps resulting from a multicriteria analysis are used to explore the potentially affected areas, and a loss analysis (as a simplified quantitative risk analysis) is performed on the physical environment for the city of Bacău, as examples of GIS graphical capabilities.

Keywords Dam break • Flood wave • Hydraulic modelling • Inundation maps • Hazard • Vulnerability • Risk analysis • Inundation area • Flood extent • Multicriteria analysis

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Introduction

Background

Geographical Information System (GIS) technology appeared in the 1960s from the need for storing topography in computers (Mark 1997). It has spectacularly evolved ever since, together with the development of computer technology, spatial data acquisition, and handling systems. A new geographical information science emerged with enthusiasm, driven also by the more and more complex required applications (Goodchild 1992). Many areas have begun to use GIS in their applications (ESRI 2011; Huissman 2009) until it has become a vital tool for practitioners and researchers of different fields for data collection and measurement, processing, analysis, and presentation of results in space and time (e.g., Antenucci et al. 1991; Margo et al. 2009; Huishi et al. 2015). Thus, GIS applications became interdisciplinary studies requiring complex working teams.

This chapter presents a GIS application for the case of a dam break scenario. Urbanisation, industrial, and agricultural development have led to continuous water and power demand, particularly in areas with very uneven time and space distributions of precipitation, or water shortages (IPCC 1995). This is why during the last century a large number of dams were built all over the world, as well as in Romania (Stanescu and Drobot 2002; Rădoane and Rădoane 2005). Inevitably, some of the dams were built in seismic areas and/or upstream of densely populated areas. Extensive damage and loss of lives could occur if a dam should fail. Unfortunately, quite a few such events took place in the world, from which many lessons were tragically learned (Alcrudo and Mulet 2010; Özdemir et al. 2010; Altinakar et al. 2010; McClelland and Bowles 2002; Londe 1987). Different causes may lead to dam failure (USACE 1997; Stematiu et al. 2010; Singh and Panagiotis 1988) from which, the most common – listed in decreasing order of statistical occurrence – are: structural damage and foundation failure (due to insufficient knowledge of the geological conditions and/or reservoir sediment fill leading to increased uplift pressure), breach of impervious layers and overtopping during storms, poor quality construction and/or materials because of insufficient funding, buildup of high pore water pressures for the rockfill/earth dams, wars or sabotage acts, landslide or slip between the dam abutment and the rock, faulty operation and maintenance or equipment malfunction, and earthquakes. Gravity dams break rapidly (order of minutes) along the concrete joints through overflowing, whereas earth dams break gradually (order of hours) through a pipe-shaped breach (Gee 2009; Wahl 2004). Usually the response time available for warning is much shorter than that for precipitation-runoff floods. The most risky periods of time prone to dam failure accidents are during construction and the first five years after commissioning (30 % of accidents) (Regan 2010).

Over the last 65 years, more than 2000 hydropower dams were built in Romania. Few of them are located at distances greater than 100 km from the Vrancea earthquake's epicentre. One hundred forty of these dams are considered large and are registered in the World Register of Dams. Some of the reservoirs also have huge storage volumes, such as Iron Gates 1 (2.1 km^3) on the Danube River, Stanca Costesti (1.29 km^3) on the Prut River, and Izvorul Muntelui/Bicaz (1.23 km^3) on the Bistrița River. Dam safety is carried out in Romania through the proper integration of design methods, execution, and operation procedures. Nevertheless, one single dam break accident happened in Romania in 1991, at the Belci dam on the Tazlău River, after an exceptional rainfall event and led to the loss of 108 human lives and important material damage (Chendeş et al. 2015). Romanian legislation in the field has been updated (E.O.244 2000; R.23 2006; O.1422 2014) to meet European demands on the development of flood risk management plans. Standard dam breach scenarios were defined for hydrologic conditions that may trigger the accidents for possible failures of different types of dams.

Inundation maps for hypothetical dam failure are required from the early stage of the design phase of dams to predict the space and time evolution of the flood wave. This information is needed to assess and mitigate the impact of such a catastrophic event on the exposed population, buildings, and environment (E.O. 2000; R23 2006). The multidisciplinary studies based on terrain topography and hydraulic numerical modelling, provide flood inundation/hazard maps, and vulnerability and risk maps. Use of GIS technology is indispensable for such analyses because it provides a georeferenced environment. The development of GIS has also contributed to the evolution of hydraulic models, by facilitating data preparation, processing, and graphic output visualisation (Haile 2005).

Downstream dam break flood routing has a pronounced 2D character. However, due to the length of inundated river reaches, computational difficulties, and availability of data, 1D hydraulic models are often applied for such situations, even for meandered rivers and/or community developments situated near the floodplain (Bornschein 2014; Gee and Brunner 2005; Altinakar et al. 2010; Alexandrescu 2010; Horrit and Bates 2002). The results of the hydraulic models are highly dependent on the quality of topographic data in the floodplain and the bathymetric data in the river channel (Marks and Bates 2000; Zagonjolli 2007). This is why, if spatial data are accurate enough – such as LiDAR data (French 2003; Chevereșan 2011; Marks and Bates 2000) – or the river reach is very long (tens to hundreds of kilometers), even 1D GIS-based hydraulic models are applicable with acceptable errors (Özdemir et al. 2010; Yochum et al. 2008; Xiong 2011). The same assumptions hold for the present study for which are used HEC-RAS 4.1 (HEC 2010) and its GIS interface, HEC-GeoRAS (HEC 2011), for spatial data processing and graphical output of results.

The results of the hydraulic models consist of flood inundation maps (with water depths and velocity values in each cell) that are very useful for vulnerability and risk assessment (Stoenescu 2009). Such information is of utmost concern for local authorities, who, knowing which are the areas most prone to floods, can adopt better regulations, conceive better policies, and take specific measures to mitigate the flood effects.

Objective

The objective of the chapter is to explore and visualise the consequences of a dam break event under a hypothetical hydrological and breach scenario. The case study is conducted on one of the largest dams/reservoirs in Romania: Bicaz gravity dam/Izvorul Muntelui reservoir (Fig. 1).

The analysed inundated Bistrita River valley is considered along a distance of 140 km, down to the confluence with the Siret River (no attempt has been made to extend the reach from Bacău city to the confluence with the Danube River).

Digital maps, satellite spatial images, orthophotomaps, bathymetric data, computed flood maps, and census and economic data are all used under the GIS environment, aiming at analysing social vulnerability and identifying possible disaster consequences. The GIS tools software used in the present study are ArcGIS 9.3., Global Mapper 11, and ILWIS 3.4.

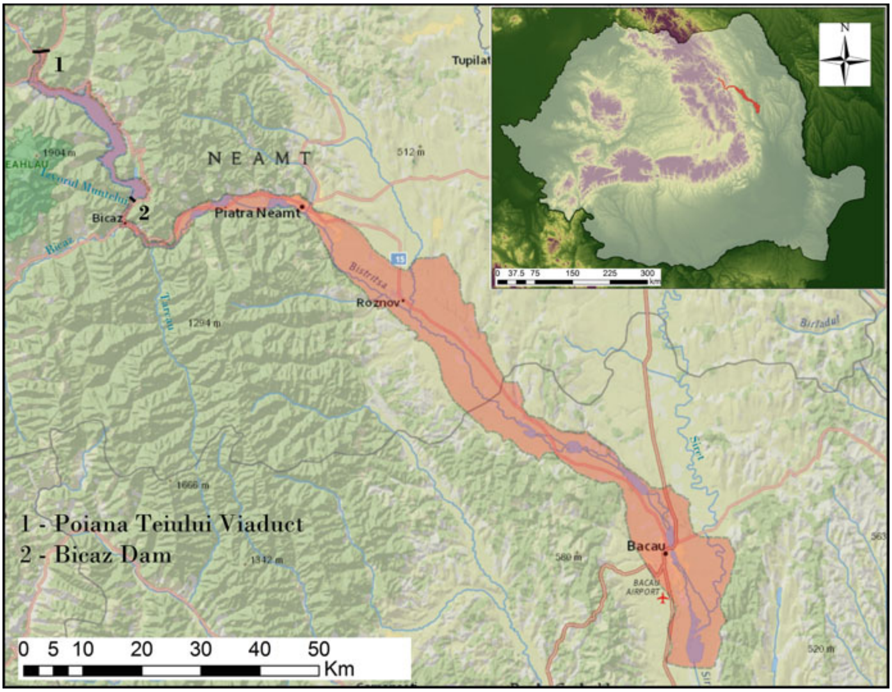

Fig. 1 Study area

Data for Failure Scenario

Topobathimetric and Dam Data

Bicaz is the third largest concrete gravity dam in Romania. When it was commissioned in 1960, it ranked the fifth dam in Europe and the ninth in the world. It has a height of 127 m, a length of 435 m at the dam crest and an elevation of 520 m (above Baltic Sea datum, which is 4.73 m above the Black Sea datum). Izvorul Muntelui reservoir, having a storage capacity of 1120 mil. m^3 at normal operating pool elevation (NOP), is designed to fulfil multiple purposes: hydropower production, flood control, irrigation, fishing, and recreation. It is 34 km in length and 2 km in its maximum width, with the highest depth of 90 m (at NOP elevation).

The 1:25,000 topographic maps from the 1980s were used to build the digital terrain model for the river floodplain. The terrain level curves were digitised in Arc GIS 9.3 (stereo 1970 projection with Dealul Piscului/S-42 Romania Datum). Reservoir bathymetric data consisted of 25 cross-section profiles surveyed in 2009 between the Bicaz dam and the Poiana Teiului viaduct (27.3 km upstream of the dam in Fig. 1). A Garmin 238 echo sounder fixed on a boat with the sensor maintained at a constant depth was used for the bathymetric survey.

The Bicaz dam has been modelled using the civil engineering data of its four-gated spillway: height, width, length, upstream and downstream slopes, piers, spillway and gate openings, crest, design head, and discharge coefficients. Two additional cross-sections were added downstream of the dam to reproduce the stilling basin schematically. For the analysis of the dam break consequences, the following sets of data were used (Table 1).

Hydrologic Data and Dam Failure Scenario

The hydraulic model has firstly been run under steady flow conditions for ten discharge values between 45 m^3/s (mean annual flow) and 2,480 m^3/s (10,000-

Table 1 Topographic and GIS-type data used in the dam break risk analysis

Data	Data source	Data type
Inundation map with water depths	Hydraulic modelling	Vector (polygon)
		Raster
Inhabited areas	Topographic map 1:25,000	Vector (polygon)
Roads, railways	Topographic map 1:25,000	Vector (line)
Terrain use	Corinne Land Cover 2000	Vector (polygon)
Orthophotoplan, Piatra Neamţ town	2005	Raster
LANDSAT satellite images (combination of spectral bands: 742)	earth.unibuc.ro	Raster

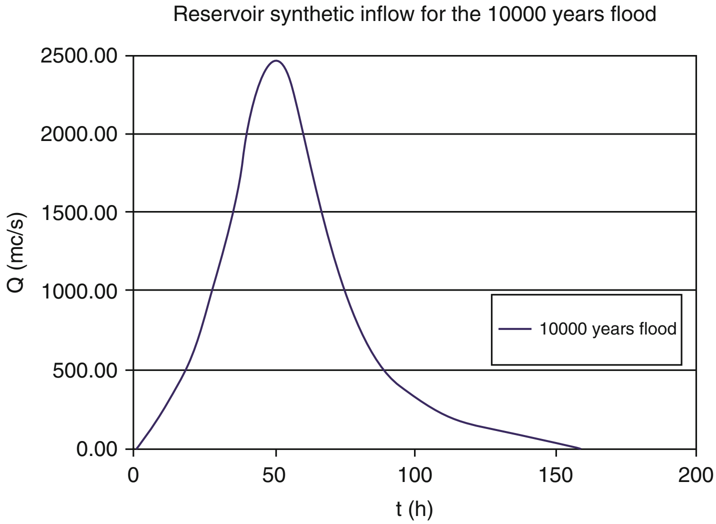

Fig. 2 Synthetic 10,000-year flood wave developed at the most upstream cross-section of the Bicaz reservoir

year flood recurrence time interval), for which corresponding profiles and cross-section rating curves were obtained. Then, for the unsteady flow conditions, a synthetic inflow hydrograph for the most upstream cross-section of the reservoir, with an hourly time step, was built based on peak flow value of 2,480 m^3/s, corresponding to the 10,000-year flood (or a 0.01 % probability of exceedance) and known statistical total duration, time to peak, and shape coefficient (Fig. 2).

Breach failure mode for the gravity dams is usually by overtopping, with a rectangular shape having the following dimensions: about 100 m in width and 100 m in height, which means a breaching scenario of about 50 % of the dam surface.

Breach formation is considered to begin when the water elevation in the reservoir reaches the NOP elevation (513 m; Fig. 3) and progresses in a sine wave shape, down to the specified stage elevation.

Method

Terrain Preprocessing

The TIN of the study area is created from the topo-bathymetric data with the help of the 3D Analyst extension (Fig. 4). Then, under HEC GeoRAS 4.3 the thalweg line, riverbank stations, and 187 cross-sections (Table 2) are digitised and used to extract from the TIN the 3D geometry of the hydraulic model. The three upstream

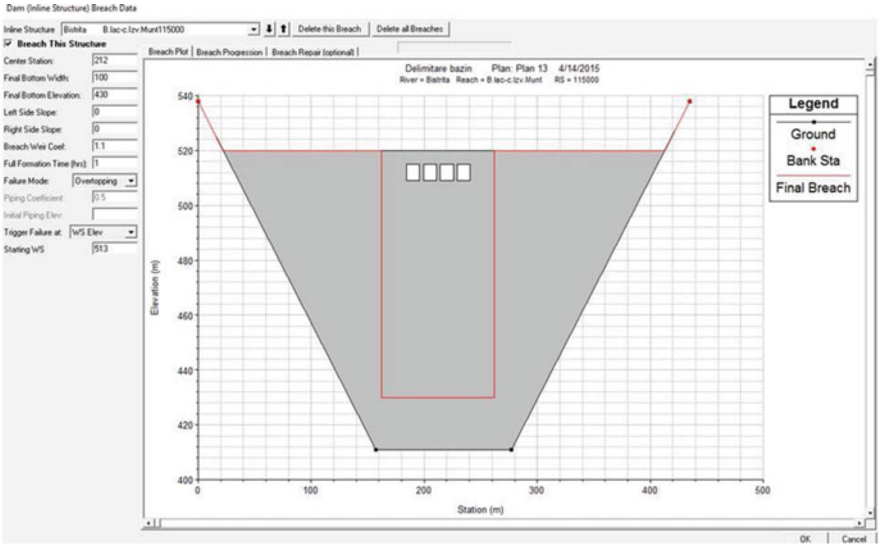

Fig. 3 Dam breach rectangular overtopping failure for the 50 % scenario

tributaries of the Bistrita River: Izvorul Muntelui, Bicaz, and Tarcău are neglected, because their inflow is negligible for such a catastrophic event. Also, the downstream hydropower plants and bridges along the Bistrita River are not considered in building the hydraulic model.

The cross-sections are then linearly interpolated into HEC-RAS at a mean distance of 390 m, leading to a total of 363 cross-sections along the entire river reach (from which 295 cross-sections are considered in the reservoir; Fig. 5). A *.sdf geometry file is exported from HEC-GeoRAS to HEC-RAS, in order to perform the hydraulic modelling.

Bank stations in each imported cross-section are corrected in HEC-RAS along the river to fit the level curves on the maps and the boundaries seen on satellite orthophotomaps.

Hydraulic Model

HEC-RAS version 4.1 (Hydrologic Engineering Center 2010) is used to carry out the flood routing in the event of Bicaz Dam failure. The software is a one-dimensional unsteady flow routing model which solves the mass balance and full momentum – Saint Venant – equations (Nistoran et al. 2007) governing flow in river and floodplain. The continuous river reach flow domain (river and floodplain) is discretised by the cross-sections into cells for which all hydraulic variables

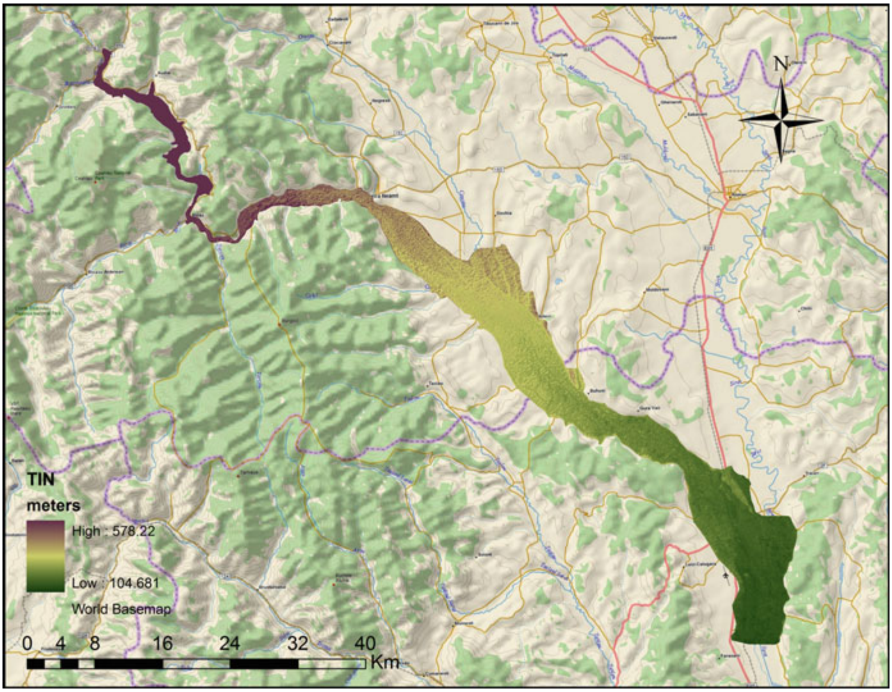

Fig. 4 TIN of the study area (Izvorul Muntelui Dam and Bistrita River floodplain, down to the confluence with the Siret River)

Table 2 Geometric characteristics of the Bistrita River reaches and the surveyed cross-sections

Bistrita River reach	No. of surveyed cross-section profiles	Mean distance between cross-section profiles (m)	Reach length (km)	Invert stage difference (m)	Bottom slope
Izvorul Muntelui Reservoir	25	1,080	27.3	94	0.00345
Bistrita (down-stream of Bicaz Dam)	162	830	119.2	283.8	0.00238
Total	179				

(discharge, depth, velocity) are computed at each time step (Fig. 5). The differential form of the equations is converted into a system of algebraic equations which requires specification of initial and boundary conditions in order to be solved.

Surface roughness value is defined through the Manning coefficient. Its values are estimated based on previous studies, field observation, experience, and literature in the field, inasmuch as no model calibration on observed data can be made for such a hypothetical accident. For the sake of simplicity one single value is considered for the river channel (of 0.03) and one for the floodplain (0.05) (Ramesh et al. 2000).

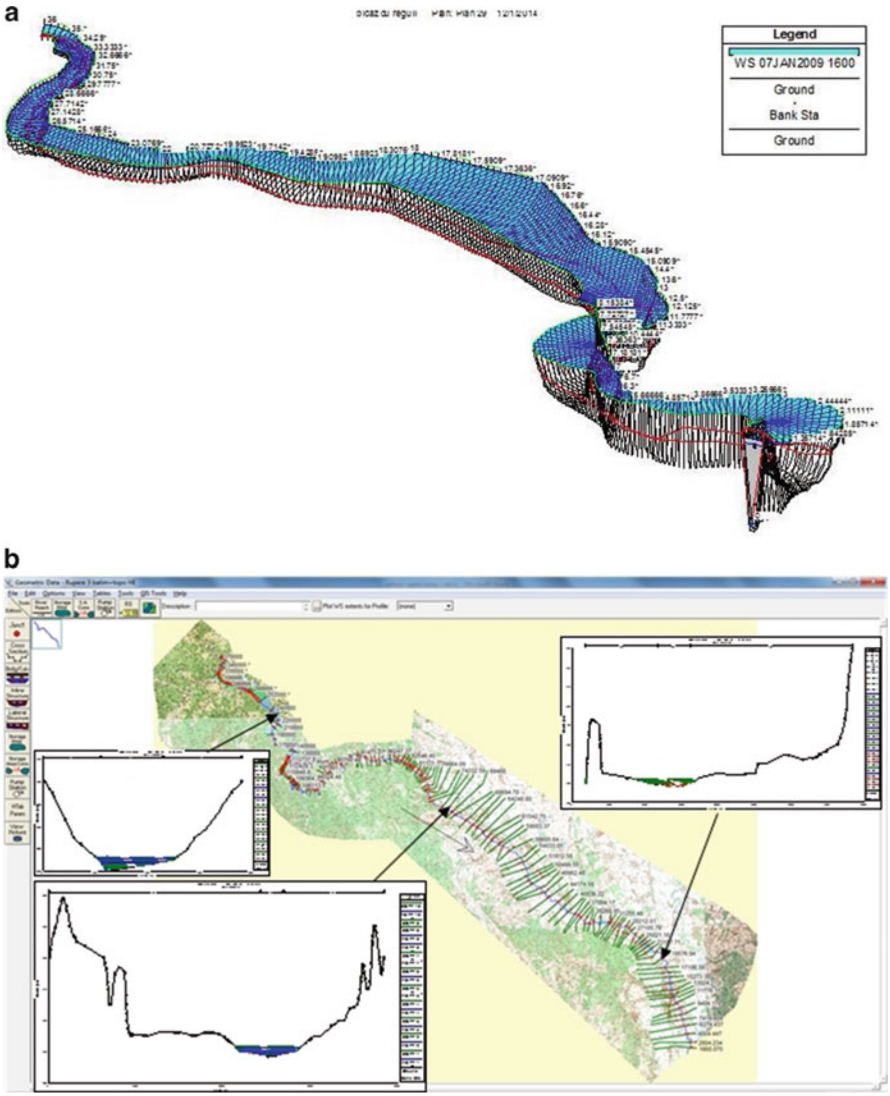

Fig. 5 (**a**) The topobathymetry of the Izvorul Muntelui reservoir with Bicaz Dam (reproduced by 295 cross-sections); (**b**) The river schematic and floodplain topography of Bistrita River downstream of the Bicaz Dam to the confluence with Siret along river reach (292 cross-sections)

Vulnerability and Loss Analysis

Vulnerability describes the predisposition or propensity of a community, system, or asset to suffer damage from a hazard. In computations, vulnerability is a nondimensional number having values between 0 (not affected by the hazard) and 1 (totally affected by the hazard).

Hazard is the dangerous phenomenon, natural or anthropic. In technical settings, hazards are described quantitatively by their frequency of occurrence. In this chapter, *hazard* has been analysed as the product between the spatial probability that a cell of the study area is inundated by the dam break flood wave and the annual probability of this flood occurrence.

Two analyses of vulnerability are conducted in this chapter: one along the Bistrita valley (i) and one focused on Bacău city (ii), for the loss analysis. (i) At the valley level *social vulnerability* is chosen for the analysis from the different types of vulnerability. It refers to the inability of people, organisations, and societies to withstand adverse impacts to hazard due to characteristics inherent in social interactions and institutions. In this chapter, social vulnerability is based on the census data from 2002 and it is approached from the perspective of social scientists. Social vulnerability is considered as a set of socioeconomic factors determining people's ability to cope with disasters (e.g., O'Brien et al. 2004). To assess it, a multicriteria analysis is applied, and implemented in the SMCE module of ILWIS 3.4 – GIS software. Different *social indicators/criteria* are selected, normalised, and weighted in a specific criteria tree, generating a complex aggregated vulnerability index map of the study area, as explained later in the text. (ii) For the loss analysis focused on Bacau city, *physical vulnerability* (Douglas 2007) of the buildings is selected and analysed.

Risk is generally understood as the probability of loss that may occur due to a hazard of specific magnitude (Bowles 2007; Morris et al. 2012). It may be quantified as the product of the probability of flood events with different return periods and expected losses. In this chapter, for presentation purposes, we limit our analysis to the 10,000-year return period flood, coupled with the dam failure scenario and loss calculation. For the considered example of Bacau city we have used only the loss estimation as a component of risk analysis.

The equation for the quantitative loss computation (Eq. 1) derives from the general risk formula:

$$L_s = P_t \cdot P_s \cdot V \cdot A \tag{1}$$

in which *Pt* is the annual temporal probability of the flood event scenario with the given return period; *Ps* is the spatial probability of the occurrence of such an event in every pixel of the study area; *V* is the vulnerability of the elements at risk (e.g., buildings as in the Bacau example); and *A* represents the quantification of the loss/damage of the elements at risk, which for the buildings in the Bacau city have a monetary value in euros.

Results

Inundation Mapping

The most important results of the dam breach scenario are the inundation maps for maximum flood extent and depths (Figs. 6 and 7).

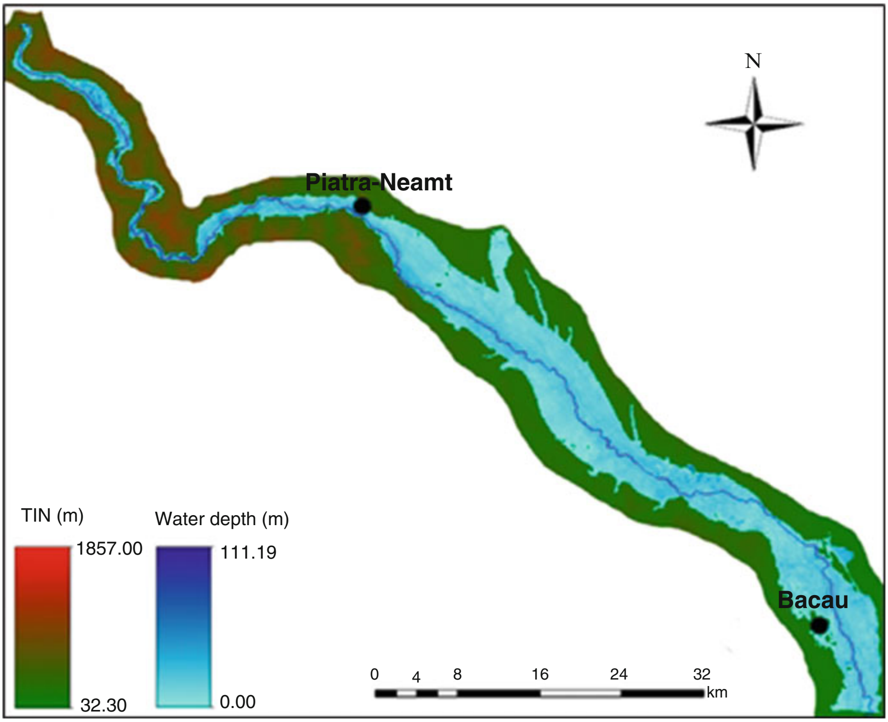

Fig. 6 Flood mask for the maximum water depth (including the reservoir)

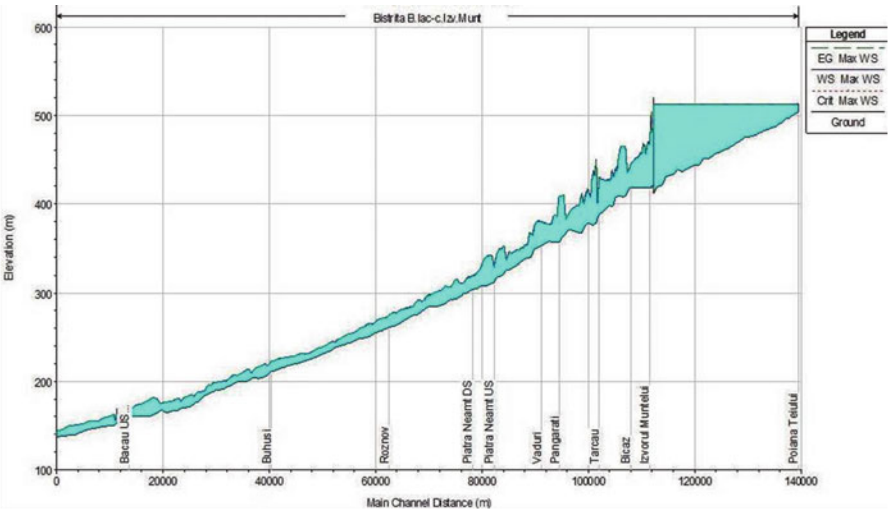

Fig. 7 Maximum water depth along the study reach in the considered dam breach scenario

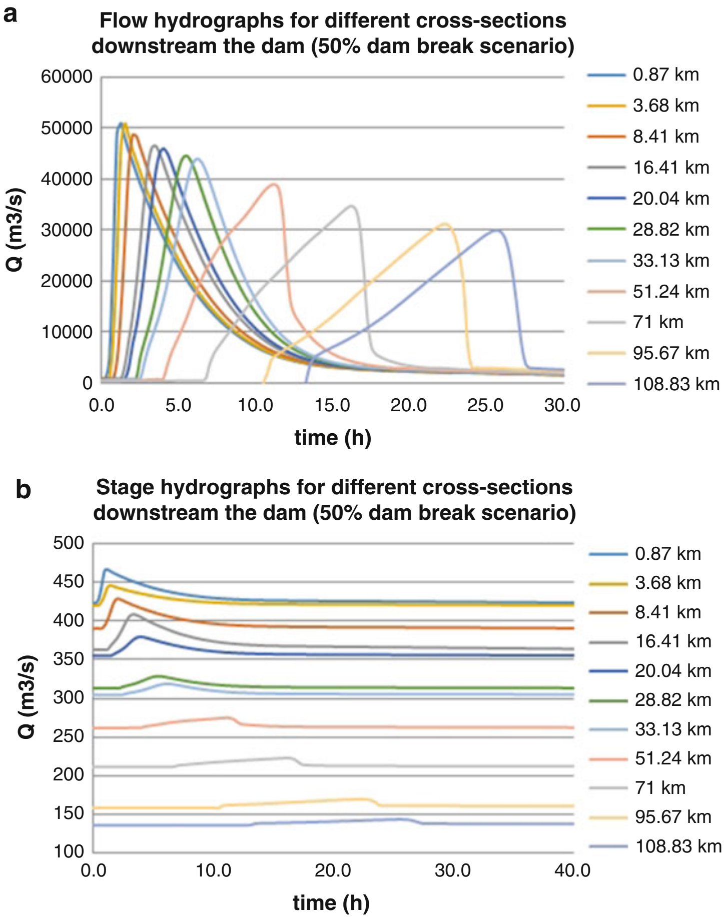

Fig. 8 Flow and stage hydrographs of the dam break wave along the Bistrita River for the most important social and economic objectives (at different distances from the dam) down to the confluence with the Siret River for the considered dam break scenario

In Fig. 8 are presented the flow and stage hydrographs of the flood wave at the most important social and economic objectives downstream of the dam shown in Fig. 9. The corresponding distances of these cross-sections from the dam are listed in Table 3. One may observe the effect of flood wave attenuation downstream of the Bistrita River and the huge values of the released peak discharge, immediately downstream of the dam (at the confluence with Izvorul Muntelui) for the considered scenario: 51,000 m^3/s for the 50 % failure of the dam surface. The peak depth is of 49.5 m, just downstream of the dam. The travel time of the front of the flood wave down to the confluence with Siret River is about 13 h.

From the numerical simulations one may obtain for each location along the Bistrita River the most important hydraulic parameters for the risk analysis, such as:

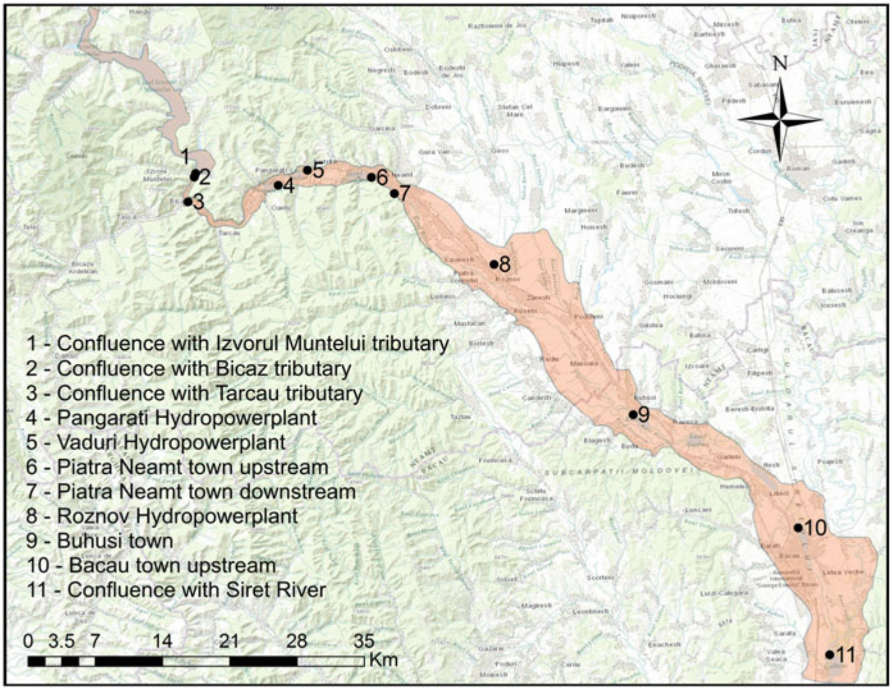

Fig. 9 Most important social and economic objectives downstream of the Bicaz Dam

Table 3 Distances from Bicaz dam to the most important objectives (cross-sections) downstream of Bistrita River

No.	Distance from the Dam (km)	Important objective downstream of the dam
1	0.87	Confluence with Izvorul Muntelui tributary
2	3.68	Confluence with Bicaz tributary
3	8.41	Confluence with Tarcau tributary
4	16.41	Pangarati Hydropower plant
5	20.04	Vaduri Hydropower plant
6	28.82	Piatra Neamt town upstream
7	33.13	Piatra Neamt town downstream
8	51.24	Roznov Hydropower plant
9	71	Buhusi town
10	96.67	Bacau town upstream
11	108.83	Confluence with Siret River

travel time of the wave front, peak and rear, peak stage or depth value of the flood wave, flow velocities, and wave propagation speed.

One may see from Table 4 and Fig. 8 that for the considered scenario, the peak of the flood wave would reach Bacau city in about 21 h. The maximum water depth varies between 59 m at the dam to 8 m downstream of the study reach. The width of

Table 4 Maximum stage, water depth, discharge, and travel time of the flood wave peak in the most important cross-sections along the Bistrita River, for the considered dam Breach scenario

Cross-section	Distance from the dam (km)	Max. water level, z	Max. water depth, h	Max. flood wave travel time, t	Max. discharge, Q	Max. velocity	Max. width of flooded area
		mdM	m	Ore	m^3/s	m/s	m
Bicaz dam	0	479	59	00:00	51,268	5.84	316
Confl. with Izvorul Muntelui	0.87	467	49.5	00:15	50,976	8.77	388
Bicaz town	3.32	446	28.4	00:30	50,850	4.88	652
Tarcau village	8.16	428.5	44.4	1:00	48,585	5.34	551
Pangarati HPP	16.41	408.6	52.6	2:30	46,510	1.1	1,154
Vaduri HPP	20.04	380	25	3:00	45,966	1.85	1,843
Piatra Neamt City US/DS	30	329/319	16.9/15.6	4:30/5:15	44,557/43,944	5.63	946/1025
Roznov HPP	51.24	275	14.17	10:15	38,905	4.12	4,600
Buhusi town	71	223	14	15:15	34,684	2.74	4,271
Bacau city	97	170	11.5	21:15	31,127	2.14	4,300
Siret confluence	108.83	144	8	24:30	29,880	2.63	3,400

the flood mask is quite large, varying between 316 m and almost 5 km. The smallest width values of the flood mask are immediately downstream of the dam, in a narrow valley; these small values are maintained down to the exit of the Subcarpathian area. Downstream of this area, the flood mask width reaches 4 km and over, in some areas. The computed water velocity is useful in order to assess the stability of the buildings when exposed to such a catastrophic flood wave. Progression of the flood wave downstream of the dam along the Bistrita River with the corresponding flood mask at different moments following the dam breach is illustrated in Fig. 10.

Peak discharge value (Q_p) of the flood wave at the dam may be calculated with different empirical formulas obtained by researchers from real case accidents of dam breaks. One of these formulas was obtained after performing a regression analysis on data from multiple accidents (Costa and Schuster 1988; Froehlich 1987; MacDonald and Langridge-Monopolis 1984), as a function of the dam factor (*DF*), defined as the product of the water depth at the dam, h_w and water volume, V_w in the reservoir triggering the failure:

$$Q_p = 0.981(DF)^{0.42} = 0.981(V_w \cdot h_w)^{0.42} \tag{2}$$

For the considered scenario at Izvorul Muntelui/Bicaz, h_w is 111 m, whereas the volume V_w is obtained by adding to the storage capacity at spillway crest level (1,020 mil. m^3) the volume of 200 mil. m^3 of water brought into the reservoir by precipitation (area underneath flood hydrograph). Therefore $V_w = 1{,}220$ mil. m^3 and Q_p computed with Eq. 2 is 46,450 m^3/s.

According to Broich (1998), the peak discharge may also be computed with the following two equations, in which V_w is expressed in millions of m^3:

$$Q_p = 255.859\ (V_w \cdot h_w)^{0.449} \tag{3}$$

$$Q_p = 72{,}611\ \left(V_w \cdot {h_w}^4\right)^{0.256} \tag{4}$$

which gives 51,538 m^3/s and 55,657 m^3/s, respectively, for the study case. All three values are close to the one obtained from the numerical simulations (51,268 m^3/s in Table 4).

In defining and analysing the risk, inundation maps are the most important results. The inundation maps have to include the maximum water levels and the flood wave travel time from the beginning of the accident, and have to be superimposed onto detailed maps of the flooded areas with terrain contour line values, transportation roads and railways, and inhabited areas with the most recent census data. All of these data are processed in a GIS environment. The advantage of working with GIS technology is that all simulation results may be superimposed over the maps, orthophotomaps, or satellite images (Fig. 11).

By overlapping the inundation map obtained in the considered scenario (corresponding to the maximum water level in each cross-section along the Bistrita River), over the maps, orthophotomaps, or satellite images of the study area, one may notice on Fig. 12 that more than 70 human settlements would be flooded. Two

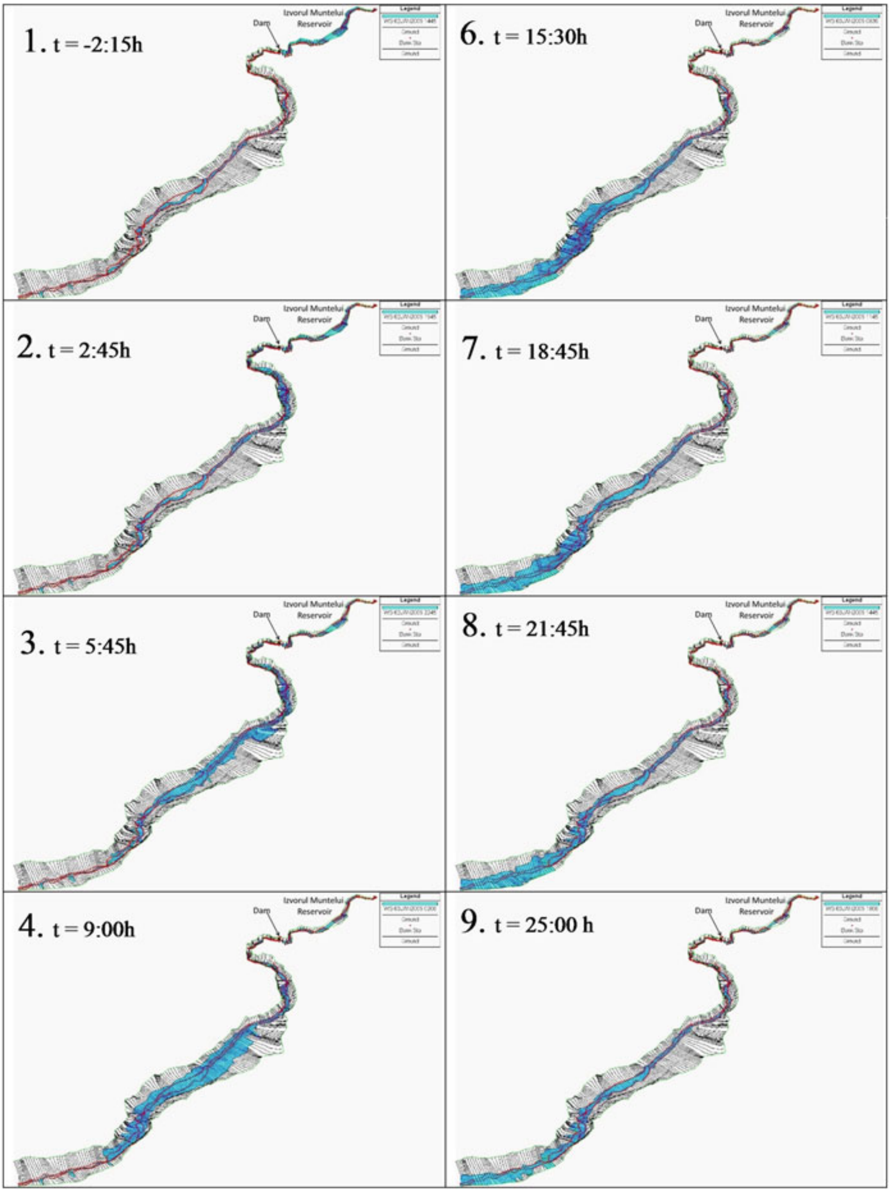

Fig. 10 Progression of the flood wave and corresponding flood mask at different moments after the dam breach

of these localities are county residence cities (Piatra Neamţ and Bacău) and another two are towns (Bicaz and Buhuşi). Sixteen of the inhabited areas would be completely flooded, and the rest would be partially impacted, depending on the distance from the Bistrita River thalweg line.

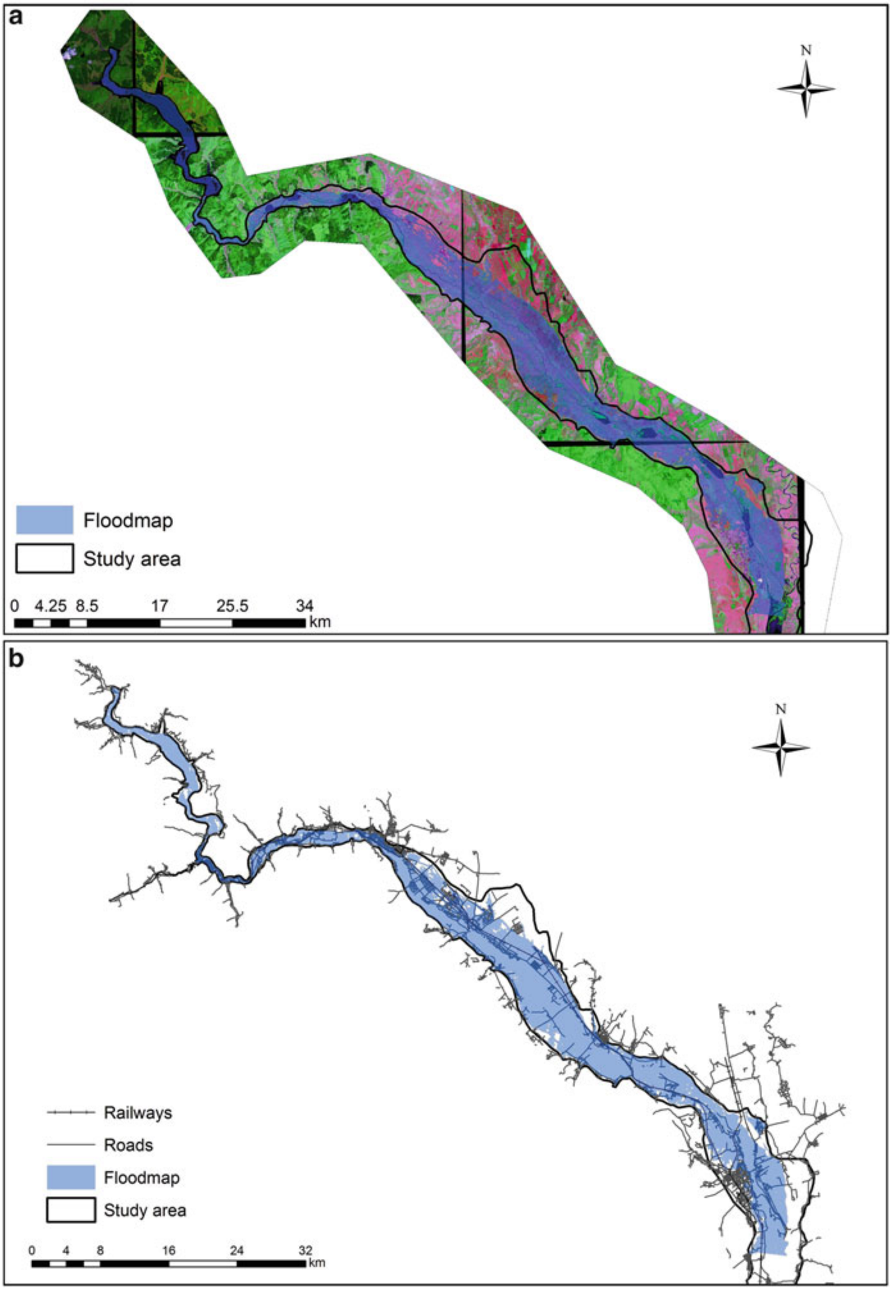

Fig. 11 Inundation map along the Bistrita River valley for the maximum water depth, in the case of the 50 % dam breach scenario. Depth values are superimposed (**a**) over a LANDSAT ETM+ satellite image (band combination 7–4–2) and (**b**) over a vector layer of inhabited areas

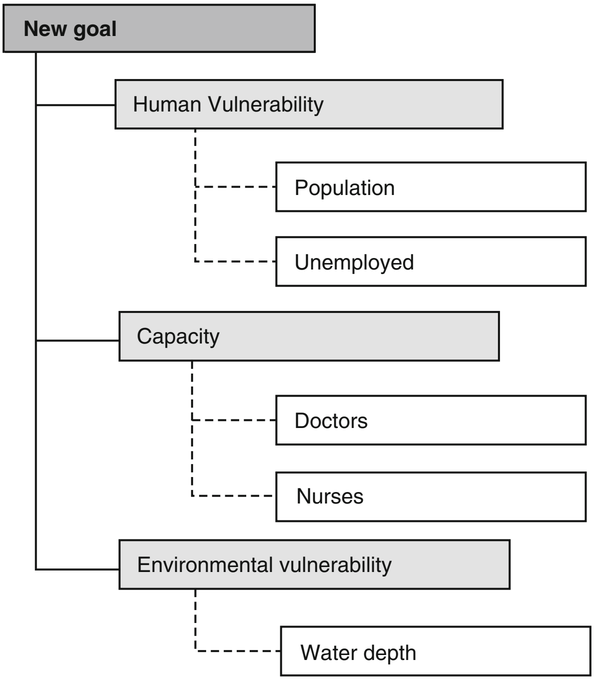

Fig. 12 The decision tree used in the vulnerability assessment

Results show that inhabited areas, as well as transport infrastructure would be affected. Roads and railways within Bistrita Valley make the connection between Moldavia and Transilvania regions in Romania. Many localities would remain isolated should such an event happen. Land uses would also be impacted, agricultural fields becoming unusable for a long period of time due to the water excess.

Almost all the components of the environment would be affected if such an accident would occur. The magnitude of the flood may be easily observed in Fig. 12. One may see that nearly all the localities (either small or important) are covered by water. Piatra Neamt City, the residents of Neamt County would be the most affected (in terms of human fatalities and damage). Nearly half of the city would be covered by water, but the most affected area would be the central part, with the greatest population density, where the highest buildings are located.

Social Vulnerability Assessment

To assess social vulnerability, a multicriteria evaluation is performed. This procedure is often used (Armaş 2008; 2011; 2012; Munda 2004) in risk analyses (Armaş and Radulian 2014; Barbat et al. 2010; van Westen et al. 2005) because it can take into consideration a large variety of different spatial and nonspatial factors at the same time. It can also help decision makers and local planners, contributing to better decisions for risk mitigation plans (e.g., better building regulations, more efficient evacuation plans, etc.). Another major advantage is that it can allow the aggregation of quantitative and qualitative indices, based on human judgement. In the present paper, the module SMCE (spatial multicriteria evaluation) of the ILWIS 3.4 software is used for performing the vulnerability assessment, on a locality scale. The data used are organised in a decision-tree structure (Fig. 12).

The decision tree starts in ILWIS by setting the main goal of the analysis, in this case the social overall vulnerability (Fig. 12). The subgoals set are human vulnerability, capacity, and environmental vulnerability. For each subgoal different criteria are imposed.

Thus, for human vulnerability the criteria considered are (i) the number of people living in each of the localities of the studied area and (ii) the number of unemployed persons. Even though there is not a commonly-accepted framework for establishing the indicators that should be used when assessing human vulnerability, there are several studies (Armaş 2008; Dwyer et al. 2004; Adger et al. 2005; Blaikie et al. 1994; Brooks 2003; Tapsell et al. 2010) which state that the most significant indicators, in addition to the number of population, are the ones that contain the economic factor, directly or indirectly. From a social point of view, the more people live in an area, the higher is the human vulnerability. Similarly, a poorer population, unemployed, with a reduced education level, has more difficulties in coping with and recovering from a natural disaster (smaller resilience).

For the capacity subgoal, the criteria used are (i) the number of doctors and (ii) the number of nurses for each human settlement of the studied area. The capacity represents the instrument that people may use for mitigating the damage caused by a natural disaster (Blaikie et al. 1994; Tapsell et al. 2010) and it can consist of different assets that people may use (e.g., a higher education level can lead to better preparedness for a natural disaster; a higher income can determine a shorter recovery period in the postdisaster phase). In this chapter, based on the available datasets, the number of doctors and nurses from each human settlement is selected. This selection is made because doctors and nurses can offer assistance during and after a disaster occurs, thus contributing to the mitigation of human life losses. Even though not all localities have medical facilities, at least all of them have doctors and/or nurses who can promptly provide medical assistance during and after the occurrence of such disasters.

The third subgoal is the environmental vulnerability, represented by the maximum water depth in case of a dam failure.

After setting the main goal, the subgoals, and the criteria, all the necessary data are introduced in a criteria tree. As each criterion has its own unit of measure and the criteria have to be aggregated and weighted, a prior normalisation of the data is performed as a second step of the multicriteria analysis. The normalisation is achieved through value functions (Sharifi et al. 2004; Abella and van Westen 2007). In other words, the person who performs the multicriteria analysis gives a meaning of the values of a certain criterion with respect to the overall social vulnerability (direct or inverse proportional) considering (i) the maximum value of the criteria as 1 and the minimum value as 0, for the direct dependence; or (ii) 0, for the maximum value of the criteria, and 1 for the minimum value, for the indirect

Table 5 Chosen subgoals, criteria, and standardisation

Subgoal	Criteria	Normalisation method	Reasoning
Human vulnerability	Population	Direct	The more people live in an area, the higher is the overall vulnerability
	Unemployed	Direct	The more unemployed people live in an area, the higher is the overall vulnerability
Capacity	No. of doctors	Inverse	The more doctors are in an area, the lower is the overall vulnerability
	No. of nurses	Inverse	The more nurses are in an area, the lower is the overall vulnerability
Environmental vulnerability	Depth	Direct	The deeper the maximum water level is, the higher is the overall vulnerability

dependence (ITC 2012). The performed normalisation for each criterion is synthesised in Table 5.

The third step in the multicriteria analysis uses weighting values from 0 to 1. Because not all criteria have the same influence on the subgoal, and not all the subgoals have the same influence on the main goal, there is a need to weight the criteria and the subgoals, based on experienced judgement. In the present study, the method used for weighting was the ranking order method (Sharifi et al. 2004; ITC 2012) which ranks and weighs the subgoals according to their importance.

For the human vulnerability subgoal the number of unemployed persons was considered a more important criterion than the total number of people living in each human settlement. This was based on the judgement that even though there are many people living in an area, those who have an income are better equipped to face the impact of the flood and to recover sooner after the disaster (Tapsell et al. 2010).

For the capacity subgoal the number of doctors was considered to be a more important factor than the number of nurses in the case of such an accident.

Subgoals are ranked in the decreasing order of importance for the area, as follows: human vulnerability, capacity, and environmental vulnerability. Based on the total number of people and on the social and economic characteristics of individuals or groups of individuals from an area, the overall social vulnerability can be assessed (Cutter and Emrich 2006; Cannon 2008; Tapsell et al. 2010).

Several intermediate maps and a final map are obtained after applying the weighting methods (Fig. 13).

The inundation map was divided into three classes (high, medium, and low in Fig. 14), based on the histogram of values. The map indicates that low values of vulnerability are very scattered across the studied area whereas the two main cities, Piatra Neamt and Bacău, have the highest values of vulnerability, mainly due to the great number of people and the high water level.

The present vulnerability analysis may be improved by using more detailed indicators (e.g., income, ethnicity, education levels, special medical conditions, property type, etc.) or by collecting data at a larger scale (e.g., census-unit scale or better, at household level). Unfortunately, such data are still of limited coverage in Romania.

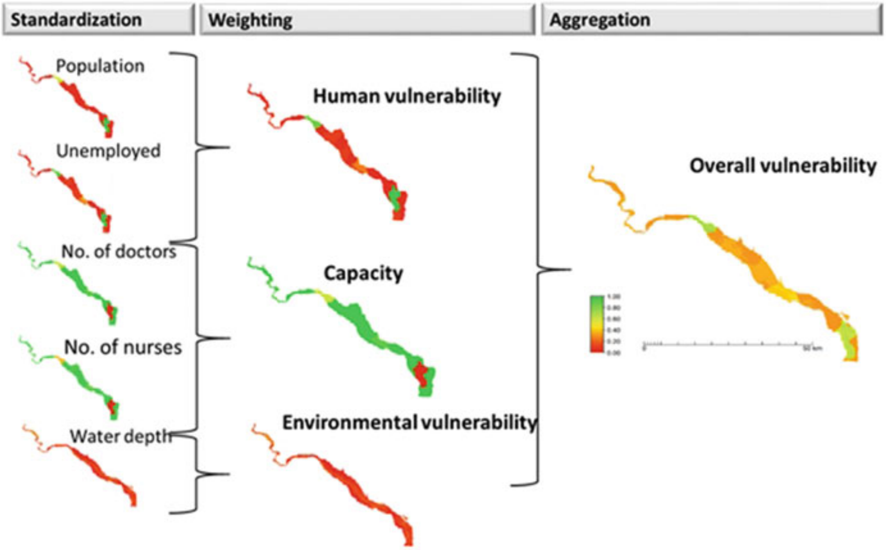

Fig. 13 The methodological workflow used for the vulnerability assessment

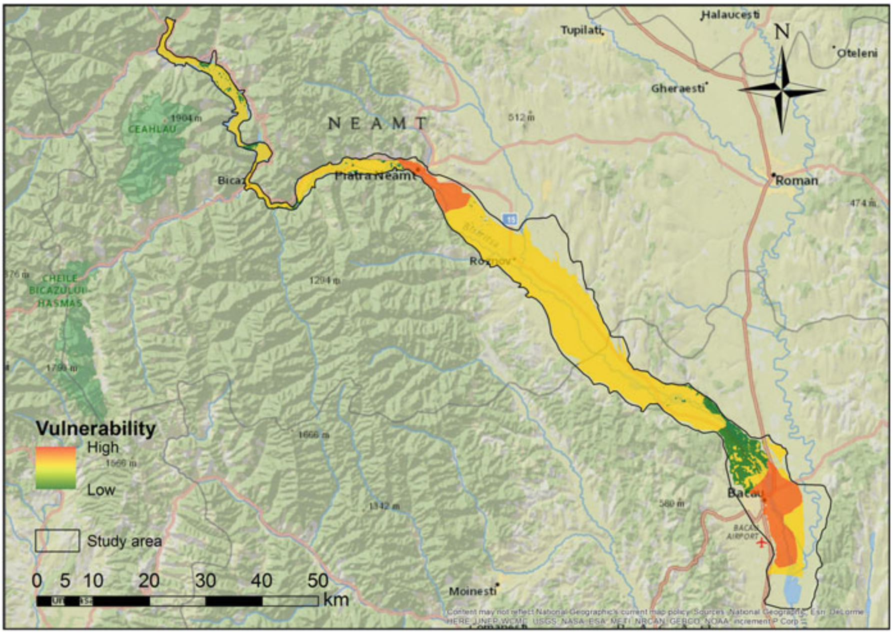

Fig. 14 Vulnerability map

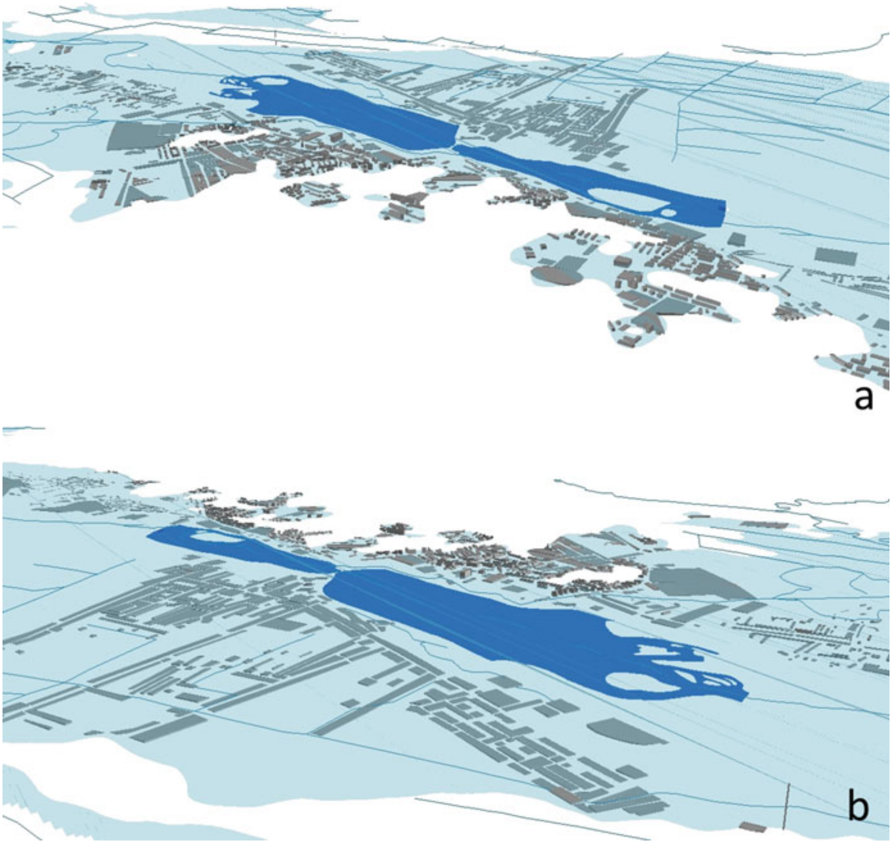

Fig. 15 3D view of flooded buildings from Bacau City: (**a**) view from SW; (**b**) view from NE: *dark blue*, the Bacau reservoir; *light blue*, dam break flood extent for the considered scenario

Loss Analysis Focused on Bacau City

In this section we exemplify the analysis of direct losses from the impact of the maximum flood hazard on buildings in Bacau city county residence. This choice was made because Bacau is the most important city along the entire Bistrita River valley. The town is situated 9 km north from the confluence with the Siret River (Fig. 4). Most of the city is located on the second terrace of the Bistrita River and in the floodplain. Residential areas cover about 80 % of the total building and commercial areas. The industrial area has a ring shape around the city, with two concentration zones in the southern and northwestern parts of the city, together with a linear setting along Bistrita River. The inundated area in the 50 % dam break scenario would be 18,716,668 m^2, which represents 53.7 % of the city surface (Fig. 15).

The loss analysis is conducted at the level of the physical environment. To achieve this goal, the hazard information regarding the flood scenario is combined with the vulnerability of buildings to produce the estimated losses in terms of the amount of money which is likely to be lost in the case of this flood scenario. The vulnerability of buildings in the flooded area was estimated using four criteria: construction year, building material, type of structure, and building height.

Because no census data on population living at each level of the building were available, this study does not focus on life safety and the consequence of a dam break on life loss (number of fatalities) for Bacau city, but on the possible financial damage due to building destruction.

Results show that 4,044 residential houses, 5,296 other buildings, and 806 blocks of flats would be affected, corresponding to a total damage of over €97 mil. For the blocks of flats, the water would mainly affect the ground floors and the first floors (Fig. 16), and the cost of repairs would reach over €77 mil. This cost was obtained assuming that for a block of flats about 480 m^2 would have to be renovated at a rate of 200 euros/m^2 (Coca 2016).

Among the affected buildings of great social, economic, and cultural importance are: two retirement homes for elderly people and one for abandoned children, 13 schools and two universities, seven churches, and two memorial houses. Also, in the inundated area there are buildings such as the National Bank, Palace of Justice, ambulance and firefighters headquarters, television tower, bus station, markets and malls, and so on.

The affected railway length would be of 5 km, which would produce a damage of about €50 mil. (assuming the repair of 1 km is about €10 mil.). National road E85, which crosses the city, would be covered by water over a distance of 4 km. The rehabilitation works would cost €3 mil./1 km, therefore another €12 mil. Total direct asset damage is evaluated at more than €280 mil. Indirect asset damage is difficult to estimate. For example, in the inundated area there are some factories that pose a major environmental risk. The most important one is Bacău Chemical Factory, with its sterile dump containing ammonia and other very toxic substances, and extending over an area of about 155,500 m^2 (Coca 2016).

Conclusions

The chapter highlights the graphical and mapping capabilities offered by GIS for assessing the hazard, vulnerability, and loss associated with a catastrophic event, such as the one simulated through the hypothetical Bicaz dam failure on the Bistrita River, Romania. The resulted inundation maps can be used to assist in land use planning and to develop contingency plans to mitigate the possible losses to human life and property damage in case of such a disaster (e.g., preparations of evacuation plans, flood warning systems, and classification of inundated areas).

The inundation maps obtained for the considered catastrophic scenario are superimposed over different thematic maps, orthophotomaps, or satellite images,

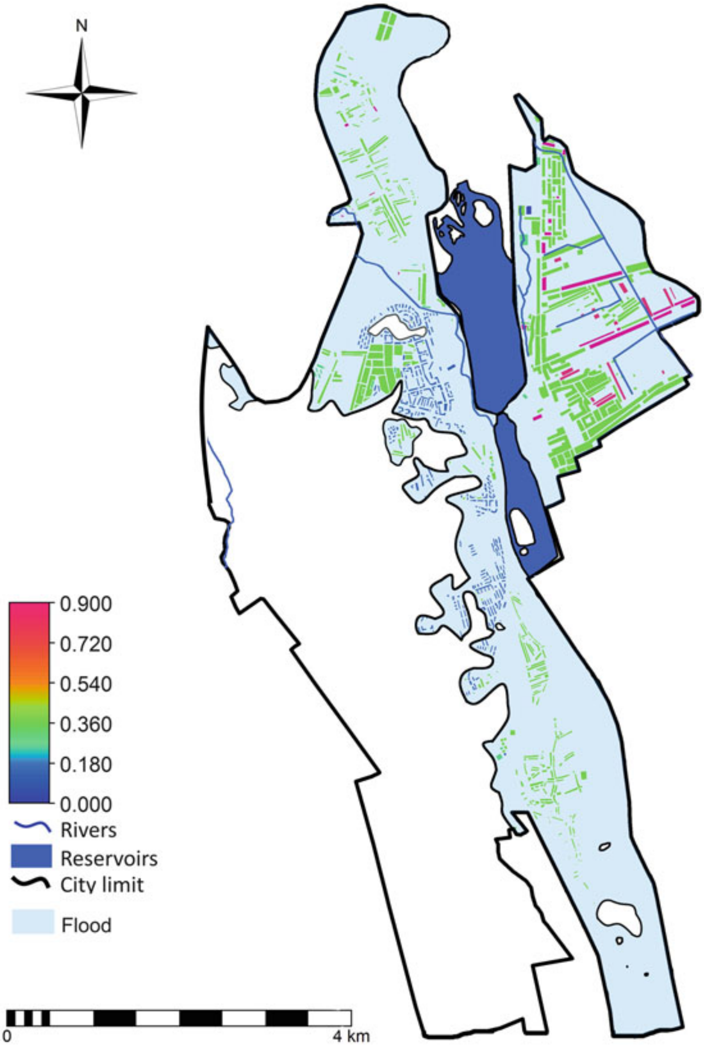

Fig. 16 Buildings affected by the dam break flood in Bacau City (0, not affected; 1, totally destroyed)

each pixel-cell of the flooded area having an attribute of water depth, velocity, wave travel time, and so on. Examples of socioeconomic vulnerability and loss analyses are performed to present the analytical and visual possibilities of the GIS environment. Thus, even if tested with scarce data, the loss estimation (as a component of risk analysis) conducted for the city of Bacau illustrates such capabilities.

A real risk analysis requires extended information concerning population census data, the values associated with each building-type, and stage-damage functions, most of which are not yet available in Romania.

The present example did not take into consideration the more catastrophic muddy nature of such a flood, also full of debris (simulations were performed under a "clean water" simplifying assumption). Moreover, because the dam break simulation results show the flood wave does not attenuate down to the Siret River confluence a more comprehensive study for such an accident should also take into account the Siret River valley down to the confluence with the Danube River.

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Limits and Possibilities of Computer Support in Priority Setting for Earthquake Risk Reduction

Maria Boştenaru Dan

Abstract Several computer-aided methodologies are available to select buildings or urban areas for priority action by those involved in earthquake preparedness measures. These serve to measure the criteria after which structural engineers, project managers, or regional planners will set priorities. The potential for interactivity between the computer tool and its user decides the possibilities and limits in meeting the optimal solution. Usage of strong motion data to predict damage to buildings and urban areas is exemplified. The development of tools suitable to set priority criteria to protect urban settlements from earthquake impact is shown.

Keywords Priority setting • Earthquake • FEM • Dynamic loading • Buildings • Urban areas • Multimedia

Introduction

Risk management is a process the steps of which are identification, assessment, mitigation, monitoring, review, and communication of risks resulting from a certain hazard on a site or an activity. The 1755 Lisbon earthquake left the widest echo in history, as it triggered discussion and measures across natural sciences, engineering, philosophy, literature, arts, and architecture. In this chapter we aim also at a multidisciplinary approach to earthquake risk management. Scale-independent instruments to seismic risk management along its structural dimension are redefined: the morphology (organisational) and the resilience planning (operational), by exchanging lessons learned at different scales. Resilience planning serves sustainable risk mitigation. To the instruments of the seismic risk management process belong timely constituted planning types: recovery, preparedness, mitigation, and resilience stages (Bostenaru 2005). Methods in research address the complex dimensions of resilience (Bruneau et al. 2003, and the European RISK-UE

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project – Mouroux and Le Brun 2006a, b). The RISK-UE project also accounts for the development of the macroelements method used in this chapter. In the *World Housing Encyclopedia* (www.world-housing.net, Brzev and Greene 2004) seismic performance and seismic vulnerability are based on the description of earthquake-resilient features, seismic deficiencies, and earthquake damage patterns of building elements, to which seismic retrofit measures are then addressed. At this building level, apart from these empirical findings the instrument urban theory is available for systemic analysis between resilience and morphology lack. Also research on architectural morphology is limited (Bögle 2004). We aim to make a link between the tectonics of construction materials and morphology. A 'computational morphogenesis' technique for structural design has been developed by Ohmori et al. (2005), extending the concept of 'evolutionary structural optimisation' (Xie and Steven 1997) based on the step-by-step removal of the inefficient parts of the initial structure, also including the extension of the necessary parts. Aou and Ohmori (2005) proved the suitability of the approach for frame structures such as those in this research, subjected to earthquake loads. Frampton (2001) looked at tectonics, a concept related to the origin of earthquakes, from the point of view that the expression of a structure reflects its load-bearing role. In this case, sincerity in architecture is followed, and the form reflects the structural morphology. The concept of morphology, which means the study of the form, was initially promoted by Goethe (1891); the term was first used in bioscience, which connects to the approaches in this project regarding the urban organism or the evolutionary structural organisation inspired by organic forms. Alexander's participatory and phenomenology approach (1977) leads to organic shapes. It is based on tradition, which is something we envisage also at an urban scale when relating reconstruction language to the 'heritage habitat' (Gociman 2006). Under this concept, the reconstruction should call up the memory of the affected population to rebuild using urban and architectural structure compatible with their memory map. The idea of 'heritage habitat' is based on the approach of Lynch (1960) regarding the perception of the urban image, which we previously used for urban analysis in decisions for retrofit (Bostenaru 2004). For the purpose of defining the 'heritage habitat' in reconstruction it is important to study the existing built substance in the area. The structures in the city renew themselves continuously, just as do living organisms, as structure-forming forces have been acting since the founding of the city. Therefore the task of urban planners is one of the most difficult ones if their intervention is asked for, such as due to an imminent danger of disaster. Outgoing from urban topology and the topological transformations given by movement, projection, and deformation, Florescu (2009) goes over to urban morphogenesis, the result of the dynamics of urban forms and generator of the complexity of these. Discontinuity is caused by risks and vulnerability at the urban scale. Discontinuities can be static and dynamic, the latter relating the urban form to the context. Risks are a relating element between form and context, relating continuity and discontinuity in the evolution of the urban organism. Florescu (2009) developed formulas regarding the risk in the context, in the static form of the urban form and in the metabolic form of the urban form, thus relating the risk of the individual element to that of the urban form, depending on discontinuities, which affect the vulnerability. This is different for buildings, which enjoy a certain degree of autonomy for change by their owners. Following the philosophy of Deleuze (1980) and the way a space can be smooth and striated, there is an applicability to disaster research inasmuch as destruction can be an occasion for a new beginning through reconfiguration. The corner points of 'heritage habitat' (Gociman 2006) shall be kept.

There has not been any research on the applicability of computational morphogenesis, this crossdisciplinary method from mechanical engineering, in building retrofit. Consideration given to earthquake loads in the method and the fact that any retrofit is based on redesign suggest suitability. The resulting organic wall/brace shapes could thus build retrofit elements added to an existing frame structure to be retrofitted. Glaister and Pinho (2003) and Borzi et al. (2008) developed loss models, which are based on knowledge of the buildings, and the team of Kappos et al. (1998, 2007, 2008) investigated the costs of seismic retrofit after the 1999 Athens earthquake. The portability of this method is limited because it relies on databases. Also previous research of the author (e.g., Bostenaru 2006) was in this direction, but limited to a deterministic approach of predefined and unoptimized retrofit algorithms. It did not approach the statistical relevance through the probabilistic. The new developments within this chapter are applied to the N–S boulevard in Bucharest, for which data are available from the previous German project SFB 461 in which the first author did work. These data don't consider, however, cultural value protection aspects such as urban protected zones or architectural individual and collective monuments. Current decision-making research on seismic retrofit of frame structures is being performed by Caterino et al. (2006, 2007, 2009). Games can also serve decision-making processes. Several modeling approaches to costs of natural hazards in both computer and board games will be analysed in further research. Apart from games theory, principles from drama theory in decision making on seismic retrofit, which is a gain compared to overwhelming studies on vulnerability are included through the Saaty method. The continuing point for this is the research on qualitative balancing among the criteria (Bostenaru 2004, 2006; Armas 2012). Thus far drama theory has been applied for dealing with climate change (Levy et al. 2009).

In the past years applications at urban scale for assessing vulnerability increased in number. This development was also possible because of the development in the use of computers. On the other hand this use led to an overflow of information, sometimes more than needed.

In 1989 the USA Federal Emergency Management Agency issued a handbook and the supporting report (FEMA 1989) called 'Establishing Programs and Priorities for the Seismic Rehabilitation of Buildings.' The handbook provides guidelines in 'making informed decisions on rehabilitating seismically hazardous existing buildings. The guidelines are intended to incorporate a methodology for identifying and evaluating the most significant factors and impacts that influence choice of a rehabilitation program and the setting of priorities for the types of buildings that should be included in a program.' The handbook is intended to be used by key staff, decision makers, and interested participants. It includes detailed information on the program development process, vulnerability analysis and loss estimation, damage estimate, building priorities, building strengthening, economic and social impacts of rehabilitation, rehabilitation program types, and finally loss study examples. Although comprehensive, the book only shows methods and algorithms, but no thoughts on decision support. The program manager in this FEMA report was Christopher Arnold, an architect who also had the idea of the *World Housing Encyclopedia* (Brzev and Greene 2004).

The UIA, the International Union of Architects, currently has a working body in the field of urbanism called 'Urban Settlements and Natural or Other Disasters,' directed by Emine Komut from Turkey. Together with the work programmes on habitat, heritage, architecture and children and architecture and the disabled it belongs to the group 'Architecture and Society.' The working group published some of the research done.

Several methods developed by fellow scientists, such as the 'deformation based seismic vulnerability methodology' by Simon Glaister and Rui Pinho (2003) were reviewed as part of the tests done in the experiments carried out and presented in this chapter. Displacement spectra are a fundamental ingredient of displacement-based design procedures. Glaister's method (Glaister and Pinho 2003) was employed in the experiment that envisaged a priority setting on an urban scale and for which the shape of displacement spectra was of importance in the priority setting. Consequently, a number of related articles were reviewed prior to carrying out the experiment. When the natural period of a structure is greater than a certain value T_0, depending on the frequency of velocity pulses, the displacement response spectra of the proposed approximation agrees well with those of recorded ground motions, which is the case also in the paper by Faccioli et al. (2004). The increasing diffusion of structural methods of analysis based on displacement demand, in design and also for assessment of existing structures motivated Faccioli et al. (2004) to perform a study on displacement spectral shapes in the long-period range in order to improve seismic codes. Faccioli et al. (2004) considered for their study moderate earthquakes ($5.5 < M < 6.0$, 0–10 km) from Umbria/Italy, Athens/Greece, and Japan, intermediate earthquakes ($6.0 < M < 6.5$, 10–30 km) from Japan and large earthquakes (M~7.5, 30–50 km) from Chi-Chi/Taiwan. The aim was to investigate the dependence on magnitude and site conditions of the shape of the horizontal displacement response spectra. For this purpose features of displacement response spectra in the long-period range were determined as a function of magnitude, source distance, and site conditions. It was concluded that basic trends of the spectra are easily appreciated by visual inspection. All investigated spectra tend to increase up to a 'corner period' beyond which the spectral ordinates remain constant for the M7.6 records, whereas for the other magnitude classes they tend to decrease gently towards the peak ground displacement (Faccioli et al. 2004). The corner period in this magnitude range lies typically between 1 and 2 s. For the Chi-Chi earthquake the normalized average spectral shape computed by Faccioli [8] is different, with a corner period between 6 and 7 s. Faccioli et al (2004) observed that the effect of distance on the normalized spectral shape is small, at least up to 50 km from the source, due to the predominantly geometrical attenuation effect, whereas for M < 6.5 there is a moderate increase of the corner period with distance, likely due to the increasing influence of surface waves. From analytical models of displacement waveforms Faccioli et al. (2004) derived analytical expressions for the displacement spectra. These expressions demonstrated that the moment magnitude and distance control the shape of the spectra to be consistent with the commonly accepted models of the seismic source. Analytical expression of the variation of peak ground displacement with magnitude and distance, useful in the formulation of design elastic displacement spectra for seismic codes, and in zoning studies of seismic hazard for long-period structures, were formulated (Faccioli et al. 2004). It was investigated if simple models featuring basic features of the displacement response spectra derived from simple analytical pulses are able to provide a satisfactory interpretation of the observed spectra. An A-type motion (the near-field large magnitude: Chi-Chi) featuring a 'fling-step' pulse with a permanent offset and B-type motion (Athens) featuring a narrowband displacement pulse were considered. The study of Faccioli et al. (2004) demonstrated that normalized displacement spectral shapes can be reproduced, at least qualitatively, by simple displacement pulses, defined by only two parameters: the velocity pulse half duration t_0 and the peak ground displacement $d_{\max}$ (for the Chi-Chi final fault offset).

In our project we aim to bring to dialogue the zoom of scale between building element, building, and urban zone, which can be superimposed as layers in vulnerability assessments.

Experiment 1: Structural Mechanics

This experiment aims to assess some limits and possibilities for a computer-aided priority setting in earthquake preparedness at the urban area level. The experiment was designed to test whether by using urban-scale techniques it is possible to predict the most vulnerable types of framed buildings.

In 2003 Glaister and Pinho (2003) developed a simplified deformation-based method for seismic vulnerability assessment. Central to the method was the relationship between qualitative damage states as defined in loss estimation studies and interstorey or global drifts in buildings. Conclusions are drawn from the shape obtained by the intersection of the capacity curves, which are displaced as a function of the effective period, and the demand curves, which are displacement spectra as a function of the period, plotted. These concern which height class of buildings from a stock with certain reinforced concrete frame member characteristics are most likely to suffer damage in certain limit states for the earthquake considered.

The model used the methods applied for the single building, in a simplified way, applied at territorial scale. Probabilistics are going to overcome the errors given by assumptions in simplification.

The assessment was done for reinforced concrete buildings, whereas for masonry other methods exist (Borzi et al. 2008).

Deformation-Based Seismic Vulnerability Methodology

This experiment was carried out using data from Romania (1977 Vrancea earthquake). The distribution of heavy damage on buildings of different heights, but having the geometrical and material properties of the frames subjected to the Vrancea earthquake was estimated using the assessment methodology proposed by Glaister and Pinho (2003), which is described in the following.

In a first step effective height coefficients were computed. The formulas for effective height coefficient for column-sway frames proposed by Glaiser and Pinho (2003) were used.

In the second step the computation of capacity-height relationships for yield limit states was done. Based on the material characteristics of the frames the yielding strain (Glaister and Pinho 2003)

$$\varepsilon_y = \frac{f_y}{E_s} = \frac{343MPa}{200000MPa} = 0.001715$$

was used. Based on the geometrical characteristics a column depth

$h_c = 300$ mm
and a column height
$l_c = 3{,}000$ mm.

In the third step the capacity-height relationships for post-yield limit states were computed. The post-yield displacement is given by:= 14.76 (Glaister and Pinho 2003),

$$\Delta_{pi} = \theta_{pi} H_x$$

where(Glaister and Pinho 2003).

$$\theta_{pi} = L_{ph} \Phi_{pi}$$

Based on the characteristics of the frame $L_{ph} = 250\,\text{mm}$ was considered. To compute the post-yield capacity further the ultimate strain in the given limit state in concrete ($?_{C(LSi)}$) and steel ($?_{S(LSi)}$), corresponding to column-sway mechanisms was considered. Based on this and with the column characteristics height specified above $?_{LSi}$ was computed. Now (Glaister and Pinho 2003)

$$\Phi_{pi} = \Phi_{LSi} - \Phi_y$$

could be calculated, and substituting all the obtained values in

$$\theta_{pi} = L_{ph}\Phi_{pi}$$

(Glaister and Pinho 2003).

The plastic displacement, however, depends on the height of the yielding member, which in the column-sway mechanism is the soft storey height giving the inelastic displacement capacity. Thus the capacity curve depending on height could be plotted.

In the fourth step the ductility at the limit state and scaling of the demand curve were computed. Ductility was computed to be

$$\begin{aligned}\mu_{LSi} &= \frac{\Delta_{LSi}}{\Delta_{LSy}} \\ &= 1.99.\end{aligned}$$

Using the ductility factor the demand curve for the given earthquake could be scaled. Using the software SeismoSignal the period spectra at yield (5% damping) was derived. The displacement values at post-yield depend proportionally by a factor of those at yield. In this case the damping

$$\begin{aligned}\xi &= 2\left(1 - \frac{1}{\mu^{0.5}}\right) + 2\% \\ &= 9.30\end{aligned}$$

and

$$\begin{aligned}\eta &= \sqrt{\frac{10}{5+\xi}} \\ &= 0.83\end{aligned}$$

were computed and the spectra were scaled.

In the fifth step the computation of vibration period and of capacity curves was done. The period at yield is a function of height given by the formula

$$\begin{aligned}T_{LSy} &= 0.1 \times H_T^{3/4} \\ &= 0.21.\end{aligned}$$

Period post-yield is a function of this and is given by

$$\begin{aligned}T_{LSi} &= T_{LSy}\sqrt{\mu_{LSi}} \\ &= 0.3.\end{aligned}$$

The capacity curve is thus transformed into a displacement-period function.

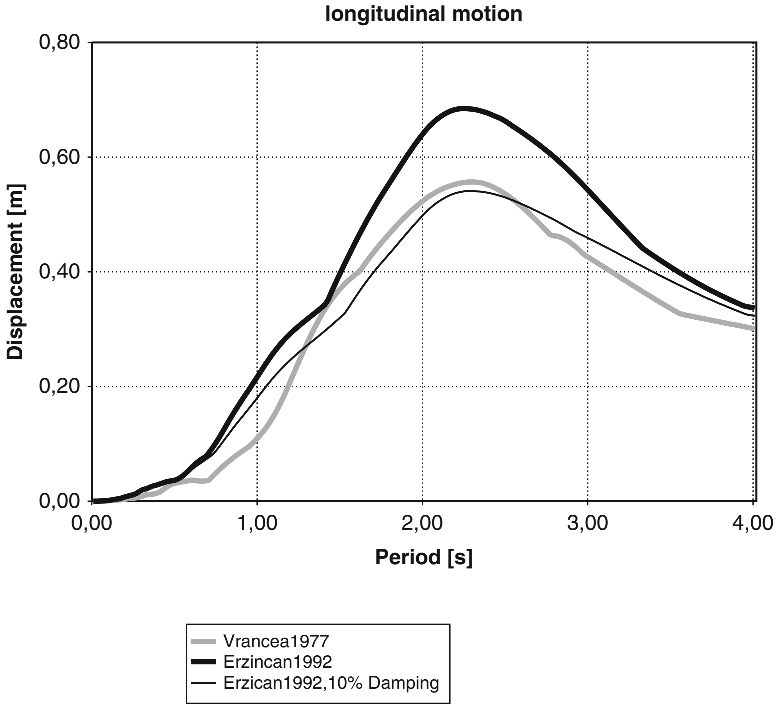


Fig. 1 Displacement spectra for Vrancea and Erzincan earthquakes, showing that different sites can produce similar vulnerability

The capacity and displacement curves (Fig. 1) can now be superimposed. The intersection point of the two graphs separates the building where capacity is over demand of those where capacity does not reach demand (these are the buildings not reaching the required limit state). In the population of buildings considered this limit lies at four storeys.

Results

As a result of this experiment buildings of four upper stories and more of height were estimated as being the most vulnerable. In order to verify whether this corresponds to reality, data on buildings that actually suffered the most severe damage were needed. This was done by consulting literature such as Bălan et al. (1982). The most damaged building classes were RC frame with solid clay infill with five and more storeys in Bucharest, Fig. 2). Insufficient repair of previous structural damage from earthquake or other causes made the buildings vulnerable to severe damage in the earthquakes considered in this study in Bucharest. Deep and soft alluvial soil conditions and high water table conditions are found in Bucharest.

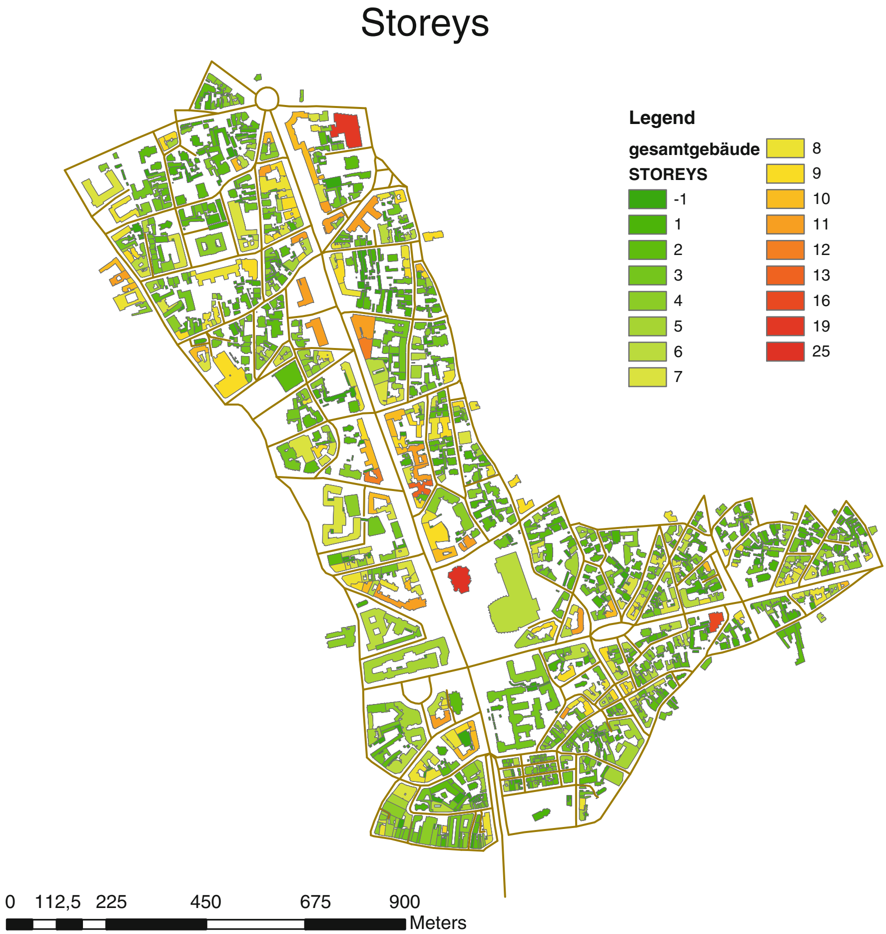


Fig. 2 Height mapping for Magheru Boulevard in Romania from the EQSIM database (Used by permission)

The experiment produced good results, as the same height classes were predicted by the method.

Discussion

The 1977 Vrancea earthquake was characterised by an epicentral distance of 161 km, a fault distance of 115 km. The accelerograms were recorded on a site with very soft soil. It had a thrust fault mechanism. Using Faccioli's (2004) method the following values were computed: t_0 ~0.5 s, $a_{max} = 1.976$ m/s^2, $d_{max} = 186$ mm

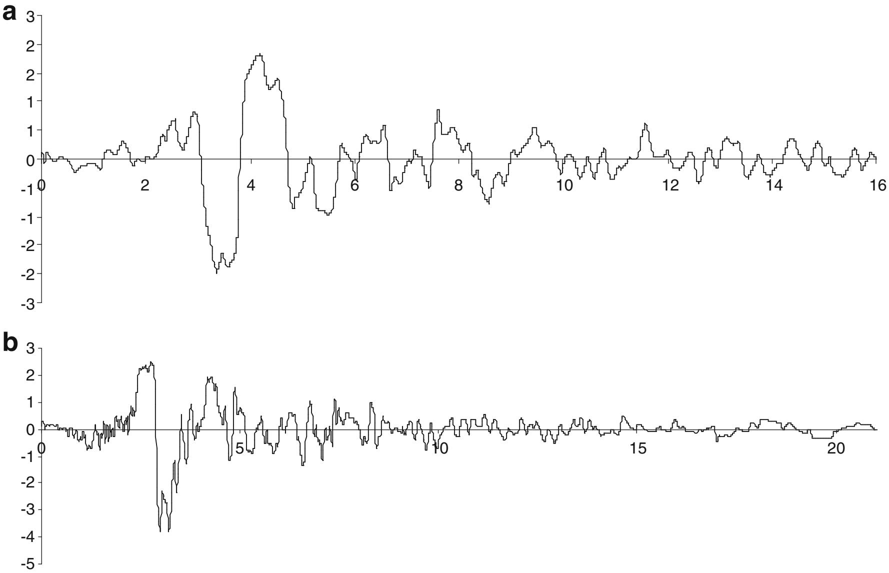


Fig. 3 Accelerograms for the two earthquakes considered in the experiment at urban scale (longitudinal component, X axis time in seconds, Y axis acceleration in m/s^2): (**a**) Vrancea earthquake 1977; (**b**) Erzincan earthquake 1992

(between 210 mm and 130 mm real values) and $v_{max} = 500$ (see Fig. 3 for acceleration, velocity, and displacement time histories).

In Bălan et al. (1982) a description of the strong motion recorded in Bucharest during the 1977 Vrancea earthquake was given: In a first phase, corresponding exclusively to the creation of longitudinal waves (the P-principal waves), which were recorded 18 s long, the oscilations war predominantely vertical, low-frequency (under 0.1 s) and low amplitude (under 0.5 m/s^2). In the second phase, in which also the transversal shear waves appeared (S-secondary vaves), the oscilations became mainly horizontal and the accelerations reached high values up to 1.6–1.7 m/s^2 in the E–W direction and 2.1–2.2 m/s^2 in the N–S direction, which leaded to a peak acceleration of 2.5 m/s^2. The vertical accelerations increased up to 1.1–1.2 m/s^2, maintaining high frequencies. For the horizontal movement main periods of 0.8–1.0 s in the E–W direction and 1.4–1.6 s in the N–S direction could be observed. In the N–S direction a cycle of huge, almost sinusoidal oscilations appeared very clearly at the begin of the phase. The oscilations were damped relatively fast, and the phase of strong oscilations represents only 10–15 s of the whole length of the records, which differs from the records made in case of other strong earthquakes.

Bucharest, the capital of Romania in 1920 to 1940 saw the construction of the residential blocks along Magheru Boulevard, the new city centre, north of the historic centre, a rare feature in Europe of having a compact interwar city centre. In 1940 the first strong Vrancea earthquake (M7.2) of the twentieth century affected

Bucharest, posing a new test to the newly constructed mid- and high-rise RC buildings in the city centre. In 1977 a second strong intermediate depth earthquake (M6.7) occured in Vrancea beneath the Carpathian Mountains. The effects of destruction were greatest in Bucharest, attributed mainly to the so-called 'Mexico-City effect', as Bucharest lays along the rivers Dâmbovita and Colentina, on alluvial soil deposits, particularly in the centre.

This part of the experiment was carried out knowing that there are inherent limitations in the application of the method due to the deterministic state in which the development stays for the date. The most important is the deterministic state of the method used, where slight variability in frame characteristics of the building type considered can result in high variability in the estimation. This is important because such variations can occur within the same building. However, this seems not to have affected the overall estimation.

Experiment 2: GIS Statistics

Limits and possibilities for computer-aided priority setting in earthquake preparedness were assessed at the urban area level (decomposition in a coarse grid considering all types of buildings in the area) after performing an analysis at the building level (decomposition in a fine grid selecting buildings of the same typology from the whole city).

In this case instead of a mathematical model, the probability of damage is based on observation from previous earthquakes and vulnerability indices are developed. Such a method requires databases on which basis matrices of damage probabilities are built. They consider a building class, but it was possible in this experiment to take into consideration both RC and masonry, whereas, for the first experiment, we considered only RC although methods for masonry are available as well (Borzi et al. 2008).

Methodology

The possibility of making the choice typologically and not zone-based was taken into account for this experiment. Although a pure regional planning-supported decision works with urban areas as entities, this approach should allow working with groups of buildings of similar types spread in different areas. The experiment itself aimed to investigate if computer support can appropriately take into account such a type of options.

For this experiment only buildings on the site of the N–S Magheru Boulevard in Bucharest, Romania were taken into consideration. The data on buildings for the fine grid were built up of construction-type reports from the World Housing Encyclopedia Internet-Based Database (Brzev and Greene 2004), and the coarse grid was defined by an urban area in Bucharest surveyed in site analysis. With data stored in the Encyclopedia (Brzev and Greene 2004) the Romanian building stock can be described. From the urban plans statistical data on the distribution of this housing type were derived, thus testing if the criteria obtained by the database search in the encyclopedia (Brzev and Greene 2004) constituted complete survey details for the respective construction types.

The very first step was carrying out the site analysis. For this reason several criteria and the classes in which buildings could be categorised according to those criteria were set. An investigation onsite followed this. Although the practice was made by colouring on different urban plans the building polygons according to their category, survey by checklists, where for each building a form comprising all criteria and the classes established by them is completed, is a viable way to approach this (Table 1).

The next step was to compile the housing reports. Although the information needed to complete the forms resulted from an experience that was also useful in the previous step, the chronological succession in performing the works is this one. These reports were subjected to a rigorous peer review procedure before being published. The building types surveyed by the author and her collaborator cover the relevant housing construction types in Bucharest, Romania. Building types considered were: from before 1850; 'wagon' type; single-family unreinforced brick from the turn of the century; multistorey URM from the turn of the century; interbellum buildings; postbellum buildings; international style buildings; and post-modern buildings.

The values in the GIS database were normalised, then multiplied with the weights (Table 2) so a prioritisation for a decision could occur, according to the method of Armas (2012).

The experiment itself was carried out by counting the constructions of the above-established building types in several zones for which site analysis had been previously performed and then assigning the adequate vulnerability class according to the data given in the reports. For the European Macroseismic Scale (EMS) based vulnerability values all three possibilities: minimal, average, and maximal probabilistic damage were considered. Then the average for the zone was computed based on the values for the buildings. Regarding the probable damage types and the retrofit methods coming into question a list for the zone could be compiled based on the statistics on building types.

For the prioritisation we follow the pairwise comparison method first developed by Saaty. The different criteria included in the database are assigned weights, which are then introduced in GIS as has been shown. According to this method when comparing the classification according to a qualitative or quantitative criterion, the one assigned more importance gains priority. Strassert (1996) used the method at territorial scale, but Bostenaru (2006) used it to assess priorities at building scale.

Table 1 Questionnaire used in SFB 461. Classification of structural material by the Author

Construction: □ please check

□ open construction (isolated house) □ closed construction (row, block construction)	□ existent soft storey		
Material of the load bearing structure □ timber □ reinforced concrete □ reinforced concrete prefabricates □ masonry □ other	Construction year: sure date:.............................. □ before 1850 □ 1850 – 1880 □ 1880 – 1920 □ 1920 – 1945 □ 1945 - 1977 □ 1977 - 1990 □ after 1990		
□ Skeleton structure/frame structure with Load bearing structure out of: □ reinforced concrete □ steel □ light construction □ frame construction □ timber □ infill out of: □ masonry □ clay brick □ concrete brick □ light/AAC brick □ .... □ reinforced concrete □ not load bearing infill out of: .... □ cover out of:	□ plate construction (walls and floors out of reinforced concrete prefabricates) □ cell construction		
	□ masonry construction □ not reinforced □ reinforced □ timber/steel frames and columns □ stiffening reinforced concrete – ring beam/columns		
	Floor over	NF*	floor**
	Floors out of		
	□ reinforced concrete		
	□ cast in place		
	□ prefabricated		
	□ beams with infill		
□ Massive construction (= reinforced concrete) □ fagure □ columns in soft storey □ cell type □ columns in soft storey □ tube in tube	□ System floor (joists+bricks)		
	□ timber		
	□ vaults		
	□ over the whole floor		
	□ partially		
□ mixed construction type (mixture of skeleton and massive construction) □ stiff core □ stiff perimetral walls	* majoritary floor type ** possible: UF, GF, roof (RF) or UF Nr.		
	□ other construction type:		

Discussion

As the data in the Encyclopedia are empirically based, no comparison with real field data was necessary in this experiment. This kind of analysis can be performed for any other site, providing completeness of the Encyclopedia for that country and availability of urban site analysis plans. The data on typical damages and suitable

Table 2 Assessment of weights for prioritization in GIS

Data in GIS Database	Weight
Number of apartments (to count how many inhabitants)	5
If collapsed in 1977 earthquake (location factor)	4
Function	3
Material	3
Recesses at upper floors	4
Inclusion in risk class	5
Shape of the roof	2
Presence of soft storey	4
State of maintenance	4
Number of storeys	5
Structure class	3
Year of construction	2

retrofit or strengthening methods for this scope can be expanded over computing repair/retrofit costs. All these qualitative computations can win additional qualitative values if combined with a GIS.

Experiment 3: Macroelements

Also in this experiment the dialogue between the building and the territorial scale is taken into account. Instead of simplified mechanic models, finite element modelling (FEM) leads to modifiers to be considered in the macroelements method of Giovanazzi and Lagomarsino (2004).

Methodology: Finite Element Modeling

Buildings were modeled using the finite element method and subjected to dynamic earthquake load. The results were compared with real damages suffered by buildings in the respective earthquakes. The experiment was designed to assess the level of damage to building elements that can be predicted by using this modeling method.

The first author developed a methodology (Bostenaru 2010) to assess the position and the degree to which reinforced concrete frame elements of a building are predicted to be damaged in an earthquake. For this purpose two simplified models 'Gregor' and 'Özzi' were used (Fig. 4). In 'Gregor' the kind of retrofit is varied, between column jacketing with reinforced concrete and steel as well as reinforced concrete shear walls and bracing. In 'Özzi' only bracing is chosen, and the amount and position of the elements varies.

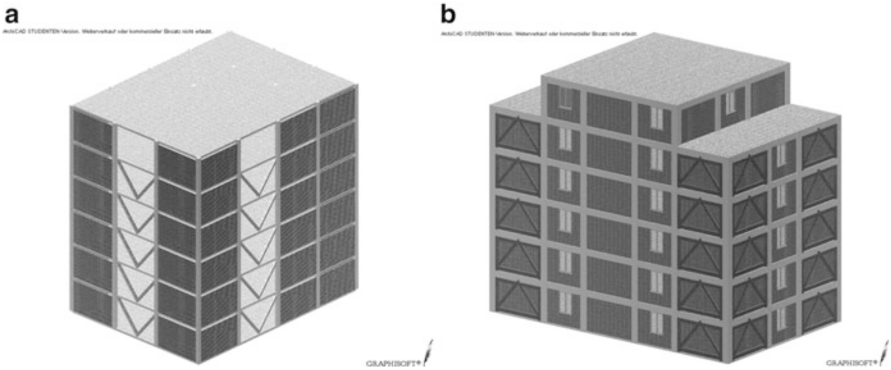


Fig. 4 Models “Gregor” (**a**) and “Özzi” (**b**) employed in simulation.

First the accelerograms to be used in the dynamic analysis were composed. The software used (SeismoStruct) allowed computation of cumulated damage; this means that a strong motion solicitation can be applied on a predamaged structure if in the curve used a plateau is left so the structure stops oscilating. Considered were various accelerograms for the Vrancea earthquakes (1977, 1986, and 1990, respectively) from Ambraseys et al. (2002). Bosi and Pegon (2009) updated these data with contemporary efforts. It had the possibility of allowing us to plot not only the failure mechanism but also the degree of damage in constructive frame elements that could be identified by their location. For this purpose the text log generated during the simulation was used, and converted to a format which could be imported in a database environment. In this experiment MS Access was used. First the categories were identified in MS Excel; then database queries were performed to return from the fine grid used in the simulation to the coarse grid necessary for further evaluation. After counting the damaged elements and marking the most damaged ones on the respective building plans, comparison was made between the simulated damage and the damage reported to have been suffered by buildings in the respective earthquakes.

Results

A general pathology description was offered by Penelis and Kappos (1997). A damage type in the case of columns is given by cyclic bending with low shear force and strong normal force. It finds its expression through failure at the lower and upper ends of columns, in crushing of compressed concrete parts successively on both sides: first spalling of the concrete cover on reinforcement; then the core expands and the concrete crushes, the longitudinal reinforcement bends under compression force, while the stirrups break. It is a very serious, brittle failure type. The column loses its rigidity and the capacity to carry vertical loads. This type of damage actually occurred in Bucharest (Bălan et al. 1982) and is predicted by SeismoStruct. However, there are differences in the position predicted (interior versus exterior columns).

Another column damage type occurs due to cyclic shear and low bending. It finds its expression in X-formed rifts in the least resistant zone of the column. Affected by this damage type are primarily short columns: ground floor columns and those with one-sided masonry infill. This is also a dangereous failure type, through which vertical elements are destroyed and need to be immediately supported. It is only supported by the simulation with SeismoStruct in a newer version than that used in this experiment.

In beams, first vertical rifts on the beam axis along the tension zone are noticed. This failure type presents no danger for structural stability. Another damage type is brittle shear failures near the columns. This also represents no danger for structural stability. Bending rifts appear on the lower or upper side of the beam near columns. Apart from this, shear or bending failure can appear at the supporting points of secondary beams, which is of importance for models of Romanian real buildings with a reinforced concrete (RC) skeleton structure. Also these are not dangerous for building stability.

Damages in beam column joints, slabs, and masonry infill were not computed and although the damage image is available from Penelis and Kappos (1997) it is not presented here. Structural walls are uncommon for the type of buildings considered for this study.

A typological analysis to check how far the considered models represent the Romanian built substance was conducted as well. This analysis served as tool in order to enable making variations in the considered simple structural models and to calibrate the obtained structural results for further interdisciplinary studies. The selection was made according to the number of frames and bays, the spans, and the number of storeys. An archive research was conducted based on a literature survey concerning interwar buildings and buildings classified risk category I, to see the floor plan and the section of buildings and establish the models. The most vulnerable Romanian buildings are 7 to 11 storeys high, but the multifamily residential buildings considered in the analysis show similar features in construction above 4 stories. Regularity in the distribution of columns depends not so much on height, but more on the employed concept in the flat shape. Thus three 4-storey buildings, two 5-storey buildings, two 6-storey buildings, one 7-storey building, and finally three 8-storey buildings were investigated. Irregularity in the distribution of columns in the 4-storey buildings is low, but there are irregularities in the plan, due to the existence of more or less infilled frames. Also the spans are similarly wide, but there are differences in height. One of the 5-storey buildings considered had columns distributed with high irregularity. One of the 6-storey buildings was more deeply investigated, as it proved that variations made to model 'Özzi' brings the latter closer to this one. With height, spans decrease, as in the case of the 7-storey building. Although most of the real buildings considered can generally be seen as belonging to a 5×3 or 4×3 grid, in the case of one of the 8-storey buildings investigated similarities are the strongest. An important difference is that the spans vary in the two rectangular directions. In conclusion it can be said that the models investigated in this experiment were well chosen. Buildings of this size can be found in the building stock in Bucharest (Fig. 5).

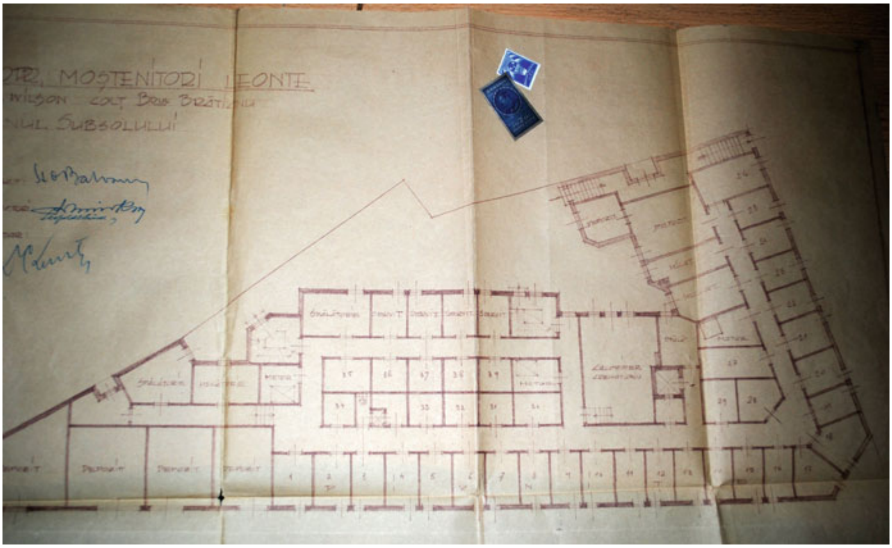


Fig. 5 Archive plan for a vulnerable corner building construction (Bucharest city archives, used by permission)

Discussion

Numerical methods in dynamic structural analysis (FEM) allow for direct use of strong motion data to estimate earthquake loss. Options regarding the location of the same retrofit system as well as actions concretised in different retrofit systems for the same building under earthquake action in Romania (Vrancea 1977) were simulated. Different damage distribution is the result. Damage is only one of the criteria taken into account for retrofit priority setting.

When using strong motion data several assumptions were made, namely:

- Uniform stiffness (simulation of stiffness is important in the case of varying stiffness)
- No slabs were modeled and instead but beams stiff in their plane
- Stirrups are not explicitly modelled but defined by the confinement
- No plastic hinges

Only two accelerograms successively were considered. Several types of building damage (e.g., in slabs and masonry infill) could not be predicted. Some of these were overcome since the experiment was carried out (shear failure can be now computed; through increased number of nodes, slabs can be simulated through equivalent struts), but some are still not (masonry infill, targeting to a certain performance). Even with more nodes, modelling the slabs gives difficulties. Assumptions regarding stiffness led to prediction of most damaged columns in the interior, whereas reportedly the exterior columns were mostly damaged.

This kind of approach is useful for economic studies because the position and the degree to which reinforced concrete frame elements of a building may be damaged in an earthquake are predicted. This way it contributes to the measurement of the fulfilment degree in the case of criteria set by actors belonging to the categories of investor, structural engineer, and user. The investor can calculate the costs of retrofit. The structural engineer can assess the performance. The user can be informed about the spaces that are more likely to suffer use interruption. The results in this first experiment suggest also the possibility to extrapolate the method to urban scale.

Bostenaru (2013) has compared the Romanian and the Italian building stock from the point of view of vulnerability and consequent preservation possibilities in case of hazard. Certain common points between the two typologies resulted from the study: the Romanian interwar one, best represented by the buildings on Magheru Boulevard, and the Italian Rationalist buildings. As Romano (2014) points out, building on this work, structural characteristics of buildings from that time are known insufficiently to allow for reliable structural mechanics models. For this reason the application of macroseismic models is proposed (Lagomarsino 1998), which takes into consideration aspects from both methods: characteristics of the buildings at the level of a structural decomposition into macroelements and aspects of macroseismic intensity. In fact, according to this method, the macroseismic intensity of a past earthquake can be established seeing the level of damage to macroelements. Initially the method of Lagomarsino (1998) was developed for monumental buildings such as churches, however, Romano (2014) applies it for multistorey buildings such as the Italian interwar ones.

The modifiers to reinforced concrete buildings in this method are (Giovanazzi and Lagomarsino 2004):

– Maintenance state
– Number of stories
– Irregularity in the plan
– Irregularity in the height
– Position in the plan—next to another
– Type of foundations
– Localised vulnerability (short columns, bow windows)
– Dishomogeneities
– Partial increase in height (the so-called recesses)

The database considered for the GIS considers a number of these parameters, whereas the irregularity and the topologic position have to be assessed based on the geometry in the GIS drawings.

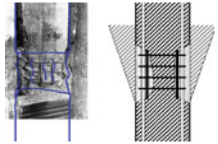
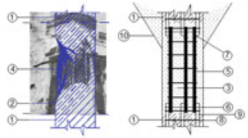
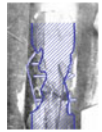
Romano considers a number of study cases:

– Casa del Fascio a Genova Bolzanetto
– School of the Italian Youth of Littorio in Genova
– San Pietro restaurant in Genova

For the first evaluation she performs a finite element model study.

For our simiplified models of the Magheru Boulevard we also performed finite element models studies. As in Romano (2014) we performed statical and dynamical

Table 3 Damage Degrees in Reinforced Concrete Colums

				 1. alter Beton, 2. beschädigter alter Beton, 3. neuer Beton, 4. ausgeknickte Bewehrung, 5. neue Bewehrung, 6. neue Bügel, 7. Schweißdraht, 8. alte Bügel, 9. alte Bewehrung, 10. Schalung	
(Concrete) *crack*	X	X	X	X	X
$?_b > +0{,}1\,‰$					
(Steel) *yield*		X	X	X	X
$?_s > +2{,}5\,‰$					
(Concrete) *spall*			X	X	X
$?_{bu} < -2\,‰$					
(Concrete) *crush*				X	X
$?_{bc} < -6\,‰$					
(Steel) *fracture*					X
$?_s > +60\,‰$					

analysis (Bostenaru 2010). Variations according to the macroelement modifiers (typical characteristics of Rationalist buildings) have been done to the initial complete finite element model of the Casa del Fascio. In the case of the School of Italian Youth the modifiers were according to the extension of the building, and in the case of the restaurant according to the demolition of part of the building.

In our study we also took into consideration modifiers in varying, for example, the grid to fit the variations in the building stock of Bucharest. Further modifiers are the recesses, and irregularity. Most important, however, is that the retrofit elements Bostenaru (2010) defined also are suitable for definitions of macroseismic scale, inasmuch as they display damage degrees (Table 3).

Conclusions

The three experiments show that computers together with decision makers can provide the level of support needed to set priorities for earthquake risk reduction. Even at this level of development of the methodologies shown, the value of such information to decision makers would be considerable if made available in the first phases of retrofit design. But the study has also identified limitations in what can be performed by the computer alone, in terms of using strong motion data as input. In the first experiment the methodology to use strong motion data was simply aided by a spreadsheet environment file, with an analytic base. For the second experimental methodology extensive use of modern technologies was made, namely GIS. Similarly to methods used in finite element modelling to overcome errors at high values, a fine and a coarse grid were integrated. The dialogue between geographic scales is essential in assessing vulnerability, just as it is essential to consider in remote sensing the aerial and the eye-level image.

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Conclusions

Maria Boştenaru Dan and Cerasella Crăciun

Abstract In concluding this book, the author presents the initial thoughts in which context both 2D and 3D representations can be found regarding employment of digital methods for translating past, present, and future art and architecture objects into virtual reality. Approaches to this can be grouped into 3D city models, digital modelling of landscape, digital survey of building and landscape, employment of digital photo and video and their mapping and participative methods of mapping and modelling for decision making. This grouping led to the structure of the book, which is presented here. Authors from leading laboratories in the field in Europe, with whom the author collaborated through exchange visits, common applications, networks, and conference participation were invited either as authors or reviewers. The framework of the cooperation is presented. In detail, a review of Digital Landscape Architecture 2013 is given as an example. Conclusions are drawn on how this networking influenced the research presented in this book which contributed to the overall framework of NeDiMAH research, highlighting thus the way virtual mobility can contribute to research. Future initiatives are also presented.

Keywords Virtual mobility • Digital methods • Networking • Virtual reality labs

Introduction

Because of the development of IT methods in the twenty-first century, digital methods became unavoidable in every field. The humanities had a pioneering role in applying methods which were not developed in the own discipline in its frame,

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introducing the so-called 'digital humanities'. Methods to explore the text are intensively applied, and the ESF research networking programme NeDiMAH explores these methods also in the framework of the arts. In the case of the arts, a unique place in the world is Zentrum für Kunst- und Medientechnologie (Centre for the Arts and Media Technology) in Karlsruhe, Germany, which, apart from applying multimedia on the Internet or on CD/DVD made the step to installations. This level, of the multimedia installation, with application to the architecture object and the public space, was introduced innovatively by Iannis Xenakis, the composer and architect born in Brăila, Romania, and can be refound in multimedia façades which went from the exhibition pavilion to common architecture. The book explores an example of rebuilding lost architecture by virtual reality, as is the project of rebuilding the Philips Pavilion by Xenakis. Another chapter explores creating such multimedia façades at more or less common buildings. In Germany an early example was given by the EXPO Cube in Saarland by Kramm and Strigl, who then created a multimedia façade at the shopping centre at Ettlinger gate in Karlsruhe. But even earlier was the employment of multimedia in making dancing fountains with light and music, where, long before the one at the EXPO in Barcelona, the one at the Mostra d'Oltremare in Naples, the Fontana del Esedra, featured the same.

The topic proposed for this book goes, however, from this aspect of design to the research which puts the basis of design, namely the research of the existing landscape, architectural, and art heritage. If the existing heritage can be emphasised by applying the multimedia technique, it is at the same time a basis for all later design decisions and has to be investigated as such. In this context, of researching the existent built substance, the history of architecture and urban planning makes use of methods which can be seen as a branch of digital humanities: digital art history. We invited both theoreticians from this category as well as practicioners of architectural, urban, and landscape research to debate the aspects.

The book proposed to debate the issues of employing digital methods in the arts, with emphasis on architecture and urban planning. Initial reviews in the framework of the NeDiMAH network included connected artistic fields such as textile art and mural painting, following the main obstacles in approaching the methods, the potential application domains, and the possibilities for interdisciplinary cooperation.

The problem approach started at the urban level. At this level, prior to NeDiMAH, the university was represented by the first editor in the COST network TU0801 'Semantic enrichment of 3D city models for sustainable urban development'. The mentor of the current postdoctoral project in the same field was the other management committee member in that network. In the framework of the network activity it became clear that 3D city models are less widespread in Eastern Europe. The international cooperation aimed to make this issue known to a large public. The virtual reality example in this book is an example of creating an historical 3D city model, historical 3D city models being represented in the network as well, through Liege and Nantes.

The next step was the transition to the architecture object, through the cultural landscape. An excellent field of application for digital methods is the building survey, the basis for any future intervention on heritage buildings and the urban assemblies in which these can be found. Currently rapidly developing is laser scanning to obtain geometry or colour, respectively, for mural painting or for the volumes of urban assemblies. 2014 in the call REFLECTIVE 7, in the framework of the Horizon2020 programme, the European Commission called for proposals for 'Advanced 3D modelling for accessing and understanding European cultural assets'. It is a primary application field for 3D scanning, and as a secondary output virtual reality can be considered. The digital building survey can, however, also be seen differently, considering the historical records which became available over the years. The architectural heritage object is described by photographs and drawings, drawings of the plan, section, façade, and sometimes perspective views and constructive details. Generations of students and researchers made building surveys of historical buildings, and for some more recent buildings the building permit documents are available in the shape of drawings in the archives. Making these archives accessible is a complementary way of making available the historic journals in which these plans were first published, an endeavour presented in the framework of the NeDiMAH network with Andreea Popa. The History and Theory of Architecture and Heritage Conservation Department at the "Ion Mincu" University of Architecture and Urbanism had several projects to make such archives available. One of them was the Tzigara-Samurcaș archive (http://tzigara-samurcas.uauim.ro/en/) on which the author also worked for digitalisation. This project is listed in the map of projects (http://nedimah.eu/content/map), one of the outcomes of the NeDiMAH RNP. It includes more than 100-year-old photographs spread over Europe, a geographic view to the beginnings of art history. More recent endeavours of the History and Theory of Architecture and Heritage Conservation Department include the digitisation of building surveys (http://relevee.uauim.ro/), from which a first volume was published and presented at the Architecture Annual event in Bucharest in 2015. The building survey is a research method in urban and architectural history as it was stated in the Collaborative Research Centre 315 'Preservation of historically significant buildings' at the University of Karlsruhe, Germany, about 20 years ago, when the author collaborated on a building survey with conventional methods for a textile factory in Myslakowice, Poland (Häffner 2005). Apart from technical methods on how to set the points of measure, these traditional building surveys were drawn in Germany by hand, to allow for representing the irregularities in historical walls. Methods to translate this to digital representation are still looked for. In a current project, the way architects of the past saw the building survey as research methods are looked at, namely the building surveys of Richard Bordenache, in Romania and Italy. The book presents a contribution by Augustin Ioan, with a view to archives. Ioan participated in several projects on modelling historic buildings in a virtual environment, either by 3D scanning (reSITUS http://resitus.inoe.ro/ or SALVart) or alternative methods, in reSITUS and other projects, using photography in a different way. SALVart was a project funded by EEA grants and mentioned in the discussion of the Structure from Motion approach in the chapter of Bourlotos and Bostenaru. Contemporary or historical photography can be used with the method called Structure from Motion, and dedicated software exists, such as PhotoModeller. The software was also employed in Karlsruhe, in the framework of the Collaborative Research Centre 461 'Strong Earthquakes' for reconstructing buildings collapsed in disasters (Schweier et al. 2004). These ruins are not the ruins of antiquity usually reconstructed in virtual reality, but the approach is welcome for the context of this book where we also consider the digital representation of disasters. The contribution by Bourlotos and Bostenaru, an approach developed in a related framework to the CRC 461, presents an alternative code for CAD to do Structure for Motion, using the principles which are also used for hand measurements for German building surveys such as the one in Myslakowice. As in the case of the first topic to reflect on, that of 3D city models, the role of the building survey in architecture and urban planning research is as important as its transposition in digital methods. It permits going over the stylistic investigation of the façade, to the interior of the building, and building interiors are as important in preservation and restoration. They are important when the function changes, or when postdisaster reconstruction or predisaster retrofit imposes changes in the layout of spaces and walls. The plan, as recorded, can help architectural and structural investigation, as also in the later chapter by Bostenaru (2016).

The photograph, also used in the building survey, is an instrument in itself in architecture and urban planning research (Eftenie 2010). This is a third topic to deal with. Digital photography and video are such an instrument, and the digital landscape architecture approaches are relevant for this. This chapter details such approaches as seen at the DLA conference, but the chair of Professor Girot in Zürich is also doing seminal work in the field, as presented by the contribution of Fricker. Film and image archives were a digital component in cultural projects funded by the Romanian Ministry of Culture, such as the one on textile art presented by Tincuța Heinzel at the NeDiMAH workshop in Bucharest. Irina Pața, a participant in the NeDiMAH workshop in Hamburg, did her doctorate on digital landscape video at the "Ion Mincu" University of Architecture and Urbanism. She developed a method to analyse the composition of landscape in dynamic records such as video, and built a database of such analysed compositions. In a future Springer book the author will do a similar analysis and database for historic photographs from the nineteenth century of catastrophes, thus also linked to the dedicated section of the book, but also to the Tzigara-Samurcaș project mentioned. In a former book of the editors (Craciun and Bostenaru 2014) Stephanie Brandt contributed a paper on living landscapes, a way to see the participative dimension about which we speak.

All these digital models, at urban and at architectural object scale, are researched with the scope of elaborating projects, of intervention and conservation. Another topic to reflect on is the democratisation of this design and planning process through participation. The mentioned COST action (TU0801) also investigated the applicability of 3D city models in decision systems (participatively or not). In the ESF RNP this was continued. We started doing research in the COST action and continued in NeDiMAH. The participative potential of digital platforms – for example, in games – is recognised (Poplin 2014: Bostenaru and Panagopoulos

2014). Also in recent years in Eastern European countries participative methods spread and tend to develop from protest actions to constructive ones, enabled by specific funds for NGOs, such as the EEA funds (see, e.g., the work of the Association for Urban Transition http://www.atu.org.ro/).

The city in the age of information, as Cristina Enache presented at the NeDiMAH workshop in Bucharest, is a mix of physical and virtual networks. From the historical network research presented by Sun one can go over to the contemporary city if participation was to be analysed.

As we mentioned, digital methods in the humanities are a recognised field. In these as well as in media art there are degree studies in Western European countries. Digital methods in architecture and urban planning are not so well recognised, and are seen more as a complementary instrument. The role of the book is to make known to those involved in media art and in digital humanities the role of these methods in architecture and urban planning research, including research by design, and on the other hand, to the architects and urban planners the potential of these methods as research instruments.

Making this book also aimed to involve specialists other than those directly involved in the NeDiMAH networks, also from other countries. We hope for smaller-scale cooperation in future.

Structure of the Book

The book consists of 17 chapters, including the Introduction and Conclusion. The substance articles are grouped in six sections: digital landscape, digital art history, digital art, virtual reality, virtual recording, and virtual representation of hazards. Thus, the first three sections deal with digital methods applied to different fields of arts and humanities (landscape design, art and architecture history), and the last two sections are dedicated to methods of collection and, respectively, representation of data.

The first section on digital landscape consists of three chapters. The first two deal with digital map material, in Bucharest and, respectively, in Romania. They both investigate the way one can visualise on the maps of today landscape complexes from yesterday, building thus also a history and a geography of landscape at the same time. The third contribution is looking to design of landscape today, with digital methods.

The second section is dedicated to digital architecture history. It introduces the issue of memory, as built heritage is a way of expressing cultural memory. This section also includes three chapters. The first chapter deals with historical network research applied to architecture history. The other two chapters are essayistic approaches to the topic of archiving and memory, two related ones if we think of Nietzsche's critical thinking of history.

Thus, if the first section was looking to digital methods applied to a field of geography, a social science, the second section is looking to digital methods applied to a field of history, in humanities. The third section is looking to digital methods applied to the arts, and thus covering the NeDiMAH fields of arts and humanities.

The third section contains two chapters. One of them looks at artistic enhancements of built objects of architecture, and the other is the review of the outcomes of a project on digital art. The digital art reviewed there is unique maybe in the whole world, but, due to rapid technological development in the field, art work may become no longer accessible in a short time, for which digital conservation is necessary. This way art will be further enjoyed by the publicum and not remain history like some of the lost landscapes in the first section. For built heritage items virtual reality may be a way to assure them a revival as digital art, transforming the real into virtual, but also these virtual items have to be conserved, especially if designed interactively between the real and the virtual world as some of them are.

Therefore the next section dealt with how lost items of landscape or architecture, which can be found only in cartographic material as in the first section or in archives as in the second, building the basis for research of lost social connections, can be visualised in virtual reality. The fourth section contains two chapters exemplifying approaches on the topic. The first one is an example of creating virtual reality of lost architectural and urban scenes. Virtual reality representation of historical architecture pieces is spread nowadays, encompassing different approaches, such as superimposing now and then states of ruins of antiquity, rebuilding temporary architecture such as the Philips Pavilion at the EXPO Brussels, visualising lost stages of the developing architecture of palaces as in the example of Ştirbei Palace in Bucharest, to name also a Romanian example reviewed in the framework of NeDiMAH. Special about the one chosen here is that the destruction happened through a natural disaster, linking thus to the sixth section, suddenly. Special also is the use of Second Life software, which allows social relationships visualisation as reviewed in Section 2, first chapter. The second chapter is connected to reviewed digital art: it is a detailed view of the technical approach to build a virtual presence of this kind, in a semi-physical space, not only on the screen.

Not only landmarks of yesterday, but also those of today have to be recorded. Even if we do not consider the unhappy event of a disaster, as in Section 6, this way they are made accessible without supralicitation in the case of cultural tourism. For this reason Section 5 deals with virtual recording. It comprises three papers, out of which two deal with GIS methods, applied to a prevention of hazards in one case, and to landscape investigation in the other case. The third paper is dedicated to the architecture side of the book, namely to buildings. This latter one is also useful for investigations as proposed in the sixth section, because the building survey, apart from the material in archives, is an important ingredient of the integrated planning chain towards structural investigation for preventive retrofit.

Section 6, as already introduced, deals with digital representation of hazards. One of them is about GIS methods in a huge impact on landscape of these hazards, and the other deals with GIS and alternative methods in assessing heritage building vulnerability in a protected urban zone. Brînduşa Savin, one of the authors of the first contribution, is a former participant in the COST action training school on 3D methods for disaster management and contributed there to the creation of the ontology on floods, whereas Maria Bostenaru contributed at the same place to that on earthquakes.

Digital Landscape Architecture Conference 2013

6–8 June 2013 another edition of the Digital Landscape Architecture Conference (http://www.kolleg.loel.hs-anhalt.de/landschaftsinformatik/dla-conference.html), chaired by Professor Erich Buhmann took place in Bernburg, Germany. The theme of the conference was 'Collaboration and Transdisciplinary Planning and Design'. Experts from 33 nations attended the conference. The conference featured plenary talks, a poster competition (Fig. 1), but most importantly workshops. The first keynote lecture was given by Professor Dr. Carl Steinitz, Harvard University, United States, on the topic of his acclaimed and widely translated book. This was followed by parallel sessions in English and, respectively, German. The German whole day forum 'Neue Technologien und Anwendungen in der Landschaftsarchitektur und Umweltplanung' (New Technologies and Use in Landscape Architecture and Environmental Planning) was aimed at members of town administration. In English attendees could listen to 'Environmental Information in Planning and Design' in the morning. Other keynotes were given by Professor Dr. James Palmer, FASLA, Vermont, United States, by Professors Dr. Josef Strobl, University Salzburg, Austria and Dr. Jörg Rekittke, National University of Singapore. Parallel sessions on the second day were on 'Modeling and Visualization of 3D Landscape' and 'Teaching Geodesign and GeoDesign Applications'.

The following workshops were offered throughout the 3 days:

– On the first day: '3D Visualization of Plants', 'Standardization for GeoDesign', 'QuoVadis Landschaftsarchitektur? –Schöne neue Welt der Dienste und Services in der Landschaftsarchitektur und Umweltplanung' (in German: 'QuoVadis landscape architecture? Beautiful new world of the services in landscape architecture and environmental planning').

  On the first day we attended the workshop on 'Standardisation for GeoDesign' given by Thomas Kolbe from the University of Munich and which built on work developed within the COST network 'Semantic enrichment of 3D city models for sustainable urban development'.
– On the second day: 'Geo Design Curriculum Development and Design', 'Patch-Scape; pads, pods, phones and Spatial data'

  We attended the 'patch-scape' workshop and we learned about comob.org.uk, a software to trace the movements in the landscape where we were sent to investigate the landscape with i-Phones, taking photos and writing short sentences Fig. 2 shows the final result.
– On the third day '3D Geo-Designed Mapping: DataScaping' held by Nadia Amoros from the University of Toronto and her partner. We were acquainted with the software DataAppeal, also represented at a stand, which allows the

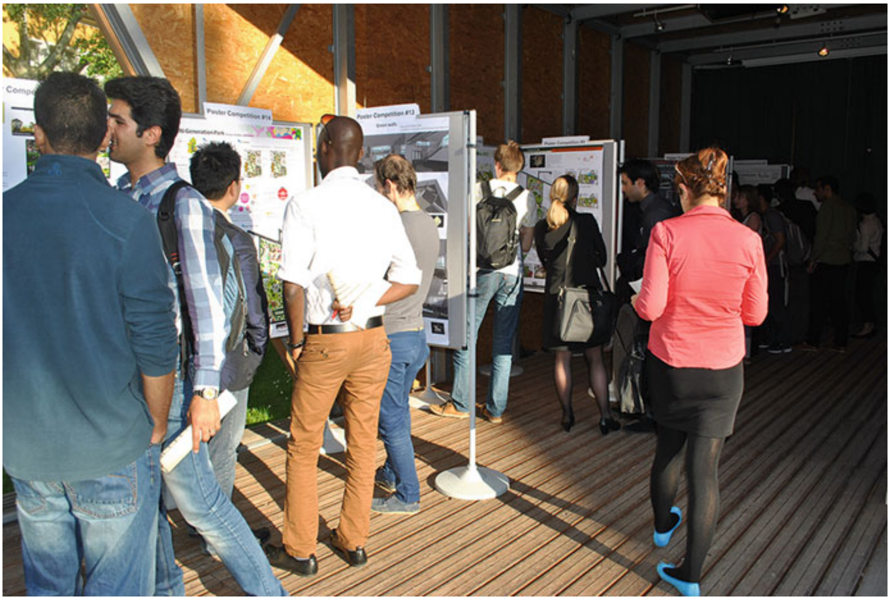

Fig. 1 Poster exhibition at Digital Landscape Architecture Conference (Photo: M. Bostenaru 2013)

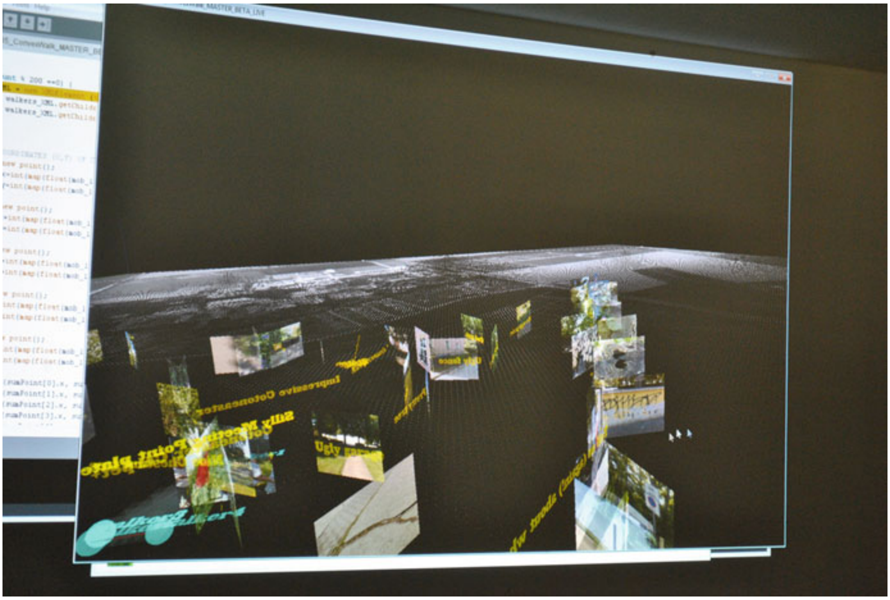

Fig. 2 Use of pads and pods to document the landscape visually – workshop at the Digital Landscape Architecture Conference (Photo: M. Bostenaru 2013)

Fig. 3 Field trip in Bernburg – facilities of the landscape architecture masters (Photo: M. Bostenaru 2013)

representation of own datascape in the manner introduced by MVRDV in the seminal book *Metacity/Datatown*.

The third day featured a plenary session on ‘Digital Communication in Landscape Architecture’. A poster competition on the topic ‘My 3D landscape’ was organised for students and recent graduates. Figure 1 shows the exhibition. The award ceremony was held on the last day and the prizes based on voting. The organisers supported the accommodation of the competition participants.

Despite the biggest flood in 100 years which hit the Saale crossing the city and the Elbe in which it flows, the conference also enjoyed a rich social programme (singing together, official dinner, excursions). The flood in the city was an occasion to see successful catastrophe prevention (Fig. 4).

Throughout the conference there were stands of vendors presenting different software useful in the field. For example, we got acquainted with the ESRI software CityEngine, but also with initiatives to promote green walls in Argentina.

At the closure the next conference, which will take place, as it will be every two years, in Zürich, Switzerland, was introduced by Pia Fricker and Ulrike Wissen.

At the end of the conference an excursion was organised (Fig. 3). Instead of Wörlitz, the park in Dessau of Georgium was seen, which follows a romantic layout with perspective lines that are not followed by the paths (Fig. 5), accompanied by the landmarks of Bauhaus Dessau.

Despite the very crowded and tiring programme, this proved very useful for learning new techniques to be employed in further research through the hands-on

Fig. 4 The 2013 flood prevention in Bernburg (Photo: M. Bostenaru 2013)

Fig. 5 Views in the Georgium park in Dessau – excursion of the DLA 2013 Conference (Photo: M. Bostenaru 2013)

workshops and through the talks with the vendors, constituting a set-up recommended for other conferences as well.

The conference proceedings have been published in a volume available in bookstores.

Further Development

Participation in the Digital Landscape Architecture Conference made it possible to become aquinted with several methods used in NeDiMAH research. These included the Data Appeal software by Nadia Amoroso (Amoroso et al. 2013), which can be employed to generate datascapes such as MVRDV, used to visualise the semantic enrichment of GIS data for the Magheru Boulevard in 3D instead of 2D. This was a late response to the COST action 'Semantic enrichment of 3D city models for sustainable urban development' being formulated, continuing the research line. The results were included in the research of the short visit to the Karlsruhe Institute of Technology and also in the later publication from the COST short-term scientific mission (Bostenaru and Panagopoulos 2014) as one of the reviewed enriched city model types, a superimposition of GIS and Google Earth. Another useful method regarded the COMOB mapping of photos, which can be employed afterwards for mapping existing photos, such as the ones in the book on digital architecture history launched at the end of the NeDiMAH network (Bostenaru et al. 2015) through addition of GPS data. The way this integration can happen was explained in an earlier Springer volume in a paper resulting from the short visit (Bostenaru and Dill 2014).

From 'Semantic Enrichment of 3D City Models for Sustainable Urban Development' we learned about reconstruction of models of historical cities (Nantes, Liege), mapping of air quality in 3D (pollution, temperature, wind), disaster management in 3D, and mapping of mobility – pedestrian movement (Billen et al. 2014).

Virtual reality applications as reviewed in this book range from mapping and visualisation of the past (such as pre-earthquake Lisbon, e.g.), and current and future reality (scenarios).

Efforts in the field of digital art and architecture history are also being made elsewhere in the world, for example, through a continuous funding from Getty at the University of California in Los Angeles under the title 'Beyond the Digitized Slide Library' (http://www.humanities.ucla.edu/getty/index.php/the-digital-art-historians-toolkit/). The author will convene a session outside the frame of NeDiMAH but born of the cooperation already started under COST TU0801 and continued with this book at the 13th International Conference on Urban History in Helsinki, 2016, under the title 'Digital Cities: A New Paradigm for Urban Historical Research'. To make its way into teaching, seminars at the Karlsruhe Institute of Technology were proposed on the topic. These will follow the approaches to map through photos or in 3D past reality, another digital architecture and urbanscape history. In the same line are the mapping of lost landscapes approached in two of the papers. Connecting GIS and historical maps would be a further step. It would allow in a future development to investigate why green space decreased today in cities such as Bucharest, and allow for planning and designing future green spaces to contribute to fighting pollution and as a result to human well-being. In this sense a pedagogic project was elaborated (Bostenaru et al. 2015, not published). This would cope with environmental questions, an important issue today, and serve the low carbon society. Results from 'Semantic Enrichment of 3D City Models for Sustainable Development' regarding the mapping of air quality can also be employed in this context, making the step from GIS to 3D. The author also acted as reviewer, along with other participants to the COST action, of the conference series 'Geographical analysis, urban modeling, spatial statistics conference series' organised by Beniamino Murgante, another author in this book, over several years. As such, this connection was also reinforced.

GIS is, however, because of Habitat II, seen as a promising tool for the scenarios introduced by Kahn (1962) as a means for strategic planning. The connection between GIS and strategic planning still needs investigation, and is the current postdoc topic of the author (Bostenaru and Armas 2015). Scenarios are useful for decision making. In this sense participatory games can support such decision making, and the serious game industry is a promising line of the future. Contacts were established with Alenka Poplin, funder of GeoGames Hamburg, through an ERASMUS with the HafenCity University of Hamburg, in the field of urban planning. The digital art related to this from Karlsruhe was reviewed in this book and discussions held during the short visit to Karlsruhe. These will continue in future. Some of them led to other visit applications which could not be performed. In the framework of the COST action contact was established with another serious games application author, Luca Caneparo from SimTorino, a translation of future scenarios for the Italian city of Turin using the tools of SimCity, just as the contribution of Murteira et al. in this book uses those of Second Life.

During the NeDiMAH time Irina Pață, participant at the NeDiMAH workshop in Hamburg, concluded her doctorate on digital video (Pață 2014). This is accompanied in Romania with some initiatives which can be related to those in Karlsruhe, such as promoting architecture film (e.g., through the association UrbanEye and its events).

Ramzi Hassan, the leader of the Virtual Reality Lab at the Norwegian University of Life Sciences, Faculty of Landscape Architecture and Spatial Planning acted as reviewer for this book. Collaboration started during the COST action, as it started with close collaborator Thomas Panagopoulos from University of Algarve, Portugal, who also acted as reviewer. Pia Fricker, one of the authors, works at the Landscape Visualization and Modeling Lab, ETH Zürich, Institute of Landscape Architecture, Chair Professor Christophe Girot and Planning of Landscape and Urban Systems (Professor Adrienne Grêt-Regamey). The two mentioned laboratories can serve as a model of virtual realities laboratories in the field of landscape. In the field of urban planning, the Karlsruhe Institute of Technology, Germany we visited has a Planning network geo-innovation, cooperating with the Centre for Art and Media for which we reviewed the digital art conservation. Innovation is investigated mainly in the field of GIS.

Approaches using GIS are related, apart from the digital art of the Centre for Art and Media reviewed in this book (Bostenaru and Dill 2016), also to virtual reality simulations such as GISon3Dmap by Carlos Coucelo in Portugal (http://www.gison3dmap.com/), an urban planning and especially landscape extrapolation of the Cave Automatic Virtual Environment. Instead of a person as centre of the interactive environment, a multimedia screen enables even dynamic changes in the projection. The contribution of Munoz et al. (2016) described such a virtual application from the Centre of Art and Media in Karlsruhe in detail, and also the employment of Structure For Motion related to the chapter by Bourlotos and Bostenaru (2016). The 3D map is a model which can be made conventionally or 3D printed to be in agreement with the digital data projected on it.

To GIS a number of add-ons may be employed in computer systems in urban planning analysis, such as Axwoman for Space Syntax analysis of street morphology, or Repast Symphony for agent-based modelling. This completes the overview of the chapter by Petrisor (2016) in this volume. Fractal computer simulation is another means of investigating street pattern morphology evolution.

Oana Marinache, art historian, another reviewer, is the author of a virtual reality reconstruction project of the Stirbey Palace complex (http://www.ideiurbane.ro/resedintele-stirbey-de-pe-calea-victoriei/). Both approaches, by Marinache and Murteira, deal with palaces, and as such connect to another ESF RNP, PALATIUM. However, the approach by Marinache deals with a building complex, and that by Murteira with selected areas in a city, as envisaged for a session in Helsinki on urban history. More progress is needed regarding the connection between scales, from urban/landscape scale to building scale beyond GML, using GIS systems. This was the topic of the postdoc project (Bostenaru and Armas 2015). This book presents approaches from both of them, and connections were established to laboratories performing both.

Some of the solutions at the organisations included contact being established in the framework of the network which led to spin-off solutions, to companies such as the one of Nadia Amoroso or Alenka Poplin. This way this line of arts and humanities is also economically efficient, can be supported by entrepreneurship, and assures working places outside academia, in industry, to graduates. For example, the University of Art and Design in Karlsruhe has a dedicated person for the economic dimension of research and education in this digital art field.

GeoGames of Alenka Poplin as well as GISon3Dmap of Carlos Coucelo are successul start-ups for digital applications. Also the contribution of Munoz et al. (2016) to augmented reality has been featured by the Karlsruhe Institute of Technology as a potential success story of entrepreneurship (KIT to business newsletter 2014) and presented to the alumni during the NeDiMAH short visit of the first author to KIT. Later on, the installation has been presented in the infosphäre exhibition of the Centre of Art and Media (ZKM) with the artistic part by Mark Lee (Fig. 6), and it is discussed if the become part of the permanent exhibition. It won an award in the competition "Germany land of ideas" in 2015 (https://www.land-der-

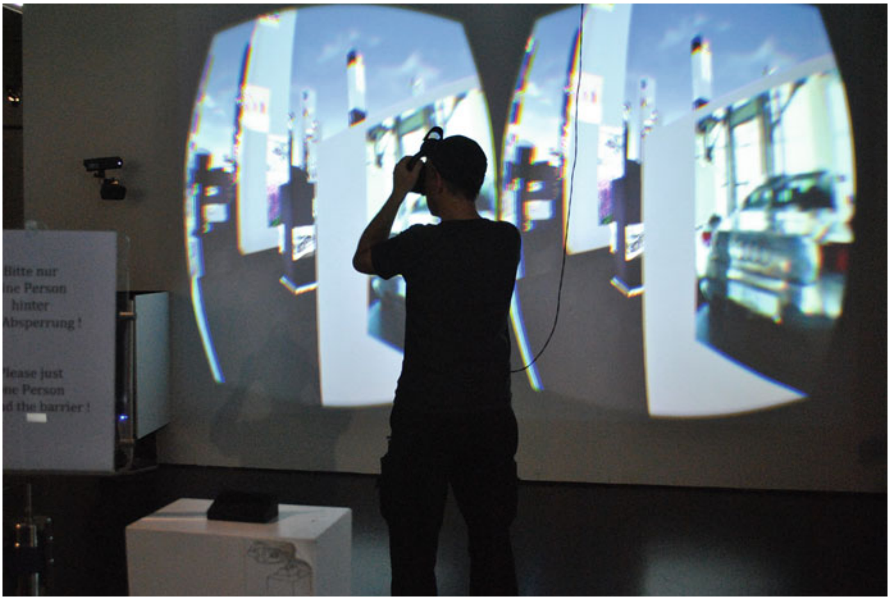

Fig. 6 10 000 moving cities – same but different, by artist Marc Lee, using the e-installation, in the infosphäre exhibition at the ZKM (Centre for Art and Media) Karlsruhe (Photo: M. Bostenaru 2015)

ideen.de/ausgezeichnete-orte/preistraeger/e-installation-virtueller-erlebnisraum-f-r-medienkunst). These augmented reality preoccupations build on what Schweier et al. (2004) proposed for disaster management applications about 10 years earlier. In Summer 2015 the Karlsruhe Institute of Technology hosted an EIT (European Institute of Technology) seminar regarding entrepreneurship in the digital world (https://www.eitdigital.eu/entrepreneurial-education/summer-schools/smart-energy-systems-entrepreneurship-summer-school/), within the offers of the entrepreneurship training at this institution. The EIT is an initiative of the European Commission to promote exchange between universities and industry and to raise the applicability of research results, with headquarters in Budapest, Hungary. During the participation at the eurodoc Conference 2014 also the first author learned the initiatives of the EIT.

Discussions were conducted by the NeDiMAH steering committee member, the author, with the Romanian responsible about a possible adherence to DARIAH (Digital Research Infrastructure for Arts and Humanities https://www.dariah.eu/). The argument for nonadherence was the existence of more beneficiaries than providers of infrastructure. Comments in this sense were made on the platform 'Digital Agenda for Europe' (http://ec.europa.eu/digital-agenda/en/country/romania) as well as as a review of the Romanian strategy on behalf of the Romanian League of Students Abroad in 2014. In Romania, digital approaches of the kind presented in this book are followed at the moment sporadically and a national strategy is needed, for example, to make available all digitising initiatives. The Ministry of Culture had some approaches in requiring such steps.

The author also signed up as a member of the European Centre for Women and Technology, which promotes the involvement of women in the ICT sector. Discussions over the Women International Research Engineering Summit (WIRES) network were held in this context in 2014.

A workshop in the framework of the EuroScience Open Forum 2014 in Copenhagen, co-organised by the author and Maria Manuela Nogueira from the European Science Foundation, funder of this network, has drawn conclusions about virtual mobility (O'Caroll et al. 2014). As a pendant to geographical mobility which led to the NeDiMAH book the launch of which was presented in the introduction, virtual mobility is an educational approach, that in addition complements intersectorial mobility from the spin-off possibility also approached here. Virtual reality is a research tool which, however, can also be used in education, for example, for training of scenarios. This book shows how a virtual mobility approach can support researching virtual reality, and as such contributes apart from mapping current approaches in Europe also to draw future directions on how this research can be performed.

This book was presented at the workshop on 'Advances in Remote Sensing for Cultural Heritage: From Site Detection, to Documentation and Risk Monitoring' in Frascati (Rome) in November 2015. This way the contribution to risk investigation included in the book will be taken care of, as well as bridging the gap between survey formats, for geodesy, including GIS for geographers, and CAD formats for the art historians, civil engineers and architects, as mentioned in the chapter by Bourlotos and Bostenaru (2016).

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