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Landscape Analysis and Planning

Geographical Perspectives

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Foreword

The concept of landscape has been present in natural sciences since the times of Humboldt and Dokuchaev. The popularity of geographical research over holistically perceived landscape has originated only during the early twentieth century, especially in the second half, since the relationship of the growing demand for comprehensive studies on rationalizing the natural resources management has resulted in the significant development of tools, techniques and methodological solutions. Advance of remote sensing technologies and growing popularity of geographic information systems techniques, accompanied with computer-assisted research process resulting in higher precision and clarity of results, collecting and processing of large data volumes, as well as overcoming a number of formerly existing barriers, such as barriers between studies in various scales, were of significant meaning.

The applicable character of the contemporary landscape research is the dominant feature, although it is worth to mention that as early as the 1930s, Carl Troll, the author of landscape ecology definition, underlined the importance of practical application of landscape studies especially for spatial planning, and promoted the use of aerial photographs in analysing the network of interrelated landscape components.

The landscape, according to the definition presented in the European Landscape Convention (http://www.coe.int/EuropeanLandscapeConvention), is understood today as an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors. The landscape understood in such a way is analysed in its structural, dynamic and visual aspects. As determined on the website of International Association for Landscape Ecology (http://www.landscape-ecology.org), the research is focused mainly on:

- the spatial pattern or structure of landscapes, ranging from wilderness to cities,
- the relationship between pattern and process in landscapes,
- the relationship of human activity to landscape pattern, process and change,
- the effect of scale and disturbance on the landscape.

The landscape analysing and planning process is closely related to the concept of the landscape potential and productivity as well as ecosystem services concept being its extension. Its governing objective involves the sustainability of the development of the geographical environment treated as a system and ensuring an appropriate quality of human life in the landscape.

This book presents recent advances in this field based on selected landscape studies conducted in the various scientific centers in ten countries. It has been divided into two sections, the first section is devoted to the landscape analysis, and the second to landscape planning. Presented are both methodology-related considerations as well as case studies.

The works published in the book were presented and discussed during scientific sessions organized by the Commission of Landscape Analysis and Landscape Planning of the International Geographical Union (IGU) in the course of the Regional IGU Conference in Kraków, Poland, during 18–22 August 2014.

We hope that this book will contribute to further increase of interest in landscape-oriented studies and will prove to be an inspiration for the development of new methodological solutions.

Andrzej Richling

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Part I
Landscape Analysis

Chapter 1
Cultural Landscape Functions

Viacheslav Andreychouk

Abstract The utilization and transformation of the landscape by humans is aimed at providing them with suitable conditions of living and development. What enables the accomplishment of particular human objectives is relevant functions of the cultural landscape. The following ten functions have been distinguished and described: spatial (consists in providing man with living and economic space), ecological (involves providing man as a living organism with the necessary physiological substances, that is, the environment suitable for living), nature protection (is to provide suitable ecological conditions for other living organisms), material supply (provides man with goods necessary for life and activity), energy supply (consists in equipping man with energy, necessary for the activity of processing), communicational (enables man to communicate, move in space, transport materials, energy and information), educational (enables human development, broadens their knowledge of man, society and living environment), recreational (provides human opportunities, improving health and mental state), sacred (meets the needs of a higher order, that is, spiritual) and aesthetical (provides human experience and aesthetic experience, necessary for spiritual and moral development and well-being). The optimization of the spectrum of functions of each landscape should be based on the principles of compatibility of the functions, their complementarity and the principle of necessity or priority of the function. The significance of the functional approach to the cultural landscape is justified, as it allows the application of the principles and methods of the system approach to the research into the landscape, which facilitates the management of the landscape.

Keywords Cultural landscape · Landscape management · Landscape functions

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Introduction

The study of cultural landscapes is becoming increasingly multifaceted and multidimensional. In Poland, for example, a clearly defined trend of research strictly into the cultural landscape was developed and has been carried out for several years by experts associated with the Commission of the Cultural Landscape of the Polish Geographical Society. Several volumes of the Commission's work have been published with hundreds of articles discussing various aspects of the cultural landscape. In recent years, also a monograph on the subject has been published (Plit 2011; Myga-Piątek 2012).

The cultural landscape[1] is primarily managed and shaped by man, while the laws of nature have a minor significance in its formation. The utilization and transformation of the landscape is subordinated to man's certain goals of providing them with conditions conducive to life and growth. Achieving particular goals is facilitated by relevant functions of the cultural landscape, which are 'forced' onto it by man. These functions and the promotion of the functional analysis of the cultural landscape are the subjects of deliberations in this article.

What is a Cultural Landscape?

A cultural landscape in the most general sense is a specified area of a certain physiognomic distinction on the surface of the Earth, where man dwells and performs economic activity. In relation to man, the landscape constitutes his environment, whose organic part, however, is constituted by man, and which is transformed by man for his own existence and development.

This determination of the cultural landscape is the result of discrepancies in the approach of different authors to determining its size (scale), boundaries (from topological dimension to regional scale) and its substance (see Plit 2011). According to the author, in the case of the cultural landscape, these questions cease to be as significant as in the case of natural landscapes. The boundaries of the cultural landscape are determined to a large extent by the function or functional spectrum of purposeful human activities in the landscape, as it is the function (activity) that

[1] The author considers a cultural landscape as a synonym for the concept of an anthropogenic landscape. The range of the capacity of these two concepts is the same. The term of anthropogenic landscape emphasizes the fact that it is man who has contributed to its creation and development, whereas a cultural landscape refers more to the way man is shaping the landscape. Any human activity in the landscape, even of primitive man in the natural landscape, represents a specific 'culture', understood as the entirety of the methods of human action (influence) in the landscape resulting from the stage of their civilizational development and local environmental conditions. Therefore, the attempts to separate these concepts or make them subordinate seem unjustified, and in any case unproductive.

shapes the landscape. In this way, adjacent natural landscapes, different (before having been influenced by man) in the nature of the geological substrate or vegetation, can merge into a single cultural landscape (e.g. agricultural) and vice versa: construction of production plants or localized exploitation of mineral resources may contribute to 'carving up' the natural landscape of one single type into several cultural landscapes. This does not mean that we should not trace common boundaries of natural landscapes (strictly speaking, of a natural part of the landscape) and cultural landscapes. More importantly, we should strive to match anthropogenic activities within the landscape to its natural boundaries, adjusting one to the other to the greatest possible extent, or complimenting the structure of the natural landscape and the infrastructure of the cultural landscape, which opens the way for functional optimization of the binary landscape system.

The cultural landscape, regardless of the more or less clearly defined boundaries, both natural and sociocultural (sometimes convergent, to a certain extent), has the nature of a coherent formation (functional system) with comprehensive characteristics resulting from the integration of man with nature through interactions with nature, specific to the particular area and epoch (determined largely by resources and environmental peculiarities). These comprehensive properties, new in quality, unusual for individual components of the cultural landscape, are made up, for example, a specific composition (organization of space) of natural and anthropogenic elements that form a whole (structure, morphology, complex), a specific material or spiritual 'product' of the landscape, being the result of human interaction with nature (wheat or dates, wicker products or cheese, '*spirit of the place*' or *sacrum,* etc.), a new aesthetic quality (scenery) and others.

Therefore, the cultural landscape is a natural–anthropogenic system, whose main subsystems are man and nature (inanimate and alive). In the case of nature, the elements are constituted by environmental components (rocks, water, air, soil, biota, etc.), whereas in the case of man—by human beings themselves, tools (techniques) and products of their activity (houses, cities, dams, roads, stations, power stations, etc.) (Andreychouk 2014). What is responsible for the connections (interactions) among natural components of the cultural landscape, that is, for its 'natural structure', is the forces of nature. On the other hand, man is responsible for the connections among anthropogenic elements (infrastructure) and for combining the two structures into the natural and anthropogenic 'mega-structure'.

Man constitutes a more organized part (subsystem) of a binary system (bistructural, or rather poly-structural) of the cultural landscape, due to his being in possession of far greater resources of information and the capacity to produce and process information. Man is capable of better managing energy and exploiting and transforming the energies of the elements (kinetic–movement, chemical–minerals, thermal–radiation and others) into its forms that are more easily assimilated and universal (heat and electricity), as well as producing energy in the quantities necessary for the deliberate transformation of the environment. Being armed with energy and information (knowledge), man is able to actively (in proportion to the level of knowledge and energy at his disposal) make use of the resources of the environment, and to transform it according to set (unfortunately, not always carefully considered) purposes.

Being equipped with knowledge (information) and power (energy), man is able to consciously transform a landscape (his immediate living space), create it, of course to a certain extent, and manage it. Of course, the subsystem of nature also 'has a lot to say' (floods, earthquakes, hurricanes, etc.), but generally, at the level of a landscape (or micro-regions), the impact of these has a disturbing character, rather than decisive in terms of the development of the cultural landscape in the long run. The fact that man is empowered to transform the environment and landscape points to the issues of the *appropriateness* of the actions and the *responsibility* for their consequences. They consist in asking the following questions:

- Why, for what purpose and how does man transform the landscape?
- What is the scope of human responsibility for the effects of the transformation?
- What system of values should constitute the base for making transformations and what principles should they follow?
- How to make transformations of the landscape optimal in their character from the point of view of the functioning of the cultural landscape according to the preferred values and principles? What scientific, philosophical or spiritual concept would serve this idea best?

The following text presents reflections on the first of the questions posed above.

Functions of the Cultural Landscape

Man transforms the landscape, as he is compelled to do so by the fact that the landscape is a direct environment of his living. It is there where man is born, is brought up, grows up, learns, implements his creative potential and life plans, changes other people's lives, creates his own oecumene, transforms the environment, and also dies and is annihilated. The opportunity for life and self-fulfilment is therefore an overriding objective of landscape management (transformation, adaptation, etc.) for human needs. The landscape should therefore facilitate satisfying man's needs: physiological (clean air, uncontaminated water, healthy food), physical (space, raw materials, energy, tools, transportation, etc.), cognitive–educational and experiential (schools, museums, tourism, etc.), recreational (recreation, health improvement) and spiritual (religious, aesthetic, etc.). Thus, *the well-being of man within the landscape* (*environment*) is the main (primary) principle behind the transformation (or better, shaping) of the landscape, adjusting it to his own needs by man.

Also important is the welfare of other living organisms in the landscape, particularly highly organized, capable of emotional experience (i.e. possessing 'a soul'). Elements of inanimate nature are of tertiary value in the system of the landscape values. Even if they are devoid of a soul (which is contradicted by the followers of Shintoism and Zen-Buddhism), they are—apart from the materialistic values—an important element of the beauty of nature, as well as the carriers of information indispensable for fulfilling the heuristic and aesthetic needs of man.

In order to provide man with opportunities for development (including also spiritual), the landscape as a living environment should serve certain functions in relation to man (from Latin *functio*—making, implementation, duty). Strictly speaking, man must contribute to the performing of these functions by the landscape. The character (nature) of the function depends on the objectives, the accomplishment of which man imposes on the landscape. These are generally the following major functions[2]:

1. Spatial—consists in providing man with living and economic space.
2. Ecological involves providing man as a living organism with the necessary physiological substances (water, air, light, etc.), that is, the environment suitable for living.
3. Nature conservation is to provide suitable ecological conditions for other living organisms, being the organic (biotic) part of the environment and landscape system.
4. Materials and their supply (manufacturing of material goods) provides man with goods necessary for life and activity (raw materials, functional objects, tools, etc.).
5. Supply of energy (electricity production) consists in equipping man with energy, necessary for the activity of processing.
6. Communication enables man to communicate, move in space, and transport materials, energy, and information.
7. Cognitive enables human development and broadens their knowledge of man, society, living environment, etc.
8. Recreational provides human opportunities, improving the health and mental state.
9. Sacral—meets needs of a higher order, that is, spiritual.
10. Aesthetic—provides human experience and aesthetic experience, necessary for man's spiritual and moral development and well-being.

Each of the aforementioned functions of the cultural landscape is aimed at meeting at least one individual human needs. Table 1.1 shows these essential needs and refers to the question of what method of the activities (anthropogenic) serves this purpose, and what tangible elements of the infrastructure are created in the cultural landscape in order to ensure the effectiveness of these actions.

The partitions and divisions in Table 1.1 are fairly conventional, especially when it comes to the last two columns. Frequently, similar elements of land development (infrastructure) occur in different types of human activities in the landscape. Some of the functions of the landscape do not have their own material infrastructure media (for example, aesthetic), but they consist of other elements:

[2] The issues of landscape functions have their own scientific history, although not very abundant in a number of publications and unambiguous formulations. In Poland, these issues are discussed in terms of a *socio-economic* function and *services* of the landscape (Richling and Solon 2011). The Russians also use the term социально-экономические функции ландшафта, distinguishing three types of functions: resource formation, environmental formation and nature conservation (Ochrana landszaftow 1982). In Germany, the concept similar to the function of the cultural landscape is the so-called landesfunctions of the landscape (Funktionen der Landschaft sozioökonomische).

Table 1.1 Functions of the cultural landscape related to human (society's) needs, and types of human activities aimed at fulfilling them

	Function of the cultural landscape	Human needs fulfilled by the function	Type of human activity in the landscape	Elements of infrastructure accompanying particular types of activities
1	Spatial	Living space (housing, home, business, etc.)	Settlement and house-building industry	Houses, streets, housing estates, sanitation, communication, etc.
2	Ecological	Physiological (unpolluted environment)	Water management	Water intakes, water supply systems, reservoirs, wells, canals, aqueducts, water towers, sewage treatment plants, etc.
			Environmental protection	Rubbish treatment plants, recycling areas, green areas, etc.
3	Nature conservation	Physiological, spiritual, aesthetic, cognitive–developmental and educational	Conservation of areas of great natural value	Infrastructure of national parks and reserves of natura 2000, ecological corridors, etc.
4	Materials and materials supply (production of goods)	Possessing indispensable goods (articles of daily use, industrial tools, etc., facilitating existence and development	Mining	Opencast mines, quarries, mines, mine waste dumps, landfills, towers and drilling platforms
			Industry	Foundries, factories, breweries, cement factories, small factories, etc.
			Agriculture	Cultivated fields, meadows and pastures, orchards, gardens, vineyards, farms, farm ponds, etc.
			Forestry	Settlements, entanglements, fencing, notice boards, timber depots, small sawmills, etc.
5	Energy supply (energy production)	Electricity (lighting of human settlements, houses, production of material goods, processing, transport, etc.)	Energetic	Hydropower stations, thermal power stations, nuclear power stations, windmills, transmission lines, transformers, etc.

(continued)

Table 1.1 (continued)

	Function of the cultural landscape	Human needs fulfilled by the function	Type of human activity in the landscape	Elements of infrastructure accompanying particular types of activities
6	Communication	Communication (movement in space, freight, energy, information transmission)	Transport	Roads, motorways, railways, subway, pipelines, ships, container ships, oil tankers, ports, airplanes, airports, etc.
7	Cognitive	Cognitive developmental and educational (learning about homeland, the country and the world, living environment and human activity)	Tourism conservation of cultural heritage	Tourist bases, hotels, hostels, camp sites, ski lifts, hiking trails and paths, heritage parks, museums, monuments, etc.
8	Recreational	Leisure and well-being (physical and mental health improvement)	Recreation	Sanatoriums, spas, forests, parks, water reservoirs, etc.
9	Sacred	Spiritual (religious)	Sacred building burial mounds, crosses, etc.	Temples of different religions, bell towers, minarets, monasteries, shrines, tombs, burial mounds, crosses, etc.
10	Aesthetic	Spiritual (perception of beauty)	Each	Overall landscape management in terms of planning, architecture, recreation and tourism, cleanliness, etc.

to be more precise, their structure and character. These and similar problems are quite natural in a particular case, because they result from a very close connection and mutual interpenetration of all types of human activities in the landscape.

Spatial Function

The landscape constitutes a living space of man who utilizes it in a direct manner, building houses, large residential buildings, etc., that make up hamlets, villages, towns, cities, conurbations, agglomerations, megalopolis and gigapolis. One of the most important functions of the landscape is to provide man with living space. The importance of this function or the value of the living space is more appreciated in countries or regions which are overpopulated or of limited 'spatial resources'. This is the reason, among others, why big cities 'grow' not only in breadth but also upwards (buildings—'skyscrapers').

The elements of functional structures which carry out this function are various kinds of residential buildings, along with the accompanying infrastructure (streets, passages, courtyards, sewage system, etc.), which sometimes occupies significant surfaces, measured in thousands of square kilometres. Development of the space through settlement and construction brings dramatic transformation of the landscape. Human settlements growing up from small hamlets to large cities not only fill up the landscape space, but also significantly change the structure of linkages among the elements of the landscape system. Thus, the soil, buried under houses and buildings, becomes 'arrested' and destroyed (almost completely), vegetation and fauna undergo changes, water circulation is subject to significant disturbances throughout the whole system, and the air becomes polluted. The impact of this kind of human activity on the landscape is significant in terms of quality and results in the occurrence of specific settlement landscapes, representing a distinctive quality of the landscape. The intensity of this process becomes the highest in the case of urban agglomeration and may reach even the scale of a region (megalopolis). Settlement and construction activate mining, because they are dependent on the use of construction materials (cement, bricks, gypsum, etc.) coming from processing raw materials of rock and sediments (sand, clay, stone, plaster, etc.).

A characteristic spatial effect of this function operating is the exclusion of large areas from use for other purposes. Due to the radical transformation of the landscape and the artificial nature of the newly developed space, an urban landscape is not friendly towards human life not only in terms of ecology.

Ecological Function

It covers a wide range of activities aimed at maintaining the landscape in a state which facilitates suitable ecological conditions (physiological) for man. In general, these activities come within the scope of the widely understood protection of the environment, and, to a great extent, water management and forestry (Table 1.1).

Human activities within this function involve definitely lesser interference in the landscape in terms of 'absorption of space', which is generally characterised by points (sewage treatment plants, wells, water towers, etc.) and is linear (water pipes, channels, straightened out riverbeds, etc.). Conservation of forests, lakes and water reservoirs, however, is of a superficial nature.

The ecological function of the landscape is accompanied by its rather minor transformations. The exception is water management and water–wastewater management, especially in the case of the construction of large water reservoirs (retention tanks, etc.). Nevertheless, the presence of water usually alleviates or compensates for negative effects of gross ecological interference in the landscape, and opens up opportunities for the development of other functions (recreational, aesthetic).

The Function of Nature Conservation

It is based on the need to protect areas of great natural value (natural landscapes or only slightly transformed) in order to preserve their natural values (gene pool, the species of organisms, etc.) and for the purposes of ecology, education, etc. This function is performed by relative isolation of landscape areas in the form of nature reserves, national parks, scenic areas, etc., of various status of nature conservation (protection rigour).

This function does not necessitate expansion of a significant economic infrastructure in the landscape, quite the opposite: it is about minimizing it. Protected landscapes represent a type of the cultural landscape closest to the original landscape.

The Function of Material Supply (Production of Material Goods)

This function has been so far one of the most important. It provides man with products and goods essential for living (to live in an artificial environment, and sustain it), and materials for production of technical tools (including those for landscape transformation) and for development of space (wide range of construction). Performing this function comprises several human economic activities, resulting in the creation of large (sometimes massive) elements of economic infrastructure—foundries, factories, mines, quarries, etc.

Each of the activities involved in the implementation of the production function possesses a particular capacity for shaping the cultural landscape. The first two (Table 1.1—mining and industry) tend to affect the landscape at some points, the last two, however, (agriculture and forestry), on a wider area of the surface. All of the listed activities are characterized by a strong impact in terms of landscape development. Regardless of the point nature of the occurrence of mining and industrial elements in the landscape, they always have a significant impact beyond the physical boundaries of the object, thus changing the structural linkages among the elements of the landscape (pollution of the surrounding areas, their drainage by cone of depression, etc.). In the case of mining or industry, the areas of their concentration take physiognomic and functional characteristics of mining and industrial landscapes. Frequently, the ‘production line’ geographically merges mining and industrial areas into a whole and thus creates mining–industrial landscapes, or even combined settlement-mining-industry landscapes, such as on the Silesian Upland.

Agricultural activity and forestry, however, are not so intense and ‘space consuming’ as mining (up to 3 km and more in the depths of the Earth), or industrial (polluting the atmosphere to the upper boundary of the troposphere); nevertheless, due to the superficial character of their occurrence, they may also radically transform the landscape. Although it is generally the destruction of only one of its layers (biotic—replacing natural vegetation with cultural; or like in the Amazon rainforest—deforestation of the area), this leads to rebuilding of the structure of the landscape (replacing components, the loss of the relationship due to the destruction of the vegetation and fauna, erosion), and hence, we are dealing with a new quality of the landscape: agricultural or degraded forest landscapes (anthropogenic savannah, pastures on the area of deforestation, etc.). If the forest management is conducted in a rational way (not just deforestation, but also reforestation), the landscape does not change or changes to some extent (replacing the species), which does not lead to qualitative changes in it.

The Function of Energy Supply (Energy Production)

Any kind of human activity in the landscape can be performed as long as there is driving power, processing and production capacity, although the demand for each type of these activities for energy is varied. The most energy intensive are mining, industry, transport and settlement (building), that is, these kinds of activities which are most material consuming and information demanding, and at the same time, to the greatest extent affect the landscape, changing it radically.

The implementation of this function in the landscape is associated with construction of power stations (coal powered, water, nuclear, geothermal, flow), producing the most universal and useful type of energy—electricity. Power stations are usually large point objects of different impacts on the landscape. The greatest impact is created by hydropower stations, which are accompanied by the creation of large water reservoirs. In this case, this ‘hybrid’ creation of combined activity of energy production and water management may be called a hydroenergetic landscape. A new quality is developed within this landscape by the fact of its being controlled: energy production and related water retention (periodic filling of the areas with water) or lowering the level of reservoirs lead to the formation of waterside geosystems (ecosystems) of a specific regime of functioning (their own cycles).

The landscape developing impact of coal-powered or nuclear power stations is lesser than in the previous case. However, their impact goes beyond the physical boundaries, especially when it comes to thermal power stations, particularly those emitting into the air large amounts of pollutants, adversely affecting the landscape even at a regional scale. What least affects the landscape (locally) is run-of-the-river and geothermal power stations, producing energy from natural elements.

It should be noted that we live in the times when gradual changes in the methods of producing energy take place, however with radical effects. Large power stations (as well as large industrial buildings) are giving way to small production sources—windmills, solar panels, etc., utilizing renewable energy resources. Their role will continue to grow and lead to radical changes in terms of landscape development (transformation). Production capacity concentrated in large power stations, as well as a large impact on the landscape will give way to forces 'dispersed' in the landscape. Increasing autonomy of energy consumers (small factories, households, etc.) will result in degradation of energy networks and reduction in energy loss during its transmission, which will eventually have positive environmental effects (not heating of the atmosphere). There will be a decrease in the share of energy infrastructures in the landscape space.

Function of Communication

Man and goods, energy and information produced by him must undergo exchange. Such are the requirements of systems superior to the landscape (regional, national, global, etc.) and the occurring differences in landscape and economy among particular regions and countries, which form predispositions ('potential difference') to exchange of goods, energy or information.

This type of human activity is extremely diverse (Table 1.1). In terms of morphology of the elements of spatial development, linear shapes are dominant, both continuous (roads, pipelines, transmission lines, etc.) and intermittent (plane routes, tanker courses), with applied point elements in places of destination or transition (airports, marine ports, railway and bus stations, bus stops, gas compressors and transformers, etc.). These elements rather do not occupy much space, and their impact on the landscape beyond their boundaries is not great enough to consider them as contributors to profound landscape transformation, for example, to the degree of development of the *communications landscape*. However, these elements, often of different types, create a dense network (infrastructure), which heightens their impact on the landscape, leading to clear functional disturbances within it. Roads also create artificial physical barriers for small flows or surface run-off, animal migration, geochemical streams, etc., thus dividing the landscape and disrupting the flow of matter and energy within it.

Cognitive Function

Curiosity is one of the most important innate human qualities (as well as of animals). The need for learning is an essential attribute of the development of every human being, and, in addition to several others, the driving force of any progress. Man is enabled to acquire knowledge and professional education by educational institutions of various levels, from kindergartens to universities and academies. Here the role of spatial anthropogenic elements of the landscape structure is rather insignificant.

Acquiring knowledge about the surroundings by man does not consist in merely receiving education. In adulthood, everyone feels the need (to a different extent, admittedly) to socialize with other people, see other regions, countries or continents, which is facilitated by tourism.[3] The movement of man in the landscape along with temporary settling down and creating different objects for tourist consumption require adequate infrastructure, sometimes considerably developed. Therefore, this type of activity involves human intervention in the landscape, sometimes so forceful that it leads to the development of a specific functional type of tourist landscape. The tourist function merges then the natural part of the landscape (values) with the anthropogenic part (tourist infrastructure) into a whole—a tourist landscape. Tourist landscapes occur along the coast (Costa del Sol—Spain; Golden Sands—Bulgaria; the French Riviera; Hurghada—Egypt, etc.). A characteristic feature of coastal tourist landscapes is their linear (or rather stripe) nature (they stretch along the shoreline).

A separate issue of the function is the appearance of ‘the industry of knowledge’ in the landscape—combined objects of science and research (institutions, laboratories) and hi-tech production institutions. A special case of the industry of knowledge is the so-called Silicon valleys—areas of intense concentration of hi-tech knowledge of the IT and electronics industry. Most recognized are the areas in the United States (Silicon Valley—California; Silicon Prairies—Texas; Silicon Forest—Oregon; Boulder—Colorado; around Boston—Massachusetts Institute of Technology; the Chicago area et al.). In Europe, they are Silicon Glen (near Glasgow), Silicon Fen (Cambridge) and a few others on the continent (France, Germany and the Netherlands). They are also in Asiatic countries—India, China, Korea, Japan, Taiwan and so on. The areas occupy sometimes large surfaces, which allows them to be defined as ‘silicon materials landscapes’ (Wilczyńska and Wilczyński 2004).

The Recreational Function

Some cultural landscapes, which are characterized by special environmental values (climatic conditions, diversity of relief, the presence of water objects, varied

[3] This is an oversimplification, because tourism provides man also with some sensations (emotional experience).

vegetation, etc.) or therapeutic values (mineral water, therapeutic mud, healthy climate) and accessibility, also serve a recreational function by facilitating physical and mental relaxation, that is, improving health. What constitutes functional elements of the infrastructure in the landscape, serving as recreation, is all the places of organized accommodation in the terrain (from campsites to guest houses and sanatoriums), pump water, spa parks, artificial lakes, gardens, etc. They are characterized, especially in the case of 'spa' landscapes, by concentration in one or several locations related to the location of the healing resource (agent). In such places, the landscape undergoes sometimes a significant (short-range) transformation, though not entailing negative effects. In most cases, the landscape here is 'ennobled' by man (spa palaces, park architecture, etc.), to which landscape architects have always greatly contributed.

In the case of the recreational transformation of the landscape, particularly within the spa, there is a substitution of natural elements by anthropogenic ones (forest—park), creation of small components there (decorative reservoirs), which generally, however, does not interfere with other functions performed by the landscape, such as ecological. The recreational landscapes as such should not be taken into consideration here, due to the limited occurrence of elements of specific infrastructure there. However, if we take into account conservation of the forests around the spa aiming at, among others, preserving the natural environment as a favourable background for the spa, we can attempt to distinguish such landscapes. Recreation landscapes frequently appear on the shores of the sea, lakes and artificial water reservoirs, in river valleys and in the mountains.

The Sacred Function

This function has accompanied man in the landscape since the dawn of history. In the time of pagan religions, deification of nature by man and religious 'totalitarianism', artificial objects of sacred infrastructure in the landscape were not created. Their functions were performed by natural objects: rocks, mountains, caves, lakes, animals, trees, etc. Transformation of the landscape as the effect of its performing this function did not take place.

With the development of monotheistic religions, such elements begin to come into existence, also on a grand scale (temples, churches, monasteries, including those carved in rock, etc.). They did not have any significant impact on the landscape, as usually they accompanied human settlements, scattered among them, they constituted their small part. An exception might be the activity of the Cistercians in the vicinity of the monasteries; however, in this case, shaping the environment was pragmatic (economic), and not religious.

At present, the progressive commercialization of places of worship results in expanding sacred objects in the landscape through creation of accompanying elements (shops, market stalls), parasitizing on the sacred function of the object (e.g. Lichen or Lourdes). But also in these cases, changes in the landscape are not significant enough to talk about creating a new landscape quality—a sacred landscape (unless the approach to the landscape is too wide). The holy mountains (Mount Fuji, Kailas) or sacred forests form sacred landscapes, but not in terms of formation of an anthropogenic landscape, only in terms of spiritual perception.

The Aesthetic Function

Harmony is a general feature of nature; therefore, man tends to harmonize his life (religion, ethics, art) with the environment (feng shui, gardening, landscape architecture). A natural landscape is a harmonious creation. Admiring the 'wild' landscape from a scenic overlook, we can clearly feel this harmony, although we cannot explain it in a rational way. The harmony of a natural landscape lies in its essence, which is dependent on the processes shaping the landscape.

Harmony in a 'humanized' landscape is dependent on man shaping the landscape. At the pre-industrial stage of human development, when human activities in the landscape were completely conditioned by the environment (raw materials, materials, shapes), artificial functional elements coming into existence in the landscape (settlements, fortresses, etc.) regardless of their functions formed parts of the landscape, often imitating it (building with local materials, wood or stone, borrowing shapes from the environment—various types of convexity, etc.). Examples are European medieval fortresses and castles crowning hills, Moroccan Kasba on the rocky background of the mountains, the Egyptian pyramids resembling monadnocks in the desert, or the wavy shapes of Bedouin tents, 'emerging' from the sea of sandy dunes on the horizon.

The industrial era has generally brought about 'deharmonization' of the landscape, often even its destruction, devastation, and degradation, which means the loss of its aesthetic values. Currently, however, there is an increasing tendency towards returning to aesthetic values of the landscape, in the context of deliberate, intentional (contrary to impulsive, unconsciously imitative) shaping of the beauty of the landscape, even in the case of industrial landscapes.

Multifunctionality of the Cultural Landscape

All of the previously described functions of the cultural landscape are 'anthropogenic' and 'anthropocentric'. It is the presence of man in the landscape that necessitates their operating—the functions of the landscape at the service of man. Without man, these functions are unnecessary or even impossible, because they are intended for humans and activated by them (not by nature) in different forms of intentional activity. Man creates these functions (through materials, energy and information) and then 'intensifies' them by developing and building up, or neglects and abandons them.

Natural landscape as such has a variety of predispositions towards initiating the aforementioned functions by man. They are different types of resources (raw minerals, fertile soil, clean water, etc.) and properties of the landscape (friendly climate, favourable relief, etc.) enabling and determining the development of these or other functions.

Each cultural landscape usually serves several functions, which makes it multifunctional. These include indispensable functions, e.g. ecological (environmental) functions of greater (production—manufacturing goods necessary for life) or lesser importance (e.g. aesthetic or recreational). The spectrum of landscape functions is dependent on the natural predisposition of the landscape, as well as on population and human needs in a given (but not only) area. Some landscapes perform only one or two functions, e.g. the landscapes of polar deserts (in the Antarctic), where man resides only at research stations carrying out, together with the landscape, merely a cognitive function (research, education). On more accessible peripheries of the polar regions (Spitsbergen, Greenland, the coast of the Antarctic, the Arctic islands), in addition to the cognitive function (including tourism), man brings about economic functions (production of goods and energy, communication) and others (aesthetic—e.g. observations of polar auroras). However, in regions more friendly towards life, as in central Europe or in the eastern United States, in the majority of landscapes man realizes all the aforesaid functions simultaneously.

Regardless of the number of the functions, in most cases, we deal with the functional specialization of one or another landscape. It occurs in the case of the landscape characterized by unique (rare, important or necessary) resources, e.g. mineral resources (coal, gold, iron ore, etc.) or properties (climate) or the necessity of developing the landscape in some particular way resulting from socio-economic or political conditions.

Investing in a given landscape function along with building up suitable infrastructure leads to a one-sided transformation of the landscape and formation of its specific functional type (recreation, tourism, communication, etc.) In this respect, it is worth considering the creation of a functional typology of the landscape. Such a typology would not be an alternative for genetic typology (mining, agriculture, settlement landscapes, etc.), but a good supplement to it. The ‘added value’ of this supplementation consists in the fact of ‘landscape incompleteness’ of the distinguished genetic types of cultural landscapes. For every landscape, whether agricultural or mining, contains in its spatial and functional structure not only a genetic factor, but also elements associated with both subordinate and necessary functions. An agricultural landscape is made up not only of fields and farms, but also of individual houses and villages (space and settlement functions), roads and transmission lines connecting them (communicative function), rivers and canals (number of functions), just as a mining landscape does not only consist in mines and coal waste dumps, but also in housing estates, numerous routes and other components of the landscape, related to functions other than mining. It may be worth creating a hierarchically constructed genetic and functional typology of the cultural landscape, which is more appropriate with regard to explaining (theoretical modelling) the complex nature of the cultural landscape and its diversity. In both cases, however, the key question is 'What is understood as the idea of the cultural landscape?'

What might also be interesting is the retrospective study of the cultural landscape functions, e.g. by employing the key of 'stratigraphy of the cultural landscape', developed by Myga-Piątek (2005, 2012). It would consist in recreating the image of landscapes from different historic (or prehistoric) periods using various historical and palaeogeographic methods.

It should be noted that the study of the functional spectrum of the landscape, that is its multifunctionality, contains in itself something significant—a holistic thread. The landscape is studied as a functional whole. Spatial effects of all the functions, which are closely related, like the function of the components of the natural landscape (the association of soil with vegetation, relief, climate, etc.), are studied in the same way. Building settlements or houses is connected to convenient locations and access to water, mines—to deposits, farms—to fields or channels, and all of this must be connected by a network of roads and supplied with energy, etc. Hence, examining retrospectively (but functionally), for example medieval agriculture and its environmental impact on a particular area, the contemporary settlement/colonization or communication cannot be ignored; otherwise, the images of the reconstructed landscapes will be at least 'incomplete'. The knowledge of the nature of functional relationships in the landscape may help to restore a more complete picture.

Conclusions

From the point of view of the function of the cultural landscape, the practical objective of the research into the landscape is to harmonize its functions (mutual agreement, optimization) in a given area. This should be dealt with by the branch of the science of landscape—the management of the landscape. The proper methodology the management should be based on is, without a doubt, system methodology, and above all its branch responsible for the management of complex systems, i.e. cybernetics.

The functional approach to the cultural landscape is necessary if we want to initiate the use of cybernetic principles, methods and studies and apply them successfully for the management of the landscape. Remaining at the stage of merely considering how complex and diverse the cultural landscape is (or sometimes even—what it is) without taking into account the issue of purposefulness of our environmental activities and, accordingly, its functions will hinder the effectiveness of management of the landscape, i.e. harmonization of its functions. By examining the functions of the cultural landscape, which are interactions of its components, primarily anthropogenic and natural, by building functional models of cultural landscapes, we pave the way for the following:

- application of methods of system analysis in the studies on the cultural landscape, formalization of the structure of the landscape;

- mathematical modelling of the functioning of the landscape system in order to optimize its functions and prognosis of the consequences;
- constructing optimized regional functional models of landscapes, taking into account local, regional, state, etc., human needs.

Harmonization of the cultural landscape features should not be construed very literally, that is, as the lack of functional internal conflicts. They are inevitable, and even necessary, as without opposites there is no development. What matters is matching a proper spectrum of the function to a particular landscape and determining the thresholds of the functional loading of the landscape in relation to each function. Ideally, choosing a perfect function (which happens rarely) should be based on the principle of the compatibility of the functions. The recreational function of the landscape goes with ecological (environmental protection), aesthetic and educational functions, but does not match the function of goods production (mining industry). The principle of complementarity is equally important. According to it, it should be attempted to load all the functional elements of the landscape (agriculture and mining, settlement and communication, etc.) with the aesthetic and education function. Absolutely essential (the principle of necessity or priority of the function) is performing by each landscape the ecological function to which other functions should be subordinated to some extent.

According to the author, a functional approach to the cultural landscape opens up new opportunities for exploring its nature and, more importantly, creates predispositions towards rational, practical actions based on functional system models of the landscape.

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Chapter 2
Land-use and Landscape Changes: A Methodological Proposal for the Creation of Sustainable Cultural Tourism Itineraries

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Abstract The debate on the role of itineraries as instruments of territorial valorisation is now 'mature' (Trono and Oliva 2013; Candela et al. 2005). More and more 'territories' are organizing activities to design and create new itineraries, convinced that they can act as a driving force for local development. By linking places, atmospheres or assets, they provide the keys, for understanding the 'places', and their evolution, to a growing number of 'new tourists'. It becomes, however, a priority to carry out an evaluation of the territorialization processes that characterize the areas that they 'touch' (in particular land use); this is in order to determine their impact on the state of health of the territory being 'crossed'. Current technological evolution has allowed us to go beyond the classical statistical analyses based on the calculation of indicators, integrating them with geospatial analyses capable of including what is mentioned above. Here, we propose the illustration of a case study conducted on this subject, which is presented as a working model. In 2013–2014, the research team carried out a diachronic (visual and overlay) GIS analysis. Our aim was to represent the changes taking place in the territory to the east of Verona, quantify them and evaluate the feasibility of the proposal for an itinerary in the conceptual stage, partly in the light of urban development planning. The case study has the value of substantiating the need to reflect

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on the often absent relationship between environmental and territorial research, and the development strategy related to it.

Keywords GIS analysis · Landscape · Land-use and land-cover change · Tourist routes · Planning

Conceptual References

Tourism and cultural routes—Tourism by both international and domestic visitors has grown considerably in many countries over the last few decades (Rocca 2013; WTO 2014). Mass tourism is giving way to 'slow tourism' and 'slow travel', which are in line with conceptions linked to:

- a respect for the places being visited and an appreciation of the cultures (Corna Pellegrini 2004; Stephenson 2008; Nistoreanu et al. 2011; Timms and Conway 2011; Yurtseven and Kaya 2011; Fullagar 2012) and of the typical products of the host countries (Petrini 2005; Bryant and Grillotti Di Giacomo 2007; Heitmann et al. 2011);
- the selection of smaller destinations (Radstrom 2011; Grzelak-Kostulska et al. 2011);
- the abandonment of haste;
- a propensity to savour landscapes and atmospheres;
- as well as to the use of unhurried modes of transport (Dickinson et al. 2011; Calzati et al. 2012; Calzati 2012; Georgică et al. 2013; Mogollón et al. 2012[1]; De Salvo et al. 2013).

At the same time—notwithstanding the occurrence of massive landscape changes—awareness has grown as to the extent to which natural assets as well as those due to the work of man are widespread. A pervasive process of valorisation of areas or individual sites has thus been set in motion: destinations that stand out as tourist resources of many different kinds.

As a consequence, there has been a boom in the creation of brand new itineraries (e.g. Schmude and Trono 2003) and the rehabilitation of historic ones like the network of the Via Francigena from Canterbury to Rome with a flourishing of websites and a related journey literature. Interest in the planning of long-distance tourist/cultural itineraries is very much in line with the concept of slowness and has been adopted by the European Council which, since 1987, has recognised and sustained 29 cultural routes and landscapes that are deemed to form part of the

[1] Here, the authors highlight the principal elements of demand and supply as regards slow tourism—a relaxed pace, an experience and environmental and social ethics—with references to the works of Calzati, Matos, Lumsdom, McGrath, Petrini, Dickinson and others.

common heritage of Europe[2] (Berti 2013). All of these routes, which have already been fully designed, are smart in one way or another.[3]

Moreover, the planning of prototypes for smart itineraries in both urban and extra-urban environments—and therefore more limited in scope than the ones just mentioned—has greatly involved researchers and practitioners since 2000, that is to say since ICT has become pervasive, and mobile tourism and mobile guides have established themselves in the marketplace (Smart Environments 2005; Edwards et al. 2006; Rizzo 2008; Kenteris et al. 2009; Chu et al. 2011; Fu and Yu 2013; Arnaboldi et al. 2014; Dickinson et al. 2014). Indeed, geo-technologies have become increasingly important not only because they are essential for creating routes and trails (Rizzo 2014) or their customization (Garcia et al. 2010), but also:

- to deliver or gather—during the trip—information based on the location of tourists (Nie et al. 2009) and/or to analyse tourist behaviours (Girardin et al. 2007; Asakura and Iryo 2007; Asakura and Hato 2009; Zheng et al. 2012);
- to bring tourism information to users in a more immersive manner than traditional text or maps (granting access to/providing augmented reality information at distance) (El Choubassi et al. 2010);
- as tools and settings in which to integrate, aggregate and diffuse information (and, therefore, enhance the communication of the route, e.g. via web-GIS) (Cataldo and Rinaldi 2003).

In creating itineraries, various problems have been faced up to, depending on the academic background of the researchers involved (engineering, computer sciences, geography, etc.).

Routes and regional development—The itineraries have also always been recognized as embodying a cultural value and have been attributed the ability to have an effect on local development (Rizzo et al. 2013; Dallari 2013). Examples in this regard are the numerous routes drawn up by local action groups (LAGs) throughout Europe; their design is in fact one of the operations that was financed by LEADER and—now not only for LAGs but more broadly—may be financed under the ad hoc measures of the EU rural development programmes, partly within the scope of the growth of forms of rural tourism. Today, these local or/and circumscribed itineraries may present themselves as already available and ready for use on the Web[4] or the user himself may fine-tune them as needed (D'Amico et al. 2014). Given the massive land use that exists, with often widespread sprawl phenomena (Freire et al.

[2] http://www.culture-routes.lu/php/fo_index.php?lng=fr&dest=ac_00_000&lng=en. Accessed 23 September 2014.

[3] On this subject, we refer the reader to the material produced under the CERTESS project (Capp 2012).

[4] An example is constituted by the 7 multimedial *itineraries for alternative tourism* from northern to southern Italy—from Trieste to Salerno—drawn up by various authors (2014) in Bollettino dell'Associazione Italiana di Cartografia (A.I.C.), Laboratorio GIS dell'Università di Trieste—Dipartimento di Studi Umanistici, A.I.C./Associazione Geografi Italiani (http://www.openstarts.units.it/dspace/handle/10077/9911). This work was produced by a Research Group of Italian university geographers coordinated by A. Favretto.

2009; Rizzo et al. 2014), it is worthwhile understanding whether itineraries that are currently set up or that may in future include further significant points of interest—even in areas rendered complex by past intervention—may persist or whether they will be spoiled by future interventions in the territory. This gives rise to a need for pervasive applications that take into account medium-to-long-term scenarios (Güell 2013) which consider routes—including tourist choices and scenic POIs—and the territorial planning of government institutions.

Build-up and landscape—The need for a similar reflection becomes even more compelling when considering the spread of architectural and building forms that clearly reflect the paths of the territories, which are often problematic: examples which, documented by widespread 'crane landscapes' and omnipresent 'for sale' billboards (Bonora 2009: 23), in any case constitute a narrative of places and processes of 'reification' that characterize them. In Italy, the inability to regulate the growth (especially of built-up areas) has given a result of pervasive expressive poverty. Building modules—sometimes bizarre—often have an impact on the landscape, resulting in disharmony and deterritorialization. Landscape-related urban and rural relationships are being challenged by development models, rendering the territories being examined as incoherent realities and amalgams of fragments. Often artificializa tion/anthropization projects become 'unbalancing events', acting as obstacles to local development (when adopting a medium-to-long-term viewpoint). Despite becoming part of the fabric of places and their local economy, they in fact leave behind material evidence incoherent with the true long-term (environmental) needs of the area as well as symbolic evidence that has little to do with the identity of the territory.

Structure of the Paper

This paper seeks to illustrate the results of a study carried out in 2013–2014. In section 'Research design', we shall clarify what are its objectives and the methodology used to obtain them. In section 'Discussion of the Results', we shall discuss the results, initially presenting the route we created and on which we tested our work model (section 'Conceptual References'). Subsequently, we shall illustrate what emerged from our analysis of changes in land usage (section 'Land Use in the Area Covered by the Study. For a Quantitative Level 1 Evaluation of the Regional Data') and on the impact that these may have had on the possibility of enjoying the countryside,[5] the principal tourist resource that the itinerary aims to promote (section 'Land Use, Landscape and Visibility: Possible Negative Interactions? POI Classifications by Impact Assessment of LUCC'). Some concluding notes will follow (section 'Conclusions and Cues for Reflections'), in which we shall reflect on the subject of 'tourist itineraries, landscape and territorial planning', partly in view of renewed interest in studying the link between these aspects and the use of innovative tools and methods for building a tourist attraction.

[5] Landscapes, in particular.

Research Design

Objectives

As tourism and landscape are interrelated concepts, as we have seen, work has been carried out on developing tools for the design of tourism planning and management strategies with landscape (conservation) as a reference (de Aranzabal et al. 2009). Our work intends to contribute to the topic by adding results which look at things in a different perspective: one that also reflects on cultural landscape routes (potentially) acting as a tool allowing the tourist to gain access to sites that are linked thematically with each other as well as with the landscape 'systems' of which they form part (Rizzo and Trono 2012: 4). The implementation of marketing actions for cultural routes begins—we believe—with the identification of appropriate methods aimed at the creation of a specific tourism product. Traditionally, this is achieved *in primis* by analysing the demands of the market and of the users themselves. It must, though, also depend on the use of innovative tools capable of revealing the structural patterns of territorial processes and determine if, ultimately, they facilitate or hinder its success. The itinerary, as said, acts to coalesce and systematically reorder the available supply, in our case landscapes. As a result, it is necessary to combine the moment of its creation with careful verification of how the territorial fabric to which it refers has evolved, so as to find connotations that, over time, invest the planning of the route with coherence. To be economically viable as an engine for development, in fact, the (territorial) valorization project—aiming at helping tourists to read the signs of history in the landscape and to decompile/interpret associated collective meanings (Laurens 2007; Berti 2013)—should be long lasting. With that in mind, the identified research problem may be formulated as follows: How can innovative geospatial technologies, tools and methods enhance the capacity of territorial actors to design more sustainable routes, taking under due consideration land-use-related territorialization processes that are capable of affecting cultural landscapes and impacting on the experience a tourist can enjoy (and on his perception of it)? Therefore, the general aim is to evaluate the impact that land-use/cover changes (LUCCs) have on landscape visibility (and, thus, on 'fruition'/perception by tourists) given a planned tourist route.

The aforementioned statement of the research problem determined the following operational objectives:

1. LUCC evaluation in the area crossed by the route;
2. Assessment per point of interest (POI) of the impact that LUCCs have had on landscape fruition (visibility) within a given buffer zone;
3. Assessment of the global impact that LUCCs have had on landscape visibility within a given buffer zone considering a particular factor: the overlapping of possible effects;
4. Same as (3), but focussing only on municipalities whose territory is entirely included in a given buffer zone.

The Case Study Area: An Overview

The case study area is located in the province of Verona (Veneto Region—Italy) and in particular a hilly zone in the north-east of the province itself. It involves eight municipalities (San Martino Buon Albergo, Verona, Mezzane di Sotto, Tregnago, Illasi, Cazzano di Tramigna, Soave and Monteforte d'Alpone), whose limits are close to the regional park of Lessinia and in the cultural region that goes by the same name (Sauro 2010). The territorial setting is characterized by parallel ranges downgrading into the underlying plain. It offers different kinds of landscapes:

- an agricultural environment of intensive grapevine cultivation (sometimes fragmented by olive trees);
- small sections of rural landscape (in particular that dedicated to pastures);
- the urban context of a small walled town (e.g. the town of Soave with its medieval castle);
- the precious (heritage) landscape generated by the presence of historical Venetian Villas (e.g. the Municipality of Illasi);
- a 'sacred' landscape consisting of 'minor' religious heritage (sanctuaries, abbeys, parish churches, shrines, etc.).

The area is easily accessible by means of the provincial roads that cross transversally the five valleys of Squaranto, Mezzane, Illasi, Tramigna and Alpone. Driving along these roads allows one to appreciate the above landscapes in the typical manner of so-called slow travel (Mogollón et al. 2012)[6] passing through Wine Routes (Soave and Valpolicella), Wine Towns (Illasi, Monteforte d'Alpone and Mezzane di Sotto), Olive Oil Towns (Illasi and Mezzane di Sotto) and areas boasting the *Bandiera Arancione* of the Touring Club Italiano (Soave). All of these elements are part of RES TIPICA (Calzati et al. 2012) (Fig. 2.1).

Methodology

Data sets Used

To fulfil the objectives set, we availed ourselves of a set of data made up of the following:

1. Limits of the spatial units examined in .shp format (downloaded from the geoportal of the Veneto Region): NUT3 (province of Verona) and LAU2 (municipalities studied);
2. The POIs that identify the points of interest in .shp punctual format. Each point was located using Google Earth. Subsequently, we generated the corresponding shape file to be imported into the GIS.

[6] See table no. 1, which summarizes the main headings of the slow philosophy: slowness, experience and environmental/social ethics.

Fig. 2.1 Italy, Veneto and the Province studied. *Source* Map created by the R.G. Rizzo (2014)

3. The route of the itinerary—created ad hoc—in .shp polyline format.
4. The technical maps of the Veneto Region [scale: 1:5000, in raster (.tif) format and relating to our case study area] used to generate the digital elevation model, on which our analysis was based.
5. Data sets referring to land use and land cover:

   a. Corine Land Cover (CLC) for Italy (1990, 2000, 2006) [database downloaded from SINAnet in .shp format; scale: 1:100,000];
   b. data in .shp format on land use/cover (scale: 1:10,000) relative to the years 1983, 1996 and 2006 made available by Veneto Region and relative to the province and the municipalities studied.[7]

These data sets (5a. and 5b.) represented the starting point for all our overlay calculations and the extraction of the values of class changes, below described.

[7] 'The genealogy of the data produced by the Veneto Region is the following. With regard to the production process, the table associated with the data derives from the geometric processing of the database of the land use and land cover of the Veneto Region. This database, which for the urban coverage refers to the archives produced in the project GSE-Land, was implemented using the photo-interpretation of AIMA orthophotos, for the 1994 period and of the CTR, in the original 1983 edition. The sources are therefore varied: CTR from 1983 and subsequent editions; digital AIMA orthophotos from 1994; AGEA orthophotos 2006–2007; GSE-Land archives of the land use and land cover' (Rizzo et al. 2014: 23).

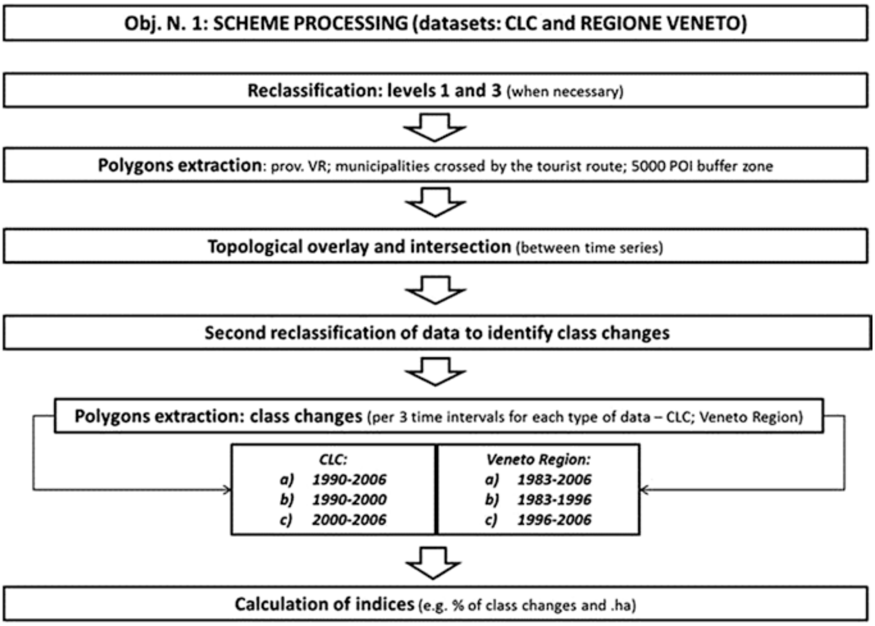


Fig. 2.2 Outline of the methodology used in Step 1–3 (polygons extraction, data reclassification, topological overlay analysis, indices calculation; datasets: CLC and Regione Veneto). *Source* Charts by R.G. Rizzo

Procedures Carried Out

Once we had obtained or produced the data, we made them converge in a GIS (specially created using ArcGIS 10.2). From the inputs above–mentioned, we implemented the following phases (Figs. 2.2 and 2.3):

1. The first step was that of creating the area of analysis of the CLC and of the data in .shp format on land use/cover of the Veneto Region (for both data sets, we carried out a clip operation using the boundaries of the province of Verona and of the municipalities studied as the clip theme);
2. Secondly, we reclassified such data sets[8] at level 1 [the CLC, one should remember, uses a hierarchical three-level classification that includes 44 subsections (Bossard et al. 2000; Gardi et al. 2010: 29). The Region's data set is in line with this. For the purposes of this study, we deemed it sufficient to concentrate our attention on the macro-classes of land use. This led to the necessity to group together elements on the basis of the '(macro) function performed'];
3. Using topological overlay (intersect), we proceeded to extract the past polygons from class 2 (agricultural areas) to class 1 (artificial areas) (respectively, from 1990 to 2000 and 2006 for the CLC and from 1983 to 1996 and 2006 for

[8] Corine Land Cover and BDCS (Banca Dati sulla Copertura del Suolo) of the Veneto Region, that is.

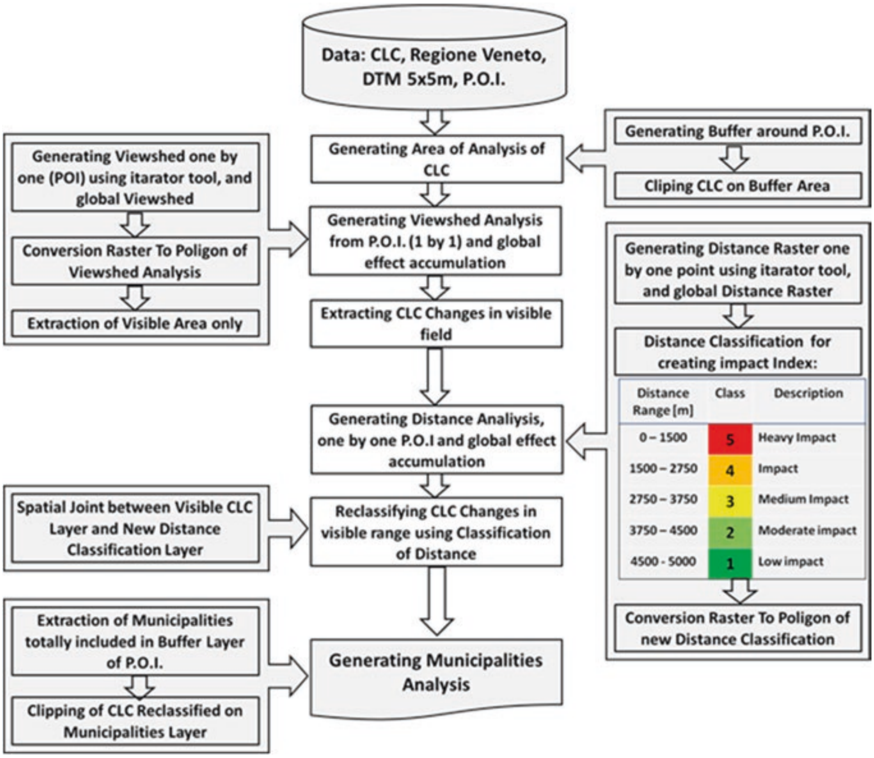


Fig. 2.3 Outline of the methodology used in Step 4–6 (viewshed and distance analysis). The example given refers to the analysis of CLC data. When analysing the dataset of the Veneto Region, the team followed the same steps. *Source* Charts by L.S. Rizzo (2014)

the regional figures). Furthermore, with regard to agricultural and viticultural practices—such as for example the new vineyard plantings on high-altitude hillsides—we used the same approach, transferring the past polygons from classes 1 and 3 (woodland territories and semi-natural environments) to class 2. This allows us to quantify the changes in the landscape. Our procedure highlights the accentuation of artificial modelling of the land or—on the contrary—its return to a natural state; moreover, it permits us to calculate indices of synthesis: the percentual rate of change (not on an annual basis but by period/interval) and its actual effects in terms of hectares.[9] Using the same approach, we analysed the changes to the third degree of detail, to which we refer the reader elsewhere for reasons of space (Rizzo et al. 2014). In order to validate the work carried out, we decided to convert into KML format the layers in shape format deriving from the overlay procedure we implemented. As is well

[9] The data sets (Corine Land Cover and BDCS of the Veneto Region) were, of course, treated separately.

known, Google Earth is capable of opening KML and KMZ files. We visualized the results of the study in 3D. Superimposing the files produced on the orthophotos uploaded in Google Earth allowed us to verify that the polygon does indeed correspond with the new registered land use.

4. Subsequently, the DEM—on which in particular our visual analysis was based—was generated using the technical maps of the Veneto Region. These, dated 2005, are distributed on a scale of 1:5000, presenting an error of measurement of around 1–2 m in the x-y plane and about 2–5 m in the z plane. The elements that make up these maps are for the most part three-dimensional. Two-dimensional elements, such as contour lines, triangulation points, roads, waterways, and anthropic elements, such as supporting walls and discontinuity, have information regarding their elevation that is also useful for creating the model. Consequently, these were also transformed into three-dimensional elements. This process is called for two stages: (a) construction of a triangulate irregular network (TIN) model and (b) transformation from the TIN for the generation of a raster with 5×5 resolution/a 5×5 grid.
5. Remaining within the ambit of the methodology applied to the research being carried out here, we went on to make a visibility analysis[10] of the case study area in two stages: of the individual points of interest and of the route as a whole. Initially, we created a zone visible from a given position (the individual POI): the so-called viewshed. To do so, we used a DEM to calculate—by means of an algorithm—the difference in elevation of a cell (optical cell) compared to one nearby (target cell). In order to establish the visibility of the latter, one examines (for each cell) the line of sight between the observation point cell and that of the destination. At the moment when the highest value cells coincide with the target ones, one's line of sight is blocked. With regard to the destination cell, this is part of the viewshed as long as the line of sight is not blocked. If the contrary is the case, this cell is not included in the viewshed. In the study described here, this analysis was carried out with the aim of identifying which areas that have undergone land-use change form part of the visible output raster.[11] As mentioned above, two different scenarios were generated: (a) viewshed analysis referring to each individual POI; (b) analysis referring to all of the individual POIs. Masks were obtained as outputs which, in a

[10] For the visibility study, we referred to the viewshed techniques utilized over the last few decades (Fisher 1996; Llobera 2003; Štefunková and Cebecauer 2006; Qiu et al. 2011; La Rosa 2011).

[11] We should like to specify that, in this phase of our work, we decided to apply visual analysis and distance analysis only to the results of the overlay analysis carried out on the Veneto Region's data set on land use and coverage. We decided to make reference to other data sets apart from that of the CLC in order to 'correct' the lack of precision due to its low resolution. Though highlighting a growing and pervasive distribution of artificial areas, Corine does not register small changes which, however, when added together, have a definite influence on the maps produced. This finds confirmation in a reading of the metadatum: though the Regional data use the same nomenclature as Corine, the two data sets are not homogeneous.

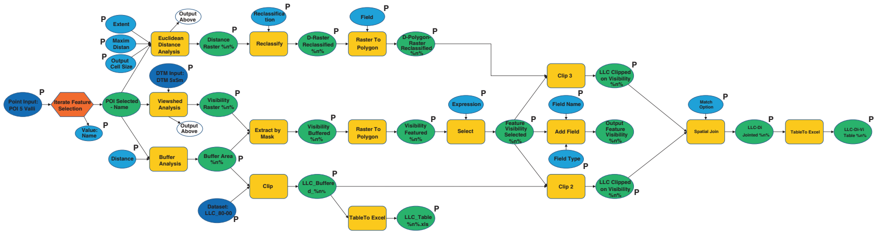


Fig. 2.4 Model builder. Example of the model created for the analysis for and from individual POIs. *Source* Chart created (in ArcGIS 10.2) by F. Smerghetto (2014)

subsequent phase, were superimposed on the elements of land-use change and on the distance from each individual POI.

6. Once we had performed out the visibility analysis, we carried out Euclidean distance analysis using Euclid's theorem that allows one to calculate adjacent cells with respect to a given observation cell (starting point for the process of analysis). This allowed us to identify at what distance the various land-use elements[12] were located with respect to the individual POIs. We then proceeded to carry out a reclassification based on putative impact on the field of vision. This reclassification refers to distances. Considering a buffer zone of 5 km,[13] we identified the classes of impact as a descending hyperbolic function, as shown in the figure.

All of the analyses—reclassification of the data associated with topological overlay, as well as visibility and distance analyses—were carried out using the Model Builder tool, the use of which is briefly described hereafter (Fig. 2.4). By means of an iterative process for each POI, we obtained an initial visibility analysis from which to generate the mask of the visible areas. It was necessary to transform

[12] Such as those on which the changes in land use we registered are based.

[13] The decision to have a 5-km buffer zone derived from the 'combination' of the concepts of visibility and slow tourism. The analysis of intervisibility, often used to determine the impact that major works/buildings have on the territory, considers both short- and long-range visual perception. The field of vision of the human eye varies according to the physical, chemical and environmental conditions prevailing in a given moment. This—usually depending on distance, on the altitude of the observer and on clarity (often influenced by the humidity of the particles suspended in the air)—may vary from a minimum of 3000 m to a maximum of 250,000 m. Slow tourism, on the other hand, has as its objective to move around the territory in a relaxed and attentive manner (Babou and Callot 2009). Priority is given to observing perceptible details in the vicinity rather than to allowing one's gaze to 'wander' into the deeper recesses of the landscape and of what is visible on the horizon. Our choice therefore fell on a (relatively short) distance to which we could rigorously apply a visibility analysis that allowed us to give greater emphasis to perceptible details. Also, we should like to remind the reader that we are dealing with entities which, in the municipalities being studied, are not particularly high. Therefore, if one is thinking in terms of taking advantage of the countryside, one's 'view' is affected more by a change in colour than by the obstruction of one's field of vision by elements of considerable size (e.g. wind farms).

the above-mentioned area into a polygon and extract just the visible areas. Subsequently, we created the distance with a buffer limit of 5 km, reclassified that raster according to the classes of impact we had established and converted it into a polygon. By means of clipping operations, we thus extracted those areas where visibility was significant with regard to land-use change. Finally, by means of a spatial join, we attributed impact values related to the distances and the elements of land-use change. An analogous procedure was performed for the analysis carried out on the various municipalities included in the area under examination.

The implementation of the steps mentioned allowed us to produce appropriate thematic cartographies.

Discussion of the Results

The 'Chosen' Route: Five Valleys in the Eastern Hills of the Province of Verona.[14] *A Short Description*

Once the area had been chosen—and after having finalised the evaluation process of its resources—it was decided to use the route just traced by R.G. Rizzo and available in the Internet. It is important to specify that it runs mostly through hilly areas. Their surface is characterized by little villages and isolated houses in a rural landscape. The route crosses the five ranges of the Lessinia region and also reaches flat territories such as the plains of the valleys at Mezzane di Sotto, Tregnago and Soave. The scenic driving or walking route starts from San Martino Buon Albergo and ends in the walled town of Soave. It passes through seven municipalities and the sites of (1) San Martino B.A., (2) Ferrazze, (3) Montorio (Verona), (4) Pian di Castagnè, (5) Postuman, (6) Mezzane di Sotto, (7) Mezzane di Sopra, (8) Tregnago, (9) Marcemigo, (10) Illasi, (11) Costeggiola, (12) Castelcerino, (13) Fittà, (14) Monteforte d'Alpone and (15) Soave. It covers about 100 km in the Squaranto, Mezzane, Illasi, Tramigna and Alpone valleys. With 29 multi-thematic POIs, it crosses a landscape of vineyards and olive groves, but also of heritage villages, Venetian Villas, castles and ancient churches. The whole territory is quiet and dotted with wineries and small restaurants serving typical local food, and it is well served by winding bike trails and footpaths (Fig. 2.5).

[14] Route no. 3 stretching for 100 km by R.G. Rizzo *Le 5 valli nelle colline orientali veronesi* in http://www.openstarts.units.it/dspace/handle/10077/9911. The route with 29 POIs (see the photographs of the buildings and landscapes) can be seen in the maps using: Google Streets, Google Maps, Bing Maps or Bing Satellite.

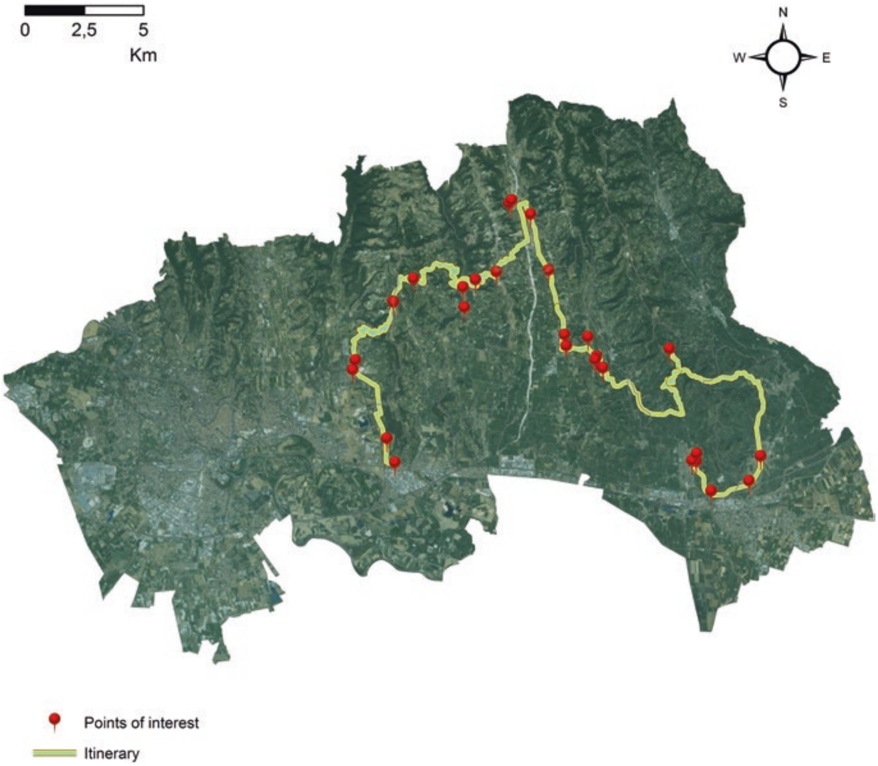


Fig. 2.5 Tourist route traced in 2013–2014 by R.G. Rizzo and available in Internet (http://www.openstarts.units.it/dspace/handle/10077/9915). *Source* Map created by R.G. Rizzo (2014)

Land Use in the Area Covered by the Study. For a Quantitative Level 1 Evaluation of the Regional Data

The results obtained will be discussed, first focusing on the province of Verona, then on the municipalities listed above and—lastly—on the buffer area at 5000 m. The provincial data will 'function' as a benchmark against which the performance of the municipalities will be 'weighed' and to determine the virtuosity of the trajectory made by the territories or, conversely, the regressive character of the same.

The province of Verona—The landscape profile and the land use appears to be affected by a significant change. The analysis has therefore aimed to do the following: (a) verify how much of the surface has changed its intended use; (b) understand which classes have favoured from this and which have been disadvantaged. It was then decided to further analyse both the period 1983–2006 and the two intervals 1983–1996 and 1996–2006. This was done at level 1 and at level 3 of the classification, both for the CLC and for the data produced by the Veneto Region. Only the latter, however, is reported here.

The implementation of the topological overlay procedures on the total years covered by the database reveals that the change which took place particularly favoured the macro-class 1. A total of 8016 ha changed their intended use between 1983 and 2006 and have been classified as 'artificially modelled territories'. The class that has been replaced, however, has been class 2 (99 % of the total changed hectares). Conversely, a small number of hectares (48) were 'lost' in favour of classes 2, 3[15] and 5.[16] A study that takes into account the two sub-intervals (1983–1996 and 1996–2006) highlights that the most pronounced change regards the first period (57 % of the total, when considering the hectares that switch to class 1). However, the phenomenon is also evident (43 % of the total) in the second period. For literature on the modes of dissemination of the urbanization from Verona—the capital city of the province—to the municipalities of the first belt and then of the second urban belt, especially along the radial lines of communication that come out of it, and with phenomena of building growth within the same ranges in recent years (see Robiglio and Rizzo 2009). Over the years, industrialization has been established, especially with the phenomenon of industrial clusters, a commercial tertiary and of various services—even quaternary—and logistics for the transport and exhibition nodal role of Verona at the national and European level (Robiglio 1996, 2009). Added to this is the tourism function of Verona city, UNESCO. Built-up areas are also taken into account, due to expanding tourism in the Verona side of the internationally acclaimed Lake Garda (over 11 million overnight visitors in 2013), with a lakeside tourism, along with theme parks, and tourism based on culture, wellness, food and wine.

The level 1 analysis only gives a small indication of the changes in the land use and cover that occurred between 1983 and 2006. It was then made a more in-depth analysis. By disaggregating the data at level 3, details have emerged that we believe are noteworthy. For example, when there is a change in intended use in favour of the 'artificially modelled territories' class, it was found that the sub-classes involved are 1.1.2 (discontinuous urban fabric) and 1.2.1 (industrial or commercial units) at 30 and 40 % of the hectares, respectively. It was also noted that this occurs mainly at the expense of the sub-classes 2.1 (Arable) and, in a much less pronounced manner, 2.2 (permanent crops).

Focus on the seven municipalities in the itinerary and on the buffer at 5000 m—Focusing on the territory of the seven municipalities crossed by the tourist itinerary has allowed the clear illustration of how the changes are often not contained and mainly affect the following areas: the municipalities of Verona, San Martino Buon Albergo and Soave. The analysis of the three thresholds at level 1 enables the outlining of the following profile: approximately 1400 ha switch from class 2 to class 1 (non-negligible figure, given that it represents 20 % of the total change detected at the provincial[17] level and represents almost the totality of

[15] Forested territories and arable land.

[16] Water bodies.

[17] It should be noted that the Province of Verona comprises 98 municipalities.

Table 2.1 Province of Verona and the 7 municipalities: sealed area and LUCCs (1983–2006). *Source* Data processed by L.S. Rizzo (2014)

Admin. unit		Indices				
		Sealed area: % on tot. (ha)		Var % 2006–1983 (CL. 1)	Class change (1983–2006)	
		2006	1983		% on tot. (ha) of the admin. unit	ha
Prov. of Verona		13.6	11.0	23.4	2.6	8063.5
Municipality	*All together*	*23.4*	*19.5*	*20.0*	*4.0*	*1417.0*
	San Martino B.A.	20.2	16.7	21.0	3.5	122.1
	Mezzane di Sotto	7.9	5.9	33.1	2.0	38.5
	Tregnago	6.6	6.0	10.7	0.6	23.9
	Illasi	11.0	9.2	19.9	1.8	45.4
	Soave	*16.1*	*10.7*	*50.9*	*5.4*	*123.2*
	Monteforte d'Alpone	14.0	10.9	28.1	3.1	62.7
	VERONA	32.1	27.1	18.3	5.0	1001.0

hectares that become artificial areas). When other changes are revealed, towards class 3 and/or 5, for example, the values considered, in hectares, are negligible. Overall, the growth rate of the built-up areas stands at +20 %, with peaks of 50 % in the case of Soave, and 33 and 28 % when considering the dynamics expressed by the Municipality of Mezzane di Sotto and of Monteforte d'Alpone (Table 2.1).

A study that considers the two sub-intervals (1983–1996 and 1996–2006) reveals that the processes that have transformed the territory were mainly deployed in the first period: it refers to 70 % of the hectares that have changed intended use. The figure—of which the Municipality of Mezzane stands out (85 %), although in line with the provincial trend—occurs in a more pronounced manner with respect to this. The drive to land consumption—despite still being considerable—seems, however, to be slowing down (probably due also, and above all, to the economic crisis). Where there are changes of intended use that artificially shape the land and change the landscape, this is still to the benefit of the sub-classes 1.2.1—which on average stands at 40 % of the total (except for Mezzane)—and 1.1.2 ('discontinuous urban fabric'), to the detriment of 'agricultural' sub-classes (as expected). Switching to class 1.1.2—on average 24 % of the hectares that are transformed into built-up areas—is equal to almost 50 % of the hectares affected by the change in the municipalities of Monteforte d'Alpone and Soave.

The area covered by the buffer at 5000 m, last but not least, stood at 39,500 ha. Within this, 1220 ha have been lost, which have changed their intended use to favour class 1. A quantity that represents 86 % of the total shown above refers to the municipalities crossed by the route. A quick examination shows that the phenomenon was particularly evident in the period 1983–2006 and that it is characterised in line with what has already been described (Fig. 2.6).

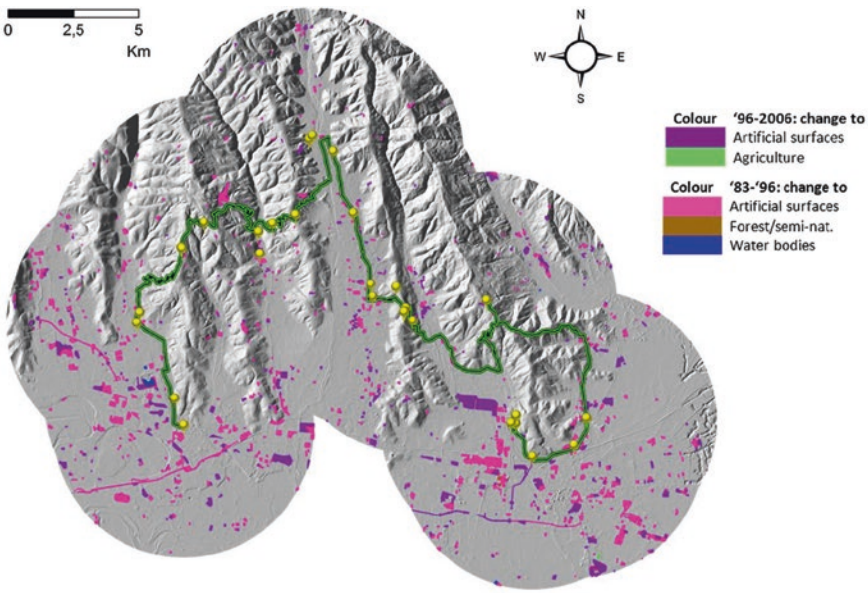


Fig. 2.6 5000 m buffer area: LUCCs 1983–1996 and 1996–2006. *Source* Map created by R.G. Rizzo (2014)

Land Use, Landscape and Visibility: Possible Negative Interactions? POI Classifications by Impact Assessment of LUCC

The analysis from and for individual POIs has provided intervisibility evaluation and the classification of the visual impact as a function of the changes in land use. It allows one to rank all POIs in terms of how problematic their (individual) relation with LUCCs is in terms of landscape fruition. For space reasons, though, it is not possible to analyse the full impact on each POI (Fig. 2.7). For a fuller account, we refer the interested reader to the authors' work. This short article is confined, for space reasons, to some essential points emerging from the remaining two levels of analysis.

Global effect (*POIs*)—The extension of the analysis area was—as said—a total of 39,435.5 ha. Within this, the area affected by the changes in land use consists of 1220 ha, equal to 3 % of the total analysis. If considering the area affected by the visual impact that falls within the 5-km buffer, it is 6,140 ha (about 16 % of the total area). What remains is the extraction of the areas of the land-use field falling within the visible areas. These amount to 178.5 ha: 3 % compared to the visible area and 0.45 % with respect to the buffer area. Now, examining the classification carried out, the predominant class observed is 5 (the class with the greatest impact). In fact, it occupies a surface of 83 ha within the area of visual impact, equivalent to 1.5 %. The other classes, from 4 to 1, respectively, occupy 55, 24, 13 and 2.7 ha or rather 0.8, 0.3, 0.2 and 0.04 %. These percentages do suggest that the zones are affected by the change to the territory that is taking place.

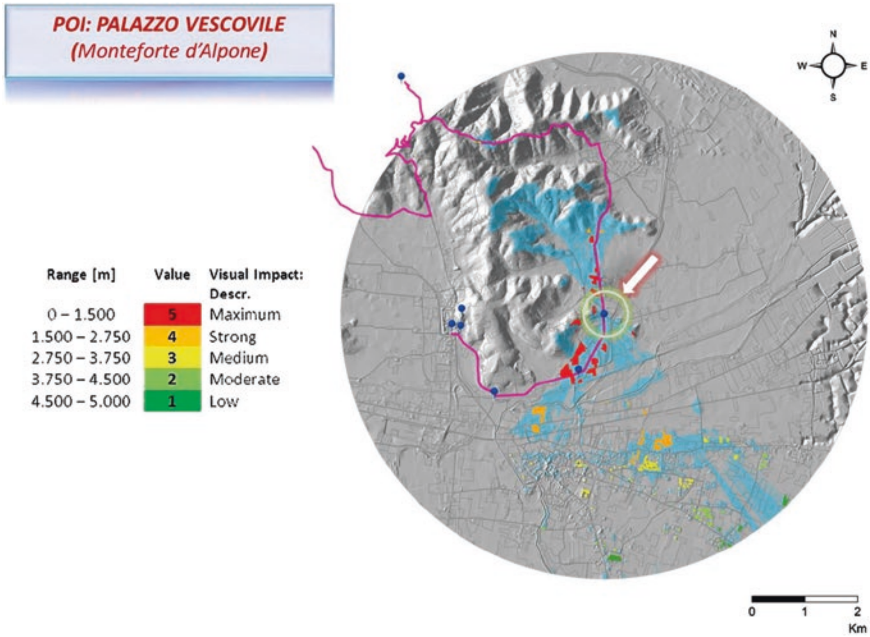


Fig. 2.7 Impact of LUCCs in the (blue) area visible from the POI "Palazzo vescovile" in Monteforte d'Alpone, within the 5 km buffer zone (all LUCCs refer to a switch to class 1 of the CLC classification adopted in the dataset of the Veneto Region). *Source* Map created by L.S. Rizzo (2014)

A study of the data according to sub-interval (1983–1996; 1996–2006) reveals a trend consistent with what was discussed in the previous paragraph. In the first interval, at 109 ha, the model attributes a notable impact on the perception that the tourist may have of the landscape (52 ha fall within class 5; 43 in class 4; and 14 in class 3). In terms of total hectares, the phenomenon is less pronounced in the subsequent period. Comparing the two intervals, it can be seen that there is an increase in the weight of the POIs that fall within class 5, in relative terms: that is, which is associated with the maximum impact (which switches from 44 to 52 %). Conversely, the distribution of the remaining classes is more homogeneous (class 2 increases—which expresses a moderate impact—of three percentage points and class 3—medium impact—of five). Furthermore, class 4 drops by 17 % points (Fig. 2.8).

Analysis per municipality totally included within the buffer area examined—The analysis developed in the municipal territory was carried out on those communes that are totally included within the 5-km analysis buffer zone. This decision was dictated by the desire to avoid any error that might be linked to the proportional analysis defining the relationship between the area of impact within the commune and the total area of the municipality. The changes we found fall within impact level 5, which comprises a total area of 46.47 ha; we also registered 6.49 ha with an impact of 4, 0.68 ha with an impact level of 3 and 0.63 ha with class 2 impact. Such a scenario goes to show that the changes have influenced areas in the vicinity of landscape resources or points with panoramic views. One

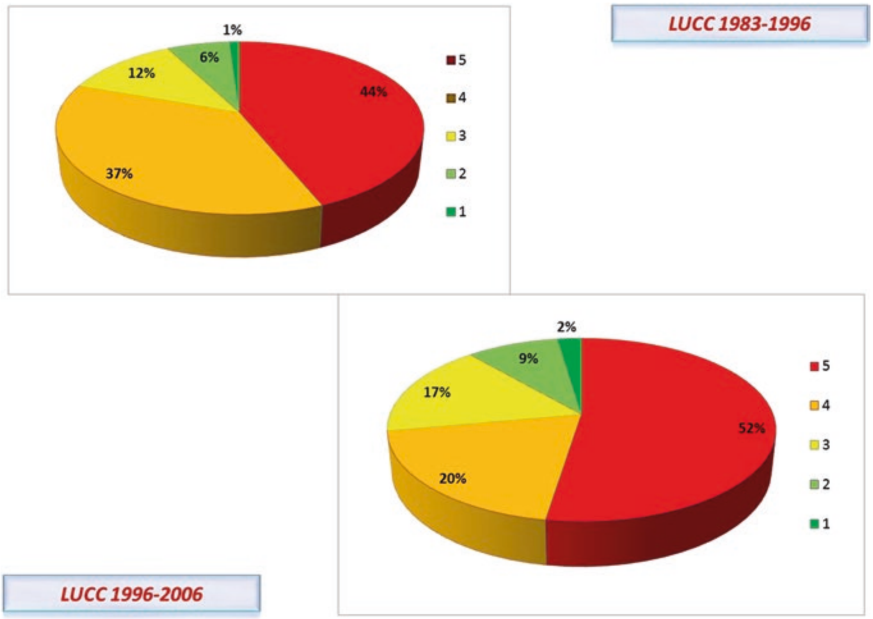


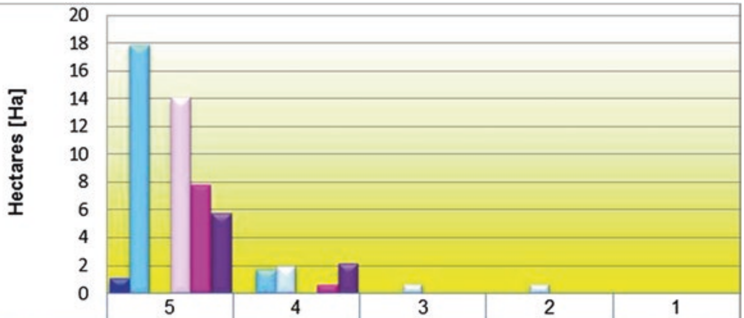
Fig. 2.8 LUCCs 1983–1996 and 1996–2006: hectares (in percentage) associated with the classes of impact. *Source* Data processed by F. Smerghetto (2014)

finds, moreover, that these impacts are to be noted mainly in flat areas. Passing on to the relationship defined earlier, we note that class 5 considers a rapport of 0.4 %, while the others are considered as practically of zero value. Considering the details with regard to the municipalities, one can carry out two evaluations: (1) by area and (2) by level of impact. With regard to the area devoted to change in land use, the most virtuous municipalities are Monteforte d'Alpone and Soave, with 1.03 and 2.23 ha, respectively. The commune with the greatest variation in its territory is Lavagno with 19.65 ha, followed by Illasi with 14.06 ha. Taking the level of impact in examination, Soave is the most virtuous, followed by Monteforte d'Alpone. Lavagno and Illasi remain unchanged with alterations in land use falling in impact class 5 virtually throughout their territories (Figs. 2.9 and 2.10).

Conclusions and Cues for Reflections

The work has aimed to test methods and identify tools that can be used synergistically and immediately by collective players, interested in operationally reasoning on the link between land use, landscape and tourism planning.

Recent advances at the level of representation systems and spatial analysis, together with the development of theoretical approaches that reflect on the concept of territory, have enabled the development of a synthesis. The outcome is the



	5	4	3	2	1
Monteforte d'Alpone	1,03	0,00	0,00	0,00	0,00
Lavagno	17,91	1,74	0,00	0,00	0,00
Soave	0,00	1,93	0,67	0,63	0,00
Illasi	14,05	0,01	0,00	0,00	0,00
Mezzane di Sotto	7,79	0,66	0,00	0,00	0,00
Cazzano di Tramigna	5,69	2,15	0,01	0,00	0,00

Fig. 2.9 Total change (ha) within the municipalities wholly comprised in the 5 km buffer zone. *Source* Data processed by F. Smerghetto (2014)

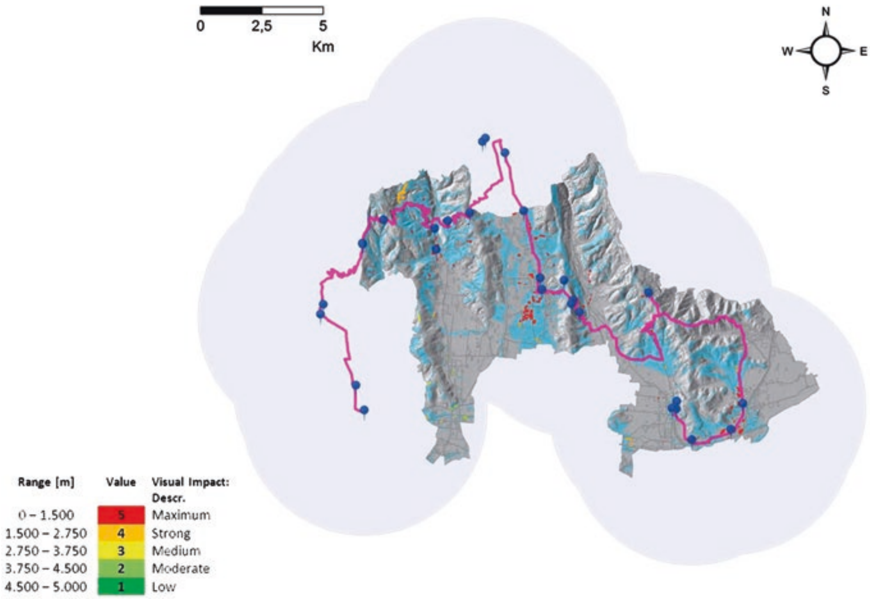


Fig. 2.10 Visible LUCCs (in blue) within the municipalities totally comprised in the 5 km buffer zone: classes of impact (all LUCCs refer to a switch to class 1 of the CLC classification adopted in the dataset of the Veneto Region). *Source* Map created by L.S. Rizzo (2014)

proposal of a model through which the reflective contribution of the cartography can primarily emerge, to promote a more sustainable exploitation of the landscape assets in complex territories, and long-term management of their enhancement. This model helps us to identify spatial relationships between the route under construction and land-use-related processes. A by-product is the identification of weaknesses in the valorisation strategy (i.e. the proposed POI), on which local communities are able to intervene. The methodology is certainly innovative when applied to the field of tourism. It could instead be partly reinforced when considering the uses that could be made of it—especially at the level of visual analysis—to evaluate the impact that large buildings have on the landscape.[18]

The identification of a more appropriate scale of impact will be the subject of subsequent reflections by the research team. The work presented here aims to act as a first step. It requires refinement, in order to find solutions that solve the risk of an otherwise approximate assessment. In this study, the scale of impact was based on the distance factor, limited to the meaning expressed in Euclidean terms. The need that is perceived is that of refining the model in a way that takes into account the multiple factors that contribute to 'defining' the complexity of the impact of changes in land use, subject of the study. Potential 'catalysts' on which to reflect for designing a tool for comprehensive evaluation, in addition to the distance as defined above, are identified in the range of geometric and topological factors, such as shape, layout and fragmentation.

No less important is the analysis of the territory, incorporating georeferred data into the model relative to the approved transformability (parts of the urban and territorial planning, or created by ad hoc editing). For the present work, the planning information has not currently been made available by the institutions. Applying the model to them—both the developed one and its more elaborate version—would allow projection of the analysis into the future and to produce scenarios that can diachronically reflect, in greater depth, on the rate of transformation of the territory and the direction that it expresses. It could have, in fact, positive or negative implications, where it is orientated towards greater naturalness or towards a growing artificialization that may not be adequately controlled in the results and that outlines the establishment of:

- an increasing geometrization and homogenization of the landscape;
- (conversely) a random territorial development;
- a marked differentiation of the natural and landscaped components.

All of these are aspects which, when considered through an impact index that is capable of reading them, could generate evaluations with diametrically opposite results in different analytical situations.

Beside top-down decisions (to which our model could contribute), the fruition of rural countryside landscapes could increasingly benefit also from the adoption of a bottom-up approach. The creation of participatory maps based on community

[18] For example, wind turbines for energy production.

perceptions—despite its actual known limitations (Mather 2000)—could complement the traditionalGIS-based route building, furthering the identification of relevant POIs (landscape-wise). Integrating the 'official' spatially referenced data making use of information possessed—and delivered—by community groups or project-affected people could allow to access yet untapped sources of precious local spatial knowledge (Vajjhala 2005; Dunn 2007). Despite not being our focus, we are well aware of how the above could complement the tools tested by the research team.

Acknowledgements The contribution is a result of authors' joint work. Luca S. Rizzo, though, wrote: *Routes and regional development and Build-up and landscape* and ***Structure of the Paper*** in paragraph **Conceptual References**; ***Objectives*** in paragraph **Research Design; Procedures Carried Out (points: 1–3)** in sub-paragraph ***Methodology*** (also in paragraph **Research Design**); Focus on the seven municipalities in the itinerary and on the buffer at 5000 m in sub-paragraph ***Land Use in the Area Covered by the Study***. ***For a Quantitative Level 1 Evaluation of the Regional Data***; Global effect (POIs) in sub-paragraph ***Land Use, Landscape and Visibility: Possible negative interactions? POI Classifications by Impact Assessment of LUCC*** (in paragraph **Discussion of the Results**).

Raffaela G. Rizzo composed: Tourism and cultural routes in paragraph **Conceptual References**; ***The Case Study Area: An Overview*** in paragraph **Research Design**; ***The 'Chosen' Route: Five Valleys in the Eastern Hills of the Province of Verona***. ***A short description*** in paragraph **Discussion of the Results**; The province of Verona in sub-paragraph ***Land Use in the Area Covered by the Study***. ***For a Quantitative Level 1 Evaluation of the Regional Data*** in paragraph **Discussion of the Results**.

F. Smerghetto wrote: **Data sets used** and **Procedures carried out (points: 4–6)** in sub-paragraph ***Methodology*** in paragraph **Research Design**; Analysis per municipality totally included within the buffer area examined in sub-paragraph ***Land Use, Landscape and Visibility: Possible negative interactions? POI Classifications by Impact Assessment of LUCC*** (included in paragraph **Discussion of the Results**). In addition, the paragraph **Conclusions and Cues for Reflection** is by all three authors. All the maps created were produced with ArcGIS 10.2.

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Chapter 3
Assessment of the Exposure of Tourism-Related Landscape Values of the Silesian Beskids Based on Computer Visualization

Jerzy Nita, Urszula Myga-Piątek and Damian Absalon

Abstract This paper presents an analysis of the visibility of landscape values, which are important in terms of tourist attractiveness. The paper focuses on the area of the Silesian Beskid Mountains, which have highly diversified (in terms of structure, functionality and physiognomy) natural and cultural values. Due to its location near large urban agglomerations, the region enjoys high tourist interest, and it hosts intensely used recreation facilities. However, as a result of changes in land use and excessive afforestation, the area has lost its sightseeing value, which could result in the decreased interest of tourists and a loss of identity determinants in the landscape in that region. The foundation of tourist attractiveness lies in the visual diversity of elements of the natural and cultural landscape. Forests, which are common in the Beskids, are of unquestionable ecological value; however, from a tourist's point of view, their prevalence creates scenic monotony and decreases visual attractiveness because they hinder the perception of other valuable forms of landscape (e.g. surface features, hydrographic objects or cultural entities). The article presents existing and possible (computer simulated) states of landscape where the improvement of physiognomic value is planned. To visualize landscape values, the authors used methods and techniques of computer-aided modelling. Interpretation was based on topographic maps at various scales, aerial and satellite photos, a digital elevation model (DEM) and digital thematic maps.

Keywords Landscape · Visualization · Valorisation · GIS

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Theoretical Inspirations and Terminological Presumptions

Landscape is a basic research notion in geography, which uses a number of research methods and approaches also multiple definitions (Myga-Piątek 2001, 2005a, b, 2012; Ostaszewska 2002), but in tourism, landscape is considered a basic resource (Andrejczuk 2010; Myga-Piątek 2006, 2010, 2011). Landscape is also an essential indicator of regional identity (Myczkowski 2003; Myga-Piątek 2008). For the needs of the present article, the authors have adopted the pragmatic definition of landscape following the document of the European Landscape Convention (Journal of Laws of 2006), which defines landscape as "an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors". The notion of landscape management is referred to as "action, from a perspective of sustainable development, to ensure the regular upkeep of a landscape, so as to guide and harmonise changes which are brought about by social, economic and environmental processes". The convention also specifies another practical aspect of human action in landscape by stating that "landscape planning means strong forward-looking action to enhance, restore or create landscapes".

The region of the Polish Carpathians enjoys much tourist interest because of its landscape (natural and cultural) value (Plit 2004; Myga-Piątek and Nita 2004). The range of the Silesian Beskids, which is described in detail herein, is situated near the urban agglomerations of Katowice, Bielsko-Biała and Krakow, thus providing tourist facilities for several dozen cities in the region. The Silesian Beskids are explored by tourists all year long. What inspired the authors to explore this topic was the observations that the Beskids tend to contain excessive afforested areas of scenic attractiveness and monotonous forests within the Silesian Beskids Landscape Park. At present, unfavourable socioeconomic processes occur in the analysed region, affecting the landscape. These processes include the following:

- abandonment of Beskidian pastureland and continuous succession of forests onto hilltops;
- uncontrolled and dispersed growth of human settlement in valleys and lower sections of hillsides (including building second houses and seasonal-summertime settlements);
- intense expansion of tourism-related infrastructure (skiing routes, surfaced tourist routes, parking lots, inns, access roads);
- development of accompanying infrastructure (catering and accommodation facilities).

As a result, the diversity of usage surrenders to physiognomic unification. Traditional methods of agriculture and settlement formation have become subjected to tourism and modern building styles. Villages have become locations with an urban architectonic style. The mountain-related identity of the place is vanishing. Consequently, it is necessary to protect and reinforce the existing scenic and cultural distinction. Sustainable landscape management, including the needs

Fig. 3.1 Location of the Silesian Beskids in relation to Poland and the Western Carpathians

of tourism, should be preceded by professional cartographic analyses. These analyses would help assess the attractiveness of tourist regions so as to expose the most valuable places while planning and controlling tourist traffic. The GIS-aided analyses presented in this article make it possible to set scientific foundations for guidelines regarding the protection and reinforcement of the Silesian Beskids.

The scenic value of selected areas of the Beskids (Fig. 3.1).

Landscape parks (as the name suggests) should be the most efficient form of legal protection of the landscape, contributing also to the needs of tourism (Pietrzak 2005; Solon 2004; Nature Protect Act 2004). The preservation form of land protection, which currently dominates, combined with excessive tourist activity (tourist absorption and capacity), causes changes not only in the natural environment but also, if not first of all, in the physiognomic value of the region. Also, numerous obstacles appear in the management of landscape park areas (compare Poskrobko 2008; Zimniewicz 2008).

It seems absolutely appropriate to make use of the European experience as well as good and bad practices in actions aimed at developing the landscape and making it available, e.g. to tourists (compare Dolnicar et al. 2008; Ewald 2001; Haines-Young 2007; Gerlée 2008; Klijin 2004; Millera et al. 2010; Zsilincsar 2009).

The Objective, Scope and Methods of Research

The experience gained by the authors while working on the valorization and protection of the landscape does not always bring about optimistic conclusions, and it raises numerous questions. Decisions regarding establishing a landscape park and its borders were based on pragmatic factors (e.g. the range of communes, state property, little-urbanized areas), which is why many genuine values stayed outside the borders of the Silesian Beskids Landscape Park. The environment, and particularly animate nature, became protected in an institutionalized way. There are still doubts concerning the degree to which the landscape should be protected as a whole rather than selected entities or species. Was the area of the landscape park delimited with regard to genuine complex scenic and natural-cultural values? Were the borders of the landscape park not determined based on a unilateral approach and on the protection, e.g. of animate nature values only? To what extent do the originally delimited borders of parks (determined over 30 years ago) include the most important landscape values, and how should these borders be currently verified?

These questions compose the main objective of the article, which is an attempt to assess landscape values as a leading tourist attraction and to determine computer-simulated ranges of visual accessibility of sightseeing values of the Silesian Beskids Landscape Park and its protection zone from selected peaks that are most frequently visited by tourists. The results of these analyses should be used to verify further plans for park protection and to work out strategies for the sustainable development of tourism. The results will also make it possible to direct tourist traffic more precisely towards places of scenic attractiveness by means of guidelines for building infrastructure harmoniously composed in the landscape (e.g. viewpoint towers, specially designed scenic routes or campsites).

One of the most efficient methods of assessing landscape values is to analyse their visibility (Nita 2001). Thus, among other methods, the research methodology consisted of field comparative analysis within the Silesian Beskids Landscape Park with a map of selected landscape values (Fig. 3.2) and viewpoints.

The analysis employed GIS technology and tools, and the interpretation was based on topographic maps at various scales, aerial and satellite photos, a digital elevation model (DEM) and digital thematic maps (Absalon et al. 2004; Absalon and Jankowski 2001; Nita 2002; Nita and Małolepszy 2004; Nita et al. 2007; Li et al. 2005; Kurczyński et al. 2007). During the research, the authors used various GIS software (ArcInfo, MicroStation, MapInfo, Vertical Mapper, Global Mapper, and Ilwis) to build databases and create visualizations. SRTM-3 data from NASA and Landsat 7 imagery (14.25 m pixel size) were also used. These data are public and are available for Europe, including Poland. The DEM is from the radar topography mission of the space shuttle Endeavour during February 2000 (Gotlib et al. 2006; Irvin et al. 1997).

Parts of the paper use black-and-white aerial photos at a scale of 1:13,000 commissioned by the Agency for the Restructuring and Modernisation of

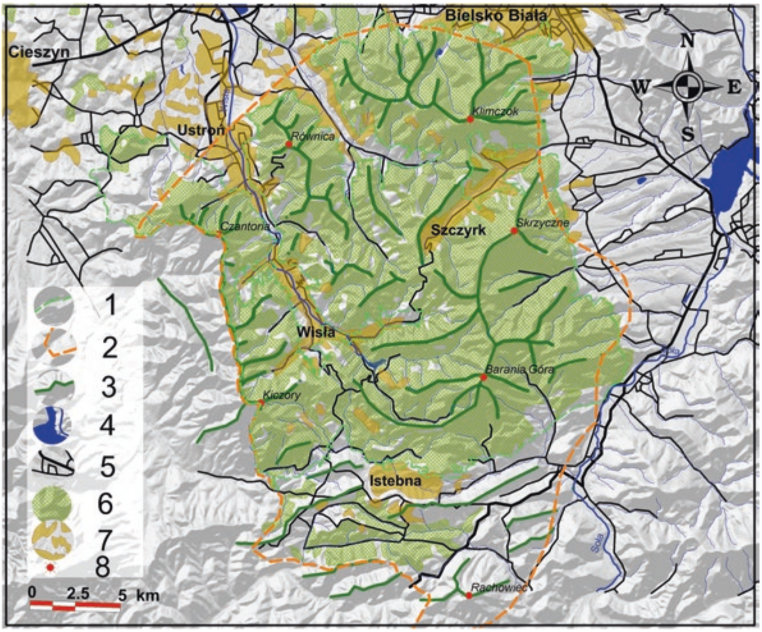

Fig. 3.2 Distribution of natural values of the Silesian Beskids: *1* boundary of landscape park, *2* boundary of the Silesian Beskids, *3* dorsal lines, *4* rivers and water reservoirs, *5* roads, *6* forests, *7* buildings, *8* selected elevation points

Agriculture and the Main Office for Geodesy and Cartography in 2003. To determine the visibility range of the landscape, the authors performed analyses using unprocessed digital models (DEM), which visualize the layout of the infrastructure and plant cover in the area, and processed models (DTM—digital terrain models), which only visualize the surface features (Torlegård et al. 1986).

Scenic Landscape Characteristics of the Silesian Beskids

The Carpathian region is characterized by a large area of legally protected land, amounting to 5256.36 km^2, which is almost 30 % of the total area of the Polish part of the Carpathians. The natural and cultural values of the Carpathians are confirmed by the high density of national and landscape parks. As many as 6 national parks with a total area 830.96 km^2 and 13 landscape parks with a total area of 4,425 km^2 have been established in the Polish part of the Carpathian range (compare Plit 2004; Pietrzyk-Sokulska 2004). In the present article, the authors focus on the values of the Silesian Beskid mountain range.

The Silesian Beskids are the most compact mountain group of the whole Beskidian range. The Silesian Beskids are composed of two nearly meridional mountain ranges separated by the Vistula valley, which extends for 26 km meridionally and 30 km longitudinally. The eastern range of Barania Góra (1220 m a.s.l.) is much higher and has side ridges. To the north, the ridge runs towards Malinowa Skała (1152 m a.s.l.), where it is divided into the right range with Skrzyczne (1257 m a.s.l.) and the left range heading towards the Klimczok range (1117 m a.s.l.); the other is the Czantoria range (995 m a.s.l.). The northern slope of Barania Góra is where the Vistula River starts its flow. From Mount Kiczora (990 m a.s.l.) through Stożek (978 m a.s.l.) to Czantoria, the range delineates the Polish-Czech border. The north-directed range of Równica lies to the east of the Czantoria range.

The landscape values of the Silesian Beskids result from diversified surface features determined by the geological structure. The Silesian Beskids are built of massive Godula and Istebna sandstones. In the southern part, the mountains are built of Magura flysch. There are deposits of sandstone and, less frequently, limestone, which contains mining pits that are visible in the landscape. These quarries present scenically interesting compositions and geotourist attractions (e.g. the Obłaziec-Gahura quarry in Wisła and the quarry in Brenna).

The Silesian Beskids are characterized by a hydrographic network that is related to its geological structure and surface features and is regarded as an important landscape value of the region.

The landscape diversity the Silesian Beskids is emphasized by the high hypsometric contrast between the mountain ranges and the separated valleys, which reach a maximum of approximately 800 m (Fig. 3.3). There are differences in the

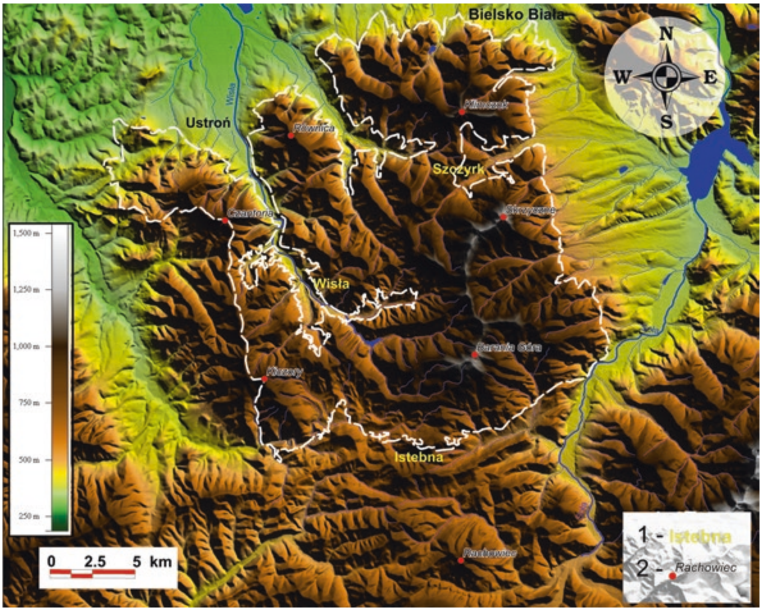

Fig. 3.3 The Silesian Beskids; DEM visualisation, NE lighting direction, the *white line marks* the boundary of the landscape park

relative height of peaks, which is the main reason for the altitudinal diversification of the plant cover in the region (Figs. 3.3 and 3.5). Morphological diversity, varied courses of the main ridges and watercourses with their valleys, spring headwalls and bog-springs as well as occurrence of natural exposures and caves should all be regarded as major values of the Silesian Beskids. The valleys, with their numerous towns situated alongside, are natural scenic axes (Fig. 3.2). Settlement concentration in the valleys (with the valleys being excluded from the area of the park and included in the protection zone) represents the most interesting natural and cultural sightseeing values related to settlement processes remaining outside the park.

The values of the Silesian Beskids are highly diversified in structural, functional and physiognomic terms. Throughout the area of the park, values of a point, linear and plane nature can be distinguished. These values can be analysed using the method of patch-corridor-matrix models in further research regarding ecology and landscape or as panorama and landscape interiors in proceedings concerning landscape architecture from the point of view of physiognomic values. Analyses using DEM and DTM imagery demonstrate that afforestation, commonly considered to be a major ecological and sightseeing value, is a dominant and excessively exposed value in the group of natural values. The forest “mutes” opportunities to perceive other valuable forms of landscape, mainly various values related to the relief and hydrographic elements. The forest makes the landscape monotonous and poorly diversified (Fig. 3.4).

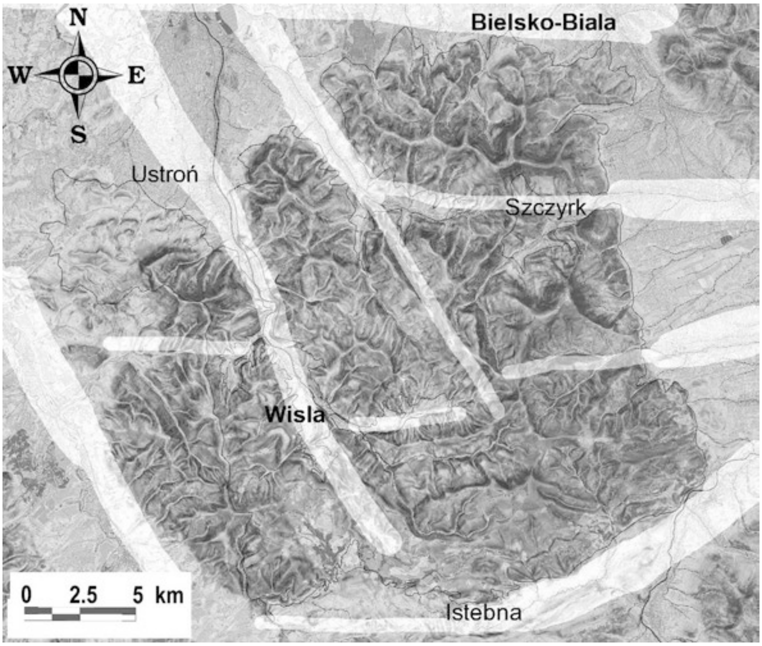

Fig. 3.4 Main scenic axes of the Silesian Beskids (*lightened areas*) against the background of a shaded DEM model overlapping a Landsat 7 composition, *N* lighting direction

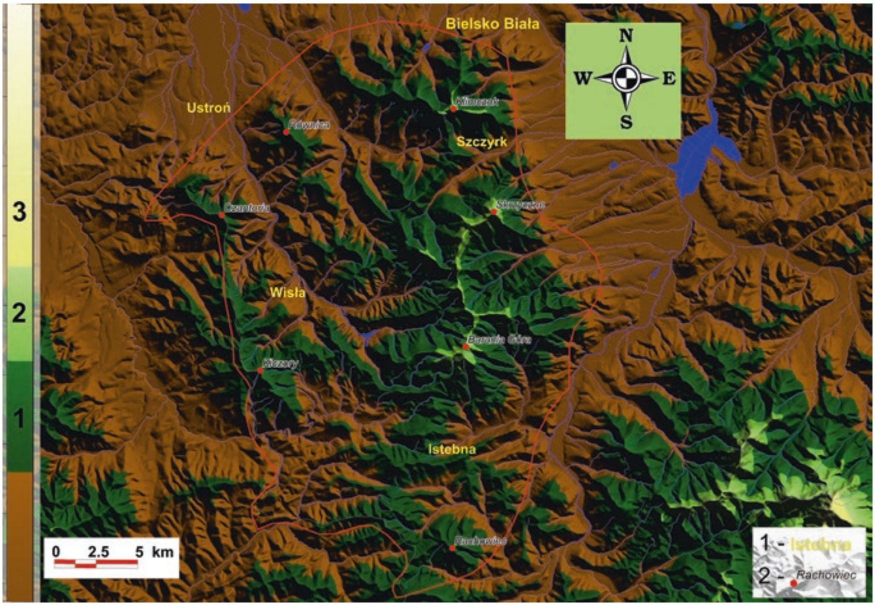

Fig. 3.5 Zonal arrangement of the landscape heights of the Silesian Beskids: *1* lower floor, *2* medium floor, *3* upper floor

The landscape of the Silesian Beskids shows altitudinal zonation (Fig. 3.5):

- a low (foothill) zone covering the inhabited river valleys and the outer forelands of the slopes of the Silesian Beskids, mainly typical of the area of the buffer zone of the park; landscape in that zone has cultural features, and it is increasingly less frequently used for agricultural purposes (up to 650 m a.s.l.);
- a middle zone found on the slopes that features natural landscape with predominant dense forest cover; this zone is the lower mountain region (650–1050 m a.s.l.);
- an upper zone, including hilltops and peaks, which features a natural-cultural landscape where forest cover and individual outcrops exist alongside pastureland showing anthropogenic features with scattered shepherds' houses (1050–1222 m a.s.l.); this zone is the upper mountain and relict pastureland zone.

With reference to *Landscape-architectural studies of the Silesian Beskids Landscape Park* (Grzybowski and Danyluk 2001; Sendobry 2001), five landscape zones can be suggested for the park:

- the southern part of the Silesian Foothills,
- the Brama Koniakowska zone,
- the western part of the Żywiec Basin,
- the inner-mountain valleys of the Vistula, the Brennica and the Żylica rivers,
- the mountain plateaus of the Silesian Beskids.

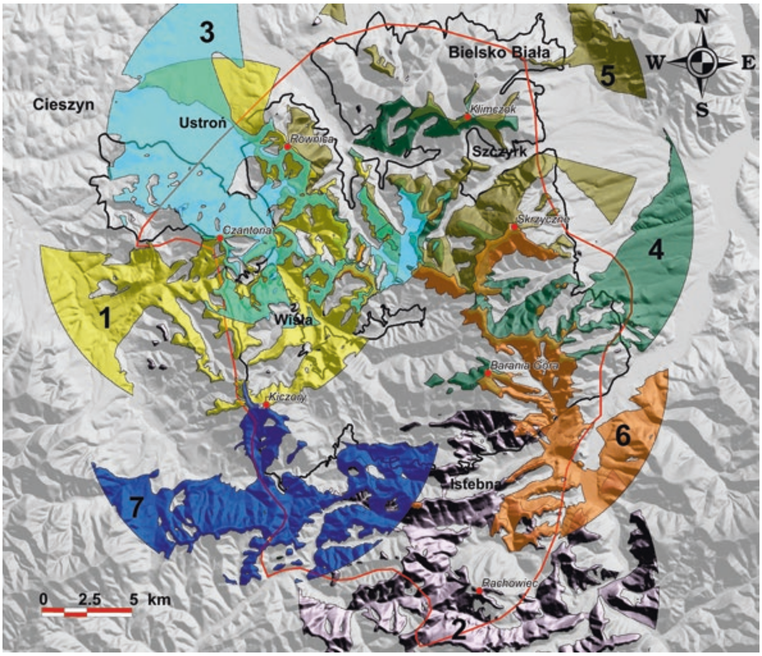

Fig. 3.6 Example simulation of the landscape observation range from seven selected peaks with the radius set at 10 km at 2 m above the peak and with no trees or buildings on the plateau: *1* Czantoria, *2* Rachowiec, *3* Równica, *4* Skrzyczne, *5* Klimczok, *6* Barania Góra, *7* Góra Kiczory

Exposure Assessment of the Landscape Values

The role and importance of landscape forms, which are important from the point of view of tourist perception, were assessed in terms of their visibility from selected viewpoints (Figs. 3.5 and 3.6). An assessment of the values, visual exposure and availability of the landscape was performed using computer simulation of visibility from four peaks in the following set conditions (as an example) (Table 3.1; Fig. 3.6):

- a maximum observation radius of 25 km,
- a height of 2 m above the peak,
- a lack of afforestation on the plateau (which is not the case in practice, as the terrain is densely covered with trees).

Simulations were conducted for the various observation radii (5, 10, 15, 20 and 25 km) to determine whether the most interesting natural-cultural entities are available to tourists.

Moreover, the aim of the simulation was to determine whether the area of the Silesian Beskids includes places that are convenient for a thorough view of the

Table 3.1 Percentage of visible area at observation radii of 15, 10 and 5 km with an observer situated at heights of (+)2, (+)10 and (+)20 m above ground observing an object at least 25 m high at a distance equal to the observation radius

		Location	1	2	3	4	5	6	7	
Observation radius		Name of the peak	Czantoria	Rachowiec	Równica	Skrzyczne	Klimczok	Barania Góra	Góra Kiczory	Mean value
		alt. m a.s.l.	995.0	954.0	885.0	1257.0	1117.0	1219.0	990.0	
$R = 15$ km	Observer	alt. +2 m	46.7	32.2	34.5	30.0	28.5	22.8	19.7	32.77
		alt. +10 m	54.6	34.6	44.1	41.0	42.0	35.2	32.3	42.69
		alt. +20 m	57.0	35.9	52.1	44.0	45.2	38.3	39.3	46.69
Mean value			52.77	34.23	43.57	38.33	38.57	32.10	30.43	40.71
$R = 10$ km	Observer	alt. +2 m	40.1	39.8	36.8	23.0	22.0	20.8	22.3	30.69
		alt. +10 m	52.6	44.1	49.0	44.4	35.4	33.8	34.3	43.37
		alt. +20 m	55.2	45.9	58.7	50.2	39.4	38.9	43.5	48.83
Mean value			49.30	43.27	48.17	39.20	32.27	31.17	33.37	40.96
$R = 5$ km	Observer	alt. +2 m	41.2	57.8	32.3	16.0	16.4	23.6	13.0	29.33
		alt. +10 m	60.1	72.6	37.8	30.4	35.7	38.4	22.7	43.24
		alt. +20 m	65.1	76.7	51.6	50.2	41.4	43.7	35.6	52.76
Mean value			55.47	69.03	40.57	32.20	31.17	35.23	23.77	41.78
			52.51	48.84	44.10	36.58	34.00	32.83	29.19	41.15

landscape, i.e. where over 50 % of the area can be observed, for the observation radius covering the entire Silesian Beskids.

Based on the DEM analysis for the Silesian Beskids, the seven most convenient viewpoints were selected covering the highest percentage of observation range. The analysis of average observation coverage based on the DEM models used various observation radii and heights of the observation points above the elevation. The simulations performed on the model, including data from multiple observation points, concerned the possibility of noticing an object, 25 m high, situated on the ground at the distance of the observation radius.

Results of the Analysis and Conclusions

The visibility (sight area range) is as follows: from Klimczok—50.4 %; from Czantoria—49.0 %; from Skrzyczne—37.8 %; from Barania Góra—0 %, which is the percentage of a full circle with the radius of 25 km. The optimum observation radii (in terms of area and size) for the Silesian Beskids are between 5 and 15 km (Table 3.1; Fig. 3.7). This analysis provides information that is necessary for arranging potential viewpoints on plateaus (selective deforestation, restoration of pasture or building additional viewpoint towers and platforms of specific heights). The best-exposed

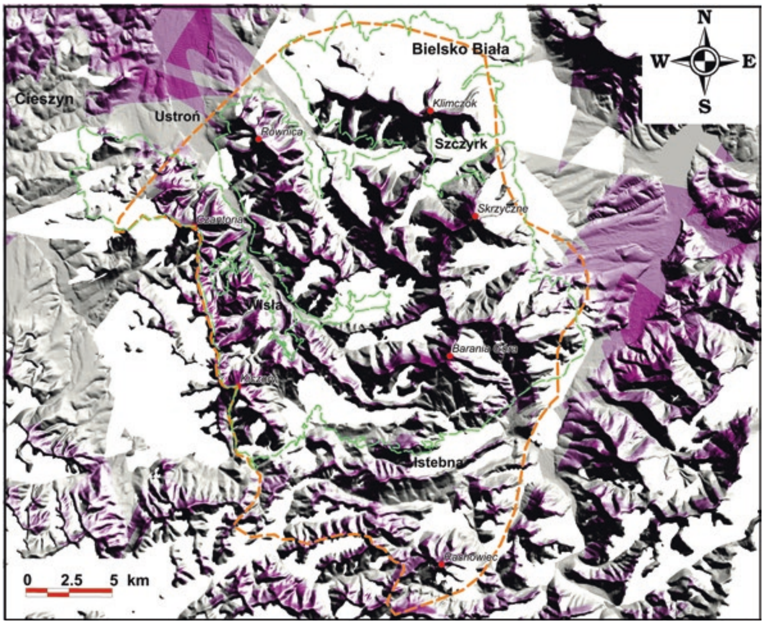

Fig. 3.7 Simulation of landscape observation range in the area of the Silesian Beskids covered by the landscape park from four peaks: Czantoria, Klimczok, Barania Góra and Skrzyczne (*white fields mark areas* not visible from any of the selected viewpoints)

landscape can be observed on top of Czantoria, performed due to a 29-m-high viewpoint tower built by the Czechs in 2002. Thus, the observation level from the peak was raised to 1,016 m a.s.l. The tower makes it possible to admire the landscape values of the area in full, as visibility from the top increases to 58.6 % of the observation range within 25 km. A similar simulation was performed for Barania Góra, which had the poorest percentage of visibility (as low as approximately 21.5 %) until 1991. By building the first Carpathian (Polish part) 20-m-high tower, the landscape visibility within 25 km increased from 21.5 % to approximately 36 %. In the case of Mount Klimczok, building a viewpoint tower similar to that on Czantoria would increase the landscape observation range from approximately 50 % to almost 60 %.

Computer simulations of the exposure of landscape objects show large discrepancies between the actual state and a potentially interesting state, which would be possible to achieve with active protection. The most interesting landscape values are currently unavailable for direct tourist observation. The best sightseeing places are not adapted for observation or are uncared for. Most of these places are affected by the uncontrolled expansion of trees and shrubs. Even though some of the plateaus are the destinations of tourist traffic, a tourist will not have a chance to admire the landscape in more than 10–20 % of the observation range. Comparative simulations of terrain visibility within up to 15 km performed on selected viewpoints on the DEM and DTM models show that visibility can be increased by 15–20 % by building a tower 10–20 m high (Table 3.2). With the observation radius extended to 25 km, (reaching outside the area of the Silesian Beskids), the percentage of visible area will increase by as much as 30 %. Landscape visibility can be largely improved by means of the selective removal of trees on the hilltops or by building small viewpoint towers 10–20 m in height.

A suggestion worth considering is the building of several viewpoint platforms harmoniously placed within the physiognomy of the most frequently visited peaks (e.g., the Pieniny National Park, Czantoria and Barania Góra). A viewpoint platform might be a compromise between the restoration of sightseeing values and the simultaneous preservation of dense forest coverage.

According to the authors, the current preparatory proceedings for the establishment of new protection forms in the Silesian Beskids include, to some extent, the suggestions expressed above, which support a possible positive breakthrough in actions aimed at landscape planning and protection.

Table 3.2 Mean increase in the percentage of observation range from a 10- or 20-m-high tower situated on top of a given peak

No	Name of the peak	alt. m a.s.l.	Viewpoint tower	
			alt. +10 m	alt. +20 m
1	Czantoria	995	13.1	16.4
2	Klimczok	1117	15.4	19.7
3	Skrzyczne	1257	15.6	25.1
4	Barania Góra	1219	13.4	17.9
5	Rachowiec	954	7.2	9.6
6	Góra Kiczory	990	11.4	21.1
7	Równica	885	9.1	19.6

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Chapter 4
Modelling as a Method for Evaluating Natural Landscape Typology: The Case of Slovenia

Rok Ciglič and Drago Perko

Abstract Modern technology and data make it possible to use various geo-information tools to mitigate certain problems in determining or verifying natural landscape classifications, especially in connection with objectivity and transparency. This chapter presents quantitative evaluation of landscape typology based on the natural landscape typology of Slovenia from 1998. Based on this existing manually outlined typology of Slovenia, several modelled natural landscape typologies were produced using four selected data layers (elevation, slope, permeability and precipitation regime) and various geo-information tools. Modelled typologies were developed based on the rules (models) determined with learning samples. The next step analyzed the match of the modelled and reference natural landscape typologies and how successfully the reference typology can be reproduced using numerical models. By comparing the models and the original, it was also possible to establish the locations of the types that were classified (confirmed) the same by different models and those that were not confirmed by any model. By overlapping several modelled typologies produced with different methods, areas were identified that proved to be well classified, and areas that should be checked in terms of their classification into a separate, specific type. The conclusion proposes a general procedure for evaluating landscape classification.

Keywords Natural landscape types · Typology · Geographical information systems · Supervised classification · Geography · Slovenia

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Landscape Classification Issues

Landscape classification is a frequent activity. With the development of computers, it is increasingly facilitated by quantitative methods (Belbin and McDonald 1993; Burrough et al. 2001; Leathwick et al. 2003; Mücher et al. 2003, 2006, 2009; Zhou et al. 2003; Wolock et al. 2004; Hargrove and Hoffman 2005; Metzger et al. 2005; Wascher 2005; Breskvar Žaucer and Marušič 2006; Bryan 2006; Owen et al. 2006; Renetzeder et al. 2008; Romportl 2009; Van Eetvelde and Antrop 2009; Castillo-Rodríguez et al. 2010; Soto and Pintó 2010). However, no landscape classification is perfect. The results are subjective because one cannot avoid making subjective decisions in selecting and weighting factors and defining criteria, nor avoid digitization and interpolation errors (McMahon et al. 2004; Natek and Žiberna 2004; Ellison 2010). Many researchers agree that subjectivity is an inevitable part of classification (Loveland and Merchant 2004; Leathwick et al. 2003; Natek and Žiberna 2004; Owen et al. 2006) because classification is an abstraction (Bernert et al. 1997), in which only specific characteristics of actual structures are selected that are deemed to present reality (Zonneveld 1994). Even though changes in the natural environment are often clearly evident, such as the contact between a mountain range and plains (Bailey 1996), the majority of classifications is arbitrary (Leathwick et al. 2003). Objectivity is reduced by inadequate descriptions of procedures for delineating and classifying units (Loveland and Merchant 2004). Sometimes identifying areas is based not only on biophysical factors, but also various memories, expectations and stereotypes about the landscape (McMahon et al. 2004); moreover, the quality of classifications is rarely evaluated (Kireyeu and Shkaruba 2010). All of this shows that many issues continue to be unresolved in the complex process of landscape classification. There are increasing digital data available for physical geographical factors (e.g. digital elevation models, satellite images) as are geo-information tools, which make it possible to apply an increasing number of different approaches to classifying natural landscape types and find the least subjective solutions.

In the case of classifying Slovenia, which is a small but extremely diverse country in terms of landscape, these problems and issues become even more pronounced, even though Slovenian geographers are constantly engaged in such research (Ilešič 1957/1958; Plut 1981, 1999; Gams 1984, 2000; Kladnik 1996; Klemenčič 2004).

This chapter focuses on classifying the natural landscape in terms of more stable natural elements—that is, those that remain relatively stable despite numerous influences. Its goal is not to offer a perfect solution to the problems concerning the development of landscape classifications, but to help increase their quality, objectivity and transparency. By using and improving suitable geo-information tools and digital data layers, one can check existing classifications and lessen their subjectivity. A number of researchers have drawn attention to the insufficient evaluation of results obtained (Hargrove and Hoffman 2005) and called for more transparent and repeatable procedures in order to facilitate the verification of the scientific value of classifications produced (Bernert et al. 1997; McMahon et al. 2004).

Research Goal

This chapter presents a relatively objective method for evaluating landscape classifications using the case of the (reference) natural landscape typology of Slovenia. A natural landscape typology is a result of a procedure in which the surface is divided into natural landscape types that may be similar in terms of the characteristics of natural factors, but may lie close together or far apart.

The reference natural landscape typology of Slovenia is evaluated using various models. In addition, the reference typology with manually outlined borders is analyzed to determine whether it can be confirmed with quantitative methods. The greatest attention is dedicated to the most apparent matches and deviations between the reference typology and the modelled ones. Based on this, the weaknesses of the reference typology are highlighted.

Diversity of Slovenia

Slovenia lies in central Europe and is bordered by Italy, Austria, Hungary and Croatia. It covers an area of 20,273 km^2 and has a population of just over two million. Despite its small size, the country has exceptional landscape diversity because its territory includes the Alps, the Mediterranean, the Pannonian Basin and the Dinaric Mountains (Perko 1998, 2004, 2007; Ogrin 2004; Repe 2004; Fig. 4.1).

In the southwest, near the Adriatic coast, the climate is sub-Mediterranean and precipitation peaks in the autumn, making it possible to cultivate certain Mediterranean crops such as olives. A characteristic of this area is alternation between flysch and carbonate rock. To the northwest the terrain is very rugged; here there are narrow Alpine valleys, the headwaters of the longest Slovenian rivers, and the highest peaks, which are composed of carbonate rock, rising to nearly 3000 m. The terrain is gentlest in the east of the country. The lowlands, which are mostly comprised of silica gravel plains, and the intermediate hills with less durable rock (e.g. marl), which rarely exceed 500 m, are under the influence of a continental climate, which is characterized by peak precipitation in the summer. The southern part of the country is part of the Dinaric mountain system, which is characterized by ridges running from northwest to southeast and primarily composed of carbonate rock. Here (and elsewhere in Slovenia), such rock is one of the main reasons for the formation of karst landscapes, which have subterranean water systems, karst caves, dolines and other subterranean and surface karst features. The shallow soil in the stony karst area and its somewhat higher elevation prevents intensive farming, and so these parts of Slovenia are the most forested. In central Slovenia the terrain is comprised of hills that reach up to 1500 m separated by valleys and basins. Among the basins, the largest is the Ljubljana Basin, where Slovenia's largest city and capital, Ljubljana (fewer than 300,000 people) is

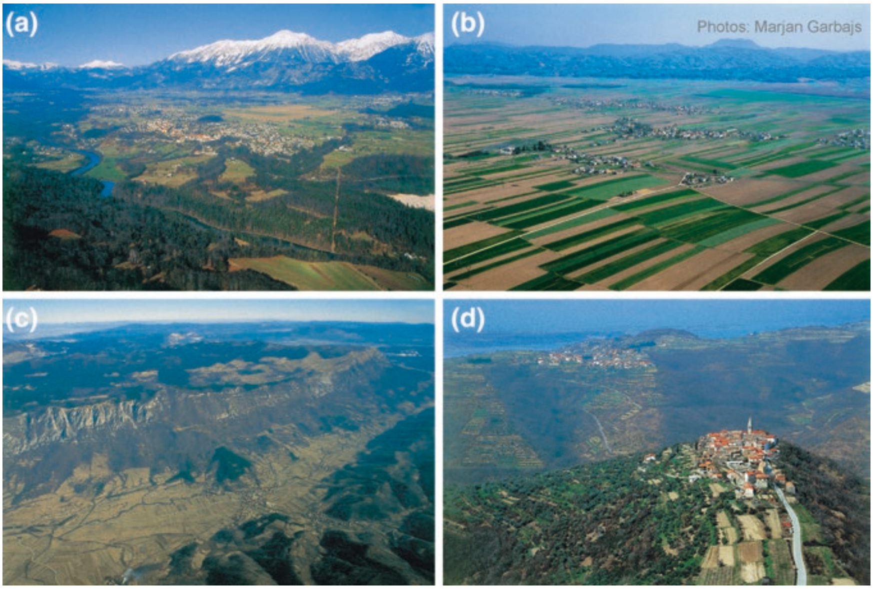

Fig. 4.1 Slovenia lies at the intersection of four European macroregions (Perko 2007): the Alps (**a**), the Pannonian Basin (**b**), the Mediterranean (**c**) and the Dinaric Mountains (**d**). **a** In the background, the Alps; in the foreground, the Sava Plain with forest-covered conglomerate and cleared gravel river terraces near the small town of Radovljica in the northwestern part of the Ljubljana Basin. **b** In the foreground, the cultivated Drava Plain; in the background, the vineyard-covered low Dravinja Hills and behind these the steeper Haloze region, known for its frequent landslides. **c** In the foreground, the Dinaric karst plateau of Nanos rises steeply above the Mediterranean flysch Vipava Valley; in the background, the Dinaric plateaus and valley systems alternate. **d** In the foreground, the low Koper Hills with its picturesque Istrian ridge villages and greatly overgrown cultivated terraces; in the background, the Bay of Piran on the Adriatic Sea

located. Slovenia's other towns are considerably smaller because Slovenia is characterized by a dispersed population in small settlements (Ogrin 2004; Perko 2004, 2007; Repe 2004).

This diversity is also visible when looking at foreign landscape classifications (see Ciglič and Perko 2012, 2013 for details). The natural diversity is complemented by contacts between various cultures: Germanic, Romance, Hungarian and Slavic (Perko 1998).

Reference Landscape Typology of Slovenia

To check the feasibility of evaluation, the natural landscape typology of Slovenia by Perko (1998; Fig. 4.2; Table 4.1), which includes nine types, was selected. Perko defined the type centres by using geographic information system (GIS) and overlapping the digital layers of natural landscape features (e.g. a 100 m digital

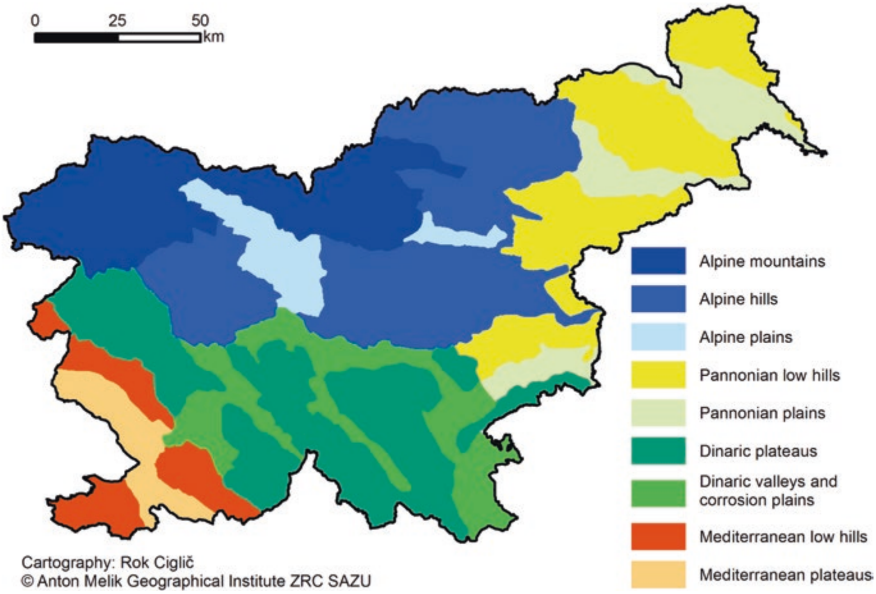

Fig. 4.2 Landscape types (Perko 1998, 2007)

Table 4.1 Landscape type names in the reference typology (Perko 1998)

Type name	Area (km^2)	Percentage (%)
Alpine mountains	3061.5	15.1
Alpine hills	4660.1	23.0
Alpine plains	819.3	4.0
Pannonian low hills	2994.3	14.8
Pannonian plains	1296.6	6.4
Dinaric plateaus	3809.2	18.8
Dinaric valleys and corrosion plains	1897.2	9.4
Mediterranean low hills	1060.9	5.2
Mediterranean plateaus	673.0	3.3

elevation model, rock types and vegetation types). He printed these on a 1:250,000 scale map and then manually outlined the borders between them. This type of semi-manual typology was ideal because the goal of this study was to determine whether the models would differ from the original and thus show its potential weaknesses. The goal was to test a procedure for eliminating problems with manually outlined typologies (including those outlined manually on a computer). Despite digital data and tools, the researcher's expertise, judgment and subjective decisions still play an important role in landscape classification.

Methodology for Evaluating the Typology Through Modelling

The methodology for evaluating the reference typology was divided into the following steps:

- Selecting the typology for evaluation;
- Selecting learning samples;
- Formulating rules/model based on the sample features;
- Applying the rule/model to the entire area;
- Comparing modelled typologies against the reference typology and looking for differences.

The evaluation was used to determine whether the reference typology could be modelled and where individual reference types could be confirmed using various geo-information tools. Learning samples were selected randomly. The maximum likelihood, the minimum distance, the nearest neighbours, and several versions of the decision tree were used for modelling (Table 4.2). Two thousand cells were included in each type sample, which accounted for a total of 18,000 cells out of 506,450, or 3.6 %. After the modelled typologies were produced, the reference typology was compared to each modelled typology and then also the match of all the models was compared aggregately with the reference typology.

Mücher et al. (2009) developed a simple theoretical equation for a landscape, according to which the landscape is a function of climate (C), geomorphology (G), hydrology (H), soils (S), vegetation (V), fauna (F), land use (LU), landscape structure (STR) and time (t):

$$\text{Landscape} = f\left(C_{(t)}, G_{(t)}, H_{(t)}, S_{(t)}, V_{(t)}, F_{(t)}, LU_{(t)}, STR_{(t)}\right).$$

Various data layers are available for Slovenia that can be used to illustrate specific natural factors and develop additional data layers (for data selection, cf. Ciglič 2012). Data layers have already been assessed in terms of their usefulness for modelling natural landscape types in previous studies (Ciglič 2012, 2014). Their usefulness was assessed based on the following:

- Correlations between data layers and existing natural landscape typologies;
- Usefulness of data layers in terms of the classification scale, meaning that it was determined at which scales an individual data layer is sufficiently diverse (variable) and hence useful for classification;
- Correlations between data layers.

If irrelevant variables are removed from analysis, one can avoid high costs and improve the implementation and understanding of the processes analyzed (Jiang et al. 2008; Tirelli and Passani 2011). Based on previous research on the

Table 4.2 Selected geo-information tools for producing modelled typologies

Tool	Module	Software	Settings	Detailed description
Decision tree, version A	Decision tree (*classification and regression trees*)	SPSS	• CRT (*classification and regression trees*) algorithm; • Impurity measure: Gini coefficient; • Tree depth: 10 levels; • 100 units in parent nodes; • 50 units in child nodes; • Minimal change in improvement: 0.0001; • Pruning (SE = 1)	Mitchell (1997), Yohannes and Webb (1999), Witten and Frank (2005), Lin et al. (2006), Kononenko and Kukar (2007), SPSS Statistics (2007)
Minimum distance	MINDIST	Idrisi	• Raw distance type; • Infinite maximum search distance	McCoy (2005), Idrisi Taiga Help System (2010)
Maximum likelihood	MAXLIKE (and MAKESIG)	Idrisi	• Equal probability for each type; • Minimal likelihood for classification: 0	Richards and Jia (2006), Eastman (2009), Idrisi Taiga Help System (2010)
Nearest neighbours	KNN (and MAKESIG)	Idrisi	• Number of nearest neighbours 30; • Maximum number of training samples per type: 2000	Kononenko and Kukar (2007), Idrisi Taiga Help System (2010), McRoberts (2012)
Decision tree, version B	Classification tree analysis	Idrisi	• Split type: information gain; • Pruning leaves with proportion: 1 %	Idrisi Taiga Help System (2010)
Decision tree, version C	Classification tree analysis	Idrisi	• Split type: Gini coefficient; • Pruning leaves with proportion: 1 %	Idrisi Taiga Help System (2010)
Decision tree, version D	Classification tree analysis	Idrisi	• Split type: information gain; • Pruning leaves with proportion: 1 %	Idrisi Taiga Help System (2010)

usefulness of data layers (Ciglič 2012, 2014), the following data were selected for modelling the reference typology (Perko 1998):

- Elevation;
- Permeability of bedrock;
- Precipitation regime (ratio between summer and autumn precipitation); and
- Slope.

Before modelling, the data layers were clipped to the area of Slovenia. According to the highest and lowest value of the individual numerical data layer, each layer was transferred to a 0–100 scale. All data layers had a resolution of 200 m, which means Slovenia was divided into 506,450 cells.

Modelling the Typologies

Based on the data layers, learning samples and geo-information tools selected, seven modelled typologies were produced.

Comparing Individual Modelled Typologies with the Reference Typology

The majority of evaluations of a classification's success compare the modelled value with the real value (Loveland and Merchant 2004). In this case, the reference typology was defined as the real value because this is what was being evaluated. In this regard, it has to be highlighted that the reference typology was produced relatively subjectively, which makes it more difficult to compare (Hazeu et al. 2010). In this part of the research, each modelled typology was compared with the reference typology by overlapping, in which it was determined how many cells in the modelled typology were classified the same as in the reference typology.

In examining the classification of the cells from the learning samples (Table 4.3), an average match of 71 % was established, with only three types matching the original at an average of more than 80 %. When the model or rule produced is used to produce a typology for all of Slovenia, the average match amounts to 66 % (Table 4.4). With such a small percentage of matching learning samples, the majority of analysts would most likely find new ones and perhaps also change the settings of the tools used. However, in the case presented, despite the low percentage of matches between the reference and modelled learning samples, the analysis continued because the goal was to determine how successfully models can be produced based on existing types and where these can then be confirmed. This analysis of overlapping is expected to reveal well-classified areas as well as those where one should consider using several more specific types and selecting additional learning samples.

The analysis showed that on average the following types matched the reference typology to the greatest degree: Pannonian plains, Mediterranean low hills, Mediterranean plateaus, Alpine plains and Pannonian low hills (Tables 4.3 and 4.4).

When examining how well the cells match, it is evident that they match better when it involves types that are more homogeneous due to larger plains (Alpine plains and Pannonian plains); it is also evident that these are the types in the

Table 4.3 Share of learning cells in the modelled typology that are classified the same as in the reference typology

Modelled typology	Share (%)									
	Alpine mountains	Alpine hills	Alpine plains	Pannonian low hills	Pannonian plains	Dinaric plateaus	Dinaric valleys and corrosion plains	Mediterranean low hills	Mediterranean plateaus	Total
Decision tree, version A	69	66	78	76	92	59	69	84	83	75
Decision tree, version B	63	68	77	88	84	52	74	84	66	73
Decision tree, version C	65	67	80	79	92	55	63	84	83	74
Decision tree, version D	62	66	74	81	88	62	49	90	87	73
Nearest neighbours	76	72	83	83	92	63	73	88	87	80
Minimum distance	55	64	67	35	82	35	13	71	77	55
Maximum likelihood	62	59	70	68	94	47	42	80	83	67
Average	65	66	76	73	89	53	55	83	81	71

Table 4.4 Share of cells in the modelled typology that are classified the same as in the reference typology

Modelled typology	Share (%)									
	Alpine mountains	Alpine hills	Alpine plains	Pannonian low hills	Pannonian Plains	Dinaric plateaus	Dinaric valleys and corrosion plains	Mediterranean low hills	Mediterranean plateaus	Total
Decision tree, version A	70	63	77	76	91	57	67	84	84	69
Decision tree, version B	63	65	76	88	83	52	71	84	67	69
Decision tree, version C	66	64	79	78	91	54	62	84	84	68
Decision tree, version D	62	63	73	81	88	61	48	90	88	68
Nearest neighbours	75	71	82	83	92	65	70	88	87	75
Minimum distance	56	63	67	36	83	36	13	72	77	51
Maximum likelihood	64	58	69	70	94	49	42	81	84	62
Average	65	64	75	73	89	53	53	83	82	66

extreme southwest (Mediterranean low hills and Mediterranean plateaus) and in the extreme northeast (Pannonian plains and Pannonian low hills). The cells also match better in the case of types covering smaller areas (Table 4.1) because the models were produced based on the same number of cells regardless of the type's size. The cells match less in the case of Alpine mountains, Alpine hills, Dinaric valleys and corrosion plains, and Dinaric plateaus. This is presumably due to their large areas and because only a small share of an individual type was included in the learning sample. The reason may also lie in the great heterogeneity of these types; the Alpine mountains include not only the mountains, but also many valleys and plateaus, and Alpine hills also include a large number of valleys. All of these types lie in central Slovenia, which also has a more transitional climate than the extreme west and east.

The comparison also shows differences between the results of different models. The modelled typologies created based on the minimum distance and maximum likelihood methods usually stand out the most in terms of weak matches. Both methods more often force their own structure than others that better adapt to the learning samples and provide results that are more similar to the original (Tables 4.3 and 4.4).

Comparing the Match of All Modelled Typologies Aggregately with the Reference Typology

In addition to comparing the matches between each individual modelled typology and the reference typology, the match of all modelled typologies was compared aggregately with the reference typology in order to determine areas of types that were confirmed by all the methods used and areas that were not confirmed even by a single method.

By overlapping, a map was produced showing which cells were always classified the same as in the reference typology (Fig. 4.3). The reference typology was always confirmed in 36.6 % of all the cells. The types that cover smaller areas were confirmed (they match the reference typology) more often than bigger types, but not always; for example, the type 'Dinaric valleys and corrosion plains' is significantly smaller than the type 'Alpine hills', but in the modelled typologies it matches the reference typology by 32.1 % less than the Alpine hills, and with an average match of slightly more than 4 % it is the least confirmed type (Table 4.5). The comparison of models with the original shows that the plain types match the best, with three types included among the top five matches (i.e. Alpine plains, Pannonian plains and Mediterranean plains). In addition, it was also observed that with the types with more dynamic relief (e.g. Alpine mountains, Alpine hills and Pannonian low hills), the models did not match completely, especially in more concave and flatter areas, such as Alpine and prealpine valleys and plains within hillier areas. Furthermore, no match was confirmed on the type borders and in

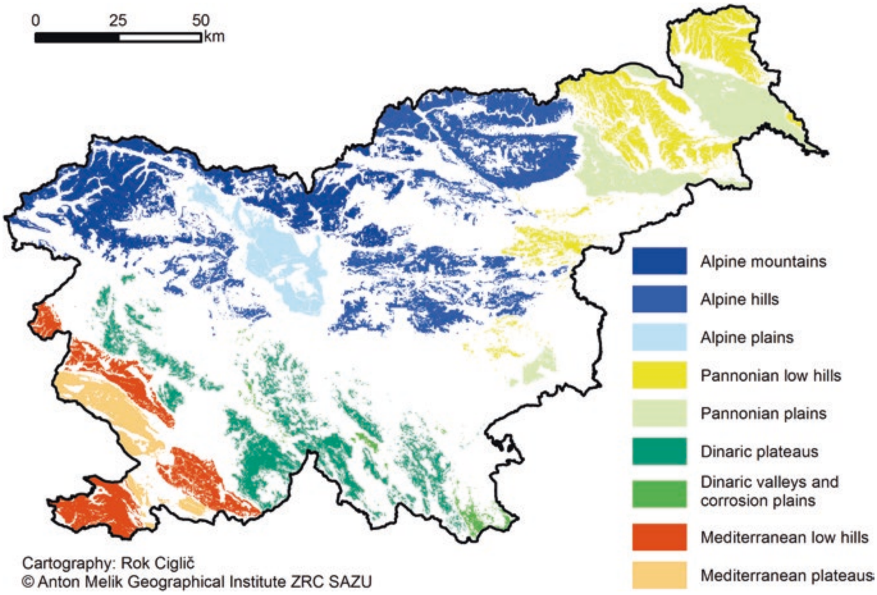

Fig. 4.3 Areas matching the reference typology across all modelled typologies

Table 4.5 Share of cells that match the reference typology in all of the modelled typologies

Landscape type	Share (%) of cells in all modelled typologies classified the same as in the reference typology
Alpine mountains	45.1
Alpine hills	36.3
Alpine plains	52.8
Pannonian low hills	32.4
Pannonian plains	71.1
Dinaric plateaus	23.1
Dinaric valleys and corrosion plains	4.2
Mediterranean low hills	65.2
Mediterranean plateaus	55.0
Total	36.6

central Slovenia, which was expected because these areas are the most transitional (and hence diverse).

Some cells were not classified the same as in the original by any model. They account for 11.8 % of all the cells (Table 4.6; Fig. 4.4). Areas that no model classifies the same as the original primarily include valleys, basins, small karst poljes, other depressions within hillier areas, and areas where various types come together; this is primarily because the reference typology was not produced at such a detailed scale as the models.

Table 4.6 Share of cells that do not match the reference typology in any of the modelled typologies

Landscape type	Share (%) of cells in all of the modelled typologies classified differently than in the reference typology
Alpine mountains	15.4
Alpine hills	12.2
Alpine plains	7.5
Pannonian low hills	6.0
Pannonian plains	2.3
Dinaric plateaus	19.3
Dinaric valleys and corrosion plains	10.7
Mediterranean low hills	8.3
Mediterranean plateaus	6.7
Total	11.8

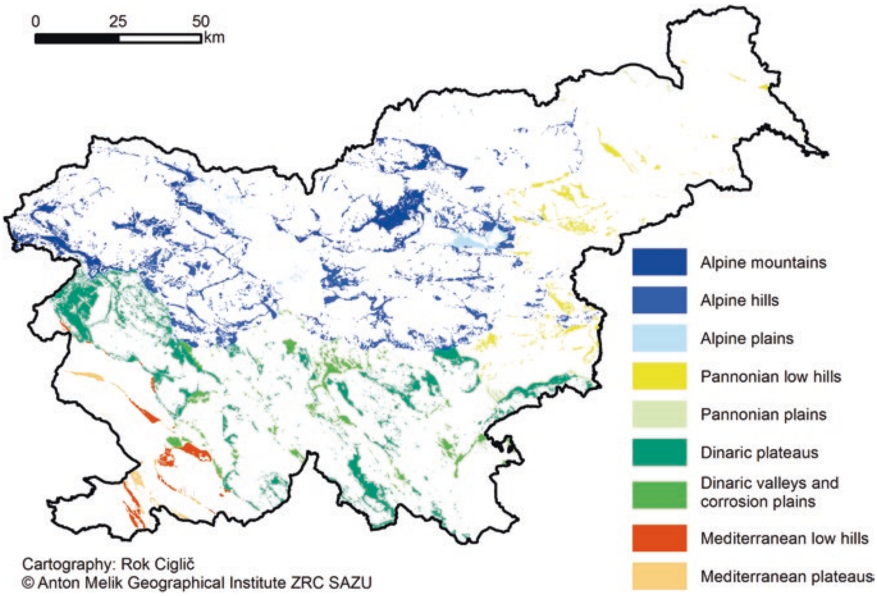

Fig. 4.4 Areas not matching the reference typology in any of the modelled typologies

It is interesting that the cells that were not classified the same in the models as in the reference typology also included those that had the same type across all the modelled typologies. They accounted for 4.2 % of all cells (Table 4.7; Fig. 4.5). These are areas that each model identified as the same types, but by human definition the classification is different. When adjusting the typologies, these areas must be checked because they might involve real errors.

Table 4.7 Cells that are classified the same in all modelled typologies, but not the same as in the reference typology

Type	Share of Slovenia's entire territory (%)
Alpine mountains	0.4
Alpine hills	0.6
Alpine plains	0.6
Pannonian low hills	0.5
Pannonian plains	0.3
Dinaric plateaus	0.4
Dinaric valleys and corrosion plains	0.1
Mediterranean low hills	0.8
Mediterranean plateaus	0.6
Total	4.2

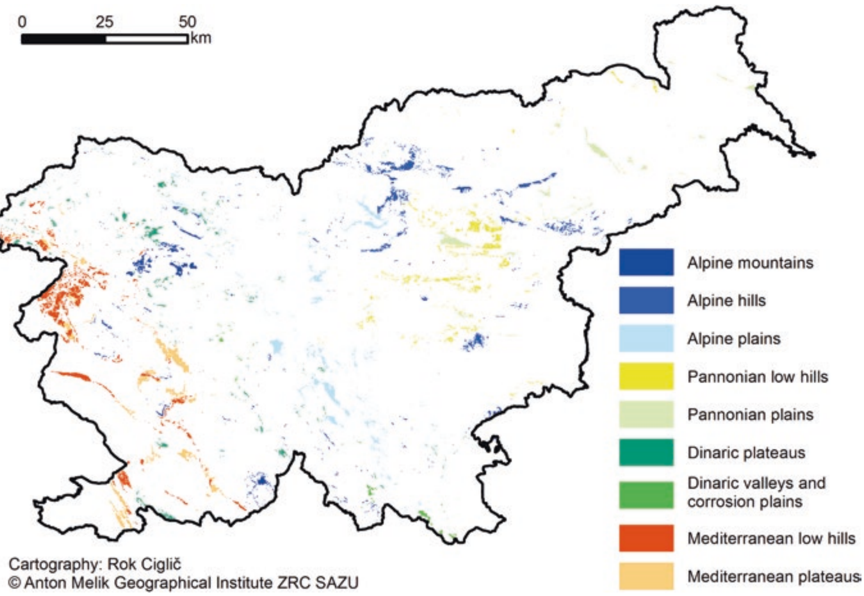

Fig. 4.5 Areas that match across all modelled typologies but do not match the reference typology. The cells are coloured to show the types by modelled typologies

These areas often include the upper parts of hills and plateaus that the models identified as parts of an Alpine mountain range, or the flatter parts at lower elevations within hills or mountain ranges that the models identified as Alpine plateaus. In addition, upper parts of lower hills are also often classified as hills. Some plateaus within the Alpine mountains are classified as Dinaric plateaus; the reason for this is primarily the flatter relief made of permeable carbonate rock at a fairly high elevation, but nonetheless significantly lower than the surrounding high mountains. Some areas, especially in Mediterranean Slovenia, are also classified differently due to differences in rock permeability. Namely, in some places the reference classification did not consistently follow the differences in rock structure.

In terms of the number of cells, the majority of areas that were confirmed by all models, but were not the same as in the reference typology, were classified as Mediterranean low hills, Alpine hills, Alpine plains and Mediterranean plateaus. Only a few such cells were classified as Dinaric valleys and corrosion plains. This was also confirmed by the analysis of learning samples, in which it was established that it was very difficult to produce a good model for this type.

Evaluating the Reference Typology

The natural landscape typology of Slovenia (Perko 1998) was modelled in several ways. The models were produced based on learning samples and used to classify all of Slovenian territory (all cells). This is how the modelled typologies were then produced. In the end, these were compared to the reference classification and the extent to which they were similar to the reference was established. The most suitable variables were selected from the database to design a model; in addition, various geo-information tools were selected that make it possible to produce various models. The learning samples were selected randomly.

Comparing Individual Modelled Typologies with the Reference Typology

In analyzing how successful the modelling was or how individual modelled typologies matched the reference one, a 51–75 % match between individual modelled typologies and the reference typology was determined. The modelled typologies produced based on the minimum distance matched the reference typology the least. This means that this method depends heavily on the quality of learning samples. In terms of types, the modelled and reference typologies matched the best for Pannonian plains, Pannonian low hills, Alpine plains, Mediterranean low hills and Mediterranean plateaus. These are the types that can probably be more easily defined due to large plains and their location in the extreme southwest or east of Slovenia, where the climate is less transitional than in the central parts of the country. In larger types, weaker matches between the modelled and reference typologies were determined due to the sampling method used (the same shares regardless of the type size) and greater diversity.

It should be highlighted that the modelling was fairly successful. In addition, the data layers were shown to be sufficiently precise and the reference typology was shown to be sufficiently well made because the modelled typologies designed with various geo-information tools matched the reference typology significantly better than they would have if the reference typology had only been drawn randomly. It can be concluded that the reference typology makes sense and is high quality from the mathematical point of view, making it possible to produce models with all the geo-information tools used. Even though the classification could mostly 'only' be confirmed up to 75 %, this is still significantly more than random matching. In our case the random matching was estimated at 15.1 %. If the study had been based on poor reference typologies, it would not have been possible to even carry out all the calculation procedures, classifications and evaluations.

On the other hand, the matches are not extremely high. A lower level of match (confirmation) with the reference typology was already indicated in the analysis of how successfully the learning samples were classified, which showed that after modelling an average of only 71 % of learning cells were classified the same. As already mentioned above, given such a small share of match, the majority of analysts would most likely find new learning samples and perhaps change the settings of the geo-information tools used. However, despite the small share of matching learning and reference samples, the analysis in the present study continued in order to comprehensively check how successfully models can be made using the existing types and where the models match at all.

Comparing All Modelled Typologies Aggregately with the Reference Typology

The analysis of overlap showed areas that were confirmed by all models as well as areas that were not confirmed by any model. With regard to the latter, the selection of learning samples should perhaps also include the use of more detailed learning samples of different subtypes that would be joined together after modelling. An example for this would be the type 'Alpine valleys', which was defined in the reference typology as a component part of the Alpine mountains. This type could be successfully modelled by defining several specific (more detailed) learning samples (e.g. subtypes such as Alpine peaks, Alpine slopes and Alpine valleys). The analysis also revealed areas that were classified the same in all the models, yet still differently than in the reference typology (and this is also where the applied value of the study lies as well as the reason why the modelling continued despite poorer indicators of learning sample suitability). This, however, indicates that individual parts of the typology should indeed be rechecked and improved.

The share of cells that match the reference typology across all the modelled typologies is 36.6 %. These are primarily the areas of both Mediterranean and Pannonian types and upper parts of Dinaric plateaus, Alpine hills and Alpine mountains. Unconfirmed parts mainly included individual elevations inside plains and valleys inside largely mountainous or hilly regions.

The share of cells that do not match the reference typology in any of the modelled typologies is 11.8 %. These primarily include the edges of individual types and some valleys and other relief depressions surrounded by higher elevations. Some areas were not appropriately classified due to the small scale used and the subsequent limited accuracy.

The share of cells that matched in terms of types across all modelled typologies, yet differed from the reference typology, is 4.2 %. These are roughly the edges of types and certain areas that should probably have been classified differently in the reference typology, but were not due to the small scale used.

On the whole, it can be concluded that the models confirmed more areas in the reference typology than were rejected. The practical findings showed where the reference typology could be improved, what the most typical areas of individual types are, and what areas are most difficult to describe mathematically. These findings also make it possible to carry out better sampling with 'subtypes'.

Proposed Evaluation of Typologies

The following procedure is proposed to evaluate the typologies:

1. Researchers use data layers selected on purpose to divide a certain area into types using their own judgment or computers, and produce a typology that they wish to evaluate;
2. They evaluate the classification produced by calculating its correlation with selected data layers (e.g. calculating the information gain, eta squared);
3. Researchers then select the random learning sample (cells or other units if the analysis is not based on raster data) of individual types and use the selected method to formulate a classification rule (model);
4. They classify all cells based on the rule produced;
5. They compare the modelled typology with their reference typology and establish the degree of match;
6. Then they can adjust the borders between types and produce a new version of the typology;
7. They can repeat steps 1–6 (producing and checking the various typology versions) several times, which means they obtain several typology versions;
8. For each typology produced, researchers have information regarding the evaluation in terms of data layers and the information on the matches with the modelled typology;
9. Researchers select the version of their (adjusted) reference typology that has the best evaluation in terms of data layers and matches the modelled typology to the greatest extent possible.

The method for modelling (geo-information tool) is selected based on the characteristics of the data layers. It has to be stressed that changing the number of types is not allowed in this procedure because this has a significant impact on the evaluation. In addition, evaluation using data layers is based on all cells (or any other units), whereas evaluation using modelling is based on the sample cells.

Conclusion

Even though researchers do not share a uniform opinion on the existence of homogeneous units in the natural environment that can be characterized as (natural) types, one can definitely find such units in the virtual world. Presuming that data layers are approximations of natural factors, one can easily classify a certain area into types that are thus approximations of general natural characteristics. In the virtual world, where the real environment is presented with numerical or descriptive values of individual spatial units, one can more easily talk about the existence of delineated types. Where the borders run in the virtual world depends on the purpose of delineation, the methods used and the interpretation of results.

A large number of data, tools and other procedures (e.g. sampling) allow for several different results or classifications. Because researchers define parameters partly subjectively, the entire classification is less objective. However, this still involves a fair amount of objectivity because the parameter settings usually apply to all the cells equally and so the classification does not involve any partiality in this regard. On the one hand, the diverse options make it possible to test various methods until one comes close enough to the desired result (which can also be misused) but, on the other hand, one can also draw more objective conclusions by comparing several different results. Different methodologies yield different results; the more frequent ones (i.e. the results that are the same despite different methodological approaches) can be understood as more objective and more realistic. This study showed that modelling using supervised classification methods can help evaluate landscape classifications because they clearly highlight the areas of natural landscape types that are classified well and those that need to be checked. This can improve existing typologies, regionalizations and other classifications.

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Chapter 5
Transformation of the Structure of the River Catchment Landscape Located in the Area of Intensive Coal Exploitation

Kinga Mazurek

Abstract The area of the Upper Silesian Coal Basin is the most important underground mining district in Poland. Coal mines, operating in the area since the eighteenth century, have contributed to massive transformations of the environment, not only in the form of its pollution or changes in topography, but also by the transformation of landscape structure. River valleys within range of intensive exploitation have been severely modified. The Bielszowice Stream (Kochłowka) catchment is an example, eminent in the region, of such transformation of the watercourse and its adjacent area. The Bielszowice Stream flows through the highly urbanized areas of Ruda Slaska, Zabrze, Swietochlowice and Chorzow. During the period of approximately 170 years (1824–1993), significant changes were observed in the area in the participation of individual types of cover and land use. In the analysed period, the stream changed its course, both naturally and due to human activities. The study has used basic characteristics and the method of landscape metrics. The presentation of relevant coefficients allows a precise definition to be stated of environmental changes that have taken place. This method allows us to specify a quantitative and area participation and an interaction between various types of land use. The presentation of the issue using appropriate measuring instruments allows us to specify the scale of a change. Tabulation of results and a graphic representation of landscape structure of the researched catchment present the full variability of the environment. The direction of development of economic activities of the population determines the nature, intensity and rate of the changes taking place in the geographical environment.

Keywords Land use · Structure of the landscape · The Bielszowice Stream · GIS · Topographic map

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Introduction

The landscape is continuously being modified by increasing anthropogenic activities (Richling and Solon 1994). The area of the Upper Silesian Coal Basin is an example of a place that is being converted in a very intense way. The image of the area has dramatically changed with the development of industrial activities and mining. Human impact and urbanization contribute to the remodelling of the landscape, which is taking on the characteristics of a cultural landscape. The structure of the landscape consists of, inter alia, the types of land use. Various types of indicators that make up landscape metrics may be used to determine the level of modification.

The most vulnerable areas to be undergoing land conversion include river catchments. River valleys located in the Upper Silesian Coal Basin constitute an interesting subject for analysis of land cover transformation. The aim of the study is to present the landscape changes in the Bielszowice Stream catchment that emerged in the period 1824–1993 (169 years). The analysis is based on archival and current topographic maps. The study area has been presented and compared in three time frames.

Study Area

The Bielszowice Stream (Kochłowka) is a right tributary of the Klodnica River (in the Oder River basin). Measuring 15.38 km, the Bielszowice Stream has its source in the area of wetlands on the border between the cities of Chorzow and Ruda Slaska. The river flows through Ruda Slaska and Zabrze, where its water supplies the Klodnica. The Bielszowice Stream catchment has an area of 32.79 sq km and spreads between four cities: Chorzow, Swietochlowice, Ruda Slaska and Zabrze (Fig. 5.1). The studied catchment is located in the central part of the Katowice conurbation and the Upper Silesian Metropolitan Union. The valley of the Bielszowice Stream belongs to the macro-region of the Silesian Upland (341.1) and the mesoregion of the Katowice Upland (341.13) (Kondracki 2002). The research area is located in the following geomorphological regions: the Kochlowka-Rawa Depression on the Bytom Plateau, the Kochłowickie Hill on the Katowice Plateau and the eastern zone of the Raciborz Basin (Karaś-Brzozowska 1960). The structure of this area is dominated by coal-bearing sandstones and Upper-Carboniferous shales covered with tertiary clays and sandstones and Quaternary sediments (sands, clays) (Kondracki 2002). The relief of the catchment has a horst character of the genesis of Hercynian and Alpine tectonic movements. The shaping of the catchment refers to typical plateaus with hills and humps separated by sags, bottoms of valleys and basins (Gilewska 1972; Pełka-Gościniak and Szczypek 2008). The Bielszowice Stream catchment is located in an area subjected to strong human impact. The original relief, due to long-term underground

Fig. 5.1 The location of the Bielszowice Stream

mining conducted in the area, as well as the progressing urbanization, is strongly modified.

In the studied catchment, there are third, fourth and fifth classes of soil valuation, represented by podsolic and acidic soils, arising from sands, clays and loess and hydrogenic silty-marsh soils, typical for moist grounds (Dobrzyński et al. 1999). In addition, the soil exhibits characteristics of anthropogenic soils—industrial soils and urban soils (Konecka-Betley et al. 1999).

Materials and Methods

The research entailed an observation of changes in land use of the Bielszowice Stream catchment. Three time frames were used for the analysis (years 1824, 1940–1942, and 1993). The following topographical maps were used as source materials: the Prussian official map Urmesstischblätter in the scale of 1:25,000 from 1827 (field measurements were taken in 1824) prepared by the triangulation method, the Prussian Messtischblätter map in the scale of 1:25,000 from the period 1940 to 1942 and a topographic map of Poland from 1994 (of the field situation in 1993). The boundaries of the catchment were set on the basis of the hydrographic map of Poland 1:50,000 (2001). Maps were calibrated and transformed to a common coordinate system—the UTM system (WGS 1984 Transverse Mercator). Materials from the nineteenth century and the first half of the twentieth century were calibrated using manually applied checkpoints. The time range covered by the study and the significant divergence time between time frames influenced the method of selection of the checkpoints. Sacred objects and characteristic crossroads and map corners were selected as points of convergence on individual maps (Szymura et al. 2010). This procedure enabled the accurate location of maps in the space. The first stage consisted in the summary and comparison of cartographic materials.

The study area was set in accordance with the course of the third category watershed for the Bielszowice Stream. On individual topographic maps, differences in the catchment course were outlined. To standardize the research area, a division shown on the hydrographic map of Poland was adopted.

Materials were developed with the help of Geographic Information Systems (GIS), i.e. ArcGIS 10.2. A set of shapefiles was prepared in the form of polygons and polylines, corresponding with individual elements of the landscape. Categories of objects corresponding to the land use were determined and aligned with regard to the content of individual maps. The cartographic materials of the nineteenth century have the least diverse content, and forest areas were not distinguished on them. Finally, the following six land cover categories were created: forests, meadows and unused land areas, wetlands and swamps, areas of organized vegetation (domestic vegetation, orchards, allotments, parks), built-up areas and reservoirs. Four types of objects are presented as lines: The Bielszowice Stream and its tributaries, transportation routes (major roads in 1940 and 1993) and railways (no railway lines in the research area in 1824). The content of the 1827 map was generalized and unified. The main division of the land is bipartite—it is either a forest area or a non-forest area. Therefore, in the case of materials from the 1940s and 1990s, a unification of areas was applied: deciduous forest, coniferous forest, shrubbery, sparse forest and dwarf pine forest. Individual trees were not taken into account. Developed types of use have created three compositions depicting land cover in the Bielszowice Stream catchment in the years 1824, 1940–1942 and 1993 (Fig. 5.2). The tested area of land use was converted into a raster which formed a basis for calculations and analyses. Areas occupied by

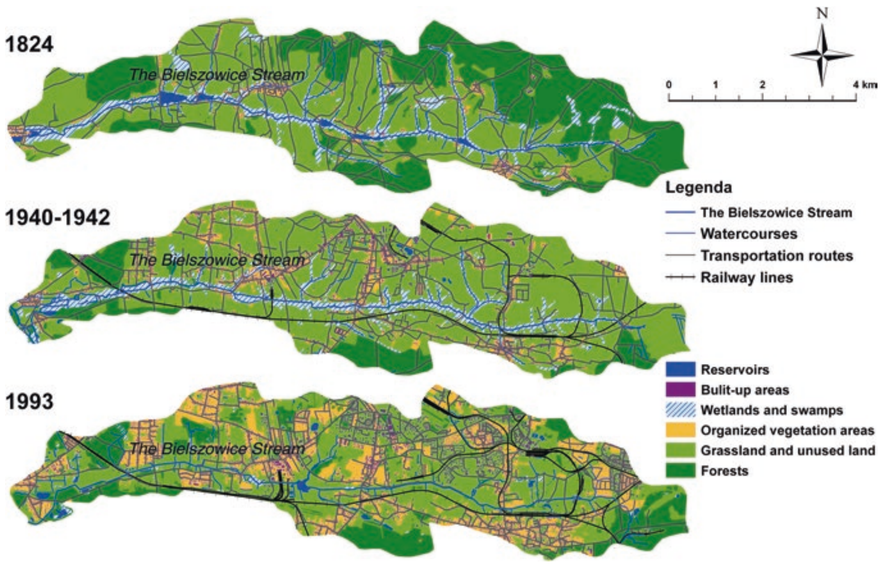

Fig. 5.2 The structure of land use in the drainage basin of the Bielszowice Stream

different types of land use are specified. Percentage changes in the structure of the landscape were calculated and they illustrate the scale and direction of environmental changes. The Zonal Statistic as Table function is used. Dominant directions of transformation are defined with the Spatial Analyst Tools (Local-Combine). For detailed analysis, basic landscape metrics representing specific environmental indicators were applied. They are measurable biotic and abiotic characteristics of the environment that allow quantitative data to be obtained concerning ecological resources and the way in which the landscape functions (Chmielewski 2013).

Results

In the period of 169 years, there was a clear reconstruction of the landscape structure of the Bielszowice Stream catchment. Today's landscape is significantly different from the one presented in the archival cartographic materials. The proportion of the various types of land use has changed. Detailed data showing changes in land cover of the Bielszowice Stream catchment are presented in Table 5.1. There has been a significant decrease in the area covered by forests, with a simultaneous increase in built-up areas. In 1824, forest vegetation covered 11.99 sq km; with respect to the whole Bielszowice Stream catchment (32.79 sq km), it accounted for as much as 36.56 % of the total catchment area. In the years 1940–1942, forests covered only 9.61 % of the catchment. After 169 years, this area decreased to 5.17 sq km (15.75 % of the total catchment area). The areas occupied by residential and commercial buildings increased by 4.82 %. In

Table 5.1 Land use in the Bielszowice Stream catchment

Ground category	Area as of 1824 [%]	Area as of 1940–1942 [%]	Area as of 1993 [%]
Forests	36.56	9.61	15.75
Meadows and unused land areas	47.70	68.74	54.43
Wetlands and swamps	10.83	9.42	0.79
Areas of organized vegetation	2.96	8.57	22.14
Built-up areas	0.82	3.20	5.64
Reservoirs	1.13	0.46	1.25
Total	100.00	100.00	100.00

1824, built-up areas covered 0.27 sq km, in the years 1940–1942, they covered 1.05 sq km, while in 1993, 1.85 sq km. Built-up areas have increased almost 7 times. The sprawl of urban areas with the simultaneous shrinking of forest areas is even. Housing estates develop along the main transportation routes. The most significant loss of forest vegetation is visible in the northern and north-eastern parts of the catchment. In the twentieth century, the settlement network has grown to a considerable size. The districts of Makoszowy (Zabrze), Wirek and Kochlowice (Ruda Slaska) have developed here. Meadows and unused areas have also shown a significant increase in their size (from 15.67 sq km in 1824 through 22.54 sq km in 1940–1942, to 17.88 sq km in 1993). The change in participation of meadows and unused areas in the examined catchment was 6.73 %. This category includes land once covered with forest complexes and areas on which no activity is carried out (such as post-industrial areas). With the development of settlement, the surface area of organized vegetation increased as well, which includes complex urban and backyard vegetation and various orchards and allotments. The size in this category has increased from 2.96 to 22.14 % (from 0.97 sq km in 1824 to 7.26 sq km in 1993). As a result of drainage of land, areas covered by water basins, wetlands and marshy lands have decreased. In 1824, water reservoirs occupied 1.13 % (0.37 sq km), whereas in 1940–1942, they occupied 0.46 % (0.15 sq km). Despite the increase in the number of reservoirs, mainly through the creation of small hydrographic objects, their total area was 1.25 % (0.41 sq km). The size of wetlands and marshy lands has changed vastly. During this period, their size decreased by up to 10.04 % (from 3.55 sq km in 1824 to 0.26 sq km in 1993). Also, the Bielszowice Stream tributaries, small watercourses and drainage channels have been modified. The regulation of water relations in the area of the research resulted in a decrease in the total length from 49.32 km in 1824, through 39.02 km in 1940–1942 to 40.39 km in 1993. This situation comes as a result of underground exploitation conducted in this area, which requires the use of appropriate hydraulic engineering operations (drainage).

Linear objects, in the form of routes and rail lines have been greatly enhanced. Based on the maps from 1827, no railway line ran through the research area. All transportation routes included in the map (mainly field roads) measured a total of 114.8 km. After nearly 170 years of railway infrastructure development, there are 53.57 km of railway within the catchment (excluding the depot and additional trackways next to mining and processing plants) and 164.64 km of transportation routes (including roads of higher rank, paved or with a bitumen surface).

The original condition and landscape has been modified (the Silesian Forest). The area has been noticeably drying, which has resulted in an almost complete destruction of swamps and marshes. Forests have been depleted, drained and converted into areas covered with grass vegetation or into built-up and remodelled areas as a result of coal mining and storage of post-mining and post-steelworks waste.

Changes in land cover are spread relatively evenly throughout the catchment of the Bielszowice Stream. The directions of development here have been decided upon by the presence of the most important car and rail routes. The stream flows through highly urbanized and industrialized districts. Areas located at the borders of the catchment have been transformed to a lesser extent. In eastern, southern and western areas, forest vegetation has been preserved.

The different directions and characters of changes in particular types of ground cover that occurred between subsequent time intervals are also of great importance. Analysing changes that occurred between 1824, 1940–1942 and 1993, the author has used the Count value indicating the number of points (pixels) of a particular feature located within the boundaries of specific polygons. The most discernible changes include transformation of forests into meadows and unused lands (85,573 points), wetlands and swamps into meadows and unused lands (21,140 points), meadows and unused lands into wetlands and swamps (17,364 points) and meadows and unused land areas into areas of organized vegetation (15,898 points). The remaining transformation scores range from 6466 to 13 points. There is a total of 143,637 points unchanged, including 111,000 points in the meadows and unused lands category. The transformation processes between 1940 and 1993 had a different profile. The most significant processes included transformation of meadows and unused lands into organized vegetation areas (51,038 points), into forests (24,309 points) and built-up areas (12,688 points); transformation of the wetlands and swamps into meadows and unused lands (24,173 points) and organized vegetation areas into meadows and unused lands (10,986 points). Other transformations remained at levels ranging from 4538 to 11 points. In this particular time interval, no change was found in 172,837 points. Also in this case, the dominant category is meadows and unused lands (133,270 points).

Discussion

Changes in the landscape structure are occurring throughout the Silesia Metropolis. There are several studies covering this type of landscape and land-cover evolutions in various areas of the Silesian conurbation (Czaja 1995; Czaja and Rzętała 1999; Dulias 2010). All the aforementioned studies refer to a general trend—the nineteenth century was a time when large areas of land had consistent use patterns. Later, numerous small patches of land arose, splitting the enormous homogeneous areas and leading to the evolution of a specific cultural landscape. The structure of the landscape is most commonly analysed from the perspective of its chronostructure. This type of approach generates interesting results, which can be visualized and interpreted in many different ways. Landscape structure, being the object of this study, is a particular set of landscape components and their mutual relations (Kondracki and Richling 1983). Identification and definition of changes in land cover and usage patterns are the initial steps in landscape structure transformation studies. They provide a starting point for investigation of more complex phenomena. This type of analysis may be an introduction to a more precise case study. It would be appropriate to apply landscape metrics in the characterization of the areas investigated. Analysis should also apply the patch-corridor-matrix model, developed by Forman and Gordon in 1986. The model allows the determination of the dynamics and trends of changes occurring in the selected catchment area (Forman and Gordon 1986). Results obtained through such an in-depth analysis may have practical significance for sustainable land-use planning in areas of existing or expected mining impacts.

Comparative analyses carried out based on cartographic materials allow the evaluation of landscape component changes or individual category evolutions (Kunz and Nienartowicz 2006). Access to adequate topographic maps as well as their quality and accuracy play a significant role in the historical analysis of landscape structure. Land use categories should be unified and data aggregation adapted to the content of all materials available before starting landscape analyses (Kunz 2006).

Summary

Adequate analysis of cartographic material allowed the determination of landscape structural changes in the catchment of the Bielszowice Stream. The analysis was based on topographic maps from three time intervals (1824, 1940–1942 and 1993) and led to the determination of general trends that occurred in the area of investigation. Application of the GIS software tools allowed the calculation and characterization of the catchment. The percentage land use pattern presented in the study determines the direction and importance of the transformation processes. The landscape structure of the Bielszowice Stream catchment has been significantly modified. Large areas of forest vegetation have been transformed into other forms of use through development of built-up areas and the associated organized vegetation zones. Meadow and unused land areas are also playing a significant role in the process. Regardless of the profile of the change processes occurring in the catchment, their percentage area coverage is significant. Over the 169 years discussed in this study, the transportation and technical infrastructures developed significantly. The lengths of roads (both hardened and tarmac) and railway lines increased. The Bielszowice Stream channel was trained (several sections) and connected with a system of land improvement drains.

Changes in the land use patterns that occurred throughout the time intervals analysed relate to the general trends in human settlement development. There is a discernible evolution from the base, farming applications towards very intense development of mining and heavy industries. The last stadium, presented in materials from 1993 is the temporary drift away from industrial activity.

This study was possible thanks to the availability of adequate topographic maps. The credibility and accuracy of the cartographic materials used allowed the digitization and adequate processing and analysis of the data. The content of particular maps should be taken into account in all comparisons and calculations. It is necessary to first perform standardization and definition of all categories presented in the map legends. A wider scope of legend information may increase accuracy of the analysis. It is however required to take into account and adapt the oldest materials analysed, as their content is often generalized to a very significant extent.

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Chapter 6
The Natural Capital of Selected Mountain Areas in Bulgaria

Bilyana Borisova, Assen Assenov and Petar Dimitrov

Abstract The purpose of this study is to analyse and assess the potential of selected Bulgarian mountains on the basis of the concepts of natural capital and landscape multifunctionality. These concepts are essential in modern geo-spatial research in the context of the debate on sustainability and its role in avoiding problems of environmental degradation, land use conflicts and natural resources overuse. The Central Balkan and the Western Rhodopes are selected as case studies representative for mountains in Bulgaria. The authors interpret natural capital as a set of potentially possible landscape functions and, thus, study them within the geosystem boundaries of the landscape. The investigation is based on a systemic analysis of the landscape structure and its anthropogenic transformation by integrating the hemeroby index. On this basis, it performs qualitative valuation of ecosystem/landscape services in the mountain areas. Integration of the opinions and perspectives of the local population is an important aspect of the valuation.

Keywords Natural capital · Ecosystem/landscape services · Landscape functions · Hemeroby · Mountain landscapes

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Introduction

This study is interdisciplinary in nature and is oriented towards the application of current methods of analysis and evaluation of the potential of some Bulgarian mountains in accordance with the concept of natural capital and multifunctional landscapes.

Mountainous areas are important sources of essential natural resources, whose practical relevance extends well beyond their territorial scope. They store representative sites of natural and cultural heritage. There is a high dependency of local population on available resources and the quality of their management. These are areas in which violations of the qualities and characteristics of natural systems under the influence of intensive or inappropriate economic development proceed at the quickest pace and have a lasting negative effect on the development of systems. Mountains are particularly vulnerable to the onset of modern geo-ecological problems and processes, such as floods, landslides, fires, droughts, invasive species, etc. On this basis, the concept of *ecosystem services* valued as their *natural capital* (De Groot 1992, Constanza et al. 1997; Daily 1997; MA 2005) is crucial in modern spatial studies of mountainous areas in the context of the debate on sustainability and their current role in solving the problems associated with environmental degradation, conflicts in land use and increasing pressure on natural resources.

Natural capital is associated with the capacity of natural processes and components to provide goods and services, which directly or indirectly satisfy human needs and serve as a basic prerequisite for human well-being (MA 2005). The concept is linked to a current perspective in planning and land management in Europe—*landscape multifunctionality*. It is expressed both in the recognition of the full range of economic, social, cultural and ecological functions of the landscape and the inter-sectoral integration for their coherent utilization and management (Borisova 2013).

Landscape Functions and Ecosystem/Landscape Services

This study considers ecosystem/landscape services (ESLS) as essential, permanently occurring system functions, features or properties, which result from geosystems' interactions. Due to that, the approach for the study of the producing system is crucial for their proper and unequivocal identification. This investigation adheres to the systems approach by organizing the research process within the landscape geosystems. ESLS are here interpreted as "flow of ecosystem services to society provided within a landscape" (Willemen et al. 2012: 86). The research analyses landscape functions, such as the capacity of land for production (Kienast et al. 2009), a spatial expression of the vitality and sustainability of the geosystems—without limiting them to the land use function.

The adherence to the landscape concept is based on the following important arguments, associated with the objectives and expected results of the study:

1. The use of the "landscape scale" (Blaschke 2006) allows the disclosure of that scale of study of multifaceted spatial systems which identifies them to the highest degree as separate objects with certain properties and functions.
2. The functions of landscapes can be objectively and fully analysed and evaluated only if they be tested as whole, complete objects—geosystems. Established in the general practice, CORINE land cover (visual landscape features), which in small-scale studies may be a satisfactory basis for conducting economic evaluations and land use analyses, is not suitable for deepening the study from regional to local level or in cases of high natural heterogeneity of the territory (as is the case with mountain regions).
3. The landscape approach focuses the analysis on the source of the ESLS, which enables decision-makers to take actions to maximize their impact and ensure their sustainability.
4. System analysis, implemented on a landscape scale, adequately reflects the needs of the local population, supports its identification with the local landscape and motivates public involvement in the decision-making process. This approach is particularly appropriate where the population is heavily dependent on the local resources, as is the case in mountain areas.

Materials and Methods

Case Study Areas

The study was conducted in mountain regions, which are representative of the Bulgarian conditions—Central Balkan (Stara Planina Mountain) and the Western Rhodopes (Fig. 6.1). Due to the applied emphasis of the research results, the analysis focuses on the territorial scope of specific administrative units—at this stage of the project—the Apriltsi Municipality and the Mayoralty of Kalofer (Central Balkan region—774 km^2) and the Municipality of Smolyan (Western Rhodopes region—854 km^2). The site selection is consistent with multiple criteria briefly summarized here. Major natural, economic and social indicators which characterize the profile of the two municipalities are reviewed (Table 6.1).

The territories are situated in medium and high mountains and include their highest peaks: Botev Mount—2376 m (Stara Planina) and Golyam Perelik Mount—2191 m (Rhodopes). Expressive height differences in the relief (1300–1900 m) are typical, as well as considerable variations in morphometric features—vertical segmentation of 100–600 m/km^2 and horizontal segmentation from 1 to 3 km/km^2 (Stefanov 2002). The selected regions are situated in the upper parts of the watersheds of two major Bulgarian rivers—Arda and Tundja—that flow through Greece and Turkey into the Aegean Sea. These areas support

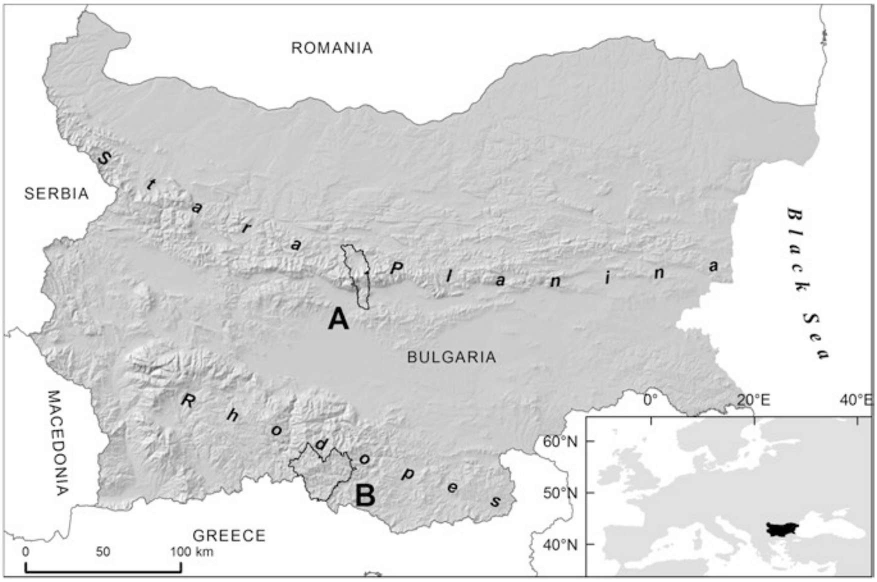

Fig. 6.1 Map of the case study areas—Central Balkan (**A**) and Western Rhodopes (**B**)

representative natural forests that are important for water resources formation. The Central Balkan region covers parts of the Central Balkan National Park that is classified as II category (according to IUCN classification). It includes the “Djendema” Reserve (Ist IUCN category) and seven NATURA 2000 protected sites. The Western Rhodopes region includes parts of 28 protected areas, as well as two reserves (“Soskovcheto” and “Kazanite”) and six NATURA 2000 sites. These are high-risk areas in respect to occurrences of natural hazards and unfavourable phenomena like intense orographic precipitation, floods, landslides and mass wasting.

The demographic situation in both areas of study is very unfavourable. At the same time, unlike other mountain areas in the country which experience depopulation and almost complete absence of business activities, here the business activity rate is higher than the national average. Forms of infrastructure use and land utilization—grazing livestock, forestry and tourism—which are typical for mountain conditions are sustained. Historically and geographically, pastoral farming has a long-lasting determining role in the formation of the culture and livelihood of local people in both regions. Transhumance between the Western Rhodopes and Western Thrace has been typical for centuries.

The main differences between the two areas of research, which are also defining criteria in their selection for the purpose of this study, are rooted in the intensity of the anthropogenic load on the available natural capital—in the historical past, as well as the one that lasts till today. Typical for the Central Balkan

Table 6.1 General characteristics of the studied regions (National Statistical Institute 2013)

General characteristics of the studied areas		
Indicators	Apriltsi municipality	Smolyan municipality
Area total	238 km^2	854 km^2
Average altitude	1031 m	1320 m
Air temperature, average	11.3 °C	9.6 °C
Precipitations, annual amount	1200 mm	1040 mm
Forest land, relative share	46 %	68.6 %
Agricultural land, relative share	49.6 %	27.9 %
Population, total	3285	40,941
Population density	13.8 persons/km^2	47.9 persons/km^2
Settlements, number	4	86
Natural growth	−18.6 ‰[a]	−6.7 ‰[b]
Migration increase	1.83 ‰[a]	−6.4 ‰[b]
Unemployment	11.7 %[a]	13.5 %[b]
Economic specialization	Wood; production of metals and metal products; tourism; crafts; permanent crops (fruit trees and shrubs); grazing livestock (mainly sheep); energy from hydropower plants	Grazing livestock (mainly sheep); wood; tourism; crafts; mechanical engineering; textile and clothing industry; perennial crops, fodder crops, potatoes; food industry
GDP at regional level	5.344.000 lv/2.740.000 euro (NUTS 2—North-West Region)	10.477.000 lv/5.372.000 euro (NUTS 2—South Central Region)
Average annual salary	4821 lv [a]/2472 euro	6336 lv[b]/3249 euro
Investments	231,051 euro[a] (costs in the investment program for 2013)	72,584.5 million euro[b] (FDI 2011)

[a]According to the Municipal Development Plan—Apriltsi (2014–2020)
[b]According to the Municipal Development Plan—Smolyan (2014–2020)

region is the very small population, concentrated in a few villages and availability of vast natural landscapes, less affected by human activity. Compared to all other mountain regions in Bulgaria, the Western Rhodopes region regularly reports a higher relative number of people and population density, as well as a denser network of small settlements and very fragmented land use. The potential of applying comparative analysis for the purposes of spatial planning and management has played an essential role in the final selection of the sites: both mountain regions are situated peripherally in the planning regions (NUTS 2) to which they belong. At the same time, significantly, the Western Rhodopes region is also peripheral to the territory of the country as a whole, while the Central Balkan region is located in its very centre.

Landscape Systematization

The lack of a commonly accepted landscape classification system in Bulgaria and the commitment of the country to the European Landscape Convention[1] pointed this study's research orientation towards the current trends in European landscape-ecological investigations and their adaptation to the pertinent regional development problems in the Bulgarian geographic conditions. The results achieved by The European Landscape Character Initiative (ECLAI) (Wascher 2005) on the development of a standardized landscape classification system in Europe and the accompanying georeferenced map of European landscapes (LANMAP2, Mücher et al. 2010) strongly influenced this research. The Landscape Character concept is also considered here a very useful tool for regional development and territorial planning (Swanwick and Land Use Consultants Swanwick 2002). The above studies have a direct impact on the selection of diagnostic criteria of landscape systematics.

This study used the classic genesis approach for systematization and classification that takes into account all possible factors for the formation of landscapes (natural and anthropogenic) under the direct influence of the existing zonal and azonal geographic patterns. At the same time, given the mountainous character of the area and the main research goal—formation of an information base to identify landscape functions—the study used an individual approach to develop the diagnostic criteria. The choice of data is motivated by predetermined conditions, including the following: representative character of the sources; accessibility and opportunity for periodic updating; informative with respect to more than one of the factors or processes (including typical or special processes) in landscape systems; data allowing wide applicability of the research results for different public sector planning, business or nature conservation purposes.

The main methodological solutions in developing a criterion basis for systematization can be summarized as follows:

Relief and subsoil: The relief forms are combined into three morphological types: flattened surfaces and gentle slopes, steep slopes and valley bottoms. Their separation is based on quantitative criteria—the values of the slope of the topographic surface and the index TPI (Topographic Position Index) (Weiss 2001; Jenness 2006). This approach makes it possible to get an idea of the intensity of morphogenetic processes and their character as regards erosion, denudation or accumulation. The analysis of the geological basis was carried out in terms of its importance for relief formation (rocks resistance) and participation in the processes of soil formation (mineral composition of the rocks).

Climate: The study uses Topliyski's (2006) research on the classification of climatic types in Bulgaria according to Thornthwaite's humidity index. The index is highly informative for tracing basic natural balances: heat/humidity (formative

[1] Bulgaria's 39th People's Assembly ratified the European Landscape Convention on October 13, 2004. The Convention entered into force on March 1, 2005.

impact on the altitude zonation in landscape distribution), the intensity of the substance-energy exchange and the nature of the potential vegetation.

Vegetation and soils: Joint analysis of data from the European database CORINE (2006) and data on habitat types and their boundaries (Assenov 2006; MOEW 2013, field studies) is applied to determine this criterion. The approach aims to adequately reflect the inherent biodiversity of the research areas and create ample prerequisites for research coordination at different levels of the landscape scale—from regional to local. In addition, the approach has many advantages in terms of using the quality of the vegetation cover as an indicator of the current state of the landscapes, the existence of processes of change in their structure and functions, including their anthropogenic transformation. To adequately reflect soil diversity, the research used Bulgaria's Ministry of Environment and Waters database and additional literary and cartographic sources (Ninov 1997).

In the process of selection and generalization of the database the investigation follows the principle of the single spatial dimension of the classification categories (Popov 2001). Compliance with this principle implies that, in accordance with the scale of the research, landscape units are defined by diagnostic criteria characterized by a specific degree of generalization of the indicators.

The analysis of the landscape structure is carried out using the FRAGSTATS software (McGarigal et al. 2012). The conducted measurements aim at detecting existing relationships between the landscape structure and the functions derived from it.

Assessment of Landscapes' Anthropogenic Transformation

For the purpose of system analysis this study uses the concept of systems' hemeroby, adapted for landscape research (Steinhardt et al. 1999; Rüdisser et al. 2012). Hemeroby index values are interpreted as degrees of landscapes' anthropogenic transformation. The authors apply the criteria of a seven-degree scale of naturalness implemented in the development of a common European indicator for landscape monitoring of rural-agrarian landscapes (Paracchini and Capitani 2011). Assessment was conducted within the boundaries of identified landscapes. The decision is in line with the objectives set for the geo-ecological information value of the landscape systematization and the use of environmentally sound, acceptable and easy to interpret indicators in the analysis of the current state of landscapes and their derivative functions.

Assessment of Landscape Functions—Ecosystem/Landscape Services

For evaluation of the landscape functions and visualization of the results the "matrix method" (Burkhard et al. 2009) is used; however, it is applied to landscapes as basic units of spatial analysis. The evaluation of 30 different aspects of ESLS (De Groot et al. 2010; Burkhard et al. 2012) grouped in "provisioning services", "regulating and maintenance services" and "cultural services" is based on a coherent analysis of landscape structure study results, hemeroby assessment, expert opinion, data from strategic development documents and face-to-face interviews with local administrators. The investigation experiments with expansion of the assessment basis by inclusion of the views of local people. A 12-question questionnaire was developed for this purpose that focuses on the study of the population's willingness to pay for the natural material and immaterial goods and services consumed. The study uses the method of contingent valuation.

This approach does not aim to establish the demand capacities (related to definition of Burkhard et al. 2012) of ecosystem goods and services, but the degree of their importance for satisfying the needs of the population and the development of local economic initiatives. The authors believe this is particularly important because the quality of services received by a landscape in mountain conditions can be considered as low, according to experts or to statistical data, but from the point of view of the local needs they may be extremely important for maintaining local traditions and subsistence levels. In addition, the authors share the view that the determining factor for the involvement of the population in the maintenance and preservation of ESLS is their confidence in the quality of the environment and, therefore, in the need for such actions.

Thus, the results of the assessment of the landscape functions should be seen both as the capacity of the landscape to provide goods and services and as significance of these goods and services in the context of local development. For its purposes, the study has adapted the 6-point scale assessment (Burkhard et al. 2009), where 0 corresponds to absence of capacity and 5 very high capacity.

Three field studies in two field seasons (in the period August 2013—June 2014) were carried out. A total of 249 respondents were interviewed (73 in Central Balkan region and 176 in the region of Rhodopes).

Results

Features of the Landscape Structure as Prerequisites for Formation of General and Specific Landscape Functions

The results of landscape differentiation show very rich modern landscape diversity with a number of distinctive features in the system characteristics and landscape pattern. A special place in these analyses is assigned to the diversity and characteristics of the spatial organization of the landscapes within the boundaries of major watersheds—Vidima River (Fig. 6.2) and Cherna River (Fig. 6.3). The authors share the view that the space that watersheds occupy presents a well-defined model of the genetic and functional subordination of landscapes, which is directly related to the formation of their current functions. An additional argument in favour of using this approach is the practical focus of the study: the results obtained within the

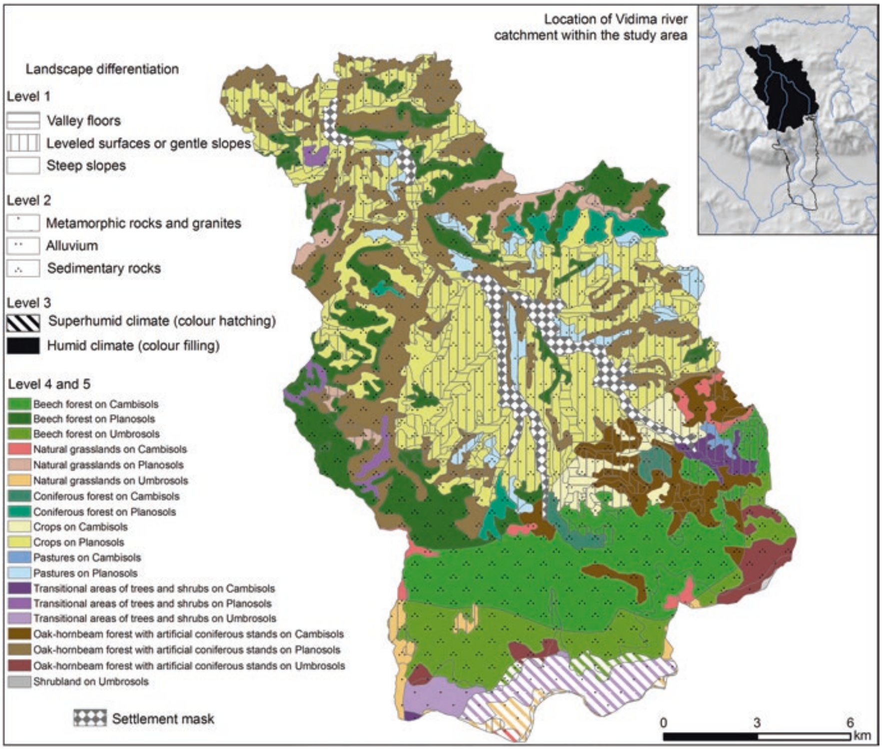

Fig. 6.2 Landscape structure of the Central Balkan Region within the Vidima River catchment basin

landscape boundaries should be easily applied within the administrative boundaries of land management. The authors believe that the watersheds have a high potential to facilitate this association and are acceptable in terms of administrative practice in Bulgaria (River Basin Directorates; Ministry of Environment and Water; Ministry of Agriculture and Foods; Regions; Municipalities).

Central Balkan Region

There is a natural heterogeneity and clear altitude zoning in the distribution of the complexes and well-manifested effect of transition of the landscape boundaries. A total of 118 units (PR, FRAGSTATS) with a high level of homogeneity (fifth level of differentiation) are identified, which in terms of the strong dependencies landscape structure-function implies the existence of a meaningful variety of ecosystems on a relatively small area. There are very good values for balance in the spatial expression of the diversity of landscape units. Aggregation results can be considered to be beneficial and enabling a wide range of landscape functions. At the same time, spatial dependencies are identified in this diversity of adjacent

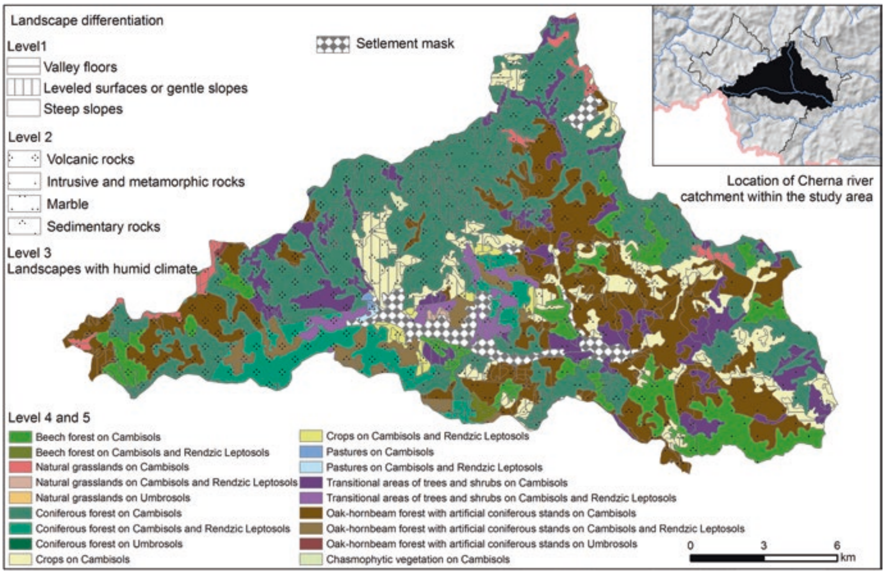

Fig. 6.3 Landscape structure of the Rhodopes Region within the Cherna River catchment basin

landscapes (e.g. pastures/landscape of oak-hornbeam forests), which require caution in land use, due to the risk of spreading the produced disturbances beyond the territorial scope of the direct impact and potential disruption of the functions of neighbouring landscapes.

Serious signs of fragmentation are absent. However, human activities (especially livestock grazing, logging, transport infrastructure) as a major factor in the generation of fragmentation should be carefully monitored. In the landscape map that is evident in the northern slope of the study area (the catchment area of the Vidima River—Fig. 6.2) the orography features, as well as the orientation of the river valleys, create greater diversity in the landscape mosaic, high variability in the size of units and suggest increased dynamics in the course of natural processes. It is worth noting the extent of the breaking up of the oak-hornbeam forest landscape in separate units, the change in their shapes and the development of linear elements. The southern slope is characterized by a clear process of territorial expansion of grasslands and transitional areas of trees and shrubs among landscapes of beech forests.

Rhodopes Region

Coniferous forest and pasture landscapes are representative of the study area. The data shows high landscape diversity—61 % (RPR) of the maximum according to the set criteria of differentiation. There is evidence of a steady, balanced landscape structure (SHEI—0.76; SIEI—0.96), formed by the participation of 175 homogeneous units (PR) (5th level of differentiation). Aggregation data (CONTAG—60.2 %) is fully consistent with the expectations at the existing landscape forming conditions and points to the need for increased control on human activity, due to the real risk of loss of landscape functions.

Deeper analysis of the landscape configuration accounts for reporting of a breach of the natural landscape contours and development of fragmentation processes. The relatively high values of the Splitting index and Landscape Shape Index can be considered as a confirmation of this thesis. These processes can be clearly traced on the landscape map, especially in the spatial organization of the landscapes of oak-hornbeam forests, as well as in the location of the transitional areas of trees and shrubs among landscapes of coniferous forests. The authors consider the traditional small scale, dispersed land use pattern to be the main culprit in this regard (Fig. 6.3). In modern land use, it should be borne in mind that the produced infringements of the landscape structure can occur rapidly and grow into destructive processes. This is explained by the particular combination of the landscape forming factors, like orography, contrasting bedrock (marble and volcanic rocks), landslides and mass wasting processes. In addition, the region has a relatively dense settlement network and relatively high population density compared to the average mountain conditions in Bulgaria.

Assessment of Anthropogenic Transformation of the Landscape

Central Balkan Region

The results of the evaluation of anthropogenic transformation of the landscapes (in degrees of hemeroby) show the expected good results (Fig. 6.4), having in mind the characteristics of the mountain (steep slopes, inaccessible terrain) and the presence of protected status areas. Over 50 % of all landscapes are defined as oligohemerobic (close to natural). They occupy the altitudinal belt between 750 and 1500 m and are explained by the condition of beech forests landscapes. About 14 % of the territory is rated as natural landscapes. These are mostly natural grasslands, presented over 1700 m a.s.l. (Fig. 6.6).

Against this background, the very high percentage of α-euhemerobic systems (away from natural), which participate in the landscape structure above 1300 m is really impressive, while their area understandably grows with decreasing altitude. Semi-natural landscapes of transitional areas of trees and shrubs are observed in all altitude belts, but their presence steadily increases above 1600 m.

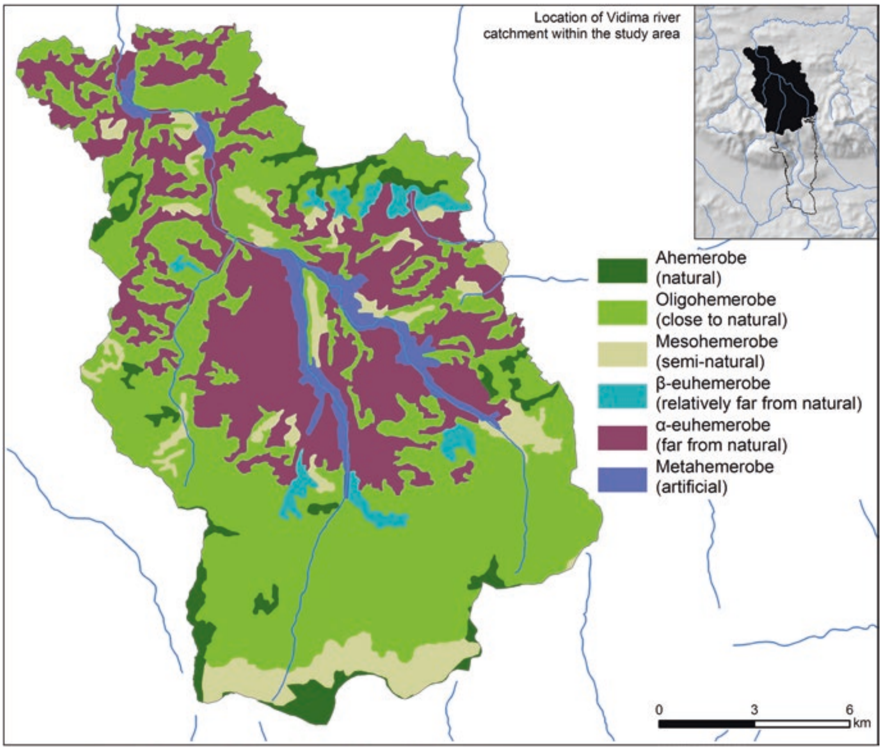

Fig. 6.4 Anthropogenic transformation of the landscapes within the Vidima River catchment basin (Central Balkan Region)

Rhodopes Region

The assessment shows that only separate landscapes of natural grasslands above the forest line and chasmophytic vegetation landscapes on limestone slopes can be determined as natural (Fig. 6.5). According to the altitude zones analysis, natural landscapes contribute less than 5 % in the overall structure and only in belts from 1800 to 1900 m—they take up to 10 % (Fig. 6.6). Oligohemerobic landscapes (coniferous forests and grasslands) dominate only the area higher than 1500 m. Below 1500 m a.s.l. over 60 % of the landscape are assessed as semi-natural. They form compact spaces in the border areas of the higher part of the Arda River watershed. The fact that these are mostly forest landscapes in the beech and oak belt is seen as unfavourable. Euhemerobic landscapes are permanently involved in landscape structure even at 1800 m a.s.l. They are ubiquitous around mountain villages and adjacent agricultural areas.

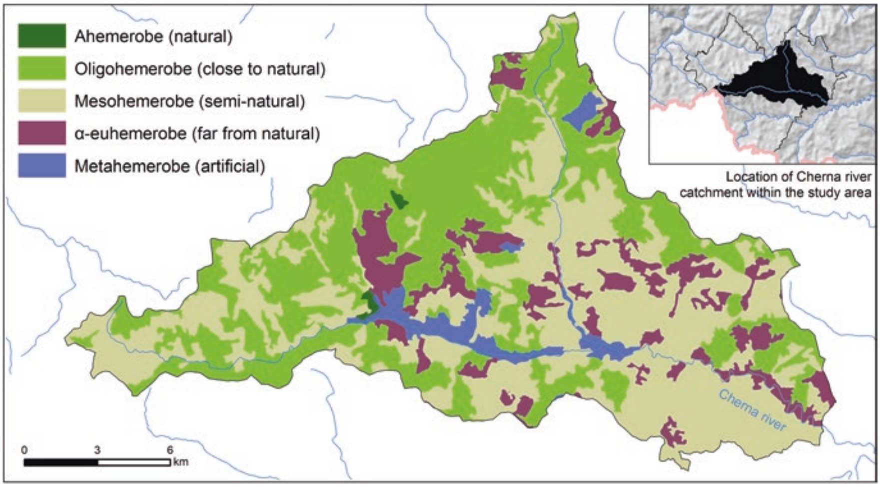

Fig. 6.5 Anthropogenic transformation of the landscapes within the Cherna River catchment (Rhodopes Region)

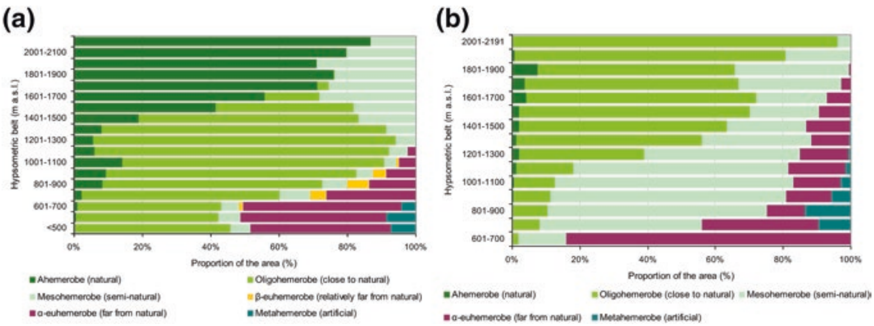

Fig. 6.6 Naturalness profile for altitudinal zones: **a** Central Balkan Region. **b** Rhodopes Region

Assessment of Ecosystem/Landscape Services

Central Balkan Region

Forest landscapes and their good current condition explain their leading importance for the region in the context of the discussed issues. The results show that both the experts and the population rate highly the landscape qualities of the beech forests across the whole range of the considered ESLS (Fig. 6.7). The higher rating of the material and cultural services provided by the natural grasslands is

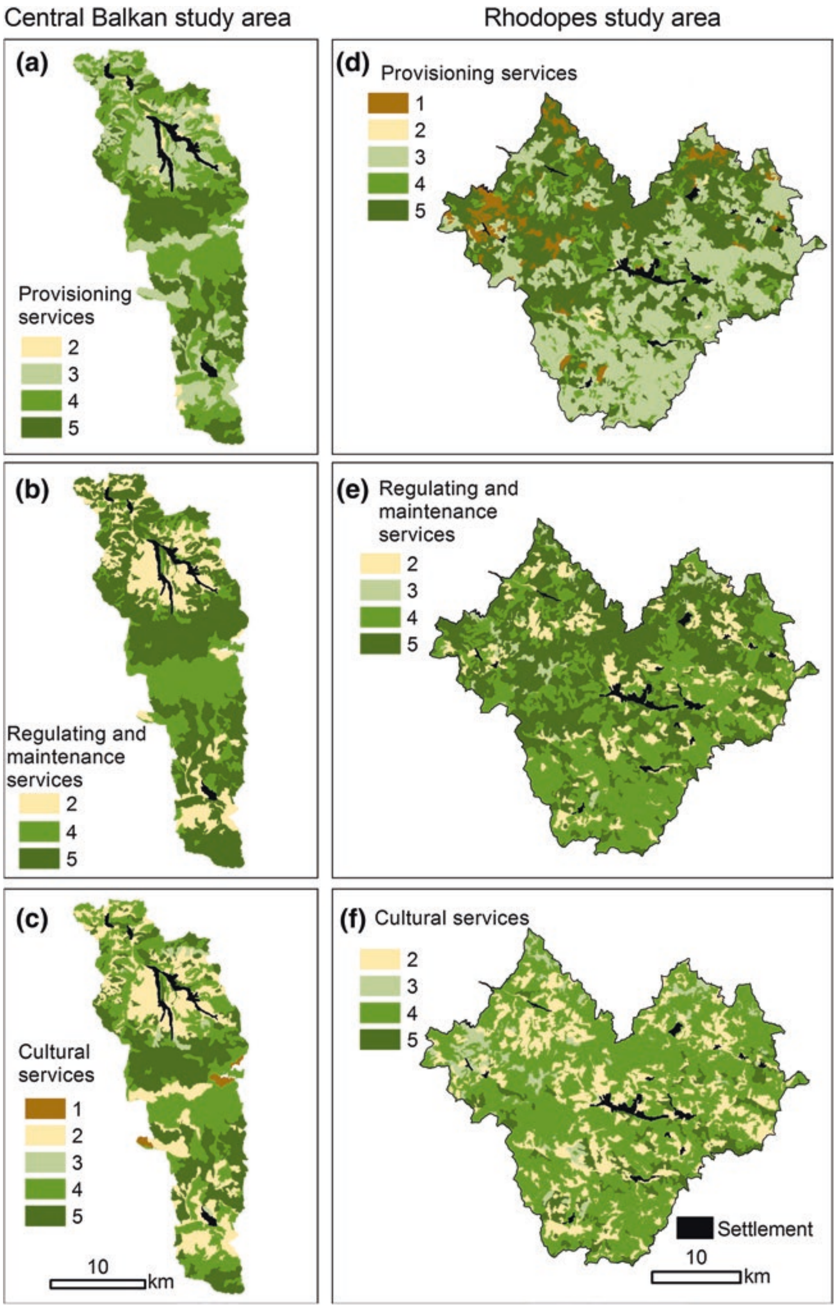

Fig. 6.7 Assessment of ecosystem/landscape services. Scale assessment: *0* absence of capacity, *1* very low capacity, *2* low capacity, *3* medium capacity, *4* high capacity, *5* very high capacity

explained by the local tradition of pastoral farming. Having in mind the characteristics of the analysed mountain area (steep slopes, orographic precipitation and frequency of flooding), the regulatory functions of oak-hornbeam forests and the transitional areas of trees and shrubs are highly rated.

The survey shows that the local population has no clear understanding of the close relationship between the supporting function of forest landscapes (e.g. for formation of water resources), and the presence of material services (waters) in their neighbouring lower altitude landscapes. At the present time, the importance of pastures is increasing, and, in relation to that, higher pressure on the natural grasslands landscapes in the middle and high mountain belt is expected.

Rhodopes Region

According to the summative evaluations, leading functions in the landscapes of the region are the regulative and the maintenance functions, followed by the cultural and lastly the material functions. This picture is fully consistent with the results of the analysis of the landscape structure and the degree of anthropogenic transformation of the systems. The importance of material services from forest landscapes, including those with transitional areas of trees and shrubs, has traditionally been high and will continue to grow in this area. It should be noted that the area displays a vulnerability to the adverse and destructive natural phenomena (landslides, floods, erosion, drought) and, therefore, carries a risk in terms of the loss of important properties and qualities.

Both the material and the cultural services derived from the pastures landscape have low ratings, which can be interpreted as a probable loss of systems' qualities and/or attenuation of traditional forms of agriculture (pastoralism) in the area.

Conclusions

The experts' analyses indicate that forest landscapes exhibit leading functions in both study areas. These landscapes are both a source of ESLS and, at the same time, a stabilizing factor for their sustainability. The effect of their influence far exceeds their immediate territorial scope. From the perspective of the local population, however, forest landscapes and pastures enjoy almost equal importance. The significance of landscape configuration, especially in the semi-natural and highly modified landscapes, stands out in the further analysis of specific localities.

Meanwhile, the two regions of study offer entirely different challenges to the assessment of landscape qualities to their planning and management as multifunctional systems. In the Central Balkan region, a balanced landscape structure exists; however, there are contrasts in the territorial concentration of the anthropogenic pressures. Landscape functionality in this region is exceptionally rich across the full spectrum of ESLS, which also bodes well for their sustainability. Limitation of the intensity of land use (especially grazing) at high altitudes and further raising the percentage of wood vegetation at the zone of transition from anthropogenic to natural landscapes are very important measures for their improved maintenance. In the Rhodopes region, high natural landscape heterogeneity, complex configuration of the landscape mosaic and fragmentation tendencies are observed. Anthropogenic influence affects over 80 % of present landscapes. Landscapes are susceptible to destructive processes. There is a high risk of losing ESLS. Forests are crucial to the preservation of the existing potential of landscape functions. A targeted intervention in the landscape configuration of separate localities is needed, as well as an increase in the forest vegetation: as green belts around settlements, in the border areas of the watersheds, and in riparian landscapes.

On the basis of the obtained results the authors argue that the conduct of the ESLS evaluation on the landscape scale is particularly suited to coordinate objectives and activities between regional and local planning and management. One of the most important advantages of the approach is the identification of landscape functions in their complexity, interconnectedness and interdependence. The investigators believe this to be a decisive factor for the formation of forms of landscape planning adequate to the specific geographic conditions from the perspective of the multifunctionality concept. Attention should be given to the very high efficiency potential for landscape management in its organization within the watershed boundaries. Such an approach allows control of the process in landscapes, while also taking account of all ESLS produced by them.

The landscape approach exhibits several advantages in the study of areas with high natural heterogeneity, such as mountains. The results can significantly optimize the quality of the ESLS evaluation.

Discussion

The ESLS concept has the potential to optimize approaches to planning and management of mountain areas. But if qualitative assessment is more accessible in terms of available methods, the quantitative evaluation of natural capital, which is quite necessary for the economic analysis and decision-making practice, is still under discussion. It requires coordinated analysis at different landscape scales, a clear time horizon and unambiguous separation of the value of the material services from the total value of the landscape that produces them in a specific geographic setting.

In the Bulgarian conditions, the practical application of the natural capital concept is likely to encounter difficulties, mainly due to the strong tradition of central planning. The landscape approach can facilitate this interaction, but the objectivity of its results is dependent on the proper selection and interpretation of the available database.

The local population survey showed that the term ESLS is largely unknown. There is also a negative reaction to their valuation. An active awareness campaign at the national level, headed by the administrative structures, is needed, so that the difficulties in the implementation of NATURA 2000 are not repeated. Even today in the minds of the mountain population it is associated with restrictions without sufficient tangible benefits and compensation.

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Chapter 7
The Landscape Research in the Svratka-River Basin Using Ecosystem Services According to the CICES Methodology

Skoupý Milan and Hynek Alois

Abstract This thesis represents one of the possible ways of utilizing the concept of evaluating ecosystem services. It is about connecting this concept with landscape research from the perspective of physical geography. The CICES—Common International Classification of Ecosystem Services methodology from January 2013—has been used for this purpose. It is one of the most advanced methodological systems of evaluation in this field. The modification that the collective of authors has prepared expands this methodology into new areas. The modified methodology allows the expansion of the perception of the influence of the ecosystem's services on the human population. Unitary humanity has been substituted by individual groups of people who live in the countryside. Another modification is the option of utilizing this methodology when evaluating the impact of planned constructions on the ecosystem services in the construction's area. It also brings a geographical way of observing the landscape into the method of evaluating ecosystem services—spatiality. Thanks to the thus created method of research it was possible to research the cultural landscape in so far unresearched context, connections and details. The individual results are shown with the help of a table chart method of research which manages to capture information in the needed context. The land cadastre from the municipality of Hluboké in the basin of the river Svratky (Czech Republic), where the author's research has been conducted, is used as an example for the presentation of this method.

Keywords Ecosystem services · CICES methodology · Svratka-river basin · Hluboké village

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Introduction

The purpose of this text is to present a possible way of utilizing the evaluation of ecosystem services during landscape research and show the possibilities of research based on methodology evaluating ecosystem services in all their complexity. The current version of the common international classification of ecosystem services Haines-Young and Potschin (2013) (abbreviated as CICES) is only the latest step in the long development of research on this phenomenon. The beginnings of the research can be found in the book Man and Nature (Marsh 1864). Since then there have been many important publications in the research on this phenomenon: Leopold (1949), Sears (1955), Carson and Darling (1962), Ehrlich (1968), Eherlich et al. (1977), Westman (1977), Ehrlich and Mooney (1983), Vitousek and Hooper (1993), Carpenter et al. (1995), Daily (1997).

The modern breakthrough in the conception of ecosystem services began in 2001 with the document Millennium Ecosystem Assessment (MEA 2003). It was the first methodological approach that was created out of the consensus by the worldwide academic community in this field. Thus, this methodology has become the founding stone for any future research in this field. This crucial document has become the basis of modern methodologies of evaluating ecosystem services. The two most advanced methodological evaluations of today, CICES and the economics of ecosystems and biodiversity (TEEB 2010), have also been based upon it. However, it is still an evolving process and the individual tools of this methodology are still being innovated and improved. Therefore, they slowly change their shape just like the perception of the outside landscape is changing in the eyes of the human population.

CICES is primarily seen as a tool that enables the evaluation of nature—the individual parts of landscape. It is based on the assumption that if we are able to evaluate—count—something, we can appreciate the value of this element and consequently treat it as something valuable. It primarily serves as an economic assessment of nature (its constituents—stock) and is based on the assumption that people only value that which is quantifiable by monetary value (money). If this does not hold true then the item is seen as universally available—to be used for free. Therefore, one of the applications of the method is concentrated on assessing the value of nature by the wide population. It is an anthropocentric methodology—everything is looked upon from the human viewpoint. That is the evaluator and receiver of the ecosystem services.

The definition of ecosystem services as they are presented here:

> For the purposes of CICES, ecosystem services are defined as the contributions that ecosystems make to human well-being. They are seen as arising from the interaction of biotic and abiotic processes, and refer specifically to the 'final' outputs or products from ecological systems. That is, the things directly consumed or used by people (Haines-Young, 26).

Ecosystem services are divided here into three categories—provisioning, regulating and maintenance and cultural services. Individual ecosystem services are incorporated into the hierarchical structure of this methodology: Section—Division—Group—Class—Class type. This allows easy orientation in the methodology and its possible comparison within the individual ecosystem services. All ecosystem services described here are products of living (biotic) parts of natural ecosystems. The current version of the methodology of CICES does not use the abiotic component, instead it is forbidden to use it and combine it with the biotic part because doing so can result in double counting of certain services and affect the entire outcome of the research.

A great advantage of this methodology is its easy modification (application) for the needed type of research. This possibility has been used by the author of this text to create a method of research of cultural landscape based on the methodology of CICES. The adjustment serves to better understand the processes and phenomena in the landscape that are associated with the flow of ecosystem services between donors (landscape ecosystems) and recipients of services—people (different human groups). This research is aimed at better understanding the links between cultural landscape and man who lives in it. The cultural landscape is perceived as a spatial product of human activity. In this research, a person is not a mere observer of the events around him. He is in the active role as the recipient of the ecosystem services as he is using them for his needs—he uses the information, perceptions, energy and material goods from them. This flow of tangible and intangible entities is processed by people and used during everyday activities. This activity and then the feedback process influence the ecosystems which had previously provided the services. This action can strengthen the affected ecosystems as well as threaten them. This constant exchange of matter and energy exists in the background of all processes in the current cultural landscape. Through them it is possible to find an as yet undescribed mutual connection between elements in the landscape and thus achieve a better understanding of them.

Introducing the Modified Methodology

The first significant modification is the change in the understanding of the focus of ecosystem services. In the current methodology of CICES everything is focused only around "man" or "humanity". However, this is a very poor summary of reality. This assumption is shown in Fig. 7.1, where the effect of ecosystem services on humanity is shown on the left; the flow of energy and matter is only one way—it flows toward man. The right part of the figure shows the situation as perceived by the author of this thesis. Natural ecosystems provide ecosystem services to particular groups of people (not just general humanity). Groups of people use them in their own way and using the feedback process then act to influence the ecosystems. This fact is needed for landscape research because "random people" with average properties of the population do not move throughout the landscape, but rather individual groups do with their different demands on energy and mass. The range of their feedback processes and intensity is also different.

In reality, there is a large quantity of groups of people and their roles that affect their environment (farmer, tourist, bus driver…). Every person can have several

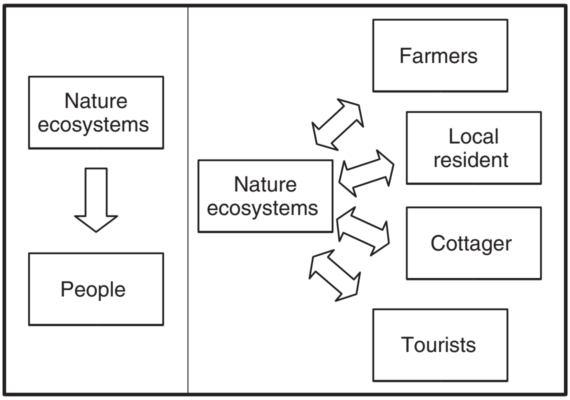

Fig. 7.1 A diagram showing the change of approach to the direction of the flow of ecosystem services in the modified methodology of CICES versus the unmodified version

roles (bus driver + tourist). These roles can even change throughout time—their number is affected by age, gender, profession, housing, transportation, time spent in a given area and by many other factors because a tourist that travels through nature and looks at its beauty (which is the main point of his existence in the landscape—his role) will affect his surroundings differently from a local farmer who sees the landscape as his source of income. The latter is focused on the situation in the vicinity of his lands, maybe the risks and threats. Its aesthetic values, the aesthetics of the surrounding landscape do not interest him. Both of these two roles can coexist at the same time in the same place; however, each brings a different basic way of perceiving the world around them. The possibility of perceiving the landscape through ecosystem services that are used by different groups of people (the individual roles) enables the relations in the landscape and their development in space and time to be described in detail. To portray the variability of ways of utilizing the ecosystem services by individual groups of people four different groups have been used. They are farmers, local residents, cottagers (those who own cottages in the landscape and come every so often to live in them during their holidays, weekends and so on) and tourists. These chosen groups increase the diversity of the ecosystem services used.

The roles used in this example are very idealized and summarized. They are chosen to maximize the variability of expected results but even with simplification they present results that are of sufficient quality to represent the modified method of CICES.

- **Farmer**: A group of the populace dealing with agriculture—it is their job. The profit from agriculture is dominant—a way of business; it influences its surroundings on a large scale—it uses the ecosystem services provisioning, regulating and maintenance on a large scale. This group, out of the chosen four, affects its surroundings the most—it has the largest sphere of influence.
- **Local residents**: People living in the municipality—they have their permanent residence here. The ties to the individual buildings are dominant here; they are very familiar with the area. Their knowledge and influence on the area decreases with the increased distance; provisioning, regulating and maintenance

are joined by cultural services. There is the possibility of further dividing the research into newly settled residents and old residents.

- **Cottagers**: A group of people who have chosen the researched locality as their place of family recreation time which is ongoing in the long-term–many years (even spanning generations)—and is focused on a specific building and its area (the garden, courtyard…). Just like with the previous group, the dominant sphere of influence is the small area surrounding the building (garden, the plot). The amount of influence on the wider area is, however, greater; it is a group of people who go to the cottage for recreation—they chose the locality and like it (otherwise they would not come there); the cottage is their base for movement around the landscape; they have a wider knowledge of the surrounding areas. The group uses provisioning, regulating and maintenance and cultural services. Cultural services gain larger importance than with farmers and local residents.
- **Tourists**: A group of people who came into the researched locality with the intention of having experiences—positive feelings and good memories. They are affected by provisioning, regulating and maintenance but their dominant group is cultural services. The reach of the influence is small (around roads and interesting places); however, often it is much more intensive (garbage, noise, trampling grass). Their influence on the landscape follows an unstable pattern—it is dependent on weather conditions and seasons.

The second innovation that the author of this thesis has used is focused on the need for **awareness of the spatial arrangement of individual ecosystem services**. The individual services affect areas of various sizes as there are services with vastly different reaches of influence. On the one hand, such an ecosystem service can gain a global scale (regulation of the global climate by reducing the concentration of CO_2). On the other hand, the influence of other ecosystem services can only have local reach; for example, the ecosystem service aesthetics, which describes the feelings and impressions of a given place (painting, photography). The reach in this particular service only reaches the vicinity of the observer (observing reach). The individual levels of the sphere of influence of ecosystem services that have been used in this thesis are: Local (up to 10 km^2), regional (10–100 km^2), supraregional (100–1000 km^2) and global (on a worldwide scale). This also influences the data that can be used for the size of the research.

Another possible way of using the CICES methodology is its application on as yet only planned projects. The planning of future projects and their evaluation is practised very often in landscape managements. The authors of this thesis have, therefore, given themselves the task of modifying the CICES methodology for this purpose, this way of utilizing it. As a basis, it is necessary to analyze the current state of the researched area. It is necessary to know not only the issue of ecosystem services but also the physical geographical and socioeconomic matters of the researched area. The history of the given area has also proved a stimulating source of information (the use of the local area in the past, the development of the system of roads). An example of future projects which can be analyzed in this way are windbreaks, wildlife corridors, bioproducts, revitalization of watercourses and ponds, planting orchards, improving the roads and many more.

As a way to comprehend the understanding of the surrounding area, the concept of spatiality has been used (Cloke et al. 2005; Harvey 2006; Hynek and Vávra 2007; Hynek 2009, 2010). In the context of the researched topic, socioeconomic and perceptional (imaginative) spatiality is used the most. However, the influence of natural spatiality from which ecosystem services come is not being neglected. One can look at the current landscape like this as a constantly evolving system of landscape elements. Individual processes are constantly evolving—they are created and are destroyed or disappear or transform into another form. However, with the change of one landscape element, the surrounding elements also change.

The advantage of this method is the option of assessing the planned change to the landscape from various points of view that arise out of a wide array of ecosystem services described in the CICES methodology. Thanks to such a wide array, it is possible to discern influences on the surrounding elements which would be missed by methodologies. This can serve to improve the intended change itself. However, one should always remember that ecosystem services are evaluated from the anthropological point of view but they also influence other living organisms (ecosystem services are used by humans and nature alike). And because of the change in the way the ecosystem services function, because of a new element in the landscape, the surrounding systems will be changed. And these affected systems will change through feedback processes the human population in the surroundings.

The surrounding results are presented with the help of a series of tables. Their creation was inspired by the following texts: Crossman et al. (2013) and Martínez-Harms and Balvanera (2012) and the table method by Hynek (2011). This method enables a large amount of information to be recorded about the researched locality in one place and uncover mutual relations which otherwise would be very hard to discern. The tables focus on individual aspects of the research of ecosystem services and their influence on individual landscape elements. Three tables describing individual aspects of ecosystem services will be used as an example of this method.

- General table—A general table representing ecosystem services in the researched locality and their feedback processes
- Table—Table focused on the possibilities of using the potential of ecosystem services by a given group of inhabitants
- Table—Describing changes in the flow of ecosystem services in the event of planned changes in future

A Case Study Presenting the Outlined Method of Research

The examples of using these tables are presented on the basis of the author's study of the area of research in the basin of river Svratka in the Czech Republic. It concerns the study of regional practices of this area's inhabitants and their influence on the surrounding landscape. The tools used in this study are the presented concept of spatiality and ecosystem services. The researched area itself spans about

220 km^2 on the middle flow of the river Svratka. The dominant feature of this landscape is the deeply cut valley of the river Svratka. Segmentations of the basin are due to the various tilt and orientation of individual positions. The altitude is between 762 m above sea level—Horní les u Rovečného—and 253 m above sea level near the confluence of the river, Loučka near Tišnov. Land use of this area is very varied. There are areas of unbroken coniferous forests (monoculture of the pine tree), mixed stands of spruce, hornbeam and beech forest to deciduous forests in the alluvial plain—alder and willows. In the higher altitudes, we can also find pastures and fields. Flatter areas are agriculturally cultivated. A specific feature of this area is the very well-preserved historical landscape structure in the area of small villages. There is clear long-term purposeful work in the landscape, which it transformed into its present state. This development began in the fourteenth century during the colonization of the region. A deserted medieval field system with accompanying linear vegetation along the roads and paths has been preserved here and in many places.

As a case study for presenting specific results, the cadastral land of the municipality of Hluboká has been used. The researched municipality belongs to those with the best preserved historical landscape in the whole studied area. The fields and pastures are segmented by a thick radial system of field roads. Along this road grows linear vegetation. This vegetation was planted here on purpose as is discernible from the terrain study (linden and ash trees). The individual conjoining of rural areas with the town residential areas is very interesting here as a very large amount of the linear vegetation is directly connected to orchards planted in the municipality; they help to create the image of the whole cadastre. Another argument for using this municipality, as an example, is its size because it is a very small municipality. Only 44 permanent residents live here, which enables the easy presentation of the method shown and its easier understanding. In the area, the spatial influence on the individual groups of the populace (the aforementioned roles)—farmers, local residents, cottagers and tourists—can also be easily identified. The small number of permanent residents is offset by the cottagers who do not build new buildings for secondary living but use the existing agricultural buildings. The fact that the entire agricultural land is used by only five users helps clarity of the local relations.

Thanks to the small area of this land, it is possible to focus on the research in great detail. As a retention spatial element land—unit had been used here. This makes it possible to study the effects of ecosystem services in great detail.

The first of the presented tables is the **general one representing ecosystem services in the researched locality and their feedback processes**. It is the first table which it is necessary to create with this method of research. Its contribution is the possibility of presenting individual ecosystem services that influence the researched area in one place and assign to them basic characteristics. It is the description of individual ecosystem services, the reach (or sphere) of influence and most importantly the influence on the individual groups of the populace. The four aforementioned groups are used, farmers, local residents, cottagers and tourists. Also not only the influence on the individual group of the populace is very important, but also the feedback processes on the landscape. The individual processes are quite concise but even so they present a first look at the researched locality and enable work with this methodology. They present the basic information without which the research could not exist.

The first step when creating this table is the identification of ecosystem services which take part in the interaction between humans and nature. In this case (the cadastre of the municipality of Hluboká), it is 34 ecosystem services. When classified into individual ones there are 17 provisioning services, 10 regulation and maintenance services and 7 cultural services. The next step is to analyze the sphere of influence of individual services. This influence depends on the type of individual service and the local physical-geographical conditions. The following step is crucial for the whole of this method. It is necessary to describe the influence of the individual ecosystem services on the interest groups of the population. The last step is then the recording of the feedback process, which influences the natural ecosystem. Because of the sheer scale the example shown has been shortened (Table 7.1).

The second presented table, **Table focused on the possibilities of utilizing the potential of ecosystem services by a given group of the population**, describes the result of ecosystem services on each individual group of people from a different point of view. It deals with the ideal state in which we can use the potential that ecosystem services offer to humanity and also the limits that block this ideal state. If we are able to describe both of these two ideal states for each ecosystem service functioning in the researched area, we can better understand the current situation or even better predict their development in the future. As an example of this approach, a part of a table is shown that has been created in this way. This part represents seven cultural ecosystem services and their ideal state (potential) and their limits—why it has not been reached (Table 7.2).

The last table presented here **describes the prediction of change in the flow of ecosystem services between humans and the natural ecosystem by specific, planned intervention into the landscape**. This method of prediction uses all discovered findings about the flow and way of utilizing the ecosystem services and shows a possible scenario how the planned change would influence the area in which it would happen. The creation of the green barrier in the agricultural area in the municipality of Hluboký is shown as an example, because this area negatively impacts its surroundings and lowers the quality of life for interest groups (Table 7.3).

Table 7.1 A general table representing ecosystem services in the researched locality and their feedback processes shown in the example of the municipality of Hluboká

Class of ecosystem services	Description	Radius	Farmers		Local residents		Cottagers		Tourists	
			The person	Feedback on nature	The person	Feedback on nature	The person	Feedback on nature	The person	Feedback on nature
Type of ecosystem services										
Reared animals and their outputs	Source of meat	Local	Source of food—meat and milk, wool	Threat to biological pollution—cowshed	Additional source of meat and eggs (chickens, rabbits)	Nutrient source—manure from animals affects the habitat of animals	Local food	–	Local food	–
Wild plants, algae and their outputs	Berries, fruits, mushrooms	Local	–	–	Harvest—fruits and berries, mushrooms	Trampling, spreading seeds	Trampling, spreading seeds; more than local residents	Trampling, spreading seeds	Harvest of fruits in addition to tourism or primary intention (mushroom)	Trampling, spreading seeds
Ground water for non-drinking purposes	Source of water for animals—watering gardens	Local	Source of water for the animals, for technical purposes	Source of water for livestock, increasing soil moisture around farm buildings	Possibility to use for technical purposes—garden	Source of irrigation water, and technology—the possibility of contamination	Possibility to use for technical purposes—garden	Source of irrigation water, and technology—the possibility of contamination	–	–

(continued)

Class of ecosystem services	Description	Radius	Farmers		Local residents		Cottagers		Tourists	
			The person	Feedback on nature	The person	Feedback on nature	The person	Feedback on nature	The person	Feedback on nature
Regulation and maintenance										
Bio-remediation by micro-organisms, algae, plants, and animals	Biological purification of waste in liquid (water flow) and solid (manure, waste from household)	Local	Cleaning around farm buildings—affected biological pollution	Source of nutrients—influence on the composition of organisms	Waste water generated by households—drains	Source of nutrients—influence on the composition of organisms	Waste water generated by households—drains	Source of nutrients—influence on the composition of organisms	Degradation of waste by tourists—in the vicinity of their residence	Source of nutrients—influence on the composition of organisms
Ventilation and transpiration	Improve air circulation—increased evaporation, temperature reduction—real and emotional	Local	Better ventilation around the agricultural product (e.g. cowshed), odour reduction, increased moisture—animal welfare	Increase moisture—reducing evaporation	Odour reduction, reducing temperature and increasing humidity—especially emotionally	Increase moisture—reducing evaporation	Odour reduction, reducing temperature and increasing humidity—especially emotionally	Increase moisture—reducing evaporation	Odour reduction, reducing temperature and increasing humidity—especially emotionally	Increase moisture—reducing evaporation
Pollination and seed dispersal	Pollination	Local	Increase production	Propagation of plants, insects, food source	Beekeeping as a livelihood, pollination in gardens and orchards	Propagation of plants, insects, food source	Pollination in gardens and orchards, the sound of bees	Propagation of plants, insects, food source	The sound of bees, local fruits and vegetables	Propagation of plants, insects, food source

(continued)

Table 7.1 (continued)

Class of ecosystem services	Description	Radius	Farmers		Local residents		Cottagers		Tourists	
			The person	Feedback on nature	The person	Feedback on nature	The person	Feedback on nature	The person	Feedback on nature
Cultural										
Physical use of land-/seascapes in different environmental settings	Tourism—cycling, trail race, water reservoir Vír	Regional	Possible damage to pastures—the movement of tourists, scaring animals, the possibility of waste	Trampling, litter, disturbance of animals	Receiving money (but closed restaurants Tale)—increase tourism in the quiet village; own movement in the country—one of the reasons why live in this area	Trampling, litter, disturbance of animals	Receiving money (but closed restaurants Tale)—increase tourism in the quiet village; own movement in the country—to the establishment of cottages	Trampling, litter, disturbance of animals	The content of tourism—movement in the landscape—the use of a dense network of paths—bicycle; cycling race	Trampling, litter, disturbance of animals—nearby roads, prospects
Heritage, cultural	Historic landscape structure, the old alley	Local	Distribution of land in the countryside—a system of roads	Maintenance of existing communities	Distribution of land (and houses) in the landscape, the way land is used—tradition—e.g. beekeeping—linden alley; imagery of landscape	Maintenance of existing communities	Distribution of land (houses) in the landscape, the way land is used—e.g. local traditions varieties of fruit trees—linear greenery land fragmentation; imagery of landscape	Maintenance of existing communities	The content of tourism—movement in the landscape—the use of a dense network of paths	–

(continued)

Table 7.1 (continued)

Class of ecosystem services	Description	Radius	Farmers		Local residents		Cottagers		Tourists	
			The person	Feedback on nature	The person	Feedback on nature	The person	Feedback on nature	The person	Feedback on nature
Aesthetic	Feelings, paintings, photos, imagery	Local	Possibility of income—tourism—yet undeveloped—cowshed—grazing sheep	Understand the beauty of the beast—a change with respect to them	Rural feel—the reason for existence, consciousness	Understand the beauty of the beast—a change with respect to them	Reason why houses exist—a rural feel, slowly passing time, and being close to nature—Panorama—snapshots in nature	Understand the beauty of the beast—a change with respect to them	Reason why tourists come to these areas—a rural feel, slowly passing time, being close to nature—snapshots in nature	Understand the beauty of the beast—a change with respect to them

Table 7.2 Table focused on the possibilities of using the potential of ecosystem services by a given group of inhabitants in the example of the municipality of Hluboká

Class of ecosystem services	Description	Agriculture		Local resident		Cottager		Tourists	
		Potential	Limit	Potential	Limit	Potential	Limit	Potential	Limit
Physical use of land/seascapes in different environmental settings	Tourism/bike	Tourism, diversification of income, sales and product experience	Not suitable land use, landscape permeability, odour, reduce landscape aesthetics	The possibility of using newly developed services for tourists; life in a small village in a harmonious landscape	Attempt to maintain the status quo, appreciates peace—a small movement of people	Recreation in a beautiful landscape—the purpose of the establishment of cottages, outdoor life	Unbound respect to the location	The content of tourism; movement in the landscape; a network of paths; the aesthetics of the landscape; views	–
Scientific	Source data; this research	Questions researchers; opportunity of a voice	Fear; lies; modifying facts	Increased interest in the area—a sense of place values, awareness	Reluctance and lack of understanding	Increased interest in the area—a sense of place value, recognizing the value	Reluctance and lack of understanding	Scientific tourism; a growing interest; and among the tourists; the greater the amount of information	–
Heritage, cultural	Historic landscape structure, old alley, tradition	The possible exploitation of the landscape—risk reduction, sustainability, possibility to improve public image	Misunderstanding; rigid thinking, only gain; lack of understanding of the local situation—live elsewhere	The feeling of rooting; home and ancestral heritage; aesthetics preserved landscape structures	Need to understand; open mind	Increased interest in the area—a sense of place values, awareness; one of the reasons for existence in this area, aesthetics	Need to establish a relationship to the landscape (different generations)	One possible reason for the visit; mosaicity and diversity of the local area; the reason for this research	Interest of tourists in this type of landscape

(continued)

Table 7.2 (continued)

Class of ecosystem services	Description	Agriculture		Local resident		Cottager		Tourists	
		Potential	Limit	Potential	Limit	Potential	Limit	Potential	Limit
Entertainment	Monitoring of plants and animals	Agro tourism; yet undeveloped, sheep, cows	Attempt to maintain the status quo	Interest of tourists and locals; awareness of the beauty, the beauty of life in a living landscape	Need to understand; open Mind	Awareness of beauty, beauty, living life in the countryside—rural feel	Need to establish a relationship to the landscape (different generations)	Reason why they are there; view, nature, animals; feelings of rural aspects	Interest of tourists in this type of landscape
Aesthetic	Feelings, paintings, photos, imagery	Agro tourism; yet undeveloped, sheep, cows	Work with the land and landscape photography need not cause	Picturesque landscape—a feeling of beauty; attracts photographers and those interested in living in the area; the view from the window	Misunderstanding of its surroundings; limited perception of the surrounding area	Landscape aesthetics encourages the existence of property and interest in the neighbourhood; rural impression, close to nature—panoramas moments in nature	Need to establish a relationship to the landscape (different generations)	Reason why tourists come to these areas; rural feel; slowly passing time and being close to nature; it corresponds to photos; Panorama—moments in nature	Interest of tourists in this type of landscape
Existence	Experiences, trouble and pleasure live in this village—story of this village	Willingness of employees to work	Misunderstanding	Why live here; story of the village; genius loci	Relationships between locals; life in the village	Reason for existence of cottagers; the story of the village; a moment in nature; genius loci	Need to establish a relationship to the landscape (different generations)	Reason for existence of tourism; experience; story; a moment in the landscape; genius loci	–

(continued)

Table 7.2 (continued)

Class of ecosystem services	Description	Agriculture		Local resident		Cottager		Tourists	
		Potential	Limit	Potential	Limit	Potential	Limit	Potential	Limit
Bequest	Willingness legacy—remember the future, ethical considerations	Continuity with the past; continuation of the practices set; inspiration	Misunderstanding heritage, potential unfulfilled potential	Interest in the heritage landscape; understanding of the place; sense of responsibility	Reluctance and disinterest	Interest in the heritage landscape—often more than locals; another way of understanding and perception of landscape	Need to establish a relationship to the landscape (different generations)	Opportunity to experience the positive experiences of the local area repeatedly; the possibility of a future return	Possibility of spreading misinformation experiences and feelings

Table 7.3 Table describing the changes in the flow of ecosystem services in the case of planned changes in the future—the construction of the green barrier around the buildings in the agricultural complex in Hluboká

Measures	Description	Ecosystem services	Range	Agriculture	Local resident	Cottager	Tourists	Nature/landscape
Green barrier around farm buildings	Mediation of smell/noise/visual impacts	Barrier of trees, shrubs and herbs forming a barrier to prevent direct view of farm buildings, reduced ventilation between the heated building and surrounding reduces odour, noise restrictions	Local (village)	The possibility of increasing reputation in the community, emphasizing the unique visual workplace, timber	Increase the comfort of life, land prices, improve neighbourly relations	Increase the attractiveness of recreation—and the building itself, increase comfort—frequency of visits	Appreciation of the municipalities in the aesthetic appearance of the assessment—the greater number of photos	Creation of habitat for organisms—allowing their life—too strong noise or odours can affect the composition of the ecosystem
	Micro and regional climate regulation	Reduce the temperature in the summer months (overheating, neighbourhood green), increased humidity	Local (neighbourhood barriers)	Improvement of working conditions in the vicinity of buildings	Improve living conditions in the area	Improve living conditions in the area	Improve the conditions for movement in the area	Suppress fluctuations
	Hydrological cycle and water flow maintenance	Increase water infiltration into the soil through the root system of trees and herbs	Local (neighbourhood barriers)	Reduce the amount of standing water on solid surfaces in the vicinity of buildings	Reduce the risk of runoff water towards the village (it could cause damage)	Reduce the risk of runoff water towards the village (it could cause damage)	Improve conditions in the surrounding buildings—move them around	Improve of the hydrological regime in the vicinity of the premises—increase humidity encourage the growth of vegetation, the possibility of supplementing groundwater resources (which avoid—hard surface—water drained away)

(continued)

Table 7.3 (continued)

Measures	Description	Ecosystem services	Range	Agriculture	Local resident	Cottager	Tourists	Nature/landscape
	Bio-remediation by micro-organisms, algae, plants, and animals	Water purification using biodegradation of the green barrier (urea decomposition)	Local (neighbourhood barriers)	Odour reduction, threats to water resources	Odour reduction, threats to water resources	Odour reduction, threats to water resources	Odour reduction, threats to water resources	Supply of nutrients to ecosystems support decomposers
	Fibres and other materials from plants, algae and animals for direct use or processing	Direct or indirect use of wood or biomass for obtaining farm	Local (Village)	Use of wood for the economic operation of buildings (heating wood, of the company or the sale of wood used as a source of income	Purchase of these products (e.g. Timber)	Purchase of these products (e.g. Timber)	–	Human intervention—can support the development of habitat—cut grass, cut trees)
	Pest control	Thanks to the presence of potential predators (e.g. Birds) reduction in their prey (pest)	Regional (km^2)	Reduce the amount of pests—mice, etc.—nearby (decrease) the cost of disposal	Reduce the amount of pests and in the wider area—urban area municipalities	Reduce the amount of pests and further afield—boundaries of the village, watching birds of prey	Activity of predators—their observations	Increase biodiversity—more predators (individuals and species)
	Global climate regulation by reduction of greenhouse gas concentrations	Binding greenhouse gas (CO_2) in the biomass	Global	–	–	–	–	Storing atmospheric carbon for growth in biomass or humus

(continued)

Table 7.3 (continued)

Measures	Description	Ecosystem services	Range	Agriculture	Local resident	Cottager	Tourists	Nature/landscape
	Heritage, cultural	Restoration appearance of the village due to the incorporation of green infrastructure elements—recreating the connection of the village and the farm	Local (Village)	The opportunity to improve the image of the company as accessible to new ideas and remembering the locals	Adjustments to improve image appearance of the village community and increase the attractiveness of housing	Nicer place for recreation—image of the village	Improve the environment for tourism—"prettier village" to attract more people	Increase biodiversity—more species and individuals
	Entertainment	Monitoring of plants and animals—e.g. nesting birds	Local (Village)	–	Illustrate the atmosphere of the village—observation of plants and animals	Illustrate the atmosphere of the village—observation of plants and animals	Illustrate the atmosphere of the village—observation of plants and animals	Subject of interest, people tend to protect—feeding of birds in winter
	Aesthetic	Feelings, paintings, photographs—barrier illustrated panorama of the village—the involvement of non-forest vegetation in the urban village	Local (Village)	Nicer working environment	The aesthetic view of the village—its urban area, covering the otherwise dominant feature on the hill	The aesthetic view of the village—its urban area, covering the otherwise dominant feature on the hill	The aesthetic view of the village—its urban area, covering the otherwise dominant feature on the hill	Thanks to the awareness of aesthetic values—can appreciate the landscape element

Discussion and Conclusion

The modification of the CICES methodology presented here displays a possible view on the research of cultural landscape through ecosystem services. The authors of this text did not want to present a complex methodological approach which should be utilized in this field. Instead it is meant to present another way of looking at landscape research and make the readers think about this topic. The presented approach is being constantly developed and improved; therefore, it is not a finished process which would not be able to accept new ideas and integrate them. The tables presented are only the beginning of this research which continues the spatial analysis of individual ecosystem services and their spatiality with the help of the GIS informational system's landscape functions. The resulting documents will be subsequently consulted with local stakeholders and corrected from their comments and insights.

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Chapter 8
Transformation of Kujawy Landscape in Central Poland (1770–1970)

Bożena Degórska

Abstract The study concerned the Kujawy Region (Central Poland), and covered the period of 200-years from 1770 to 1970. The main objective was to identify landscape transformations focusing on the rural settlement development and land use changes. Determination of the impact of environmental and socioeconomic conditions on landscape changes was a very important goal. The research included spatial analysis of landscape changes based on the historical topographic maps, calculation of the size of these changes using indicators, determination the causes of landscape changes, and identification of the main periods of transformation.

Keywords Central Poland · Kujawy · Historical geography · Landscape changes · Land use · Rural settlement

Introduction

The socioeconomic development of Poland has led to the formation of landscapes representing a range of degrees of deforestation. In the Polish lowlands, poorly afforested regions include Żuławy Wiślane, Wielkopolska, central and west Mazowsze and the larger part of Kujawy, of which the eastern part was our study area. Despite the general perception of Kujawy as an agricultural region devoid of major woodland complexes, the first topographic map of Wielkopolska (von Pfau 1778) indicates that at the close of the eighteenth century only Black Kujawy (Kujawy Czarne) was a highly agricultural region , the remaining part was covered by forests. In the European Lowlands, the formation of a treeless or highly deforested landscape is chiefly associated with the development of agriculture and stable settlements that necessitate the conversion of increasingly more land for agricultural and settlement purposes.

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Studies of historical changes of the landscape occupy an important place in the investigation of transformations of geographical space. Extensive and comprehensive historical geographic analyses of causal chains are, however, becoming increasingly rare both in Poland and globally. Antrop (2004) indicates that inference is increasingly becoming more general and aims to accomplish applied goals, mostly in the domains of spatial and environmental planning. In Poland, the precursors of extensive historical geographic studies of landscape change included Hładyłowicz (1932), and, in the post-WWII[1] period, Maruszczak (1988, 1991).

Prior to the present study, little was known about historical geographic changes of the landscape in Eastern Kujawy, unlike the western and northern part of the region. Of all published papers exploring the time span chosen for the present study (eighteenth–twentieth centuries), the largest amount of information is contained in an extensive historical–geographic–statistical work by Borucki (1882), who was an eyewitness to what was happening in Kujawy. Studies by Kukier (1969, 1973), while concerned with changes of the geographic environment of the entire region of Kujawy from the end of the eighteenth century until the mid-nineteenth century, are general in nature and concentrate mainly on Black Kujawy. Outlines of settlement and population status, mainly of towns, in Kujawy in the seventeenth and eighteenth centuries have been compiled by Guldon and Guldon (1979, 1980, 1984) and Guldon (1978, 1983). Historical changes of the landscape are mentioned in papers by Galon (1929), Koc (1972), Święch (1990, 2012), Brykała (2005, 2009), Kowalska (2006) and other investigators, but are not the main point of these works. Preliminary results of research on landscape changes in the eastern part of Kujawy can also be found in works by Degórska (1996, 2001a, b), which concentrate on changes in land use patterns.

Topographic maps also were an important source of information about this area. Such maps provide a good illustration of the process of change of woodland areas, agricultural land and the settlement network (a list of maps is included in the last part of this paper). A topographic map of 1778 that includes the study area marks an important time point, making possible the first general description of land use and land cover and the development of the settlement network in Eastern Kujawy at the close of the eighteenth century.

Preliminary Assumptions, Subject Matter, Goal and Area of Study

In the present historical geographic study, landscape transformations were analysed in the context of changes in land use patterns and the development of human settlement over a period of 200-years from 1770 to 1970. Only rural areas were investigated. The basic land use forms were treated as the main components of the horizontal structure of the landscape. Of all land use forms, we analysed changes in the area occupied by woodland, arable land and grassland. Analysis of changes in

[1] WWII—World War II.

geographical ranges was performed for woodland complexes since their borders were the most distinct on topographic maps. We also investigated those components of the settlement system that generate the greatest changes in land use while also constituting elements of the landscape (rural settlements, housing), focusing mainly on analysing the status of and changes in the density of the settlement network, density of residential housing and a synthetic assessment of landscape changes—the degree of spread of housing within the landscape and the degree of landscape transformation. Human impact was considered the main factor generating landscape changes, and population density was used as an index of human presence in the landscape.

A tentative hypothesis was assumed that socioeconomic and political relations mainly determine the intensity of settlement, while changes in land use pattern are mostly influenced by environmental determinants, resulting in marked spatial diversification of the extent and rate of change in environmentally distinct regions. In order to specify the main determinants of landscape changes, both nature-related determinants and socioeconomic determinants were treated as equally important. According to the views of Potkański, as quoted by Buczek (1958), settlement itself is the result of mutual and continuous impacts, mutual exchange of influences from the natural factor and the human factor. Thus, the impact of the physical geographic factor on the shaping of the cultural landscape is variously construed. For the purposes of the present study, it was assumed that the cultural landscape is shaped by the influence of socioeconomic factors and modified by regional or local physicogeographic factors. It was also assumed that the impact of natural determinants on landscape changes would steadily decrease. The present historical geographic study of landscape change encompassed rural areas in the eastern part of Kujawy (Fig. 8.1). This region, with a total area of 2500 km^2, is situated in the south-eastern part of the historical Kujawy, but its eastern border belt does include the borderland of Mazowsze and Kujawy, accounting for the border between the two regions along the course of the Skrwa Lewa. The southern, eastern and north-eastern limits of the study area corresponded to the borders of natural regions (after Galon 1973), and its western and northern borders were defined so as to ensure that, during the partition period, the area would belong to only one political entity at a given time, but ignoring ever changing front lines during wars.

Fig. 8.1 Location of study area

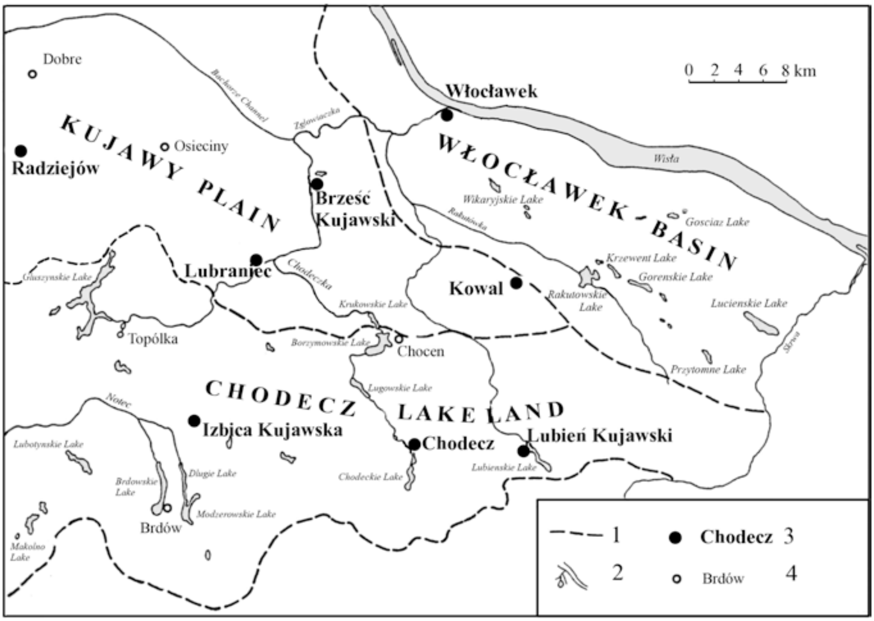

Fig. 8.2 Division of study area into regions by Galon (1973). *1* Regional borders, *2* surface waters, *3* towns, *4* major villages

The division into regions follows that of Galon (1973). The study area, with a total surface area of 2517 km^2, encompasses the whole of Włocławek Basin [Kotlina Włocławska (577 km^2)], the middle and eastern parts of Chodecz Lakeland [Pojezierze Chodeckie (1165 km^2)] and the southern part of Kujawy Plain [Równina Kujawska (775 km^2)]—Fig. 8.2.

The morphology of the terrain is much diversified between the regions. According to Galon's (1973) division into regions, where terrain morphology was the basis for distinguishing the natural regions of Kujawy, the study area is comprised of three regions (Fig. 8.3). These neighbouring regions are environmentally distinct, representing three types of natural landscape: an urstromtal (Włocławek Basin), a lakeland (Chodecz Lakeland) and a plain (Kujawy Plain). Apart from morphology, the regions also differ markedly with respect to other physical geographic determinants, such as soil cover and water regime.

Communes or parts thereof were the smallest research units (39 units)—Fig. 8.3. When the area of a commune belonged to two or even three regions (e.g. the commune of Kowal) or only a fragment of a commune was part of the study area, such parts would then become separate basic research units.

The study of the eastern part of Kujawy was chiefly motivated by its scientific aspects:

- The study constituted an opportunity to investigate an area where very little was known about landscape transformation over the last few centuries despite the titles of some papers suggesting that they had addressed this issue.

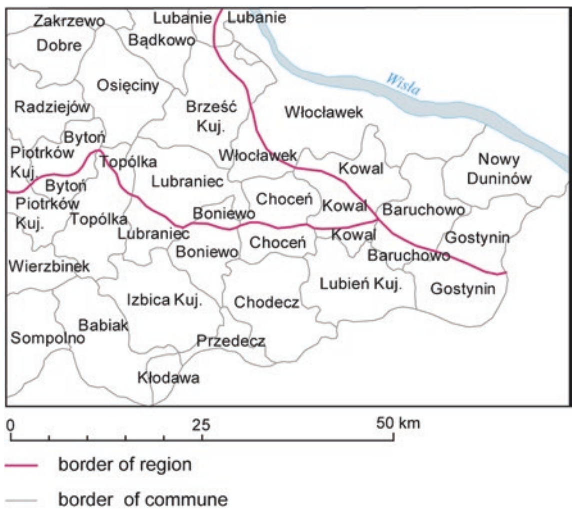

Fig. 8.3 Division of the study area into communes (according to the uniform borders of communes 1988 on)

- It was an opportunity to carry out a comparative study of environmentally distinct neighbouring regions, representing three types of natural landscape: urstromtal, a lakeland and a plain.
- It was an opportunity to trace changes in an area of particular interest for landscape change studies (Chodecz Lakeland, which was dominated by forests as late as the end of the eighteenth century, but now it is a highly agricultural region).

In order to assess the degree of impact of environmental conditions on landscape transformation, the study was carried out in three environmentally distinct neighbouring regions that remained within the boundaries of one political entity at different time points within the 200-year period that the study investigated. This allowed for eliminating much of the impact of different sociopolitical situation in the regions of interest, which might have blurred differences associated with environmental determinants. Boundaries that could be described as “political” divided the study area only episodically, reflecting the front lines of ongoing military conflicts. Thus, the regions of interest, excepting transient detachment associated with the movement of military troops during armed conflicts, were in a similar political situation throughout the study period.

The main objective of the study was to identify landscape transformations in the context of the development of human settlement and changes in land use pattern and to determine the impact of environmental conditions on such transformations in regions representing different types of natural landscape, and to determine the causes of the transformations. The following partial objectives were also defined:

- To determine the scale of and trends in landscape transformation in view of changes in agricultural land and woodland with particular regard to changes in the area occupied by forests and woodland fragmentation, and to identify the degree of overall landscape transformation,
- Determine changes in population density, density of the settlement network and houses (where local people lived) and the degree of buildings spread,
- Determine the socioeconomic causes of landscape change,
- Identify natural factors impacting on the intensity of change or persistence of landscape components,
- Determine the main periods and trends in landscape transformation in the 200-year span.

Materials and Methods

The analytical data required to solve these research questions were obtained by analysing historical topographic and thematic maps, archived and contemporary statistical data, the available literature and by interviewing local residents and experts in the history of the Kujawy region.

Plain topographic maps with scales of 1:100,000 and similar were the fundamental cartographic source of information about the status of and changes in the landscape components analysed over the 200-year span. A list of the maps is provided in the last part of this paper. Topographic maps of the late eighteenth century provided, however, very general information and could not be used for analysing ranges. Apart from topographic maps, soil and agricultural maps, and geomorphological/geological maps were also used.

The present paper, combining natural science, socioeconomic geography and history-related approaches required the use of a methodology spanning the boundary between the geographical and historical sciences, which are very important from landscape research point of view (Degórski 2003, 2005). The retrogressive method was employed, the aim being to obtain possibly precise quantitative data. Similar approaches to geographic historical studies were adopted by Hładyłowicz (1932), Maruszczak (1951), Plit (1994, 1996) and Ślaski (1951).

A significant methodological assumption was that the analysis should be carried out on identical research units, owing to which it was possible to compare landscape characteristics across space and time. Those units were the regions and communes or commune fragments (when borders between physiogeographic regions cut across a commune). The regions were determined according to a physical geographic division of Kujawy into regions by Galon (1929, 1973)—Fig. 8.2, and commune boundaries were given as of the end of 1988 as determined by the Chief Statistical Office in the form of so-called commune equivalents (Fig. 8.3).

The topographic maps allowed for analysing landscape changes at the following time points: 1770, 1800, 1830, 1890, 1930, 1950 and 1970. The years given represent only approximate timing of the mapping work. To ensure better comparability of the cartographic sources, all maps from the eighteenth and nineteenth centuries were rescaled to 1:100,000. Given that the maps from the end of eighteenth century and from nineteenth century had scales of 1:84,000, 1:87,500, 1:126,000 and 1:150,000 (with a 1:50,000 map series) and the three twentieth century maps had a scale of 1:100,000, that scale was considered optimal. Even after unifying the scale, it was not possible to use the range method to analyse changes in the extent of all land use patterns in the nineteenth and twentieth centuries. Forests were the only component where that method could be applied. A detailed spatial analysis of changes in the range of woodland complexes was carried out on the basis of cartographic sources from the nineteenth and twentieth centuries.

The area occupied by woodland, arable land and grassland in the regions was calculated on the basis of the topographic maps; as a result, the figures are approximate. Forest cover was also calculated for smaller units (commune equivalents or parts thereof). The density of the settlement network, housing density and population density in the 39 basic units and three regions was calculated on the basis of both the topographic maps and statistical sources providing data on the population and the number of residential buildings in each town or village as well as estimates. A detailed description of the methods can be found in Degórska (2015, in press). A database was compiled for the spatial units that were comparable throughout the period of study, i.e. commune equivalents or parts thereof and regions or parts thereof.

The map-derived information served to calculate two synthetic landscape indices. A landscape transformation index (LTI) was used to define the degree of landscape transformation (according to Maruszczak 1991). The index refers is calculated as the ratio of the strongly human transformed areas (built-up areas, arable lands) to the surface covered by natural and seminatural components of landscape (forests, water, swamps, grasslands). It was calculated for the regions, with the 1770 data not included in the computation. Buildings spread in the landscape of the regions were studied with a landscape building spread index (LBSI). LBSI calculated for each region and all time intervals as the ratio of the cumulative area of all plots (1 km × 1 km) where a building was present to the cumulative area of plots (1 km × 1 km) without buildings. Built-up plots was defined as the presence in a square plot 1 km × 1 km (square 1 km^2) of at least one building irrespective of its function.

Landscape of Eastern Kujawy About 1770

About 1770, the landscape of the eastern part of Kujawy was characterized by considerable dichotomy, as the area was clearly divided into a remarkably agricultural part (Kujawy Plain) and one with very high forest cover and a smaller proportion of agricultural land (Włocławek Basin and Chodecz Lakeland). About 1770, the part of Kujawy Plain located within our study area, just like the entire region, was deforested (10 % forest cover) and highly agricultural (approx. 65 % arable land). The surviving forested areas were small plots of woodland scattered among fields. Extensive wet meadows could be seen mainly in the Bachorze and Zgłowiączka valley and other, occupying, together with pastures, an area twice larger than that covered by forest (approx. 18 %).

The landscape of Chodecz Lakeland was dominated by forests (approx. 51 %). In the northern part of the region, wooded areas were fragmented into smaller patches, while relatively large complexes were preserved in the southern part, with small, though already quite numerous, enclaves or belts of arable land and settlements within. Arable land occupied the largest areas near the bigger settlements of Izbica Kujawska, Przedecz, Chodecz and Brdów and in belts of arable land and settlements usually situated along water courses of various importance. Agricultural land belonging to a particular village was often contiguous with those belonging to neighbouring villages. Large forested areas at the stage of early fragmentation, numerous enclaves of arable land and settlements within forests and belts of the same separating wooded spaces were the most characteristic landscape patterns of Chodecz Lakeland towards the end of the eighteenth century.

Włocławek Basin, with a forest cover of about 61 %, was then a predominantly forest region housing the study area's largest forest complex, extending without interruption from Skrwa Lewa to Zgłowiączka. North-west of the Zgłowiączka valley, the forests were already fragmented. The two belts of arable land and settlements in Włocławek Basin (that following the course of the Vistula and the southern one) represented different landscapes formed by agricultural land, meadows, pastures and wasteland, often with less dense housing.

The rural settlements of Eastern Kujawy at that time were generally characterized by concentrated housing, with early indications of the spread of less dense housing in Włocławek Basin and in Chodecz Lakeland. With regard to settlement density, the most densely populated regions were Kujawy Plain, with the highest settlement density of 1.8 settlements/10 km^2 in the study area, and Chodecz Lakeland, with a comparatively similar settlement density value of 1.5 settlements/10 km^2, even though more than half of Chodecz Lakeland was occupied by forests. However, these regions demonstrated different spatial patterns of rural settlement. A characteristic pattern in the rural landscape of Kujawy Plain, one that made it distinct among other regions, was a rather uniform distribution of settlements, characteristic of old settlement networks. The other regions were characterized by the concentration of housing in the form of belts or enclaves of settlements and arable land and by a higher proportion of solitary settlements and small hamlets within forests or in wetland areas.

Fragmentation of Forest Cover

The topographic maps employed in this study provide a good illustration of the fragmentation of forests followed by their amalgamation. The investigation of changes in the area occupied by forest complexes in the designated periods revealed considerable diversification of forest fragmentation between the regions. Kujawy Wschodnie, and particularly Chodecz Lakeland, was an area where several stages of fragmentation were found to co-occur, but one could be regarded as dominant and is referred to in further analysis as a pattern of change rather than a stage of the fragmentation process. Although many works distinguish successive stages of fragmentation, defined by significant changes in landscape structure and function (Forman and Godron 1986; Forman 1995; Collinge 2009), but McGarigal et al. (2005) indicate that in reality such stages are not always clearly separated as they may co-occur, which is corroborated by presented research on changes in the spatial extent of forest cover.

The fragmentation of the forests of Chodecz Lakeland at the beginning of the 200-year period of interest to use was characterized by three main patterns of change involving the perforation of large area patches of forest: an increase in the number of enclaves of settlements and arable land within forests, the expansion of existing and new, internal enclaves and their merging into belts of settlements and agricultural land that cut through former complexes of uninterrupted forest (bisection and fragmentation), and the deforestation of the outer edges of large forest complexes, which, accordingly, would shrink and sometimes were interrupted. In this region, initially, the deforestation of the outer edges of minor forest complexes only sporadically led to their disappearance.

The environs of Chodecz and Lubień Kujawski are the most typical example of the early stage of fragmentation of the forests of Chodecz Lakeland (Fig. 8.4). Settlements with their associated arable land at that time either divided the originally uninterrupted forest or formed enclaves within the forest. Two dominant

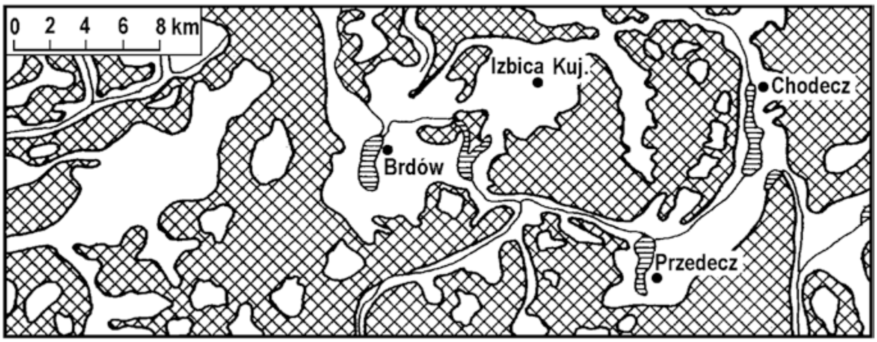

Fig. 8.4 Fragmentation of forest cover in the southern part of Chodecz Lakeland (ca. 1770) on the basis of: "Special Carte von Pohlen", von Pfau (1778)

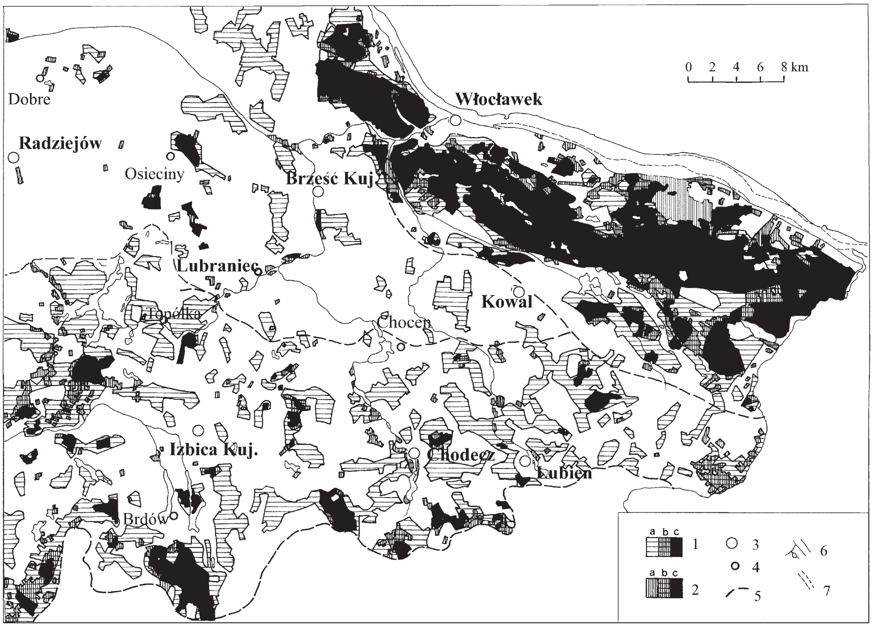

Fig. 8.5 Change and persistence of forest cover (1830–1970). *1a*, *1b*, *1c* Forest cover in 1830, *2a*, *2b*, *2c* forest cover in 1970, *1a* areas of deforestation in the period 1830–1970, *2a* areas of afforestation in the years 1830–1970, *1b*, *2b* areas deforested after 1830 and subsequently re-afforested, *1c*, *2c* persistence of forest cover in all periods, *3* towns, *4* the largest villages, *5* border of regions, *6* surface waters, *7* the course of the Vistula River prior to the construction of a dam in Włocławek

types of settlements and associated arable land may be distinguished with regard to the spatial matrix: agricultural enclaves within forests, usually with one settlement surrounded by arable land, which did not yet disrupt the uninterrupted forest; and the connected arable land belonging to a number of villages, which formed belts separating and dividing large forest complexes.

The fragmentation of forests in Kujawy Plain followed a different pattern (Fig. 8.5). A progressive reduction of forest complexes until they disappeared completely or clearfelling of smaller wooded areas were the dominant processes and led to the loss of a considerable part of woodland areas within fields. Initially, this pattern was seen mainly in Kujawy Plain, but in the nineteenth century, and particularly in the latter half of that century and in the first half of the twentieth century, it was also visible in Chodecz Lakeland and, to a more limited extent, Włocławek Basin. The fragmentation of forests in Włocławek Basin took a different course as the process mainly involved forest edges and, to a somewhat smaller extent, the forest interior in the south-eastern part of the region. Enclaves of settlements and arable land within forests were subject to expansion and would combine to form belts. The fragmentation of forests in Włocławek Basin only slightly affected the large-area forest complex. However, it did lead to the formation of a few minor isolated patches of forest.

The first half of the twentieth century was a time when the fragmentation of forests was halted. The trend was reversed after WWII, when afforestation was seen in most areas subject to deforestation in the nineteenth century. As a result of afforestation efforts, patches of forest within field in the landscape of Chodecz Lakeland and Kujawy Plain increased in number. The growth in size of a large proportion of forest complexes has been a very welcome change, and even more so is the restoration of spatial cohesion between some complexes (Fig. 8.5). The planting of forest involved mostly land of low and lowest agricultural potential and areas unsuitable for agriculture.

Landscape Transformation in the Context of Changes in Agricultural Land and Woodland

In each of the regions under study, the most intensive deforestation and increase in the proportion of arable land were noted between the end of the first half of the nineteenth century and the end of the nineteenth century, with Chodecz Lakeland being the only area where intensive transformations had also occurred earlier.

Until the end of the nineteenth century, Chodecz Lakeland was the area of the most significant changes in arable and forested land, with forest cover decreasing from approx. 50 to 8 %, and the proportion of arable land rising from 28 to 73 % (Fig. 8.6). In this region, the turn of the nineteenth century marked a point of equilibrium between the share of forests and arable land in total area, with both accounting for approx. 40 %. From then on, the proportion of forest cover was consistently smaller than the proportion of arable land. Until about the mid-twentieth century, deforestation, induced mainly by human settlement and the development of agriculture, was the main driver of landscape change in Chodecz Lakeland. The process involved both forest edges and forest interior as well as some forest enclaves within fields. At the end of the nineteenth century, the forests of Chodecz Lakeland could already be described as enclaves within fields. Deforestation affected even woodland growing on soils unsuitable for agriculture. The de-intensification of deforestation towards the end of the nineteenth century can thus be associated with the very limited resources of forested land suitable for agriculture on the one hand and the promulgation of a Forest Saving Act on the other. Our analysis of changes in forest cover within the designated basic area units whose borders were comparable throughout the 200-years' span under study show that in the years 1890–1930 in Chodecz Lakeland, afforestation prevailed over deforestation only in one unit (Choceń), as against 5 units in the years 1930–1950, and all units after World War II. Despite the initiation of afforestation, in the mid-twentieth century, the region was still at a nadir of its forest cover (approx. 6 %) in the entire 200-year span under study, and also had the highest proportion of arable land (approx. 76 %). In the first half of the twentieth century, the share of forested land was even smaller than the area occupied by meadows and

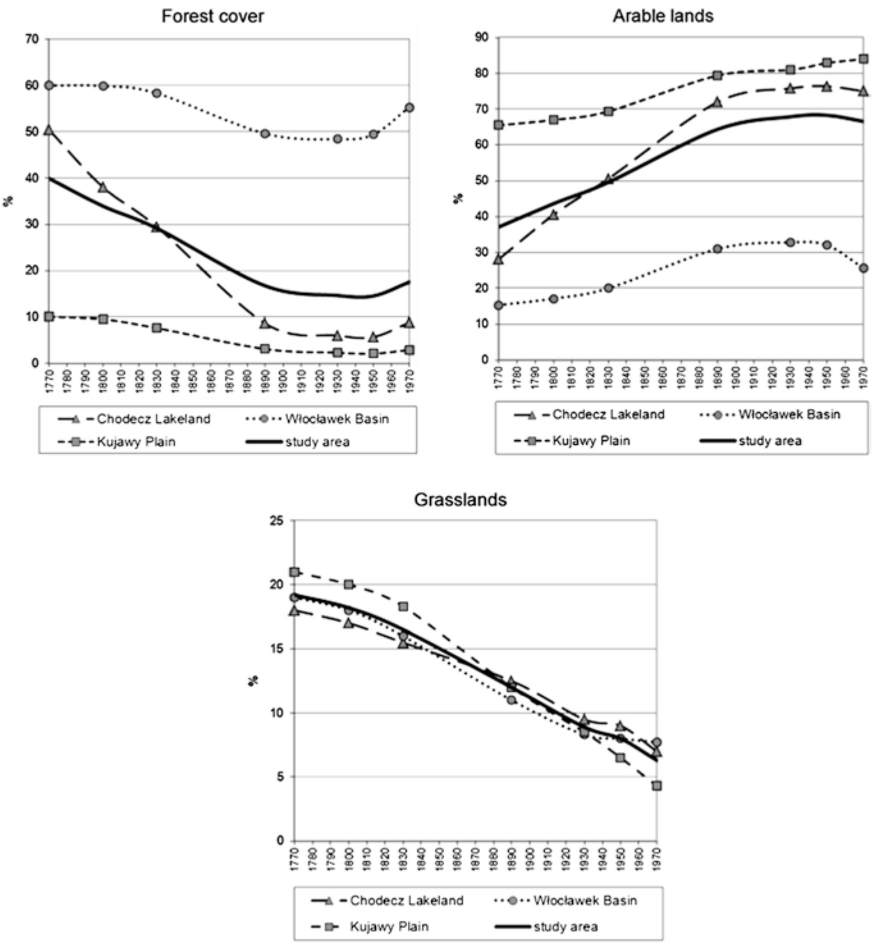

Fig. 8.6 The proportions of forest, arable land and grassland in the regions of Eastern Kujawy (1770–1970)

pastures (Fig. 8.6). The post-war period witnessed a reversal of previously existing general trends, with increasing forest cover and a decreasing proportion of arable land.

With the very intensive deforestation in Chodecz Lakeland, from the end of the nineteenth century onwards, the landscape of Eastern Kujawy was again dichotomous, the essential difference being that Chodecz Lakeland had become, together with Kujawy Plain, an agricultural region with very low forest cover and a very high proportion of arable land, while Włocławek Basin continued to have forest as the dominant component of land cover until the end of the 200-year period under study.

Kujawy Plain, which was a highly agricultural region in the 200-year period, was characterized by the highest proportion of arable land in the study area, the figure rising from 66 % in 1770 to 83 % in 1970, and the lowest index of forest cover, which decreased from 10 % in 1770 to about 2 % in the mid-twentieth century and subsequently rose to approx. 3 %. In all the periods distinguished in the 200-year span under study, forests constituted more or less numerous enclaves within arable lands. Another feature that makes Kujawy Plain different from the other regions is a relatively high proportion of meadows and pastures in each designated period, much higher than the proportion of forests. Kujawy Plain, unlike Chodecz Lakeland and Włocławek Basin, is the only region wherein the second half of the twentieth century, the area occupied by arable land continued to increase rather than decrease in size. It was probably due to the presence of high-quality soils and high population density, which continued to increase after World War II from 66 to 71 persons/km^2, while it only rose slightly in Włocławek Basin, and registered further decreases in Chodecz Lakeland. These components experienced their most dynamic changes in the second half of the nineteenth century.

The land use pattern in Włocławek Basin was the one with dominance of forests, whose contribution to the region's total area fell from approx. 60 % to approx. 56 %. Włocławek Basin was thus the only region in which the afforestation, mostly of the poorest strips of arable land and fallow land, resulted in a similar level of forest cover as in 1770. The reversal of the trend with regard to forest cover and arable land cover (i.e. a switch towards an increasing forest cover and a decreasing proportion of arable land) could be observed already at the end of the first half of the twentieth century and became more marked after World War II. Thus, the new direction of change was present here earlier than in Chodecz Lakeland. As in the other regions, the rate of change was highest in the second half of the nineteenth century.

The analysis of the rate of change and trends in changes in the area covered by forests and arable land shows that the most intensive changes in all regions took place between the end of the first half of the nineteenth century and the close of that century. Chodecz Lakeland had evidently the highest rate of change, with a rapid decrease in forest cover and increase in the area occupied by arable land seen already towards the end of the eighteenth century. Between the end of the eighteenth century and the end of the nineteenth century, the landscape dichotomy gave way to a tripartite division. About 1800, a tripartite landscape could be seen in Eastern Kujawy, with a clear division into three subregions: the highly agricultural - Kujawy Plain (arable land > 65 %), the highly forested - Włocławek Basin (forest: 60 %), and Chodecz Lakeland (forest: 38 % and arable land: 50%) — (Figs. 8.6, 8.8). In the early twentieth century, all regions demonstrated reduction of the rate of decrease in forest cover and increase in the proportion of arable land. The interwar period may thus be described as a time of relatively major stabilization: while forest cover in Kujawy Plain and Chodecz Lakeland still tended to decrease, the rate was very slow, and in Włocławek Basin, a minor increase in the proportion of forest was registered for the first time in the time span under analysis. Analysis of intraregional diversification of changes in forest cover permits the statement that the predominance of afforestation over deforestation actually began in the period 1890–1930, when it was present in 9 units of the study area, but it had no influence on overall regional trends. In the period 1950–1970, more dynamic growth in forest cover was noted across all regions. The trends of change in the proportion of arable land were, in most periods, the reverse of changes in forest cover, and so could be described as the conversion of forest land into arable land and associated settlements, with the exception of a continuing increase in the proportion of arable land in Kujawy Plain. The intensification of afforestation followed a period of considerable population loss in the wake of military and political action during World War II and immediately after it ended. Kujawy Plain was the only region where the proportion of arable land had not decreased, with new land for farming and settlements acquired mainly through the conversion of former grasslands and continued drainage of wetland areas.

Meadows, pastures and other areas of grassland vegetation exhibited similar tendencies of more or less slow decrease in the area occupied by them in all regions and throughout all designated periods. These changes were the result of the drainage of wetlands and converting them into arable land and settlements. These processes were initiated by the Mennonites, who were experts in the drainage and economic exploitation of wetlands, and continued by later settlers, landowners, the partitioning states and then the government of Poland during the interwar and post-war period (including, for example the amelioration of large areas in the valley of the Bachorza). As in the other designated regions, the changes were most intense at the end of the first half and throughout the second half of the nineteenth century.

In summary, it can be stated that the distinctive features of the regions are as follows: for Włocławek Basin, the persistence of forest cover (Fig. 8.5); for Kujawy Plain, the persistence of arable land; for Chodecz Lakeland, the highest landscape variability, mainly the conversion of forests into arable land. The ratio of the transformed components of the landscape (mainly arable land and built-up area) to the more natural (mainly forests, grassland, waters) is best illustrated by the landscape transformation index (LTI)—Fig. 8.7.

The data on landscape transformation status show that only in Włocławek Basin did natural and little transformed landscape components occupy a larger area than markedly transformed components throughout the 200-year period under study. In this region, the process of slow anthropization of the landscape continued until the early twentieth century (with the LTI changing from 0.3 to 0.8). The interwar period was a time of relative stability. After WWII, renaturalization of the landscape was noted, mediated mainly by an increase in the proportion of forested land with a slight decrease in the proportion of grassland. Some explanatory remarks are due regarding the slightly different approach to renaturalization which does not demand the restoration of the primaeval state of an ecosystem (a similar approach was presented by Wolski 2007), but aims to effect an increase in the proportion of natural and seminatural ecosystem in landscape structure. At the end of the eighteenth century and the early twentieth century, Chodecz Lakeland was also characterized by a predominance of natural and seminatural components of the landscape over those

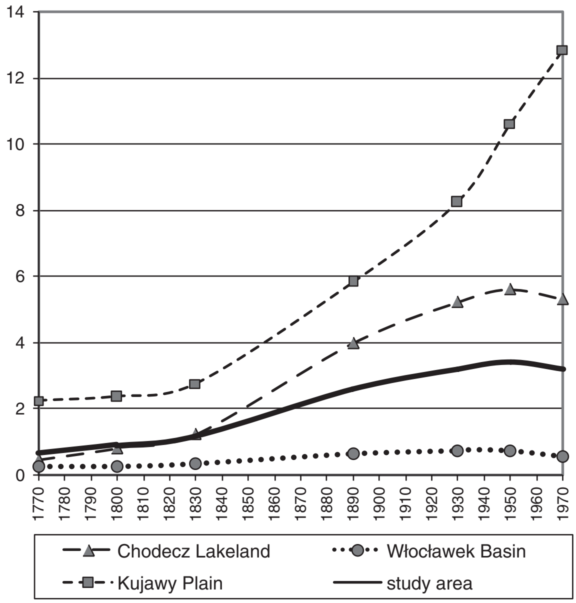

Fig. 8.7 Landscape transformation status in the years 1770–1970 according to the landscape transformation index (LTI)

more strongly transformed, but in the early years of the first half of the nineteenth century the LTI exceeded the value of 1, indicating an equal proportion of these two types of area. Very intensive anthropization of the landscape of Chodecz Lakeland continued until WWII (LTI = 6) and was followed by a period of fairly intensive renaturalization, with the LTI falling to approximately 5. However, the intensity of renaturalization of the region's landscape in the second half of the twentieth century, associated exclusively with a marked increase in forest cover, was limited owing to a marked loss of grassland areas. On the other hand, Kujawy Plain was a region distinguished by its high and, subsequently, very high level of anthropization of the landscape throughout all periods. Initially, i.e. until the end of the first half of the nineteenth century, the share of markedly transformed components of the landscape was 2-fold, and later 3-fold, higher that the proportion of little transformed landscape. About 1970, the index was as high as 13, indicating an extremely high degree of anthropization of the landscape. Kujawy Plain differs from the other regions in exhibiting a growing tendency towards landscape anthropization, which could be attributed to a considerable interest in expanding the area occupied by arable land in areas of high agricultural production potential. In this region, arable land and settlements grew in area to the detriment of, mainly, grassland.

Chief Environmental Determinants of Landscape Structure Persistence and Change

The results of our analysis of the impact of environmental conditions on persistence and change in landscape structure, with particular regard to forest cover and the area occupied by arable land, confirm not only a decisive influence of soil conditions, but also reveal other correlations, mainly with terrain morphology and the water regime. Correlations with potential habitats of actual vegetation are discussed in a separate paper (Degórska 2001b).

The investigated regions were characterized by very dissimilar habitat conditions and, as has already been demonstrated, differed markedly not only in land cover and land use patterns, but also with regard to the persistence of forests and arable land.

Kujawy Plain, a region of very fertile soils, demonstrated the highest persistence of cropland within the entire area under study. The arable land in this region in the 200-year span investigated coincided with areas of brown earth proper, leached brown earth, phaeozems and most grey soils, i.e. mainly good and very good arable land, with small patches of agriculturally less useful soils. Woodland was preserved as sporadic enclaves in fields and was usually associated with small areas of sandy and gravelly formations, that is land of little arable potential. Deforestation, initiated towards the end of the eighteenth century and practised in the first half of the nineteenth century, involved patches or grey and lessive soils, but also less fertile land. A characteristic feature in this region was the disappearance of most woodland enclaves in fields, mainly in the nineteenth century. In Kujawy Plain, originally forested land did not change its use profile in approximately 2 % of the region's total area (i.e. 21 % of forest cover in 1770 and 74 % in 1970)—Fig. 8.5.

The highest persistence in forest cover was noted in Włocławek Basin, where most of the soils are of low arable potential. Our data reveal that forest continued to exist throughout the study period in approx. 46 % of the region's area (i.e. approx. 80 % of forest cover in 1770 and 88 % in 1970). Around 1770, forests grew mainly on podzolic soils formed on dune sand, as well as some rusty and podzolic soils formed of the sand of older accumulation terraces. The arable potential of these soils is generally low/poorest or nil. At the close of the eighteenth century, the transformation of forest land into arable land initially involved rusty soils formed on sands of older accumulation terraces, with the proportion of soils of the poorest arable potential increasing from the second half of the nineteenth century onwards. From the end of the nineteenth century onwards, forests were only preserved on the land of the poorest or nil arable potential. Subsequent deforestation mainly involved soils, which were usually the poorest in this region, as they were the only type of soils on which woodland grew in the region at that time. In the interwar period, attempts were made to turn even agriculturally very poor or useless areas into arable land. Failed attempts to plant crops on the poorest soils, at a time of massive overpopulation of rural areas and immense "hunger for land", were confirmed in interviews with the oldest residents of Włocławek Basin. Kwiatkowska (1963) also described this phenomenon in Dobrzyńska Plateau (Wysoczyzna Dobrzyńska), a region bordering on the study area. In the interwar period and after World War II, afforestation work was carried out on the formerly deforested poorest arable land and fallow land along the Vistula. After WWII, large areas of swampy and peaty soils formed of low-moor peat and gyttja, associated mainly with river valley and tunnel valley habitats, were afforested for the first time in the 200-year span. After WWII, no more woodland was converted to arable land, and a new spatial phenomenon was identified near Włocławek, namely the initiation of development of residential housing not associated with agriculture or forestry on forest plots.

Areas of permanent presence of arable land in Włocławek Basin mostly coincided with areas of some rusty and podzolic soils of sands of older accumulation terraces and alluvial soils along the Vistula. However, a considerable proportion of the land chosen for conversion into settlement sites and arable land required prior drainage.

In Chodecz Lakeland, where the transformation of woodland into arable land and settlements in the nineteenth century encompassed the largest areas, deforestation initially involved woodland on brown earth soils, which are agriculturally useful, and later increasingly less fertile soils, i.e. rosty soils and fragments of podzols, formed on glaciofluvial sands and occurring mainly along the southern border of the area and south of Głuszyńskie Lake. Just as in the other two regions, deforestation involved increasingly poorer habitats.

With regard to landscape transformation, the most intensive conversion of woodland, mainly into arable land, was noted in Chodecz Lakeland, a region where the soils were mainly of high and average agricultural value. Forest cover was continuous throughout the 200-years only in 7 % of the region's area (i.e. 12 % of forested land in 1770 and 69 % in 1970)—Fig. 8.5. Around 1770, the forests of Chodecz Lakeland grew both on soils of very good and good agricultural value (i.e. lessive soils, leached brown soils, pseudogley and rusty brown soils) as well as on podzolic earth (rusty and podzolic soils), ranking among the poorest in the region.

At the end of the eighteenth century, deforestation mainly cleared brown earth soils, which were quite useful for agriculture, with some less agriculturally useful areas being deforested in the southern part of the region owing to lack of higher quality forest-covered soils. In the nineteenth century, deforestation involved larger areas of woodland growing on soils of increasingly lower agricultural value, including podzols. At the end of the nineteenth century, forests grew mainly on soils of low/poorest agricultural value. During the period of afforestation following WWII (1945–1970), woodland was restored on some fragments of arable land of low/poorest agricultural quality that had been cleared at the close of the nineteenth century and early twentieth century. The highest areas of land afforested in the 1950s and 1960s were found in outwash plains in Chodecz Lakeland, which were areas of rusty and podzolic soils formed on glaciofluvial sands. Arable land that continued to be used for agricultural purposes during the period of interest was located on brown earth proper, leached brown soils formed on medium and heavy boulder clay and clay-sands and light boulder clay and on lessive soils formed on medium and heavy boulder clay.

The factor of decisive importance for the limitation of deforestation across all regions of Eastern Kujawy at the turn of the twentieth century was a shortage of forested soils of adequate agricultural potential. In the first half of the twentieth century, afforestation was carried out on a slightly larger scale than in the nineteenth century, which brought about a state of relative balance between deforested and afforested land, and in the latter half of the twentieth century, it led to the predominance of afforestation over deforestation. The afforestation was carried out in the majority of the areas deforested in the nineteenth century on land of low or nil arable potential. Large areas were afforested in the southern part of Chodecz Lakeland and in Włocławek Basin. This improved the spatial structure of forest land as coherent one was restored between many fragmented woodland complexes, the best example being post-war reforestation in areas south of Głuszyńskie and Mąkolno Lakes and along the Skrwa River. These beneficial increases in forest cover in Kujawy, especially in those areas not situated in the Vistula valley, are particularly necessary in view of the so-called steppe conversion of the landscape.

Summing up our discussion of correlations between soil conditions and spatial changes in land use patterns in the years 1770–1970, it can be stated that the greatest structural variability of landscape was seen in those areas where the soils represented average agricultural value. The highest persistence with regard to land use could be seen in soils of good and very good agricultural value, used chiefly as arable land, and areas of poorest or nil agricultural value, as most such areas were uninterruptedly covered by woodland. Similar correlations between soil fertility and changes in the respective ranges of woodland and arable land were noted by Szymański (1984) for the Kielce region and by Maruszczak (1951) for the Lublin region.

The analysis of correlations between landscape changes and terrain morphology led to the conclusion that the highest persistence as arable land was characteristic of patches of flat ground moraine. Temporally persistent forest cover was characteristic mainly of dune areas, some outwash plains and other gravelly sandy substrates. Early on during the 200-year span of interest, landscape transformation, chiefly in the form of progressive deforestation and growth of settlements and agricultural land, predominated within patches of wavy ground moraine. Subsequently, deforestation was noted in increasingly more areas with more varied terrain morphology with numerous moraine hills and kames in Chodecz Lakeland, as well as other forms, mainly the borders of outwash plains and fragments of terraces in

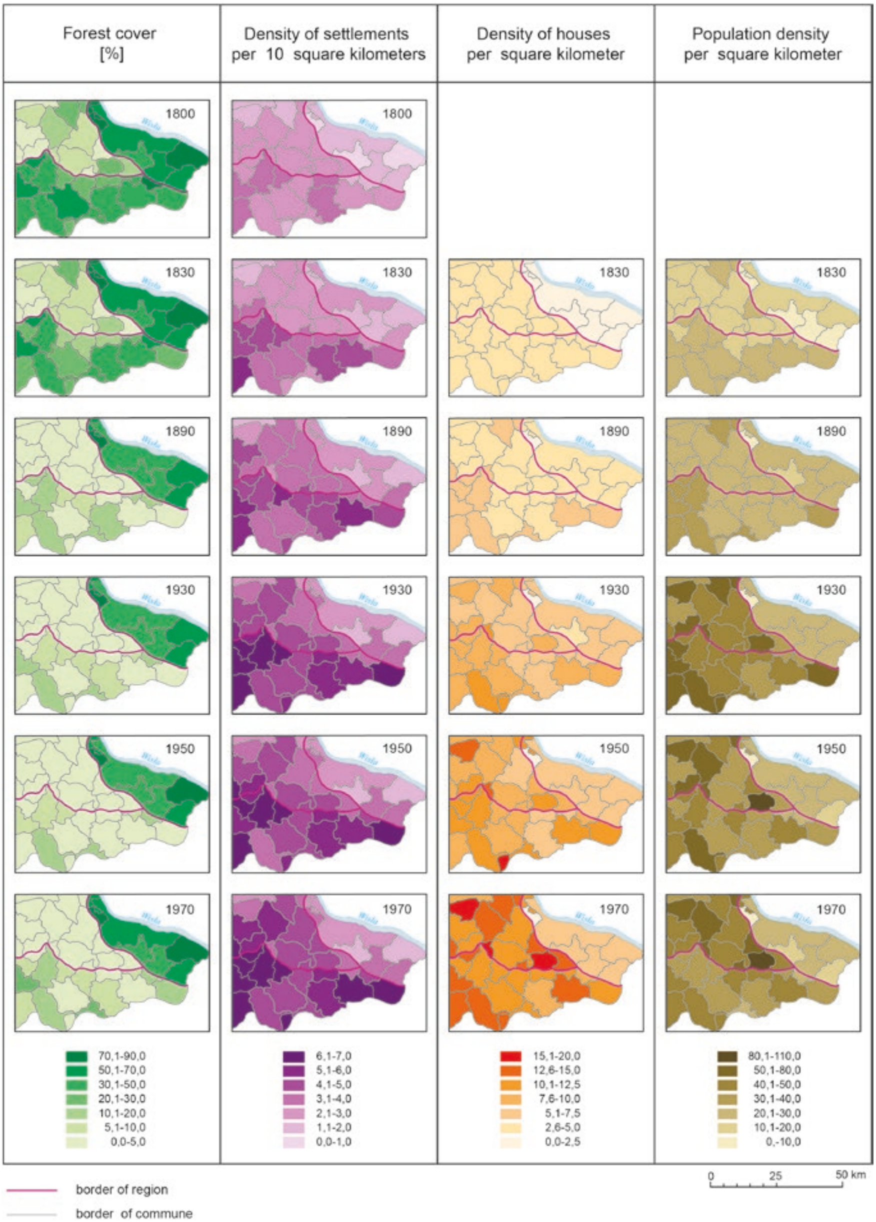

Fig. 8.8 Main characteristic of landscape according to the communes

the Vistula urstromtal. Some hilly formations, and particularly their slopes, were characterized by high variability in land use (forest—arable land—forest), which depended on the type of water conditions, mainly surface and underground discharge. Two repetitions of the deforestation–afforestation cycle were recorded in

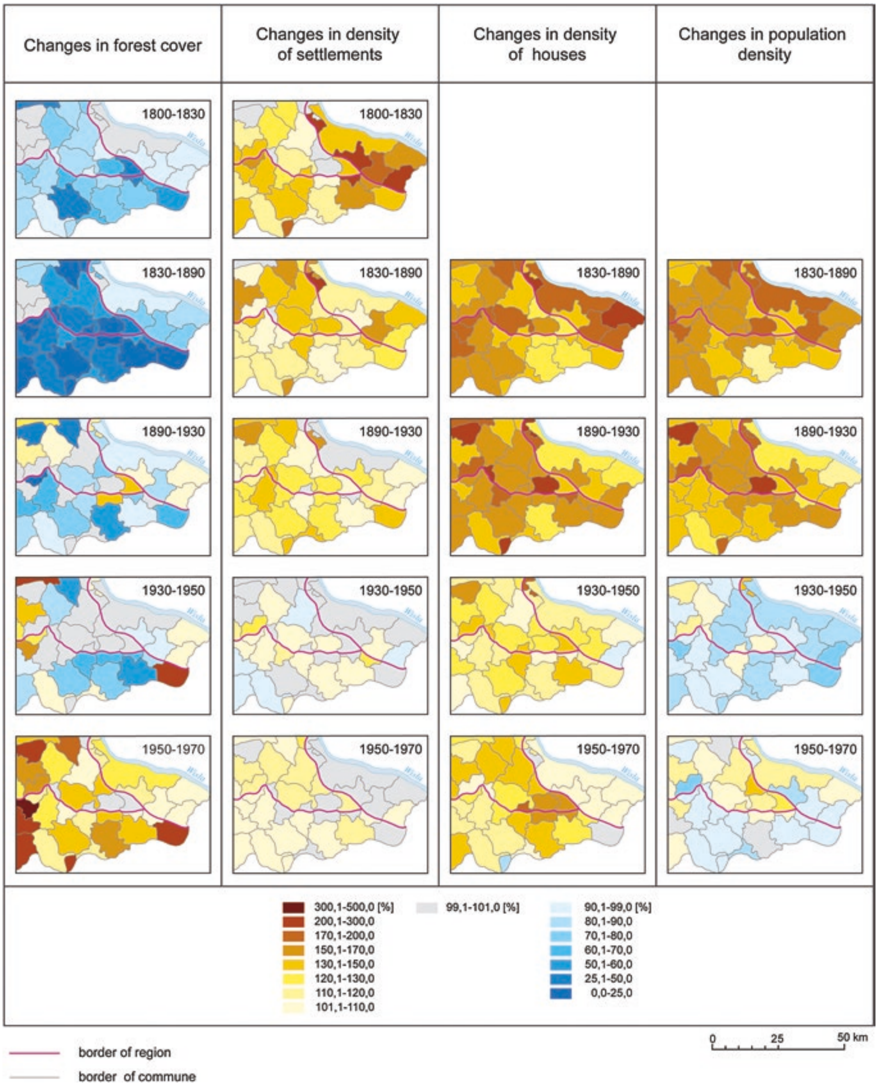

Fig. 8.9 Changes of main characteristic of landscape according to the communes

some areas, and it may be supposed that this pattern of landscape transformation was more common. During periods of undesirable precipitation/temperature relations (conducive to drought), such areas would periodically cease to be useful as arable land and, probably for that reason, agriculture was halted, leading to natural succession of forest or deliberate forestation efforts. Along the Vistula, and mainly within meadows along the Vistula, landscape transformations were also triggered by catastrophic flooding. According to Koc (1972), the largest floods in the nineteenth century occurred mid-century. They were attributable to a period of wetter and colder climate in that century. According to Hohendorf (1952) that period spanned the years 1830–1860. A comparison of maps shows that the areas subjected to damage involved buildings on three islands on the Vistula River and small-sized patches of arable land surrounding them, as these objects were marked on maps made around 1800 and 1830, but not on those dating to the late nineteenth century. Koc (1972) states that Kępa Głowińska shrank from 216 ha to 45 ha.

The earliest major afforestation efforts took place in the first half of the nineteenth century and mainly involved sandy fallow land in Włocławek Basin, where following prior clear felling aeolic erosion had begun. In the twentieth century, the afforestation programs were extended to cover agricultural land of little or nil agricultural value, mainly within terrace formations in Włocławek Basin and outwash plains in Chodecz Lakeland.

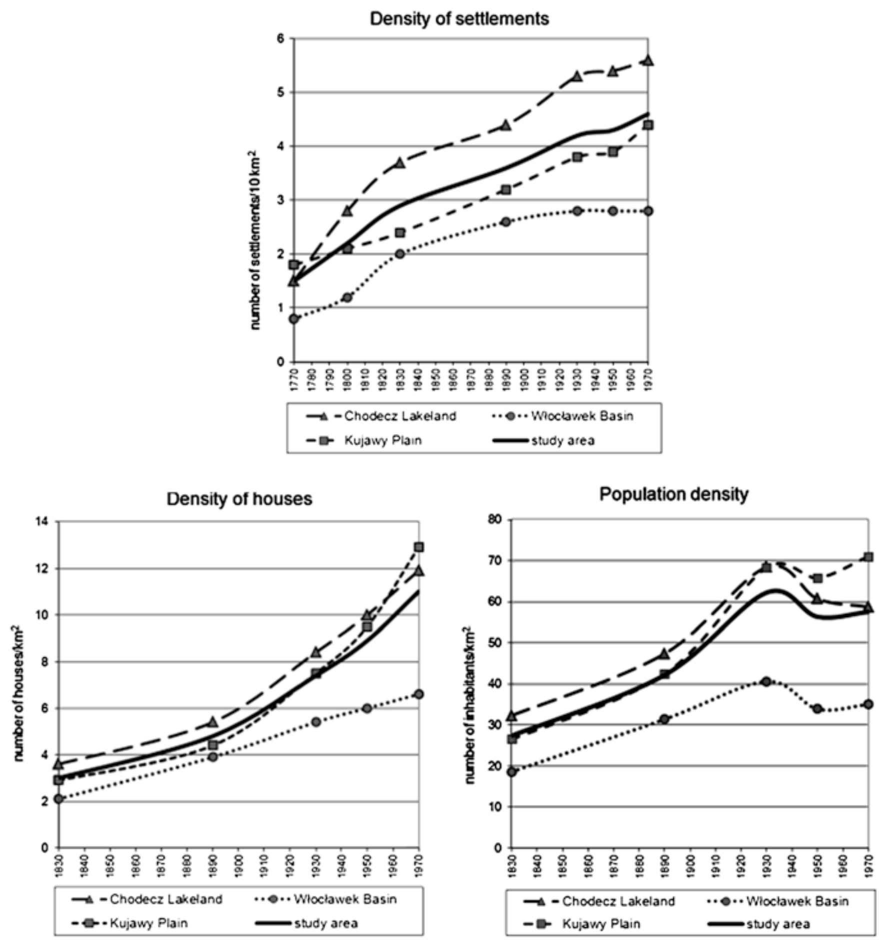

Fig. 8.10 Settlements, houses and population density

As regards the structure of the settlement network, natural conditions constituted an important determinant of the choice of a location even at the close of the eighteenth century. At that time, land of less agricultural potential, mainly due to an excess or shortage of water or poorer fertility, were not yet subject to intense settlement pressure (however, the present study showed early settlement activity in that period). Intensive development of settlements in the nineteenth and twentieth centuries was noted in nearly all of the areas. Until the end of the 200-year period we investigated, the greatest obstacle to settlement was posed by dune areas in Włocławek Basin and some wetlands. In presented study, the landscape building spread index (LBSI) reached the highest values in Kujawy Plain, i.e. the region with soils of the greatest agricultural value (Fig. 8.11). These superior soil conditions may be considered a factor that underlay a considerable increase in population density after WWII recorded only in this region, compared to relatively stable population figures in Chodecz Lakeland and decreasing population density in Włocławek Basin (Figs. 8.8, 8.9 and 8.10).

Socioeconomic Determinants of Rural Landscape Transformation

Among the wide spectrum of socioeconomic factors influencing landscape changes, of the most importance are settlement processes, agrarian revolution and population growth. Development of rural settlement network plus development and changes in the spatial arrangement of the building are on the one hand treated as the effects of changes in the rural landscape, on the other, settlement processes are a factor that generates conversion of forest land to arable land (Figs. 8.8, 8.9 and 8.10).

Landscape changes at the end of the eighteenth century including mainly the region of Chodecz Lakeland were characterized by intense process of deforestation and fragmentation of large forest complexes with a significant development of settlement and arable land on grubbed forest land or drained wetlands. In a much lesser extent, changes encompassed Kujawy Plain and Włocławek Basin. Main reason for the conversion of forest land into arable and settlement land was the process of colonization, mostly Olęder settlement. It was attended by settlers coming from the German lands, but some of the settlers were Polish peasants, and even the Czechs and the Mennonites (secondary Mennonite settlement)—(Burszta 1958; Rusiński 1947; Warchoł 1997). Inclusion of the studied area into the land annexed by Prussia, as an outcome of the second partition of Poland (1793), brought about a significant change in economic relations in the countryside at the end of eighteenth century. Intensification of the settlement process generated an increase in such forms like a long-term lease of land and rent, which in subsequent years underwent further expansion.

Inclusion of the studied area into Prussian partition, allowed duty-free export of grain by Vistula to Gdańsk, constituting one of the factors of increase in demand for agricultural products. According Kostrowicka (1961) not only did it improve agricultural technology, but also constituted an important factor of the agriculture activation. These factors had intensified the development of rural settlement and arable land. At the turn of the eighteenth and nineteenth century, the density of rural settlements and landscape building spread index (LBSI) reached the highest value on Chodecz Lakeland, while about 1770 the highest value was recorded for Kujawy Plain.

Time of agrarian revolution in Poland, dated to the nineteenth century, and especially to the second half thereof, had an influence on major changes in land use and development of rural settlements. While in the first half of the nineteenth century very intense land use changes affected only the Chodecz Lakeland, after the end of the first half of the nineteenth century, very strong transformation of the landscape encompassed all regions.

In the first half of the nineteenth century the following factors tend to be deemed as mainly responsible for rural landscape transformation: transition from feudal relations to the rent economy and further influx of settlers from the German lands, connected with the colonization policy of Prussia. There had been an increasing demand for agricultural and settlement land. In that time, forests of Chodecz Lakeland were the main area of acquiring new settlement and arable land. However, it was still maintained in all regions to drain wetlands, which was a result of the presence of settlers, who were familiar with the wetland maintenance. Period of the Duchy of Warsaw was the time of potato cultivation spread, which resulted in increase in profitability of agricultural production on poorer soils, which could lead to deforestation on such soils. Another alleged factor contributing to deforestation was introduction of rent for peasants and separation of court land from the peasant land, with the first intensity of these processes within 1831–1845 (cutting down of parts of forests for arable and settlement land). Thus, population growth followed.

Time dated back to the second half of the nineteenth century, brought about the most intense transformation of landscape, which was a result of the peak of the agrarian revolution in Poland. Factors that contributed to the further increase in the demand for new arable and settlement land were primarily: a significant increase in number of population, the order issued by the Government of the Kingdom of Poland in 1862 on mandatory rent imposition, separation of grange land and peasant land; enfranchisement of peasants (1864) and its aftermath, mainly regulating of lands carried out simultaneously with enfranchisement plus robust development of peasant settlement. Moreover, this period brought about a change in the settlement, connected with the transformation of the village onto so-called loose, scattered pattern. Predominant on the studied area until the very end of the nineteenth century, and especially on the Kujawy Plain, condensed settlements undergone rebuilding, leading not only to looseness but also spread of building.

Rebuilding encompassed even very old villages, which fundamentally changed the rural landscape, especially of the Kujawy Plain. In terms of the spread of building (Fig. 8.11), the density of rural settlements, houses and population, there

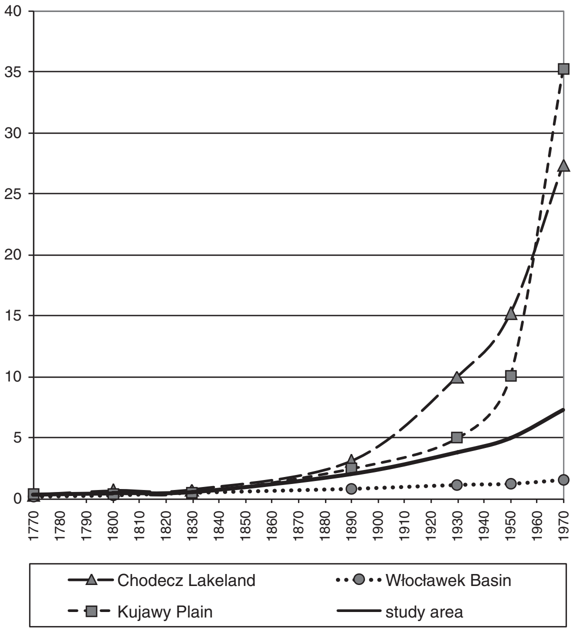

Fig. 8.11 Status of building spread between 1770 and 1970 according to landscape building spread index (LBSI)

was a strong domination of the Chodecz Lakeland (Figs. 8.8 and 8.10). Huge increase in demand for arable and settlement land plus for wood brought about the deforestation of the majority of forests of Chodecz Lakeland and Kujawy Plain with significant diminution of forest land of the Włocławek Basin.

Significant factors of deforestation were: wholesale of forests in declining demesnes after the enfranchisement, elimination of Polish administration in government forests, and its takeover by the office in St. Petersburg (1869), with donating part of the government forests (cutting down of forests for commercial purposes and farmsteads for new owners), as well as the development of industry based in large part on the wood, as an energy resource, with the case of timber industry also as an industry resource. In this period high intensity was also characteristic for the loss of grassland, which can be attributed to the development of drainage techniques, as well as to depletion of forest land suitable for agricultural development.

Turn of the nineteenth and twentieth century with the first half of the twentieth century brought a significant reduction in the deforestation process. Balance of afforestation and deforestation on Chodecz Lakeland and Kujawy Plain was still slightly outweighed by the loss of forests, while in the Włocławek Basin within 1930–1950—by reforestation process. During this period, the minimum rates of forest cover were noted in each of the studied regions and the maximum share of arable land in the Włocławek Basin and Chodecz Lakeland. Processes of further deforestation can be attributed to the threat of nationalization of forest of the large estates to the exercise of the provisions of the second land reform and liquidation of easements.

Further conversion of forest land and grassland to arable and settlement land was triggered by increasing so-called “land hunger”, connected to i.a. a large overpopulation of rural areas (68.5 persons/km^2 in Chodecz Lakeland and 68.3 persons /km^2 on the Kujawy Plain). At the same time the following factors contributed to the initiation of afforestation process: provisions of the Act on forests preservation (1898), and after regaining the independence by Poland—acquisition of administration of the government forests by the State Forests and commencement of the afforestation process on the poorest arable lands and on the previously deforested lands, which proved to have no value for agricultural purposes.

Time of the Polish People’s Republic brought about a change in a pattern of landscape transformation. It was the first period of the landscape renaturalization, resulting from an increase in forest cover in all regions and the loss of arable land on the Chodecz Lakeland and Włocławek Basin. The increase in forest cover was also a result of the implementation of the land reform of Polish Committee of National Liberation (PCNL), relating to the acquisition by the State Forests of the majority of large estates forest lands, which, disabled on these areas free cutting down of forests, and to the introduction of afforestation, especially on the poorest arable land and other barren land. PCNL Decree of 1944, in the study area carried out from March 1945. An important factor was also an inclusion of the so-called peasant forests into the surveillance of forest administration, with the introduction of mandatory afforestation of land in case of cutting down other forests, and of tax reliefs granted in exchange for afforestation of the poorest soils. The process of grasslands diminution continued, which was a result of the intensification of drainage actions, involving mainly the drainage of land, which enabled the further conversion of grassland to arable land.

Protection of forest land against changes in the form of the use, caused that meadows and pastures were the only reserve of potential arable land. Enhancement of afforestation process in Włocławek Basin and Chodecz Lakeland occurred after a substantial loss of population, as an aftermath of war damage and displacement that took place during the WWII and in the years immediately following the war. Displacement affected mostly former colonists of the German lands and their descendants, and Germans settled in Poland during WWII. In regional terms, only Kujawy Plain demonstrated further landscape antropization, resulting from an increase in arable land only in this region. Moreover, it was the only region of significant population growth—up to 71 people/km^2 in 1970. Settlement changes were also influenced by the land reform of PCNL. Parcelling of demenses and new acquisitions, led to the rapid development and spread of rural building in the landscape of the Eastern Kujawy.

Particularly intense process was noticed on the Kujawy Plain and only slightly less intense on Chodecz Lakeland, which triggered that from about

1960 the Kujawy Plain had already been characterized by the highest spread of the building in the region. About 1970 the LBSI amounted to 35, while for the Chodecz Lakeland the value accounted for 27, for the Włocławek Basin for 1.5. It means that in these regions was, respectively, 35, 27 and 1.5 times more fields (1 km × 1 km) with buildings, than undeveloped fields. The Włocławek Basin was still characterized by very small spread of building, which is connected with the concentration of building mainly in the settlement bands. Barrier its development were large forests preserved on poor and the poorest soils, which had no longer been subject to the process of deforestation in the twentieth century and numerous wetlands.

Conclusions

The trends in transformation of natural and little disturbed components of the landscape into a landscape showing relatively marked transformation observed in our study were the basis for the division of the 200-year span of interest into periods with regard to the rate and directions of landscape change. Four main periods of rural landscape transformation can be distinguished:

- A period of moderate landscape anthropization (1770–1850)
- A period of intense and very intense anthropization of the landscape (1850–1900)
- A period of slow anthropization of the landscape—1900–1945
- A period of moderate renaturalization of the landscape—1945–1970

General trends in the share of woodland and arable land in the study area during the 200-year span (1770–1970) of interest basically paralleled trends seen on all Polish lands (Kostrowicka 1961; Maruszczak 1988; Romanowska 1934; Więcko 1948). However, the mean forest cover in Eastern Kujawy compared to all Polish lands demonstrated increasing variation in the share of woodland, against the background of the same overall trends of dwindling forest cover until about the mid-twentieth century followed by increasing forest cover.

The division of the 200-year span into periods with regard to trends in forest cover in Eastern Kujawy is generally consistent with periods of landscape change as distinguished by Bastian (1987), Bastian and Bernhardt (1993) in Central Europe: the period of slow and moderate anthropization of the landscape coinciding with the close of the period of integrated development, the period of intense and very intense landscape anthropization coinciding with the industrial revolution, and the period of moderate renaturalization of the landscape coinciding with the scientific and technical revolution.

It needs to be noted that these periods describe trends in the entire area of study, thus indicating overall tendencies of landscape change in Eastern Kujawy, and generally do not account for local patterns, where considerable diversity of change can be observed, chiefly with regard to the landscape transformation index (Fig. 8.7), with much less diversity in trends of change. The trends diverged around the middle of the twentieth century.

The present study confirms the thesis that the main driver of landscape change was the development of rural settlements and their accompanying arable land. The greatest changes in rural landscapes were caused by significant socioeconomic changes, mainly in agriculture. Similar conclusions were formed by Hładyłowicz (1932), Maruszczak (1951, 1988), Plit (1996), Szymański (1984) and others, in studies of other regions of Poland. Political conditions, initially in the partitioning powers and later in the reborn Polish state, politics in occupied Poland during World War II and later the Polish Committee for National Liberation and the People's Republic of Poland also played a significant role in landscape transformation.

Natural conditions had a considerable limiting or intensifying influence on the transformations. Of the environmental components analysed in the study, habitat conditions, and mainly the soil, were the main element that had a marked limiting or intensifying effect on spatial change in the structure of rural landscapes. Apart from confirming the generally known association of the highest persistence of forested land with the agriculturally poorest habitats and the persistence of arable land with the most fertile habitats, the present study showed that, until the end of the nineteenth century, areas of average fertility experienced the most intensive changes in the share of woodland (decreasing trend) and arable land (increasing trend). The most intensive changes in the form of conversion of the forest cover into settlements and agricultural land took place in Chodecz Lakeland, a region where the agricultural value of land was generally relatively good or average. However, around the mid-twentieth century, most, previously identical, regional trends in changes in the share of woodland and arable land diverged. At that time, despite a general decreasing trend in the proportion of arable land both in the area of study and in Poland overall, Kujawy Plain registered further intense increases in the contribution of arable land. This accounts for the observed intense development of the settlement network and increase in population density, with relatively minor changes recorded in Chodecz Lakeland and decreasing population in Włocławek Basin.

In the study period, the impact of the environment on the development of the settlement network was increasingly limited over time, despite some correlations demonstrated even in the second half of the twentieth century. According to Kiełczewska-Zaleska (1931, 1976), changes in the settlement network are driven mainly by the degree of development of the economy and culture, with the natural environment playing a minor role. However, in Eastern Kujawy, environmental determinants decisively influenced the development of the rural settlement network and the associated arable land until the end of the eighteenth century, with limited development in areas of little agricultural value and in wetlands. In Włocławek Basin, this correlation was observed until the end of the 200-year span. Over the consecutive periods, particularly important drivers of the development of settlements and arable land, besides the degree of development of the economy and culture, were the colonization of rural areas in Kujawy and a very intense upward trend in population density.

The extremely low forest cover of Kujawy Plain and Chodecz Lakeland and the drainage of wetlands should be regarded as a very negative effect of human activity, especially as these outcomes affected a part of Poland characterized by very low forest cover, lowest precipitation in the country and considerable aeolian erosion. The reversal of the 150-year trend of decreasing forest cover, with afforestation prevailing over deforestation in the second half of the twentieth century, should be interpreted as a positive aspect of landscape transformation. Of particular importance for the functioning of ecosystems is the spatial dimension of these changes, as many artificially fragmented woodland complexes regained cohesion. For these reasons, the first half of the twentieth century can be regarded as the beginning of landscape renaturalization.

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Main Cartographic Materials

- Specjal Carte von Pohlen , T. P. von Pfau, 1: 87,500, Berlin, 1778
- Special Karte von Suedpreussen, Gilly, Cron, 1:50,000, Berlin, 1796–1800
- Special Karte von Suedpreussen mit allerhoechster Erlaubniss aus der Koniglichen grossen topographischen Vermessungs-Karte, unter Mitwurkung des Directors Langner, reducirt und herausgegeben vom Geheimen Ober-Bau-Rath Gilly ... die Post-Course und Hauptstrassen sind gezeichnet vom ersten General Post Amst, 1: 150,000, Berlin, 1802–1803
- Topograficzna karta Królestwa Polskiego, K. Richter, Kwatermistrzostwo Generalne Wojska Polskiego, 1:126,000, Warszawa, 1839–1843
- Nowaja topograficzeskaja karta Zapadnoj Rossii, Wojenno-Topograficzieskij Otdel Gl. Sztaba, 1:84,000, Petersburg 1909–1917
- Mapa topograficzna Polski, Wojskowy Instytut Geograficzny, 1:100,000, Warszawa, 1930-1938
- Mapa topograficzna Polski, Sztab Generalny, 1:100,000, Warszawa, 1952
- Mapa topograficzna Polski, Państwowe Przedsiębiorstwo Wydawnictw Kartograficznych, skala: 1:100,000, Warszawa, 1981

Chapter 9
Carbon Sequestration of Different Types of Floodplain Forests in the Maros River Valley (Hungary)

Márton Kiss, Viktória Cseh and Eszter Tanács

Abstract Carbon sequestration is one of the most important ecosystem services of forested landscapes. They have an outstanding role in climate change mitigation, and, as a quantifiable service, carbon sequestration can be incorporated in decision-making processes. Floodplain forests should have an outstanding role in fulfilling green infrastructure development goals. These ecosystems are characterized by a number of land use conflicts, between the local actors with different interests (forestry, water management and nature conservation). Ecosystem service assessments can help to resolve such environmental management issues. Our work was carried out with a targeted model (CO2Fix3.2.), with the aim to compare the potential of the main forest types of the area (native and non-native willow-poplar stands, managed and non-managed hardwood forests). Calculations were based on a combined dataset of detailed forest structure measurements and the management plans provided by the local forestry directorate. The biggest amount of carbon is stored in hardwood forests with long rotation cycle and in the unmanaged forest reserve. The carbon content of the soil and the wood products should also be taken into account in these complex environmental systems. These types of results can form a basis for incorporating ecosystem services in decision-making, e.g. through payments for ecosystem services schemes.

Keywords Carbon stock modelling · CO2Fix · Management intensity · Willow-poplar forests · Floodplain forests · Maros · River

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Introduction

Climate change, as one of the most important contemporary environmental issues, draws attention to the global climate regulation ecosystem service of natural vegetation, in which forests play an outstanding role. In the process of photosynthesis, the greenhouse gas, carbon dioxide, is fixed in different compartments of living biomass (stems, branches, foliage and roots) and in the soil. After timber harvesting and industrial processing, the carbon content of wood may be stored further in wood products with different life spans. In the end, it returns to the atmosphere as a result of turnover or logging. Earlier it was generally thought that ageing forests should be considered carbon-neutral (Odum 1969). This was based (among others) on the assumption that the growth trends of individual trees and even-aged mono-specific stands can be directly extended to natural forests. However, it was found later that growth and carbon acquisition in old natural forests cannot be extrapolated from the productivity of even-aged stands (Carey et al. 2001).

Recently, research on the effects of forest management intensity has shown that forest management and disturbances affect forest soils and biomass carbon stocks and emissions to the atmosphere (Luyssaert et al. 2011). Harvesting frequency and structural retention significantly affect mean carbon storage, and the mean carbon sequestration is significantly greater for non-managed stands compared to any of the active management scenarios (Nunery and Keeton 2010). Of the harvest treatments, those favouring high levels of structural retention and decreased harvesting frequency store the greatest amounts of carbon (Neilson et al. 2006; Taylor et al. 2008; Nunery and Keeton 2010). Greater harvest intensity results in less carbon storage, and the carbon in wood products does not make up for harvest losses (Nunery and Keeton 2010; Fischer 2013).

Hungarian forests are considered important carbon sinks (Somogyi 2008); in fact, they are the only significant sinks in the greenhouse gas balance of Hungary (Kis-Kovács et al. 2011). Although there are some studies regarding their carbon sequestration capacities (e.g. Führer and Molnár 2003; Balázs et al. 2008; Juhász et al. 2008; Kiss et al. 2011), the local floodplain forests have not yet been specifically studied from this respect.

Since the river regulations of the nineteenth century, the floodplain forests of Hungary have been constrained between the river and the flood control dams. Their development is defined by the hydrological and geomorphological environment. These controls affect the vegetation at the patch scale through soil quality (hydrology and fertility), stability of substrate and floodplain hydrology/hydrogeology (Brown et al. 1997). In their natural state, floodplains are notable for their diverse habitats and vegetation. Geomorphological complexity is the key for this diversity (Harper et al. 1995), but both the complexity and attendant biodiversity are only present if there is no intensive land use on the floodplain.

There are a number of unresolved problems related to floodplain forests in Hungary (Czeglédi 2004). Besides the local inhabitants, their fate is defined by three main stakeholders, acting under different regulations: Nature conservation authorities, private and state forest managers and water managers (with a high priority on flood prevention). The different priorities of these actors mean that their interests are often in conflict.

The ecosystem services approach provides a well applicable framework for resolving the above-mentioned conflicting interests. Therefore, it is important to see how different management scenarios affect the different services. In this research we examined how different treatments affect the carbon sequestration potential of the forests of the lower Maros valley and what would be the optimal way of management from this point of view.

Materials and Methods

Study Area

Investigations were carried out on the floodplain of the river Maros near Szeged, Hungary (Fig. 9.1). Most of the forests in this area are plantations of both native and non-native species. There are also a forest reserve and some stands of willow-poplar forests. The main tree species include: Pedunculate oak (*Quercus robur*), white poplar (*Populus alba*), black poplar (*P. nigra*), hybrid poplar

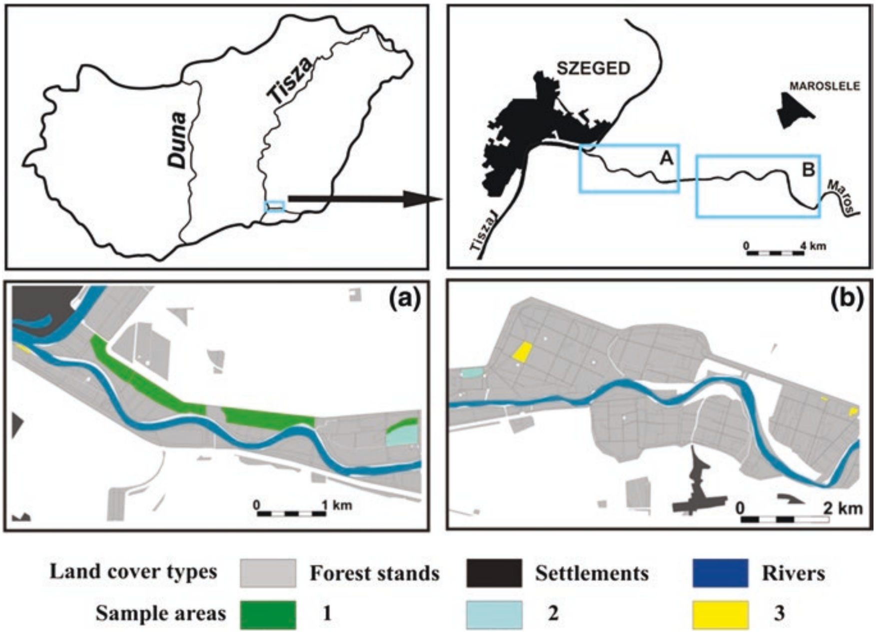


Fig. 9.1 Study areas along the Maros river. Notations: *1* most natural stands with little or no management; *2* managed mixed and native stands; *3* native monocultures or non-native forests

(*P.* × *euramericana*), the Hungarian subspecies of narrow-leafed ash (*Fraxinus angustifolia* ssp. *pannonica*), European ash (*F. excelsior*) and American ash (*F. pennsylvanica*), white willow (*Salix alba*) and European white elm (*Ulmus laevis*). In addition, black walnut (*Juglans nigra*), white mulberry (*Morus alba*) and sporadically hybrid plane (*Platanus* × *hybrida*) and common hackberry (*Celtis occidentalis*) also occur.

Eleven sample areas were selected along the river Maros from Makó to Szeged. These areas can be characterized by different species composition, age class and management intensity (Table 9.1; Fig. 9.1).

Most of the study area on the right bank of the river is under protection and belongs to the Körös-Maros National Park. There is a strictly protected forest reserve near the mouth of the river. All human activities are prohibited in the core area of the forest reserve; therefore, it is completely unmanaged. The stands here are 60-year-old willow-poplar forests with a slight shift towards oak-elm-ash forests, planted in the place of former arable land. Despite not being virgin forests, not even old-growth stands, they can be characterized with a diverse structure and relatively high species diversity. The buffer zone is considered strictly protected which in theory makes it possible for forest managers to intervene. The stands in the reserve are infested with invasive species, especially American ash, which composes most of the regeneration layer. Less intensively managed stands outside, the reserve include Natura2000 areas and other protected areas where management is allowed only with limitations. These stands also mainly consist of native species. Finally there are the intensively managed plantation forests, mainly of *Populus* × *euramericana*. One of the sample stands is situated outside the protected area, near the mouth of the river at the town of Szeged.

Table 9.1 Management intensity and naturalness of the different forest types in our study area

Age (year)	Management intensity and naturalness		
	1	2	3
0–20		A	B (1, 2)
		Poplar stand with native species (Pa, Pn)	Populus × euramericana plantation stands
20–50	C	D	E
	Willow-poplar forest at the site of an oxbow lake	Native poplar stand mixed with American ash (Pa, Fp)	Oak stand mixed with American ash (Qr, Fp)
50–	F (1, 2, 3)	G	H
	Forest reserve: • willow • poplar • European white elm-dominated stands	Riverbank protection forest (Pa, Ul, An)	Oak stand (Qr)

Notations: *1* most natural stands with little or no management; *2* managed mixed and native stands; *3* native monocultures or non-native forests

Abbreviations: *An Acer negundo*, *Fp Fraxinus pennsylvanica*, *Pa Populus alba*, *Pn Populus nigra*, *Ul Ulmus laevis*, *Qr Quecus robur*

Field Surveys

Each sample corresponds to a forest section, except in the reserve which is rather diverse, and therefore cannot be characterized properly by the usual unit of the forest inventory. The species composition and the age classes of the other stands were characterized using forest inventory data. In the different stands of the reserve, a forest structure survey was conducted in 20 m radius circle plots, where the position, diameter at breast height, crown class and species of each tree were recorded. The data of three plots in three different types of stands were chosen. F1 is a hollow with a few large old willow trees and lots of young American ash trees on the surrounding higher banks. F2 is dominated by older poplar trees (both black and white) and European white elm in the second layer, with lots of smaller American ash trees. F3 is situated on slightly higher ground, and is dominated by European white elm. *Acer negundo*, together with a few older willows and lots of young American ash trees also occur in this stand.

Due to regular flooding, the soil properties of the floodplain can be considered fairly homogeneous. Soil samples were taken from a recently planted stand in order to measure the initial carbon content of the soil and to estimate the proportion of raw and recalcitrant humus forms. Measurements of the soil properties (humus content, proportion of raw and recalcitrant humus forms) were carried out according to the MSZ21470/52-83 standard.

Brief Description of the CO2Fix Model

CO2Fix (v. 3.2), the model chosen for the analysis is a simulation model developed as part of the CASFOR II project. It quantifies the carbon stocks and fluxes in the forest biomass, the soil organic matter and the wood products chain (Masera et al. 2003; Schelhaas et al. 2004). These are estimated with a time-step of one year using the 'cohort' as a unit, where each cohort is defined as a group of individual trees or species, which are assumed to exhibit similar growth. The model consists of six modules: biomass, soil, wood products, bioenergy, financial and carbon accounting.

The total carbon content of the system is obtained by adding up the amount of live biomass and soil carbon content and the carbon stored in wood products. The overall effect on the climate system depends on the changes of the carbon content and the so-called avoided emission. Avoided emission characterizes how much less carbon dioxide is released into the atmosphere through substituting fossil fuels with biomass; it is also calculated by the bioenergy module. In this analysis, the financial and the bioenergy modules were not used.

Model Parameterization

Current annual increment and other yield data were taken from yield tables (Béky 1981; Halupa and Kiss 1978; Kiss et al. 1986; Kovács 1986; Palotás 1969; Rédei 1991). There were no yield tables available for those species which are economically less important in Hungary. Therefore, data of relative or similar species were used, based on information from the literature (Veperdi 2008).

The wood density data were taken from Somogyi (2008), and in the case of hybrid poplar from Molnár and Komán (2006). For the calculation of the carbon content of wood, the IPCC default (0.5 t C/t biomass) was used. The relative growth of the branches was calculated based on branch proportion tables (Sopp and Kolozs 2000), where the values were assigned to age groups according to the tree size. Density-dependent mortality was estimated only for the non-managed stands based on the yield tables, while management mortality was defined according to the expert opinion (from the state forest manager). Approximate thinning-harvest data were also provided by the local state forestry company.

The mean temperature and precipitation data were gathered from the National Meteorological Service (OMSZ 2006), while the growing season was defined as the period from March to October. The products module was parameterized based on the information from the state forestry company, and on analyses examining the waste and by-product utilization in the Hungarian wood industry sector (Németh 2009).

We have run the simulation for a period of 120 years, according to the longest rotation cycle used in the area (for oak stands). Each species were modelled separately and the results were added up for each stand after being weighted according to the species' proportion at the specific sample site. In the case of the most natural stands, we added some cohorts with time, thus simulating successional development and species changes. The time of the addition and the species of the new cohorts were based on forest inventory data and the field survey data.

Results and Discussion

The results of the simulations are presented in Figs. 9.2, 9.3, 9.4, 9.5 and 9.6; these show how the carbon content changes with time in the different compartments and overall in five characteristic sample areas.

Of the managed forests, the oak stands can be characterized by the highest carbon storage potential. Besides the species characteristics and the longer rotation cycle, the reason for this is mainly the high proportion of long-lasting products (e.g. furniture) made of oak wood. The relative proportion of firewood is high among the products derived from the examined sites; the share of industrial wood increases with age from the thinnings to the final clearcut. Even the comparatively long production cycle is significantly shorter than the upper limit of the biological cutting maturity, in the interests of obtaining high quality timber products. Due to

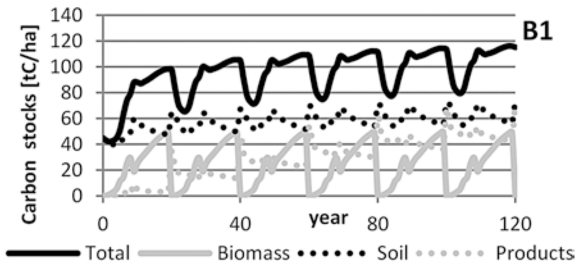


Fig. 9.2 Carbon stocks in the main compartments of the sample area B1 (hybrid poplar plantation stand)

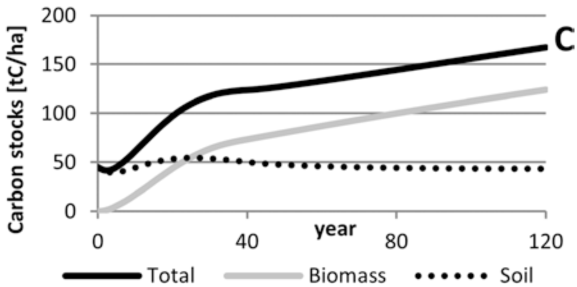


Fig. 9.3 Carbon stocks in the main compartments of the sample area C (willow-poplar forest at the site of an oxbow lake)

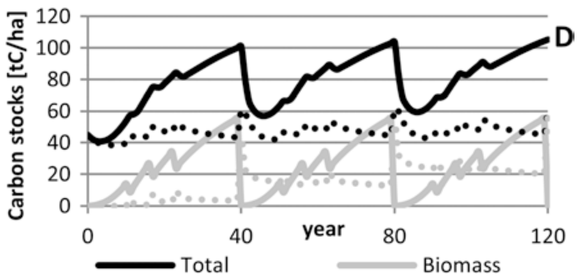


Fig. 9.4 Carbon stocks in the main compartments of the sample area D (native poplar stand mixed with American ash)

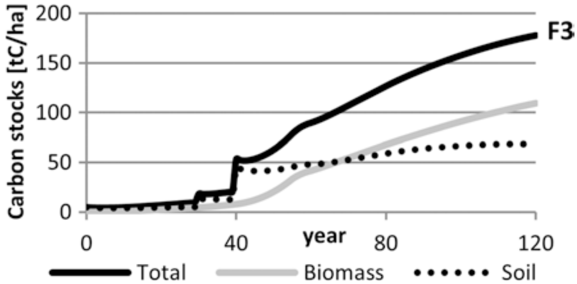
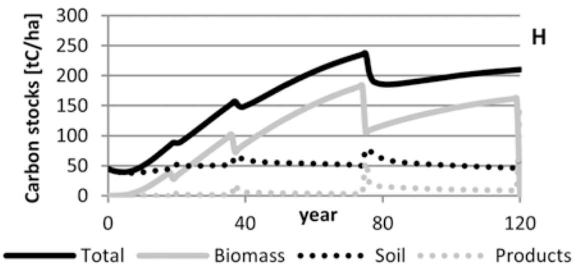


Fig. 9.5 Carbon stocks in the main compartments of the sample area F3 (forest reserve, European white elm-dominated stand)

Fig. 9.6 Carbon stocks in the main compartments of the sample area H (oak stand)



conservation interests, final use usually means clear-cutting in micro-sized plots. The wood products of the oak stands are primarily used in the furniture industry. Ash species provide slightly lower quality wood products, and an even higher proportion is used as firewood. Most of the timber is used in the sawmill and furniture industry; therefore, their carbon content is stored in products with a medium or long lifespan, as in the case of oak species. The invasive American ash has a high heating value and is characterized with a rapid growth.

The carbon storage potential of the hybrid poplar stands is much lower than that of the oak stands. The carbon stocks in the different compartments of the hybrid poplar stands basically reflect the management regime, since they are generally characterized by a rapid growth (depending on the variety), and consequently a very short rotation cycle. It should be noted that the continuous growth of the total carbon content in the modelled results is somewhat doubtful. The modelling process in this case should be further refined by introducing the soil carbon loss resulting from the soil preparation works when planting the new stands (see Somogyi et al. 2013) as well as a more precise parameterization of the lifecycle of the derived wood products. The continuous increase in the amount of carbon stored in the products is due to the fact that some of them are supposed to end up in landfills where decomposition was set to be very slow. Even though this proportion has been assigned a small value (around 5 %) in the model, in the case of short rotation cycle (when lots of products are produced), the carbon storage of the products added up. Compared to the other softwood species, hybrid poplars are utilized as industrial wood in a higher proportion, mainly in the paper and packaging industry. Due to short harvesting cycles, the initial treatments result in such small wood quantities that it is not worth transporting them; therefore they remain on site.

According to the model, the carbon storage potential of the native poplar stands was similar, but slightly lower than in the case of the hybrid poplars. However, it should be taken into consideration that the carbon storage potential of native poplar stands may be higher in reality; due to partial restrictions from the protected status, clear-cutting and the subsequent complete soil preparation are not allowed in these stands. Therefore, emission from the soil is probably less than in the case of non-protected stands. According to the forestry experts consulted, the wood products of domestic poplar species appear to have a limited use. Due to the softness of the wood, only pallets and simple storage elements are made out of them, which are regarded as medium- or short-lived products. The wood resulting from both thinning and final cutting is primarily used as firewood. Willow has practically no significant industrial use anymore; its use (except as firewood) is mainly related to the traditional handicraft.

In the Hungarian wood industry, in addition to the main products, approximately 30–70 % by-product and waste is generated depending on the sector (less in the timber industry and more in the more specialized furniture industry sectors). The immediate reuse of by-products is not typical; however, even at the lower levels of the production process they may store carbon for quite a while. For example in the manufacture of chipboard, scrap from forestry and the timber industry and waste are equally used. At the end of the product cycles of various lengths, the wood in most cases ends up in energy production (either to cover the needs of the company itself or to be taken to power plants), and thus fossil fuels can be replaced. Thermal power plants are generally favourable partners of the forestry companies because of the steady, predictable demand and the simple logistics (Alpár et al. 2011).

In the stands of the forest reserve and the other non-managed stands, a continuous increase in the carbon storage can be clearly seen. In the case of the poplar forests, it exceeds the values of the managed poplar stands. However, the results should be further refined by introducing an increased mortality at higher ages, which were not included due to a lack of dynamics-related data.

In conclusion, the older floodplain forests can be considered significant carbon sinks. In the case of the poplar species, less intensive treatment and longer rotation cycles are more favourable from the carbon sequestration point of view, mainly due to less soil disturbance, and the generally short life cycle of the products coming from the plantations (mainly paper and packaging materials), which thus retain carbon only for a short time.

Issues to be Fixed and Further Research

During the analysis, several issues were identified that need to be fixed. As most existing carbon sequestration models, CO2Fix can be best used to describe the processes of managed forests with few tree species. A serious drawback of the model is that the proportions of the cohorts cannot be defined, and the input data in the products module cannot be given for each cohort separately. We fixed this by creating a separate file for each species. However, this makes the modelling of between-cohort interactions, e.g. competition, impossible. The final results were then weighted according to the proportion of the species in the stand. Another issue probably affecting the final results is that the soil carbon loss following clear-cutting and replanting cannot be directly included in the model. Also, according to Pérez-Cruzado et al. (2012) the model overestimates the decomposition rates for the soil compartments, leading to underestimation where carbon density is high.

As Nabuurs et al. (2008) state, uncertainty in estimates obtained by the CO2Fix model partly depends on the data availability. In this case, it was the natural dynamics of the floodplain forests that could only be characterized in a limited manner due to lack of data and some further important additions would be required in the interest of getting more realistic results. One such addition is density-independent mortality, which in the case of floodplain forests is mainly caused by higher than usual, longer lasting or icy floods (or possibly biotic effects). A more precise parameterization of mortality as a function of age and regeneration dynamics should also be included. A very important aspect would be the carbon content of the shrub layer, which is currently not possible to include. In general, there is a lack of data for those tree and shrub species which are not considered economically important. Pérez-Cruzado et al. (2012) also bring up the possible role of including the ground vegetation in a more realistic estimate of soil organic content, since the model parameterization does not consider litter input sources other than trees.

Another important source of uncertainty, according to Nabuurs et al. (2008), is simplifications in the model design. The most important differences between a managed and a natural forest lie in the diversity and dynamics of the latter; therefore, simplifications based on data and knowledge from managed stands tend to favour such stands when a comparison is made. In the future, we plan to concentrate on refining the model parameters, and work around these issues.

Quantitative assessments of this kind may constitute the basis for payments for ecosystem services schemes related to carbon sequestration. Multifunctional land use taking into account geographical-landscape ecological aspects and corresponding to the requirement of sustainability should be based on the consideration of the full range of ecosystem services and the assessment of trade-off conditions (possibly in economic value). In the assessment and mapping of ecosystem services, land management intensity should be taken into account rather than simply specifying the land use type (Petz and van Oudenhoven 2012; Kiss et al. 2014). Our results provide methodological help to do this for one of the best-known ecosystem services of forests; carbon sequestration. Our findings concerning changes in biomass storage and wood products are consistent with previous economic analyses performed on similar forest types (ERTI 2007).

Rapid growth makes hybrid poplar forests highly profitable; however, in the case of the native poplar species higher soil carbon retention due to less intense and less frequent disturbance could at least partly form the basis of financial compensation. The large quantity of long-term stored carbon in oak forests (and the resulting profitability of wood products) assumes the long-term availability of funding which also directs attention to the need to ensure adequate amounts of resources. The carbon sequestered long-term in unmanaged old-growth forests is a further reason to maintain such stands, besides their ecological value and important role in research.

The net carbon sequestration presented in this study and the economic values which can be calculated from it are not directly applicable in planning compensation schemes. However, a similar series of tests carried out in many types of forest could provide results that can be used directly in decision-making. Given the current policy environment, the existing central compensation systems could be extended taking into account the capacity of the different forests to act as carbon sinks.

Acknowledgments The research was supported by the European Union and the State of Hungary, co-financed by the European Social Fund in the framework of TÁMOP 4.2.4. A/2-11-1-2012-0001 'National Excellence Program'. Expert estimates and forestry data were provided by László Vízhányó, Director of the Szeged department of DALERD Délalföldi Forestry Co. The authors would also like to express their thanks to Imre Csáki and Gábor Czanka (Körös-Maros National Park) for their help.

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Part II
Landscape Planning

Chapter 10
Landscape Ecology According to Geography: A Proposal of Tools for the Analysis and Management of the Environment

Fernando Frederico Bernardes

Abstract Landscape ecology is an inter- and transdisciplinary science, because it unites and/or transits through several sciences, such as Anthropology, Architecture, Biology, Philosophy, Geography, Geology, and Sociology, among others. The main proposal of this chapter is to cover, though briefly, the insights of Landscape Ecology within its geographical roots and to promote a method and a study methodology more adequate to today's complex environment in a more integrated perspective.

Keywords Geography · Landscape change

Introduction

Landscape ecology is an inter- and transdisciplinary science, because it unites and/or transits through several sciences, such as Anthropology, Architecture, Biology, Philosophy, Geography, Geology, and Sociology, among others. The main proposal of this chapter is to cover, though briefly, the insights of Landscape Ecology within its geographical roots and to promote a method and a study methodology more adequate to today's complex environment in a more integrated perspective.

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Exploration and Development of the Proposed Theme

Bertrand (1982) advances the study of Global Physical Geography and conceives landscape as the result of space and the dynamic combination (hence, unstable) between physical, biological and anthropic elements which dialectically interact upon one another, making the landscape unique and permanently evolving. This shows the transtemporality of the concept and the role played by context, time and space.

The term Landscape Ecology was first coined by the German geomorphologist Carl Troll, in 1950 (Bernardes 2010). According to him, the landscape is conceived as a visual and total entity of the space inhabited by mankind. Suertegaray (2001) claims that the interpretation of landscape by Troll goes beyond the visible. In her opinion, the German thinker presents a double possibility of analysis: 'the one of form (configuration) and the functionality (interaction of geofactors, including the economy and the human culture)' (Suertegaray 2001). Thus, the landscape is something beyond the visible, being the result of its constituent elements.

In the Atlas of Portugal (Instituto Geográfico Português 2005), there is also a description of the landscape as a visual spatial entity. But this approach reaches further than Troll's, as the landscape is depicted as multi-faceted, complex, historical and independent, according to the judgment and interpretation of the researcher. Additionally, it considers that natural landscapes rarely exist, as they have given place to more or less humanized landscapes.

According to the Dictionary of Human Geography (1998), the term 'landscape' was introduced in North American Geography by Sauer around 1925, with the publication of the operational system of landscape morphology, which would influence the concept of 'Landschaft', developed by German Geographers.

The concept of landscape is linked to spatial and territorial questions, such as the German 'Landschaft'. *Land* in German relates to the idea of 'land' in English as homeland, nation or country. *Schaft* stems from Wissenschaft, which means Science, therefore the general meaning of Landschaft may be 'Science of Landscape'. According to the German school of thought, the science of the landscape was born (*Landschaftskunde*), followed by that of the cultural landscape, which combines elements of the social order, as Troll underlined (1950).

The Ecology of Landscape, as the name indicates, is the study of landscapes with a focus on the spatial heterogeneity of several scales, including the role played by humans in the creation and disturbance of the processes which constitute the landscape. This type of study was initially adopted by geographers when working with large scales, such as those based upon techniques of aerial photo analysis through which the environment could be materialized.

This enabled the characterization of heterogeneous spatial relations, along the particular lines of enquiry of each researcher's interest. Besides the role of the researcher, it is fundamental to pay attention to the scale of analysis, since it will determine the adequate grid for observation (Instituto Geográfico Português 2005).

Turner (2005) questions the essential guidelines for future Landscape Ecology research. According to the author, interaction is one of the main themes of present research, especially the interaction between biophysical and socioeconomic factors and the types of scales and impacts on landscapes. For Turner, the ecological landscape must lead the next generation of research agendas, borrow from a more encompassing look to the ecological dynamics in heterogeneous landscapes.

Despite the fact that Turner poses these problems, her approach remains purely physical, mechanicist and quantitative, thus not corresponding to the endeavour she assumes in her paper. Perhaps it is due to her involvement with teaching at the Department of Zoology, at the University of Wisconsin (U.S.A.). That might explain the focus on natural disorders and their effect on natural ecosystems, especially concerning animal species and also the questions of land use and land occupation. It must be noted, however, that 'since the dawn of times—or at least since the beginning of mankind—we have been living in an environment partly built by ourselves' (Maldonado 1971). In the meanwhile, critiques of 'traditional' environmentalist perspectives are voiced:

> Classic environmentalism has bred a peculiar negative political malaise among its adherents. Alerted to fresh horrors almost daily, they research the extent of each new life-threatening situation, rush to protest it, and campaign exhaustively to prevent a future occurrence. It's a valuable service, of course, but imagine a hospital that consists only of an emergency room. No maternity care, no pediatric clinic, no promising therapy: just mangled trauma cases (Devall and Sessions 2004).

Figure 10.1 shows the interpretation of Landscape Ecology, with the first stage being the classical stance (nature in its 'pure' status) and, then, progressing

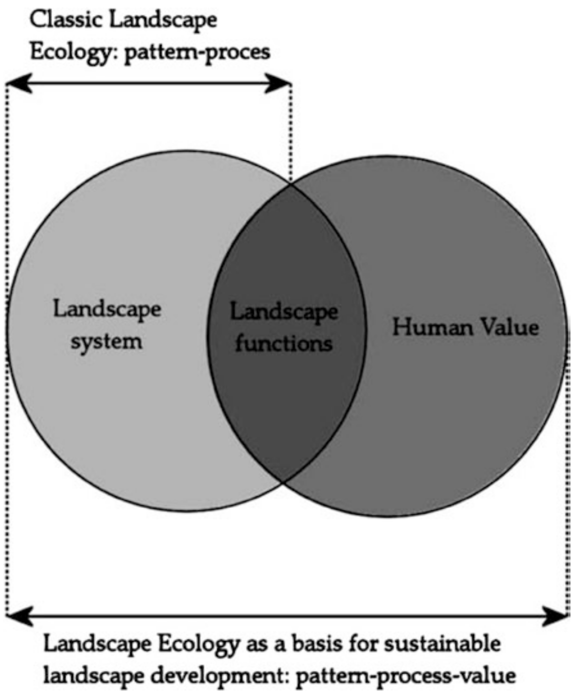

Fig. 10.1 Termorshuizen and Opdam (2009)

according to its evolution along the geographical space in order to include human values in the studies.

> Teresa Pinto Correia has underlined the complexity of the concept of landscape, partly due to its multi-faceted nature. The landscape is a complex and dynamic system, composed of natural and cultural elements, which evolve and Interact over time. Teresa P. Correia has given as an example the division of Portugal into landscape units – evoking the concepts and methodology used in a study promoted by the Department of Biophysical and Landscaping Planning of her University (Correia 2002).

In the quest for a definition of the concept 'space', Malheiros (2009) concludes that the Marxist tradition in Geography regards space as a social product, mainly resulting from the process of interaction between capital and labour.

Santos (1978) had defended that 'space is a real field of forces whose formation is unequal. That is the reason why spatial evolution is not the same everywhere'. And it is in this (more or less) unequal evolution that Landscape Ecology is also present.

The Landscape Ecology has two well-defined schools of thought. The first is the European school, whose main concerns are the built/humanized systems. Besides the German influence, characterized by Geomorphology (highly regarded in Geography), Landscape Architecture and Design Schools have played a major role on the definition of this school.

In the contemporary interpretation of the Brazilian architect Benedito Abbud:

> Landscaping is the only artistic expression in which all five human senses take part. Whereas architecture, painting, sculpture and other plastic arts use and abuse sight, landscaping further involves smell, audition, taste and touch, which enables a rich sensorial experience through diverse and complete perceptions. The more a garden is able to sharpen one's senses, the better it delivers its aim (Abbud 2006).

This view takes a different approach to landscape when compared to the geographical notion. Abbud (2006) ties in the concepts of landscape and place, respectively, introducing an artistic expression (materialized) into the perspective of landscape in Geography, but also a sensorial (perceptive) element, which refers to the concept of place in the geographical field.

The second school is the North American one, which started much earlier, in the 1980s, and focused particularly on the natural and semi-natural systems, such as the study of Natural Parks. Typically, the studies developed by this School took Biology as the reference and started in the Departments of Natural Resources, which favours a more natural than social interpretation, not taking into account the spatial heterogeneity.

However, we cannot just take into consideration the analysis of ecosystems. The landscape is much more than that. According to the European Landscape Convention, held in Florence on 20 October 2000, the landscape is 'a part of the territory, as perceived by people, whose character results from the action and interaction of natural and/or human factors'. The agreement further states:

> Concerned to achieve sustainable development based on a balanced and harmonious relationship between social needs, economic activity and the environment. Noting that the landscape has an important public interest role in the cultural, ecological, environmental and social fields, and constitutes a resource favourable to economic activity and whose

> protection, management and planning can contribute to job creation (European Landscape Convention, transposed to the Portuguese law by the Decree n.4/2005).

According to the Convention examined, the landscape notion incorporates another important concept: the territory. To Suertegaray (2001), the territory is a force field that corresponds to webs or networks of social relations.

Termorshuizen and Opdam (2009) have taken this 'force field' into consideration, as the policy of spatial planning is the basis for local actors to decide on modifications of the landscape in a given space. Therefore, these authors bring a new perspective to the study of landscape ecology, called Abstract Landscape Ecology. In addition, they consider that, due to its complexity, Landscape Ecology is the basis for sustainable landscape development.

Thus, we obtain a multifunctional perspective of landscape due to the incorporation of natural and cultural dimensions, enabling that the embeddedness of geographical space and ecological relations into a specific portion of space (e.g. a territory) becomes the basis for the sustainable development of landscape. Having taken this multifunctionality into consideration, Fig. 10.2 shows how Landscape Ecology could be used, within a qualitative perspective, as a complex instrument for the analysis, evaluation and management of the environment, seeking sustainable development through 'landscape sustainability'. In this context, there is a new method and, also, a new methodology that is underlined in this chapter, involving greater complexity, which includes the notion of geographical identity, seeking 'seizure of consciousness through society and nature' (Devall and Sessions 2004).

The aforementioned term sustainability first appeared in 1980 in a report by the International Union for the Conservation of Nature and Natural Resources (IUCN), World Conservation Strategy. There, this concept was characterized as a strategy for integrating conservation and coherent development in relation to ecosystems, preservation of genetic diversity and the sustainable use of resources. Later the term 'Sustainable Development' was enshrined in the report 'Our Common Future' published in 1987 by the World Commission on Environment and Development, United Nations, led by the then Prime Minister of Norway, Mrs. Gro Harlem Brundtland (Agenda 21 2010).

According to the Dictionary of Human Geography (1998), the term sustainable development was popularized in 1987, when the aforementioned Report by the World Commission on Environment and Development was released. Sustainable development is the growth or progress that meets the needs of the present time, without jeopardizing the ability of the generations that are yet to come. The contemporary concept of sustainable development emphasizes the complex interplay of physical and social dimensions.

In this sense, human action went from a position of 'dominated by Nature' to a position of 'ruler of Nature', due to the high level of scientific and technological knowledge of our civilization, which reduced the biophysical world to a mere reservoir of inexhaustible resources and convertible assets and services for today's consumer society. Unfortunately, this process ended up jeopardizing the survival of man himself, preventing the attainment of a real sustainable development, according to its contemporary definition (Fonseca and Ferreira 2001).

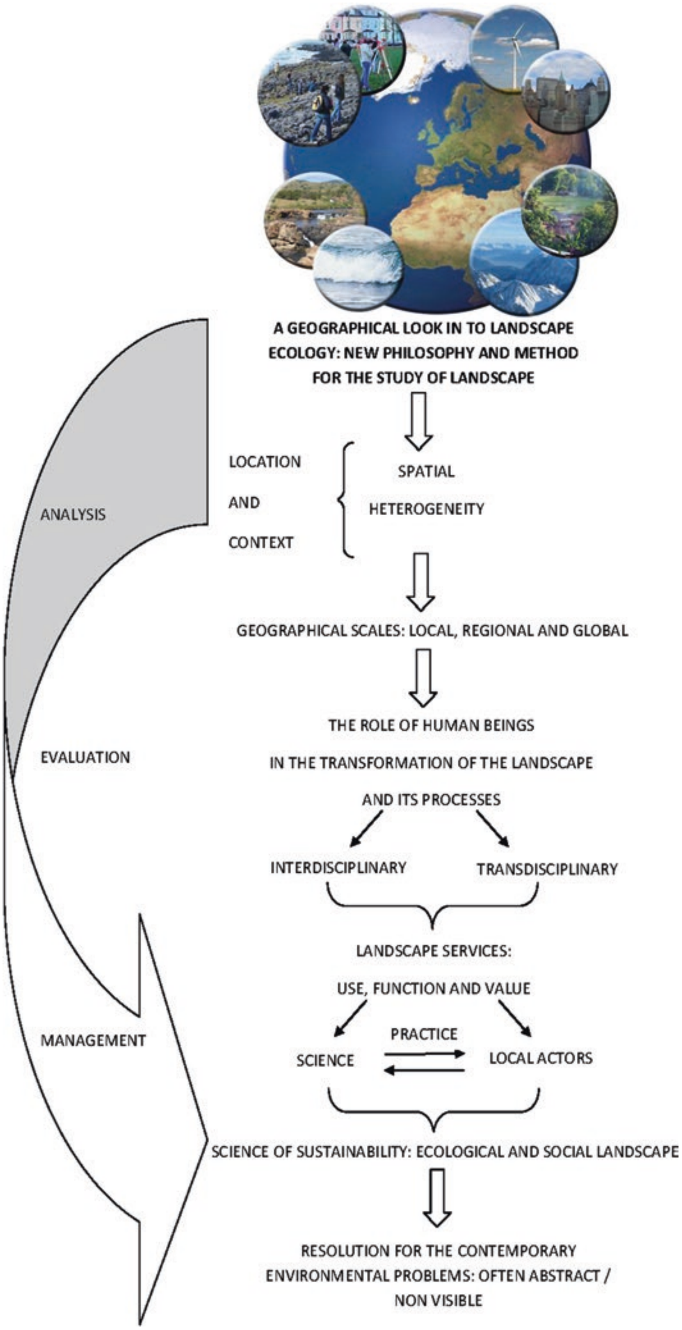

Fig. 10.2 Author's elaboration, 2013

Results

Taking into consideration the goal not achieved for this concept, I propose the schema of Fig. 10.2 for a better analysis, evaluation and management of a given environment which is inserted in a given landscape.

The first level of Fig. 10.2, spatial heterogeneity, targets a multidimensional space, i.e. a geographical area comprising the 'whole': nature, environment, place, territory and finally the materialization of the landscape, as the expression of the entire historical evolution of a given space. According to this analysis, the first level is dependent on location and context.

At the next level, the researcher will have to establish a geographical scale for the study, be it local, regional or global, in order to determine the intentional observation analysis. This level of analysis does not intend to limit the scope of a particular approach or study; on the contrary, the desire is to unite geographical scales, as often, studies or approaches depend on each other, forming a complex spatial process.

> Current Biology does not conceive species as a general framework from which the individual is a unique case. It conceives living species as a singularity that produces singularities […]. The development of ecology in biological sciences shows that single individuals develop and live in the located framework of ecosystems. Therefore, we should not exchange the singular and the local by the universal: on the contrary, we should unite them (Morin 2004).

Following the rational of the scheme, we then find the 'role of humans in transforming the landscape and its processes.' This is an important level of analysis in Landscape Ecology, because it is understood that this approach first appeared with the purpose of interpreting the role of human action in the processes related to landscape. This interpretation may have an interdisciplinary or even transdisciplinary nature, since this methodology and method provide not only the ability to unite several disciplines, but also the capacity to promote transactions between them, somehow ensuring the sense of complex integration that is associated with Landscape Ecology.

The next step of the approach identifies the concept 'landscape services.' In this view, we are again confronted with the multifunctional nature of landscape because these multiple functions involve both human and ecological issues, within the framework of geographical space, thus allowing the sustainable development of the landscape (Termorshuizen and Opdam 2009). According to this perspective, landscapes are human and ecological spatial systems that provide a range of functions that are or will be valued by humans, due to the economic and sociocultural realities and also due to ecological reasons (Chee 2004; Defries 2004; Groot 2006).

> In its logical sense, sustainability is the ability to sustain, to maintain. A sustainable business is one that can be kept forever. In other words: the sustainable exploration of a natural resource will last forever, will never be exhausted. A sustainable society is one that does not put at risk the elements of the environment. Sustainable development is a development that improves the quality of life of man on earth at the same time it respects the production capacity of the ecosystems in which we live (Mikhailova 2004).

In this context, according to the use and value of the landscape (landscape services), it is necessary to have an exchange between the perceptions of local people, based in Cultural Geography,[1] which in turn is supported by Phenomenology, relating these to the scientific practices of the qualitative approach of Landscape Ecology. Thus, the result is a science that involves sustainability, embedding natural and social landscapes in a unique and inseparable unit.

> According to A. de Brum Ferreira, exclusively natural landscapes do not exist anymore, even in inhospitable areas like the Arctic or the Antarctic regions. The human action intervenes at the scale of the global landscape (the Planet's landscape), for example as catalyst of the greenhouse effect, but the Planet, as a global system, has its own mechanisms of re(balance) (Ferreira 2002).

Considering all the levels previously explained, I intend to reach a common goal: the resolution of the contemporary environmental problems, often abstract and invisible. Actually, these issues are mainly of a political and socioeconomic nature because these relations are very often not visible. However, they can be directly or indirectly expressed in the materialization of a given landscape where the researcher can analyse, assess and manage, both qualitatively and quantitatively (even if that is not the goal proposed here) through the instrumentalization of the landscape, interacting with this methodology in a complex and sustainable environment.

To the notion of 'management' that was previously mentioned, the European Landscape Convention (2000) adds another important concept: landscape policy, because

> it designates the formulation by the competent local authorities of general principles, strategies and guiding lines that enable the adoption of specific measures keeping in mind the protection, management and spatial planning of the landscape (European Landscape Convention 2000).

Within this framework, the new methodology and the new method proposed in this paper can be coherently applied in decisions involving public authorities responsible for planning strategies in the domains of spatial planning and environmental sustainability.

To Soromenho-Marques (2001), the features of the landscapes are inseparable from the following processes: system of values, system of knowledge and institutions of the technical-scientific society that bring restlessness to the civilization homeland.

Moreover, it must also be stressed that a significant proportion of the population and ecosystems are directly or indirectly integrated in capitalism through micro or macroeconomic mechanisms of the monetary policies and, above all, through the price of raw materials.

[1] The new cultural approach is more critical. It often focuses on the present situations, the struggles involved and the problems of social justice: it continues somehow to bring the critical realism that originally inspired it. However, the new cultural approach is mainly concerned with the meanings conferred to the cosmos, nature, environment and society (…). The humanist and phenomenological roots of the new orientation are, thus, always active (Claval 2001).

Some Considerations

This methodology and method do not intend to provoke among the field experts the feeling of 'who is right and who is wrong'. Each school has its own conception of landscape, its own problems and language. The proposal presented here aims to respect the scientific identity of each subject trying simultaneously to encompass the present environmental complexity addressed by different sciences. However, being a geographical research proposal, one cannot accept the activation of this issue in an isolated or mechanical way because it is necessary to advance towards the construction of a geographical system of analyses based on hybrid concepts, building 'bridges' with other analytical approaches to the same processes.

> These are the challenges of complexity and, of course, they are everywhere. If we want a segmental knowledge, closed in one single object with the unique goal of manipulating it, we can then eliminate the concern of bringing together, contextualize, globalize. However, if we want a relevant knowledge, we need to gather, contextualize, globalize our information and our knowledge, to search, thus, a complex knowledge (Morin 2010).

The paradigm of complexity proposed by the scholar Edgar Morin mainly establishes a dialogue with (and also between) the knowledge of the Human and Natural Sciences. In this line, the Norwegian philosopher Arne Naess continues the dialogue with such sciences also demonstrating the paradigm of complexity in his research. In 1972, he proposed the term Deep Ecology or Ecosophie.[2]

To Naess (Devall and Sessions 2004), the essence of Deep Ecology is formed by deeper interrogations, that is, it spurs us to ask why and how, when others, mainly those of General Ecology, do not do it. For example, Ecology does not question what kind of society would be better to maintain a certain ecosystem. According to this philosopher, we need an extension of the ecological thought towards what he designates as Deep Ecology or Ecosophie.

The challenge the author also proposes is to question the model of society and the use it gives to its resources in a holistic environmental approach (this reflexion is built not only in school, but pervades all spheres of society). This line of thought underlines questions of social nature which also imbricate in the ecological and environmental relations, namely the interaction between capital and labour and the processes of productive restructuring (basically mechanisms of political–economic order). At present, the social ecology is presented as an increasingly distant reference (Malheiros 2009).

The Ecosophie is 'in fact, a phenomenon as complex as the understanding of the world and it is not easy to keep the balance of the effective participation of three factors—things, ideas and words' (Gonçalves 2001). As previously mentioned, the scientific identities must be respected. However, one should admit the enlargement of the analysis among things, ideas and words searching for complex responses considering the growing diversity of the present questions. Solutions

[2] "Sophie", word of Greek origin meaning wisdom which relates this term with politics, ethics, values, rules and finally the practice.

that establish a dialogue between the various scientific fields are needed. After all, 'there are no borders and everything is related to everything' (Devall and Sessions 2004). Thus, things, ideas, words and 'intentionality pulsate in the world and in the true intentionality of human imagination, this one more stimulated by the forces of reality than the specific capacity of rational beings' (Gonçalves 2001). This is a key challenge to a geography intended to be holistic and polyhedric.

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Chapter 11
Challenges to Landscape Planning and Protection in Poland

Marek Degórski

Abstract In the present-day world the proper management of landscape and its protection is one of the major challenges of civilization. The aim of this paper is to present the legal and procedural contexts determining landscape planning and protection in Poland and to show the challenges facing us in conjunction with these determinants. Particular attention will be given to those determinants of fundamental importance for the functioning of a landscape protection system in terms of both formulating sector policies and structuring Polish space. The polyfunctionality of landscape will also be emphasized as will the interdisciplinary nature of landscape research, which underlies many legislative and utilitarian difficulties in the structuring and protection of the landscape.

Keywords Landscape planning · Landscape protection · Legislative acts · Poland

Introduction

Rapid changes in the geographic space, including both the natural and sociocultural environment, are leaving a more or less lasting trace in the functional and spatial dimension of the landscape. Improved education at society level together with changes in the human perception of reality are resulting in people's increased awareness of the consequences of ongoing changes, such as the future exhaustion of non-renewable raw materials, the effects of environmental pollution, the existence of limits to growth or limitations of the potential for development and, correspondingly, of the possibilities for creating development routes. We are also

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becoming aware of the threat of losing the most naturally valuable fragments of the environment and landscape (natural assets) or the anthropogenic infrastructure (material culture assets) and see the consequence of these losses, i.e. a real possibility of deterioration of the standard of living.

All negative effects of landscape transformations determine preventive and protective actions addressing both nature- and culture-related aspects. Landscape planning and protection now rank among very significant civilization challenges in the contemporary world. The development and defining of the scope of protection has already crossed regional and country borders. International tools that could strengthen efforts to manage, shape and protect landscape are being sought. One of the most important tools of this kind is the European Landscape Convention, adopted on 20 October 2000 in Florence. It was ratified by Poland in 2004 (Journal of Laws, issue 14 of 2006, item 98). The Convention defines the place of landscape in the sociocultural system, stating that 'the landscape is a key element of individual and social well-being and that its protection, management and planning entail rights and responsibilities for everyone', as well as specifying its functions, by stating that 'the landscape contributes to the formation of local cultures and that it is a basic component of the European natural and cultural heritage, contributing to human well-being and consolidation of the European identity'.

Despite the efforts of many individuals and legal persons in developing a framework for landscape management and protection in Poland, these efforts have continued to bring little effect. There appear to be two main reasons behind this. One is the continued lack of unambiguous definitions of the landscape and the other is the lack of legislation serving to comprehensively define the legal determinants of landscape management and protection and the functioning of the landscape.

The aim of this paper is to present the legal and procedural context determining landscape planning and protection in Poland and to show the challenges facing us in conjunction with these determinants. Particular attention will be given to those determinants of fundamental importance for the functioning of a landscape protection system in terms of both formulating sector policies and structuring Polish space. The polyfunctionality of landscape will also be emphasized as will the interdisciplinary nature of landscape research, which underlies many legislative and utilitarian difficulties in the structuring and protection of the landscape.

Ambiguity in Defining and Perceiving Landscape

One cause of problems in the management and protection of the landscape is the considerable freedom of defining the concept of landscape. More than 150 years have passed since A. Humboldt presented a definition of the landscape, but the term is still subject to conceptual and, above all, semantic change. New approaches are created both with regard to the definition of the landscape and to its divisions and typologies (Drdoš 1999; Farina 2000; Ostaszewska 2005;

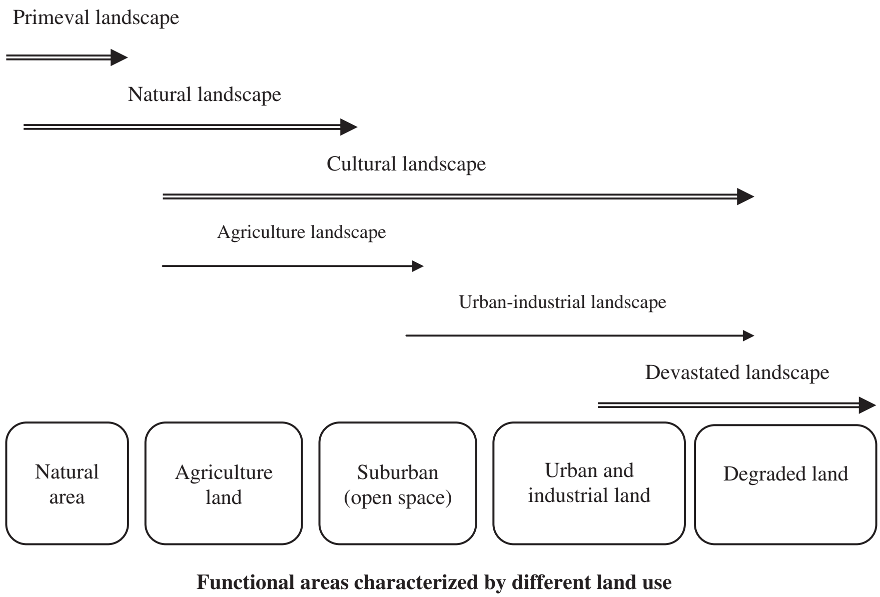

Fig. 11.1 Relationship between types as well as subtypes of landscape and functional areas characterized by different use

Pietrzak 2005; Degórski 2005, 2009; Richling and Solon 2011). Repeated attempts are also made to formulate more precise descriptions of particular categories of the landscape, such as a natural landscape or cultural landscape (Birnbaum and Hughes 2001; Rubinstein 2002; Degórski 2009). Recent years have also generated increased interest in the study of the essence of the landscape, its structure and polyfunctionality (Antrop 1998; Brandt 2000; Neveh 2000; Degórski 2003a, b; Jongman 2003; Richling and Solon 2011; Chmielewski 2012).

The problem with defining landscape actually extends well beyond academic deliberations, concerning as it does not only scholarly definitions, which are actually quite convergent between the disciplines investigating landscape, but, above all, being the product of different perceptions of landscape by those not involved professionally in landscape studies, which, in turn, is partially due to the different approaches in defining landscape by individual sciences.

The geographical sciences emphasize the comprehensiveness of the concept of landscape and interactional links between its components (geomorphology, lithology, hydrosphere, biosphere, paedosphere and atmosphere). Geographers also see humans as a very important element of the landscape and investigate human influence on the self-structuring of landscape and the interaction between the quality of the landscape and human quality of life. Thus, the defining traits of geographic studies of the landscape comprise the existence of two possible research approaches within a holistic analysis of landscape. One approach, according to the theory advanced by Wilson (2002), involves the consilience of knowledge of landscape structure and functioning through integration of a coherent collection of information about individual systems and subsystems. The other, a holistic approach, sees phenomena as forming an all-embracing system and bases its inferences on information about the system as a whole rather than about the regularities applying to its components (Degórski 2014). Within this research context, a landscape can be defined as a hierarchical whole made up of lower order wholes (the natural system and the socio-economic system, and successive subsystems) subject to evolution leading to the formation of a qualitatively new whole (evolution or degradation of landscape). Thus, it may be stated that the dualism, characteristic of geography, whereby landscape is cognized as a whole formed of two subsystems (a natural one and a socio-economic one) and interactions between them emerges as a research approach allowing for a holistic view of the landscape (Degórski 2014). Defining landscape in line with the systemic paradigm may facilitate landscape typology. The degree of anthropogenic transformation of a landscape, construed as the intensity of human impact on the landscape, i.e. the power of influence of the anthropogenic environment system on the natural environment system, makes it possible to divide the set of all landscapes into types that are mutually exclusive and also exhaust the totality of elements of the set of landscapes (Fig. 11.1). An extra benefit from the adoption of this typological convention is the possibility of applying research procedures to any geographic scale, from local to regional and supraregional to global. Degórski (2009), based on mutual relations between the natural and anthropogenic subsystems of the megasystem of geographic environment, proposes the following four categories of landscape:

- Primary landscape, understood as one formed exclusively by processes occurring within the natural environment system. It is either subject to natural evolution where change is continuous or is affected by chaotic and sudden transformations leading to catastrophic changes. All processes impacting on primary landscape are free from the effects of the system's surroundings. The natural environment, which is the substance of the system, is thus only influenced by endogenous processes, activated by the energy of the Earth's interior, and exogenous ones, triggered by the forces of the Universe. The properties of a primary landscape should not be directly, or even indirectly, influenced by the anthropogenic system. However, the latter is present, via global circulation, at least minimally across all landscapes on Earth. Thus, when talking about primary landscape, we should be aware of the presence of, albeit minimal, an indirect effect of the anthropogenic environment system on present-day functioning of the geographic megasystem. Primary landscapes can thus be found only in very spatially limited areas. They can still be identified in high mountain areas or virgin tropical forests.
- Natural landscape is construed as one forming under the prevailing influence of the system of natural environment with a very limited impact of the anthropogenic environment system. This latter impact is most commonly indirect, via the flow of human-produced energy and matter into the natural system. Direct

influence is also possible but its effects should not disrupt the functioning of the natural environment system or its properties. Human influences of this kind include forest stand maintenance, technical procedures serving to preserve vegetation consistent with the habitat potential, etc. Natural landscapes are typically found in non-degraded areas in forests, wetlands, peatland, etc.

- Cultural landscape is understood as one shaped by the effects of phenomena and processes specific both to the system of natural environment and the anthropogenic environment system. The balance of intensity of impact of the two systems determines the degree of anthropic transformation of the landscape, ranging from minor to major human-induced transformation. Optimal conditions for the development of a cultural landscape occur when the impacts of the natural and anthropogenic systems balance each other. Under such conditions, nature's potential can be utilized by man and the landscape can be consciously structured, the goal of which should be the achievement of spatial order as well as sustainable and lasting development. Certainly, the conscious human creation of undertakings is not the only type of event in a cultural landscape as it sometimes develops chaotically as a result of random action or insouciance of man, which often leads to functional disruption in the megasystem of geographic environment. It should also be borne in mind that a cultural landscape is the result of phenomena and processes that have been taking place in the megasystem of the geographic environment since the anthropogenic system appeared on the scene. In other words, it contains the effects of action of one-to-many cultural groups and the superimposition of cultural elements of different ages. Areas with cultural landscape least transformed by man are agricultural areas, while urbanized areas represent those most transformed.
- Degraded landscape is a landscape that has formed as a result of processes and phenomena occurring in the megasystem of geographic environment under the prevailing influence of the anthropogenic environment system, the processes and phenomena having caused a disturbance of the functioning of the natural environment system and, consequently, natural phenomena having limited or no influence on the structuring of the landscape. The restoration of the functional capacities of the landscape requires conscious and directed action from the anthropogenic system within the megasystem of geographic environment, the action aiming to generate landscape-creating processes. Its structure is thus the outcome of human intellectual potential and technical possibilities. While transforming a degraded landscape into a cultural landscape, man should still remember to use solutions compatible with the structure of associations of spatial units characteristic of a given geographic region. Acting in accordance with this principle, we can reach the continuum of cultural landscape. Areas of degraded landscape are exemplified by disused quarry sites.

The complex relations between the natural and anthropogenic environment systems, which shape the spatial structure, in the megasystem of geographic environment contribute to creating an area-specific mosaic of associations of landscape units (geocomplexes, patches-corridors, etc.). This mosaic reflects mutual relations between the systems and indicates the degree of transformation of the landscape from its primary and/or natural character.

Landscape architects approach the landscape differently, emphasizing aesthetic categories of perception. The landscape is viewed as a visualization of the determinants of the entire environmental system, both natural and anthropogenic, i.e. the totality of the human living space, including its structure, functioning and visual aspects. It is landscape architects who have promoted the use of the adjective *scenic* to describe a landscape, which excellently emphasizes the component related to aesthetic perception in the meaning of the term *landscape*. The landscape is beauty and harmony; it is an entity serving to provide the best possible quality of life to man.

From an ecological viewpoint, the landscape is a set of interacting ecosystems occupying a particular space (Andrzejewski 2002). The scientific interest thus revolves around the functioning of the biosphere in the context of demarcating patches and assessing their homogeneity or studying corridors with regard to potentials and the flow of energy and matter. This approach is being increasingly influenced by attempts to describe the landscape in mathematical terms, taking as the starting point analyses of biotic space (mainly vegetation cover) where data are obtained by teledetection and GIS. A problem with this approach is the limited availability of high-resolution maps, which determines analytical precision.

Urban planners present yet another approach to the landscape. For them, the landscape is primarily construed as the spatial ordering of a given area, which is very often done according to a priori criteria. The value of such studies consists chiefly in determining the basics of landscape structuring and landscape identity and aiming to identify principles underlying the existing spatial order.

The identity, canon, tradition and culture of a locality are also the main constituents of the landscape as seen by art historians and culture studies. For these disciplines, the landscape is a spatially diversified presentation of human material culture formed out of a natural foundation (natural environment) and having its roots in historical determinants (archaeological, ethnographic, architectural, etc.). Novák (1997) defined this viewpoint on the landscape as spatially diversified civilizational and cultural human settlements that have formed on natural habitats of this cultural heritage integrated like a nest with the natural environment. To further complement this definition, it is worth quoting Myczkowski (2009), who defines the canon of a locality as a collection of factors together composing the form of the landscape of the locality (interior), determining its expression and possessing a contemporary or documented form perceived by humans. These factors are often historically superimposed and should be used as the basis for establishing the principles of study and action in the realm of protection and structuring of the architectural and landscape form of a given locality or landscape.

Many more examples of how different disciplines perceive landscape might be invoked, but the short descriptions already given show that the same object of study can be perceived differently, the manner of perception being closely associated with the research methodology of a given science. With regard to the landscape, the same semantic category is used but the epistemological rationale of its ontological value is different in individual sciences.

That is why documents of significant importance for landscape conservation strive to develop definitions that would precisely embrace the concept of landscape in a simple manner that would also be as broad as possible. These documents include the European Landscape Convention, which now is of key importance for landscape protection in Europe. The definition of landscape in this document is very broad and linked to the definition by Hettner, who treated the landscape as an expression of relations between objects of the geographic environment (Richling and Solon 2011). The convention stipulates that the landscape is a basic component of the European natural and cultural heritage, contributing to human well-being and consolidation of the European identity, and that the landscape is an important part of the quality of life for people, in degraded areas, in everyday areas as well as in areas of high quality, in urban areas and in the countryside. According to the assumptions of the document's operational objectives, the Convention is supposed to serve as a completely new instrument dedicated exclusively to the protection, management and planning of landscapes in Europe. Of key importance for these actions is international co-operation since the quality and diversity of European landscapes is considered a shared resource and heritage of the inhabitants of our continent.

Lack of Legislative Unequivocality as a Cause of Problems in Landscape Planning

The changing social and economic reality in Poland is the cause of threats to all components of our country's natural and cultural heritage. In the view of Myczkowski (2009), the extent of the problem is tremendous, encompassing all levels of landscape organization, from local to regional to national, and the consequences of these transformations are dangerous, above all, to community-level and national identity due to the wide-spread influx of cosmopolitan content, form and function. This poses a particular threat of destruction to all those elements that form or should form the lasting resource of the national and local landscape. Landscape planning and management in the context of landscape protection, understood as the preservation of the naturally and culturally most valuable elements of this resource, thus become a major priority of the state policy aiming to develop European standards of quality of life for Polish citizens. Increasing support for this social perception is coming from the growing general social awareness, including the perception of a sense of 'good interest' in preserving the authenticity of landscape beauty, the interest to be construed by us as the preservation of landscape potential and polyfunctionality and the maintenance of undisturbed relations between landscape components.

One factor representing a significant obstacle to action in the area of landscape management, development and protection in Poland is the absence of tools in the form of good legislation that would put an end to existing disorderly regulations and pave the way for constructive practical solutions. The absence of one act that would put together all landscape-related legislative provisions often impedes the implementation of practical action in landscape management, including landscape protection. The landscape as the object of protection is present in six acts of the Polish Parliament or equivalent statutes, and the scope of the regulation with regard to protection and planning efforts is not mutually exclusive between the individual acts, with regard to both competences and the substance; worse still, ambiguity in defining the landscape is visible even within one document.

The regulation where the terms *landscape* and *landscape values* are used most frequently is the Nature Conservation Act of 16 April 2004. The term *landscape* appears at the very beginning of the document, with Article 1 stating that the Act stipulates the goals, principles and forms of the conservation of animate and inanimate nature and the landscape. Thus, the landscape is construed here at the same level as nature, even though the immediately following article lists it as one of 'nature's resources, creations and components' subject to protection, and the protection of landscape values is one of the aims of nature conservation. The term landscape can also be found in the definition of the natural environment, which is understood as 'the landscape together with the works of inanimate nature and natural and transformed natural habitats with their plants, animals and mushrooms'. The Act also defines the concept of landscape protection, which shall involve 'the preservation of characteristics of a given landscape'.

The Environmental Protection Law of 27 April 2001 approaches the landscape as a natural element of the environment, similarly to waters, air, plants or animals. The act stipulates the maintenance of natural equilibrium and rational management of environmental resources via, among others, the conservation of landscape values, using for this purpose Studies of Determinants and Directions of Land-Use Planning in Communes and Local Land-Use Plans. The act also contains provisions to regulate the impact of linear projects (transport routes, aerial routes, pipelines and others) on the landscape. There is also a provision stipulating that these actions be conducted in a manner ensuring, among others, the protection of landscape values. Landscape values are also to be taken into account, alongside other elements, during the planning of environmental compensation.

The Act on Spatial Planning and Management of 27 March 2003 refers to the landscape in a provision stating that the assets of contemporary culture include 'urban and landscape planning designs representing recognized output of present-day generations, if they are of high artistic or historical value'. In this way, the Act introduces more terms associated with the landscape, resulting in an extension of the meaning of the term and making more interpretations possible. Present-day landscape planning designs (just like cultural landscape) may also be subject to protection if they can be regarded as 'assets of contemporary culture'. As with the Environmental Protection Law act, the Spatial Planning and Management Act also stipulates that spatial planning and management shall account for, among others, architectural and landscape values. The regulations also apply to planning work. By way of example, it is stated that studies of determinants and directions of land-use planning shall take into account, among others, determinants related to the condition of the environment, including nature and the cultural landscape.

The studies shall also specify the principles and areas of the conservation of nature, cultural landscape and spas. Principles of the conservation of the environment, nature and cultural landscape are also to be obligatorily specified in local land-use plans. Regional land-use plans specify areas of conservation of the environment, nature and cultural landscape, protection of spas and cultural heritage and historical monuments as well as assets of contemporary culture.

Another statute referring to landscape is the amended Historical Monument Protection and Care act of 23 July 2003. Its provisions include the principles for establishing forms of area protection associated with the cultural landscape. The issue of landscape conservation appears to rank high in the so-called hierarchy of public interest in each instance of such action. The relevant competences are presented for individual state authorities, from the President of the Republic of Poland to local government.

In the light of the act, the cultural landscape is a proper and significant object of protection within the system of protection of material culture in Poland.

Protection of Landscape Values Determined by the Implementation of Provisions of International Conventions and European Commission Directives

Apart from relevant Polish statutes concerned with the landscape, we are also obliged to follow international law. Pursuant to Article 91 of the Constitution of the Republic of Poland of 2 April 1997, ratified international conventions are a source of law in Poland and have precedence over statutes. Thus, conventions or other international agreements oblige us to take action to implement their provisions under both national and international law.

Of relevance for environmental protection with consequences for the protection of the landscape, the most important of such documents include several legislative acts, of which particular attention, on account of the object of protection, is due to be paid to the following:

- The Convention on Wetlands of International Importance, especially as Waterfowl Habitat, popularly known as the Ramsar Convention, drafted in Ramsar on 2 February 1971. It entered into force for Poland on 22 March 1978.
- The Convention on the Conservation of Migratory Species of Wild Animals, drafted in Bonn on 23 June 1979, entered into force on 1 May 1996. Importantly, the protection of habitats of certain species, such as bats, is often tied to the conservation of historical objects, old churches, buildings, bunkers and underground systems, which may also be important as part of the cultural heritage and a significant element of the cultural landscape.
- The Convention on the Conservation of European Wildlife and Natural Habitats, drafted in Bern on 19 September 1979, called the Bern Convention. It entered into force for Poland on 1 January 1996. Most of the provisions of the Bern

Convention are implemented by the Natura 2000 network and the Emerald ecological network. The Convention's mission is concerned with the conservation of landscape potential through the protection of habitats, flora and fauna.

- The Convention for the Protection of the Architectural Heritage of Europe, drafted in Granada on 3 October 1985, has not been ratified in Poland.
- The European Convention on the Protection of the Archaeological Heritage, drafted in La Valetta on 16 January 1992, entered into force for Poland in 1996. Its provisions are very important for the protection of cultural values of the landscape. It defines the objects of archaeological heritage as all remains, objects and other traces of mankind from the past epochs that can help retrace the history of mankind and its attitude towards the natural environment.
- The New Convention on the Protection of the Marine Environment of the Baltic Sea Area, drafted in Helsinki on 9 April 1992 and ratified by Poland on 24 June 1999, is an extension of the Convention on the Protection of the Marine Environment of the Baltic Sea Area signed in Helsinki on 22 March 1974 (ratified by Poland on 8 November 1979). Its relation to the protection of landscape value is that the Convention refers to the protection of marine and seaside landscapes.
- The Biodiversity Convention, adopted on 22 May 1992, drafted in Rio de Janeiro on 5 June 1992, ratified in 1996. The implementation of its assumptions contributes significantly to landscape protection and to the renaturalization of degraded landscape fragments.
- The Convention on Environmental Impact Assessment in a Transboundary Context, drafted in Espoo on 25 February 1991, ratified on 12 June 1997. It is linked to landscape protection as it defines planning action in the context of protection of the quality of human life and landscape management undertakings, which contributes to better protection of landscape values in transboundary areas.
- The Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters, signed in Aarhus on 25 June 1998 and ratified on 31 December 2001. Implementation of the provisions of this convention guarantees the public access to information on the state and quality of the environment and landscape and participation in decision-making processes of importance for the protection of the environment and landscape in various spatial scales, from local to regional to national.
- The European Landscape Convention was drafted in Florence on 20 October 2000 and ratified in Poland on 24 June 2004. This document should be seen as the most important one for the conservation of landscape values on our continent. Most importantly, as already stated in the introduction, it defines landscape and establishes the principles of landscape protection, management and planning. The Convention also points to the utilitarian value of the landscape, underlining that it represents a key element of societal well-being, is a resource conducive to business activity and the protection, management and planning of landscape may contribute to the economic development of regions.

The international conventions listed above, as has already been stated, constitute a significant component of the legislative system relevant to broadly construed landscape conservation in Poland. They are all the more important as there are no documents among the European Commission directives that would directly refer to landscape conservation and the implementation of their provisions would be monitored by the European Commission. Binding directives connected with broadly construed landscape conservation comprise only the regulations forming the basis for the establishment of the ecological network of Natura 2000, i.e. Directive 79/409/EC on the conservation of wild birds, adopted on 2 April 1979 and modified by the following directives: 981/854/EC, 85/411/EC, 94/24/EC and the Council Directive 92/43/EC of 21 May 1992 on the conservation of wild habitats and wild fauna and flora. The provisions of these directives are only concerned with selected biotic elements of the environment and, in this context, certainly are a very important element of landscape conservation.

Landscape Management and Conservation Versus Spatial Planning

Landscape conservation has undoubtedly become a civilization-level challenge of the contemporary world. In trying to maintain the standards of human existence on earth, Man must take care to ensure a high quality of the environment and landscape where the natural and material resources will co-exist and the degree of degradation and resource use will be limited to a minimum necessary for sustenance. Spatial policy, and particularly solutions seeking to rationalize and optimize area management, is a tool used for the conservation and structuring of the landscape. Spatial policy has been implemented with various degrees of success for over 100 years. The first legal regulation on landscape conservation and landscape structuring was probably the Dutch urban planning law of 1901. It contained the principles of spatial planning, under which all cities with more than 10,000 inhabitants were required to develop a project (plan) specifying their future character in order to prevent chaotic urban spread. The law made it a requirement to prepare both general plans, subject to updates every 10 years, and detailed ones (Paczuski 2000).

In Poland, regrettably, as already noted in the present paper, existing regulations on spatial planning and landscape conservation are still imperfect. As there is no parliamentary act or an equivalent statute on the landscape to regulate landscape development issues in a comprehensive and coherent manner, spatial planning is missing an act defining a coherent framework of the entire planning system, establishing a hierarchy and competences, and, most importantly, making actual spatial management in Poland possible.

The provisions of the Conception of Spatial Management of Poland until 2030, adopted by the Council of Ministers on 13 December 2011, refer to action for landscape conservation, targeting both the natural and cultural landscape. These regulations clearly indicate that the provisions of the European Landscape Convention should be incorporated in domestic legislation and subsequently implemented in practice.

Landscape conservation has also been meeting with increasing understanding in sectoral policies, leading to the inclusion of relevant provisions in sectoral political and strategic documents. By way of example, The Strategy of Sustainable Development of the Countryside, Agriculture and Fishing for 2012–2020, published in May 2012, discusses landscape conservation in a few items referring to specific planning actions and solutions. Similarly, planning and strategic documents at regional level are devoting an increasing amount of space to issues of spatial order and landscape with regard to both its landscape structuring and conservation.

Recent years have also seen increased attention being directed to the protection of the cultural value of the landscape. Guidelines for the conservation of historical monuments, apart from lists of objects, specify 'conservation zones'. Such zones are formed on the basis of 'The Guidelines for Incorporating the Issues of Protection of Cultural Values in Land-Use Plans' (developed in 1981 by an Expert Group of the Interministerial Commission for the Revaluation of Towns and Old Town Complexes) and include a Zone K, or a landscape protection zone, applying to an area containing a landscape integrally linked to a heritage complex. Zones of art conservation protection together with the other forms of protection (culture heritage, historical heritage, reserves and culture parks) are established on the basis of the Cultural Assets Protection Act of 15 February 1962 and are included in the local legislation known as land-use plans (Żarska 2003).

The issues of rational use of the potential of the natural environment and landscape are thus becoming an increasingly important component of planning documentation at all levels of spatial planning. Local land-use plans are playing a particularly significant role here as they constitute binding local law and are the very basis for decisions that lead, among others, to transformation of the landscape. Inadequate coverage of the territory of Poland by such plans is the basic problem in this regard, with approximately only 26 % of the area covered. Plans for another 8 % of the area are being developed, but even with these, the coverage will only increase to a third of the area of Poland. Even assuming that such plans are not so useful for some forest and agricultural complexes, the rate of implementation of this basic form of planning documentation in Poland leaves very much to be desired, representing a major impediment to work on structuring the landscape and spatial order.

Landscape Valuation

Another obstacle to appropriate development of landscape policies in Poland with regard to landscape planning and conservation is the lack of unambiguous landscape valuation that would unequivocally identify the most naturally and culturally valuable fragments of the landscape. Currently, in view of the ongoing implementation of the provisions of the European Landscape Convention, work has begun on identifying and evaluating Polish landscapes, with a focus on the development of the methodology and main assumptions of the valuation procedure.

With regard to the use of landscape potential for improving the quality of human life and protecting its most important resources, proper identification and valuation of the landscape is important. The identification of landscape resources is also the foundation for developing criteria for their protection, leading eventually to the development of multiyear programmes aiming to rationalize the management of landscape resources and protection of their most valuable elements.

The development of criteria for landscape valuation for the entire territory of Poland is an urgent task that must address the particularities of diversification of both natural and cultural potential between regions (landscape identity), while also accounting for the coherence of the system at national level, where the mutual combinations of the intermingling socio-economic and natural systems generate an open set of co-existing characteristics. Their identification, followed by classification, should be the starting point for further work on the development of principles of landscape development in Poland, the use of landscape resources to aid the socio-economic development of the country and the protection of its most valuable fragments.

Conclusions

The twenty-first century will be a period in the development of civilization characterized by a focus on improving the quality of life of the inhabitants of Earth. This is going to be achieved not only through economic growth of individual countries or regions, but also through qualitative improvement of the living conditions of their citizens, brought about, among others, by optimization of the functioning of the system of the natural environment and landscape. One type of action associated with appropriate use of the natural and cultural resources of the landscape will undoubtedly be the implementation of the principles of landscape planning and development utilizing the best possible knowledge of its potential that will also allow the development of procedures aiming to protect the most valuable landscape resources. This work should involve large numbers of geographers, landscape ecologists, and lawyers who will develop an entire system of specific solutions addressing both legal and technical-operational aspects.

The most important challenges related to the structuring and conservation of the landscape in Poland are the following:

- developing criteria for landscape valuation on a regional and national scale and, based on these criteria, inventorying the potential and defining indications for area-based legal protection of the landscape,
- effecting the promulgation of legislation establishing all functions of the landscape in the ecological-socio-economic system,
- developing a National Strategy for Landscape Structuring and Conservation that would specify the objectives and tasks in the medium term and would constitute a list of evidence-based good landscape management practices.

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Chapter 12
Approaches in Sustainable 'Landscaping'—A Geographical Perspective

Małgorzata Luc

Abstract The review of recent publications in the field of sustainability of a landscape reveals a series of problematic issues within planning, ecological, multifunctional and visual dimensions, which make the results of the research incomparable and inapplicable. The article aims to arrange them in a conceptual framework. It looks from a geographical perspective at the idea of 'landscaping' as a complex system of activities leading to structural, functional and cultural changes towards sustainability. Finally, I try to answer some crucial questions in this field associated with (1) a contradiction of the idea of sustainability, (2) different approaches presenting varying scientific interests and research profiles, discrepancies in ideas and methodology, (3) the understanding of the structure, function and cultural and aesthetic aspects of a subject area, and (4) landscapes evaluation in terms of sustainability in planning and management, as well as their application requirements.

Keywords Landscape sustainability science · Sustainable landscape frameworks

Introduction

The first definition of landscape sustainability is thought to be a comment which appeared under the 'Sustainable Landscapes' communication at the conference *The Council of Educators in Landscape Architecture* in 1988, in Pomona, California. It spoke of landscapes that 'contribute to human wellbeing and at the same time are in harmony with the natural environment. They do not deplete or damage other ecosystems. While human activity will have altered native patterns, a sustainable landscape will work with native conditions in its structure and function. Valuable

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resources—water, nutrients, soil, etc.—and energy will be conserved; diversity of species will be maintained or increased' (*vide* Thayer 1989). The authors quite clearly imply a duality of human actions which, on the one hand, aim to protect valuable aspects of landscape, but on the other support frailer elements of its structure and function. More recently, a number of definitions describing the idea of a sustainable landscape have been forged, and these were reviewed in a recent publication by Wu (2013: 1008), however, 'a generally accepted definition (…) has been lacking'.

The study of sustainable landscape, initially in the realm of *Landscape Ecology*, or *Landscape Science*, has now become a transdisciplinary venture, where scientists cooperate with practitioners 'offering a holistic systems view of the world' (Naveh 2004: 474). This development inspired Wu (2013) to suggest the creation of 'Landscape sustainability science'. This initiative was also taken up in Musacchio's (2013) 'list of key concepts and research priorities for landscape sustainability'. However, Opdam et al. (2013) commented that Wu's (2013) concept of sustainable landscape as an interdisciplinary science was not emphasized enough and criticized the author for favouring strictly environmental issues in his work on sustainability. It is, after all, acknowledged that, in accordance with the Brundtland definition of sustainability (WCED 1987), the main emphasis ought to be on the balance between society and environment. Is the prevalence of one aspect of the sustainability problem in multidimensional interactions within environments, therefore, not itself a contradiction of the idea of sustainability?

It is also worth looking at an application as an important issue within the concept of sustainable landscape which lies within landscape management theory. Usually we describe landscape management in such a way, as to preserve as many of multidimensional landscape aspects as possible, and this in itself assumes practical utility. Moreover, recently there have been new studies pointing out insufficient measures taken to ensure relevance of these theories in practice (Antrop 2007; Musacchio 2013; Opdam et al. 2013). This discipline requires a systematic and holistic approach which seems being unrealistic. Daily et al. (2009); de Groot et al. (2010); Sitas et al. (2013) describe the reasons for this as the failure to embed research within a social process; the lack of effective institutions to govern ecosystem services; challenges associated with integrating ecosystems into landscape planning; scale mismatches. Different approaches among authors, their varying scientific interests and research profiles, yield discrepancies in ideas and methodology that make multiple studies of sustainable landscape less plausible. As Barau and Ludin (2012) assessed, Landscape Science now consists of 14 different disciplines, all of which use this idea for their own purposes which leads to differences in its interpretation Wu (2013).

Maybe a good approach in landscape studies as an interdisciplinary science is, though, applying both theory and action plans. These two general research stages concern: (1) desk work while creating definitions, frames and conceptions of approaches; (2) establishing criteria for sustainability in landscapes partially as a desk, field or laboratory work; and (3) analysis of a case study leading to building models which then should be tested before putting them into application. Such

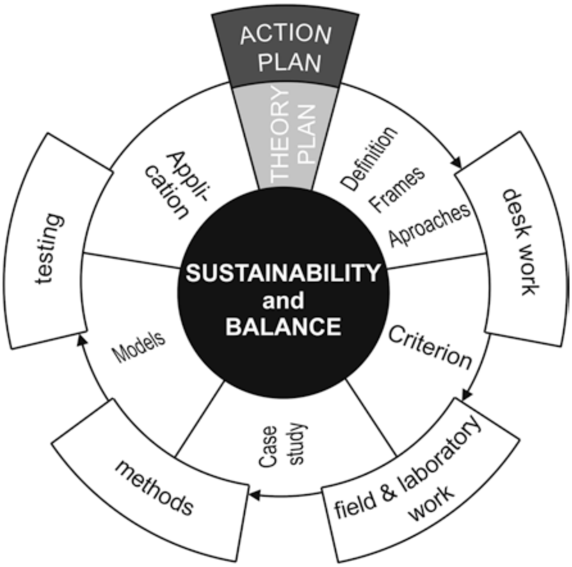

Fig. 12.1 Conceptual framework of transdisciplinary research stages in landscape sustainability theme

a conceptual model, presented on the Fig. 12.1, helps in achieving key research priorities in landscape sustainability as completely as possible in a certain case. It also provides a balance between multidimensional frameworks.

The word 'landscaping', used in the title, refers to different activities in a geographical space that modify the visible features of land and include shape of the terrain, landforms, water bodies, plants, buildings or so-called small architecture. Issues undertaken in sustainable landscape studies lack the complexity required for a complete understanding of the structure, function and cultural aspects of a subject area. Neither do they comprise a base for fully describing and evaluating landscapes in terms of sustainability, planning and management. The principles of analysing sustainability of a landscape should be similar for all disciplines involved and general enough to enable the integration of all results into a holistic vision viable for practical implementation. As poignantly put by Brandt et al. (2013) 'Our scientific ideal is still the hunt for global regularity and design principles, namely rules and concepts which can be applied in our everyday lives.'

This chapter is based on the review of literature from the last decade published mostly by Elsevier, Springer and Taylor & Francis publishers as well as found on Internet. I take part in the discussion about definition and principles of sustainable landscape from the geographical perspective and balance and sustainability in this idea, as described above. It also aims to synthesize a conceptual framework for the simplification of methodology within sustainable landscape research aiming to put results into practice in cooperation with decision- and policymakers. It is, after all, almost impossible to manage an overly complex system, existing in various scales and dimensions, as this condemns many correct and valuable ideas for cooperation to failure, as 'Only disciplines with a strong inclination for interdisciplinarity can play a significant role in resolving the massive human impact on the planet' (Barau and Ludin 2012: 5).

Sustainable Landscape Frameworks

Dimensions lie at the foundation of the theory of sustainable landscape. According to some authors, these include four values: ecological, economic, social and political (Benson and Roe 2000), or environmental, economic, social and cultural (James et al. 2000; Vileniske 2008). Selman (2008) names five components: environment, economics, society, governance and aesthetics; and Musacchio (2009) introduces the '6 E's' of designed landscape sustainability: environment, economics, equity, aesthetics, experience and ethics. Conducting research and work in all of these dimensions together comprise the basis for a sustainable approach to environment. It also provides a holistic view, crucial for sustainability, and favoured by many authors, including Antrop (2006), Barau and Ludin (2012). Publications in this field suggest the existence of three basic frameworks used to study landscapes and in the ecological, multifunctional and visual analysis of these dimensions (Fig. 12.2). However, it transpires that landscape sustainability should be evaluated from the point of view of the dynamics of landscape change and not its condition at the given time (Haines-Young 2000). Landscape dynamics also refers to the evolution of holistically perceived environmental and cultural processes, hence to all frameworks used in the approach to balance in landscapes.

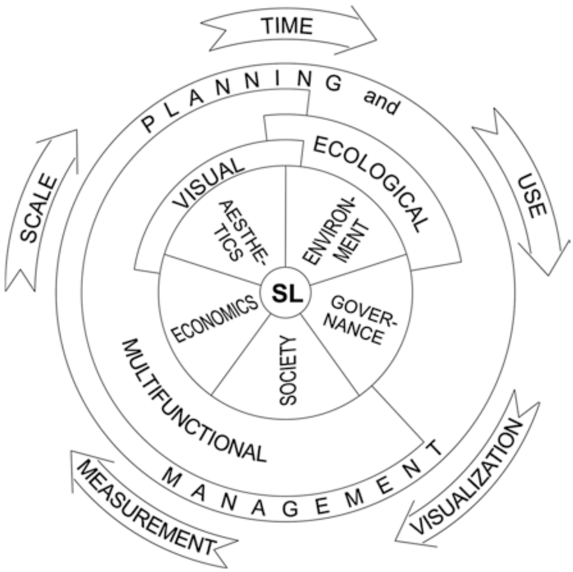

Fig. 12.2 Sustainable landscape dimensions (after Selman 2008), frameworks and problematic groups

Analysis of environmental dynamics should be multidimensional, long term and take into account the evolution of a landscape, which can be the basis for considering it sustainable.

Planning and Management Framework

The dictionary definition of planning is ‘a process of making plans, the establishment of goals, policies, and procedures’; management on the other hand is ‘the whole system of care and treatment of a disease or a sick individual’ (Websters). In a landscape approach planning can involve creating a new cultural landscape but can also mean introducing changes to an already existing structure with unsatisfactory features. In both cases eventually the phase of landscape management is reached, understood as protection and shaping through development, according to James et al. (2000) or Pena et al. (2010). Both terms therefore encompass the same process so for the purposes of the following synthesis planning and management have been treated as one and the same.

In addition to retrodiction planning and management are other examples of dynamic processes. The introduction of changes ought to be a purposeful, pre-planned and balanced process. Balance in landscape can be created by the forces of nature (by renaturalisation) leading to the creation of a renaturalised landscape as well as by purposeful changes brought on by man who transforms the predominance of anthropogenic factors in a highly transformed, degraded landscape into the predominance of natural factors (recultivated landscape). Such landscape is known as recultivated (Luc and Szmańda 2014). In both cases the changes are directional and lead to balancing of environmental, economical and cultural factors. Most commonly this is a prolonged process which at the planning stage engages political institutions and interdisciplinary expert panels and at the implementation stage needs financial input. Sustainable landscapes require either protection or management but ‘when geographers become involved in environmental management issues, the desire to consider both the social and scientific aspects of an issue has been enormously fruitful’ (Haines-Young 2000: 7).

Landscapes should not be treated as sanctuaries or ethnographic museums (Luc 2014), but as areas affected by the challenges brought about by globalization, for the benefit of local populations and with consideration for their environmental value. The needs of local populations can be met by protecting landscapes and creating new ways to improve their quality, bearing in mind the need for sustainability. Protection should be imperative but only under the condition of taking into account ‘human wellbeing’ (Rescia et al. 2010).

Zurlini et al. (2013; see Leitão and Ahern 2002) propose that there ought to be a natural link between landscape ecology and planning; however, there is still much to be done to achieve this. Considering the issue of spatial planning appropriate strategies for ensuring economic growth, as well as protecting and enhancing existing values of the multidimensional landscape are proposed in literature: (1) including appropriate legal information in official documents and programmes (Schmandt et al. 2010); (2) creating multifunctional landscapes with special emphasis on conflict areas (Kato and Ahern 2009); (3) developing greenways (Pena et al. 2010) and green infrastructure (Lovell and Taylor 2013); (4) designing landscapes in line with existing cultural values; and (5) providing direct financial aid (Stobbelaar et al. 2004). Modern challenges are seeking stability through balanced resource management and using smart management methods leading to fulfilling potential and benefiting multiple users.

Ecological Framework

An analysis of literature related to sustainable landscape from the last several years reveals that the most commonly used approach combines form and function. Termorshuizen et al. (2007) propose that appropriate landscape form should assure correct functioning of ecosystems by providing optimal conditions for the survival of a given number of species in the area. Landscape structure determines correct functioning of a geosystem via negative feedback systems. If we were to treat a landscape as an open system, which is constantly subject to change, it should additionally be issued to positive feedback between units involved in homeostasis (i.e., negative feedback loops), understood as natural regulation processes but also as a process regulated by humans, while maintaining maximal energy efficiency within the system (Nohl 2001; Lee et al. 2013). Thus, landscape ecology holds a crucial place in *Landscape sustainability science* because spatial structure and its functioning shape the physiognomy and function of a landscape and hence become the foundation for the sustainability of ecosystem services (Musacchio 2009).

Multifunctional Framework

Multifunctionality, services, and resilience lay at the foundations of sustainable landscapes, according to Selman (2008). 'Multifunctionality' is described as an active role (e.g., biodiversity) and a structure, as well as social benefits such as aesthetics. On the other hand, Mastrangelo et al. (2013) emphasize the lack of an unequivocal, comprehensive definition of multifunctionality and propose 'The capacity of a landscape to simultaneously support multiple benefits to society from its interacting ecosystems'. In this sense multifunctionality refers to the aforementioned multidimensionality of sustainable landscapes. Ling et al. (2007) define multifunctionality as not only a combination of diverse land uses, but also integrated activity within a landscape unit during a period of time. They emphasize the benefits from such an approach versus conventional approaches, i.e., those limited to social, economic or aesthetic dimensions.

Multifunctionality includes multidimensionality, a synthesis of natural and economic environment with an emphasis on the role of the human in all aspects of this complex system. It is seen differently in urban than in rural areas. However, many works reinforce the view that multifunctional landscapes form an integral part of landscape analysis aimed at 'ecosystem services'. In order to try to achieve sustainability in landscapes, functioning services ought to be reinforced and improved, which suggests changes in the spatial structure of ecosystems and land utilization.

Visual Framework

It is common practice to prioritize analysing visual aspects of a landscape in the first instance, including aesthetics and scenery (Benson and Roe 2000; Selman 2008). According to Jorgensen (2011), the two elements are not mutually exclusive, but complement one another, thus expressing different forms of landscape aesthetics. The importance of aesthetics and appearance of landscape in appropriate planning of rural areas in order to enhance their value in terms of biodiversity, cultural heritage and the significance of landscape for the people, 'in order not to compromise towards stereotyping' is emphasized by Haaland et al. (2011, 43), who quote the opinion of Antrop (2006) and Nassauer and Opdam (2008).

It is impossible to overrate the role of landscape aesthetics in social life where it demonstrates understanding of environment and the care taken to preserve it (Jorgensen 2011). Where future generations are concerned, it is imperative for the aesthetic value of a landscape, natural or cultural, to be preserved in the best shape possible, and at the same time to complement and coexist in harmony with new landscape components.

Combined Approach/Universal Framework

Most publications about sustainable landscape commonly describe using at least two research angles simultaneously. Only the exhaustive overview, including the principles of landscape ecology and relationships between society, the environment and economy, provides a complete picture of a landscape (Opdam et al. 2006; Potschin and Haines-Young 2006). Potschin and Haines-Young (2012) expanded the structural-functional approach to the evaluation of sustainable landscape by adding the analysis of local social and economic factors and describe sustainable landscape as that which is capable of supporting the values held by its people for the benefit of current and future generations. Such exhaustive analysis includes the relationships between the environment and society arising from local traditions, individual and group attitudes and social agendas concerning the application of the tasks required to build a sustainable landscape (Ash et al.

2010). Factors taken into account in combined approaches, according to Klett and Cummins (2011), are: landscape functionality, cost efficiency, visual contentment, environmental friendliness and maintenance of areas.

Therefore, if the ulterior goal for researchers in the new discipline, sustainable landscape science, is to conduct a full analysis in an interdisciplinary discussion and use its results in practice, the only solution is to use the combined approach.

Problematic Aspects of a Sustainable Landscape Idea

One of the foundations of landscape sustainability is the pursuit of multidimensionality, interdisciplinarity, and in consequence, applicability (Dramstad and Fjellstad 2013; Musacchio 2013). To start a discussion about the lack of complete criteria necessary for building the aforementioned complex ecological, multifunctional, and visual conceptual models I propose the isolation of five main topical groups which must be included in a holistic approach: (1) spatial scale; (2) time; (3) use; (4) measurement; and (5) visualization. These are consistent and mutually inclusive, so in order to consider landscape sustainability it is imperative to thoroughly study each of them and decide which criteria will suit a given landscape unit. It should be noted that five criteria, though in a narrower range of landscape planning and management, were identified by Forman (1995). However, it seems that the topical groups I suggest have a broader and more methodical meaning combining the approaches of various disciplines within Landscape Science. Among these, none stands out as more or less important from the point of view of these disciplines.

Spatial Scale

It has not been unequivocally determined on which scale landscape sustainability is realistic. However, the smaller the scale, the more difficult planning and spatial management. Concepts associated with the choice of spatial scale in research involving landscape sustainability are therefore currently significant (Kates et al. 2005; Musacchio 2013), and attempts to devise a universal scale are made despite vague criteria for this choice. According to Wilbanks (1994) main issues here are: (1) selected scale assuming sustainability will be analysed from the perspective of discrete geographical areas; (2) functioning systems can be sustainable in only a given scale; (3) scale which fits into existing spatial-administrative frameworks; and (4) actions and processes in one scale relate to their equivalents in another. Le Dû-Blayo (2011) recons scale is associated with the topics of landscape function, with the choice between a multifunctional landscape and a mono-functional one, and the synergy between sustainable development of landscapes in the economic aspect. Therefore, decisions about spatial and time scale in which approaches a problem that have to be considered by local decision makers, because research projects ought to target real needs of the areas involved (Dramstad and Fjellstad 2013).

It seems reasonable to assume, in evaluation, planning and modelling work, a scale relevant to a particular category of landscape type which applies to the landscape on a hierarchical level adequate to the given problem. This would allow studies delivered by different specialists within similar limits to be linked. Ideally, to achieve comparable results, uniform criteria for the delimitation of landscape units in different countries should be agreed.

Timeframe

The context of 'time' may refer to evolution, functioning and planning, as well as to changes occurring in landscapes. Käyhkö and Skånes (2006) propose the use of *The Landscape Change Trajectory Analysis* to improve management strategy for a given area. Vileniske (2008) suggests not only reaching into the past, where cultural values of each valuable landscape have already been acknowledged, but considering a landscape from the perspective of goals and aims associated with it, in the spirit of sustainable development as a future-oriented process. Time is a crucial dimension when determining the level of balance in a landscape, and every instance of planning and management within a landscape, meaning human intervention, creates a need to analyse such a landscape as a dynamic entity (James et al. 2000; Pena et al. 2010). It is worth pointing out that these changes are not always negative, as commonly assumed.

The issue of landscape sustainability ought to be considered within the aspect of process dynamics in time sequences including many generations (Forman 1990; Dramstad and Fjellstad 2013). Realistically, however, we are dependent on data accessibility or funds available to find and transform such data for research purposes. This is why creating universal timeframes seems impossible, although often retrospective studies evaluating landscape sustainability attempt to include the past 200 years, which is historically justified in many areas of the world.

Use

Sustainable landscape is a paradigm of dynamic innovation, characterized by moderate anthropocentrism (in an Anthropocene Era), in which man plays a key role that integrates him with the environment (Janssen 2009). I have attempted to simplify and combine aspects surrounding ecological, social, cultural, planning and political problems into a few generalized topics.

Relations of Man and Environment

Key issues related to the relationship between man and the environment determine resilience and vulnerability (Potschin and Haines-Young 2006). In the past, human intervention was largely associated with restoring degraded areas to their condition before the changes imposed on them. Nowadays, action strategies have to take into account realistic evaluation of existing data and achievable outcomes towards sustainability which have a chance of being accomplished. Many issues are still to be addressed. For example: Can a natural landscape be sustainable in terms of autoregulation? Should natural degradation, (e.g., landslides), be considered as impeding the balance in a landscape? What degree of anthropisation is acceptable before landscape balance is disturbed? How do we consider the advancing processes of fragmentation of natural and cultural areas which lead to instability of landscape functioning? Where does the border, beyond which a landscape becomes degraded due to the waning of homeostasis and homeo-anthropopression lie? To what extent should we take into account social involvement when deciding about making changes? The list of questions to be answered remains open.

Urban Versus Rural Landscapes

As a consequence of overproduction of food and its low profitability, land is abandoned and populations migrate from rural to urban areas hindering the formation of sustainable landscapes (Müller et al. 2008; Pena et al. 2010; Ciolkosz et al. 2011). The cities need new developing architectural and planning solutions focused on a configuration of urban space takes into account protecting traditional physiognomy with the use of energy-conserving materials but lacking the results of observations of functioning processes in urban systems (Nassauer and Opdam 2008). Ahern (2013) suggests strategies for interdisciplinary cooperation between landscape ecologists in the field of urban sustainability and resilience: Biodiversity, build urban ecological networks and manage connectivity, planning and design for multifunctionality, decreasing risk by modular management, and practice adaptive design by application.

On the other hand, sustainable rural landscapes are associated with changes in agricultural produce technologies, the type of buildings used, and new ways of balanced utilization; management of a space; to accept new roles in a traditional landscape, e.g., development in the direction of utilizing renewable energy sources, the spreading of green networks, the maintenance (or return) of sustainable agriculture (Le Dû-Blayo 2011); and multifunctionality or creating meaningful governance. There is also a need to support stronger sustainable use of natural resources—a concept based on correct management and planning, for example through the land consolidation process or multifunctional agriculture (EC 2006; Păsakarnis and Maliene 2010; Haaland et al. 2011).

Ecosystem Services

Landscape as a functioning ecosystem brings benefits to society in the form of: support, provision, regulation and cultural services. It combines market and non-market, use and non-use, tangible and non-tangible interests of many beneficiaries (Wratten et al. 2013). Using ecosystem services or landscape services (Termorshuizen and Opdam 2009), we may define, describe and measure varied roles and processes accompanying significant changes in the character and utilization of land, which are prominent all over the world. They form considerable potential which can be used by landscape researchers to help understand the impact of changes on landscape in practice and with their actions create a balanced, multidimensional system. A comprehensive review of the main problems with ecosystem services, including the presentation of an exhaustive list of 20 research questions which would lead to their inclusion into landscape planning, management and decision-making was presented by de Groot et al. (2010) and Müller et al. (2010).

Sustainable Landscape Measurement

In Landscape Science, evaluation uses both indicators and indices. There are a number of publications showing possible applications. They present both weaknesses (Kupfer et al. 2012) and analytic possibilities they create (Bottero 2011), and develop methods using them. Landscape metrics are used in analysis, prognosis and synthesis of planning (Leitão et al. 2002) to characterize landscapes for the purpose of comparative measurements and to deliver information about the relationship between structure and function of landscapes, as well as to provide spatial models of ecological processes including occurring changes (EPA 1995). The drawbacks of currently used indicators limit their application in evaluation of landscape sustainability and in tracking changes: (1) the use of standard statistical data instead of individually gathered data; (2) excessive aggregation of partial indicators; (3) the lack of relationship between indicators and the landscape scale; (4) lack of analysis of the links between indicator values; (5) subjectivity of choice and interpretation of indicators; and (6) assuming a false model of relationships between indicator values (Solon 2004). Due to the significance of these indicators in evaluating sustainable landscapes, these problems ought to be thoroughly looked at during area analysis.

Visualization

Visualization is 'any communication that uses visual structures to represent objects, concepts and relationships' and its results should form attractive and perceptual presentations of a given problem within sustainable landscape science for each potential receiver and make visioning, public input, decision-making and communication more powerful and attractive. It is used for the purpose of planning and design as well as modelling of processes and creating scenarios of potential changes in the future and under different management regimes (Käyhkö and Skånes 2006). This technique, supported by GIS tools, allows the formation of a nearly unlimited number of real-time simulations which opens up many possibilities on the level of creating a holistic perception of the landscape and various scenarios of sustainable landscape (Sheppard et al. 2008; Ramos 2010; Pettit et al. 2011). The issues surrounding sustainable landscape are, after all, aimed at an audience capable of putting the results of analysis into action and visualization is used to improve communication between potential decision makers or target users of proposed changes.

Conclusions

Presented publications have introduced studies tackling the problems described here as well as proposals for novel research into development of sustainable landscape. Many of them discussed interdisciplinarity of sustainable landscape research and at the same time showed the prevalence of one aspect (or framework) of the sustainability problem in multidimensional interactions within environments. It is a contradiction of the idea of sustainability. The philosophy of sustainable landscape is based on establishing the correct place for man in the environment for ourselves as well as for future generations. However, this involves integrated actions of representatives of all the Landscape Sciences in order to create common criteria for complex (ecological, multifunctional and visual) models, in various spatial and time scales, according to the need for their application in planning and management. A list of key criteria for sustainable landscape analysis (different for various types of landscapes) should promptly be formed, similar to the *Guiding Principles of a Sustainable Site* (SSI 2009). These criteria ought to be categorized according to the basic frameworks, then screened for completeness on case studies in different scales, and finally tested for similar landscapes and put forward to the appropriate institutions for application (Fig. 12.1). Only uniform, multilayer, interdisciplinary actions stand a chance of creating sustainable and balanced systems. I am aware of how difficult this is to implement, but the proposed direction of action is the only chance to clarify the rules which may in the future translate in the form of transformed landscapes. It appears that currently many authors contemplate the questions ‘Are we progressing in the right direction? Do we need a greater focus on communication to achieve sustainable landscape development?’ (Dramstad and Fjellstad 2011). No one, however, has any doubts that we need ‘Reinforcement of the cooperation with all organizations and bodies, as well as with all members, researchers or practitioners that deal with and manage European landscapes, on multiple scales’ (Antrop et al. 2013).

Furthermore, I agree with Bell and Apostol (2008) who write that sustainable landscapes should be formed with respect for the balance between human intervention and natural evolution. It should be subject to planning and management, not just uncritical replication. Change should categorically happen, but only when one of the five dimensions has been disturbed (Fig. 12.2). On the basis of the current broad discussion about this topic a few of the most important, summarizing facts should be distinguished:

1. landscape as an open system depicting the processes ongoing in the environment, therefore adaptation processes should be accepted as determining landscape features;
2. adaptation processes (Ahern 2013) involving positive feedback systems, which maintain system stability, should be based on modules/geo-complexes (Wu 2013) functioning via negative feedback systems—autoregulation, which should become the main feature of the sustainable functioning of a sustainable landscape, while the structure of the environment should be optimally varied as overcomplicating elements of the system lead to its destabilization;
3. the presence of man in the environment must be considered crucial in a sustainable landscape, and his role should be used to facilitate the maintenance of optimal environmental, social and economic conditions for his habitation, therefore, landscape sustainability ought to be treated separately from the degree of anthropopression.

Summarizing, only such scientific approaches to sustainable landscape are right in which the concept of landscape as the depiction of actions striving to achieve the idea of sustainable development is maintained. In other words, there will be sustainability in a sustainable landscape. The approaches are to be implemented cautiously, harmoniously and with a high level of visual aesthetics, as transpiring from the structure and culture of a given environment, thus guaranteeing the stability of continuing environmental, social and economic processes within a socially accepted space resulting from civilizational development.

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Chapter 13
The Landscape Plans System as a Tool for Sustainable Development in Ukraine

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Abstract On the way to sustainable development, Ukraine faces a number of social, economic and environmental challenges. The proper response to them is largely associated with overcoming the problems of spatial planning and management. In this context what is significant is the development of new approaches that take into account the modern European experience and aim to provide system recommendations effective on different levels of territorial organization of society. A number of effective methodological tools for ecologically based organization of territory are provided by landscape planning, aimed at conservation of landscape and biological diversity, ensuring the sustainable use of natural resources based on the principles of sustainable development. This approach is developed most deeply and consistently in Germany. There landscape planning is carried out on four territorial and administrative levels as a hierarchical system of landscape plans—documents that consist of a number of inventory and evaluation maps, maps of conflicts and goals and explanatory texts. Implementation of the methodological experience of landscape planning in the case of Ukraine is a very difficult but interesting problem related to the improvement and optimization of landscape planning methodology for the conditions of Ukraine, in particular involving developments in such areas as landscape science, territorial planning, environmental management and sustainable development, landscape planning integration into the system of territorial plans at various levels and Ukrainian legislation, etc. The process of landscape planning is based on sequentially solving a number of goals: The definition of framework objectives of landscape planning, cataloguing and assessment of data, detection and estimation of conflicts, development of the concept of environmental goals and measures, approval, implementation and monitoring. These tasks are elaborated on three levels of planning (landscape programme, framework landscape plan and landscape plan) using the example of Cherkasy region of Ukraine.

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Introduction

In the twenty-first century, in the conditions of globalization and numerous risks, it is almost impossible to imagine a complete and balanced development of a country without an effective system of spatial planning. Many countries, however, have to overcome significant deficiencies and obstacles along the way. Ukraine, which faces not only the complexities of socioeconomic factors and acute environmental problems, but also poor management and planning, is one of them. Gaps in the question can be explained by inadequate consideration of scientific developments, and weak representation of the environmental component, and lack of comprehensiveness, approach transparency, and, eventually, unexpressed dialogue with the local population, which 'consumes' all the consequences of the weak administration. Ukraine has still not approved the strategy or concept of sustainable development, projects of which have been repeatedly presented by scientists and public to the legislature. The significant impact of Soviet stereotypes in the field of spatial planning should also not be forgotten.

Obviously, to overcome the aforementioned gaps new approaches are required which, being suitable for Ukraine, would take into account the modern European methodology, provide systematic guidelines and their feasibility at various levels—especially at the local one.

Landscape (environmentally oriented) planning seems to be one of these approaches, to implement which a pilot project based on the example of one of its regions was launched in Ukraine.[1] With the goal of achieving balance in environmental and economic activities and improving quality of life in the region, the project was planned to follow a number of consultations regarding methodological and practical aspects of landscape planning in Germany, as well as development of planning documents for three levels (region, district, village council) and its implementation in the activities of corresponding administrations. Today we can speak about the successful completion of this work and its outcomes as implemented in Ukraine, which will be presented further in this publication.

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[1] The project was implemented under the support of German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety with means of the Advisory Assistance Programme for Environmental Protection in the Countries of Central and Eastern Europe, the Caucasus and Central Asia. It was supervised by the Federal Agency for Nature Conservation (Bundesamt für Naturschutz, BfN) and the Federal Environment Agency (Umweltbundesamt, UBA). The partner in Ukraine was the Institute of Geography of the National Academy of Sciences of Ukraine. The scientific advisers are Prof. Dr. S. Heiland and A. May (Berlin Technical University), Prof. A. Hoppenshtedt ("Planning Bureau Hahe + Hoppenshtedt"), Prof. K. Schmidt (Technical University Dresden), Prof. Yu. Semenov (Institute of Geography, Siberian Branch of the Russian Academy of Sciences, Irkutsk).

The Problems of the Degradation of Natural Systems in Ukraine and the Ways of Solving Them Toward Sustainable Development

In today's world, the issues of the interaction of society and nature are the most urgent problems among those faced by humanity. Within the territory of Ukraine, they are particularly acute. The country represents a unique region in the world by the degree of human impact on natural systems, simultaneous a large-scale environmental impact on many anthropogenic factors, which led to significant degradation of natural ecosystems, worsening of the ecological situation and the population's living conditions.

This situation in Ukraine is brought about by many external as well as internal causes. They are the specifics of the country's natural resources potential and historical features of the approach to their development, as well as causes of a political, economic and other nature.

It should be noted that Ukraine has considerable and diverse natural resources potential (NRP). Among them, such components as mineral, land and recreational resources stand out. In the recent past within Ukraine's territory, particularly mineral and land resources were actively used, which made a huge impact on the country's economic potential and its natural systems' present state. This led to the excessive tillage and agricultural development of the country's territory, and large-scale concentration of nature intensive heavy industrial production in some Ukraine regions, causing a particularly negative impact on the environment.

Due to some historically formed features of natural resources management, the potential of almost all natural systems in Ukraine was significantly undermined. Thus, the natural steppe ecosystem virtually disappeared from the territory of Ukraine as a result of intensive agricultural development (formerly the steppe biome occupied about 40 % of the state's territory). The area of wetlands decreased as a result of drainage, and was subjected to degradation under the impact of human and industrial activities. The majority of the forest ecosystems are artificial. Conservation of ecosystems has been threatened by the consequences of irrational agricultural practices, unsustainable economic activities and illegal use of biota within water resources basins, and violations of activity limitations within coastal protected areas and water protection zones.

The main factors of the negative impact of human activity on the natural systems in the process of natural resources management at the time of Ukraine's independence were as follows:

- High level of anthropogenic impact on the territory and environment pollution.
- Deformed economic structure with an excessive share falling on the nature intensive industries.
- Uneven territorial distribution of production.

- General (including innovative, technological and structural) lag and lack of the national economy's competitiveness, negative trends in Ukraine's specialization within the global economy.
- Shortage, uneven distribution within the territory and inefficient use of certain types of natural resources.

The factor which had a particularly negative impact which should be mentioned was the Chernobyl accident and its consequences.

As a result, in the first half of the 1990s since the beginning of Ukraine's formation as an independent state, the national economy remained one of the most nature intensive in the world and the country's territory was under strong anthropogenic impact. All environment components were subjected to degradation and destruction as a result of simultaneous influence of resource-intensive industry, extensive agriculture, transportation, construction, utilities and population. However, the huge-scale exploitation of the natural resources potential did not become the foundation of the country's economic prosperity. The country developed a kind of stalemate situation, in which an extremely inefficient resource-intensive economy in tycoons' hands led to environmental degradation, which in turn became an obstacle to economic and social development.

The process of the country's economic reform and its integration into the globalized world economy, which began during a deep system crisis, increased the severity of old problems and led to the emergence of a number of new economic, ecological and social problems, which in their turn led to the degradation of natural systems.

For a long time, the production of each GDP unit within general conditions of anthropogenic pressure reduction caused by the economic crisis was accompanied by certain increased levels of air, surface and groundwater pollution, and by certain increase in the energy consumption. At the same time, Ukraine's share of arable land in the land resources structure was the second in the world and the first in Europe.

Despite a slight decrease in certain production, nature intensity parameters (in 2011 the water consumption level of GDP was 48 % of 1990 levels, and the amount of harmful emissions into the atmosphere, per unit of GDP, similarly, was 64 % of 1990 levels) and the overall nature intensity of the Ukrainian economy remains very high. Particularly, the energy consumption intensity of GDP in Ukraine is 2.6 times above the world average.

The total anthropogenic and environmental impact is several times higher than that in developed countries.

About 15 % of Ukraine's territory with a population of over 10 million people is in a critical condition.

Land resources are exposed to various types of erosion. The index of arable land in Ukraine is 5 times higher than the global average, but the efficiency of land use is extremely low. Contamination of soil by residues of pesticides, various chemicals and radionuclides is considerable.

Historically formed features of the country's land use contain a significant threat to national security due to highly inefficient use of agricultural production potential, a deformed and irrational land resources structure, and their degradation, primarily degradation of the agricultural land.

In terms of forest cover, Ukraine stands at about half of the worldwide and European average. The country's forests play a vital role in maintaining the natural balance within the country, performing primarily ecological and social functions. Today there could be seen a growing trend in felling volumes.

The level of water resources provision in Ukraine is much lower than the world and European ones. The indicator of water resources per capita in Ukraine is almost seven times below the worldwide level, and 30 times below the level in the Russian Federation. As regards, the level of internal freshwater resources reserves per capita in Europe; only Moldova has an indicator below that of Ukraine.

Among some other factors causing problems with use of water, the process of urbanization should also be mentioned which causes shortage of water resources necessary to meet the needs of residents and many sectors of the economy, primarily in large cities in Ukraine, especially those located far from major rivers and which have little opportunity or unrealized potential for groundwater water. This is the problem of providing the required quantity of the adequate quality water resources.

Another set of problems is linked to peculiarities of spatial distribution and use of water resources by different sectors of the Ukraine national economy. It should be noted that, despite the insufficient level of water supply, Ukraine is characterized by high levels of production water intensity (Ukraine GDP water intensity index is 2.83 times above the world average), primarily due to the peculiarities of its industry structure and overall low technological level.

Today Ukraine, which occupies less than 6 % of Europe's territory, contains at least 35 % of its biodiversity and thus has a great potential in the areas of preservation and restoration. That is why Ukraine can be considered as one of the most powerful reserves to restore biodiversity across Europe.

Most of the country has undergone anthropogenic impact, and therefore the current state of the landscape is unsatisfactory. As a result, living conditions of the population have worsened. Landscapes where the natural state still exists (at least approximately) represent a small fraction of the country's territory. That is why Ukraine pays great attention to the conservation of biological and landscape diversity, and to the creation of the national ecological network of natural protected areas.

By 2015, according to the Law of Ukraine 'On the State Programme of the National Ecological Network in Ukraine in 2000–2015', it is planned to increase the share of protected land to 10.4 % (of which the area of national parks is 3.9 %, nature reserves 0.7 %, and biosphere reserves 0.5 %).

Issues of interaction between society and nature, as well as degradation of natural systems within Ukraine's territory have a high degree of urgency, a long history and a large number of objective and subjective internal and external causes.

Without their solution, further progress towards a sustainable (balanced) development model is impossible. To provide for such a development, it is necessary to introduce new principles and approaches to the environmental management organization in the country, along with reconstruction of the national economy which should be based on optimization of the country's natural resources use, socioeconomic, cultural and historical potential, optimization of the directions and scale of natural resources management in the country as a whole and its individual regions. When choosing the priority direction of natural resources management in some regions, the preference should be given to those which provide the most balanced result of resources utilization, and demonstrate the optimal ratio of achieved economic and social results with the lowest possible level of damage done to nature.

Achievement of that requires improvement of the long-term plans for economic, social and environmental development of the country and its regions, particularly through the active implementation of the landscape planning tools into the spatial planning practice.

The Concept of Landscape Planning in Germany and Ukraine

Landscape Planning (LP) is an important instrument in European spatial planning, which greatly ensures the implementation of sustainable development principles into appropriate policies. The need for landscape policies for successful regional development was emphasized in the Guidelines for Sustainable Spatial Development of the European continent, which is formulated as 'the integration of the landscapes development issues into spatial planning and sectoral programmes' (Guiding Principles for Sustainable Spatial Development of the European Continent 2000), and 'implementation of integrated policies aimed at simultaneous landscape protection, management and planning'. Within the European Landscape Convention, the term is defined as 'long-term planning, aimed at landscape enhancement, restoration and formation'.

In Germany during the LP, landscape is viewed in the broad sense, considering natural and territorial conditions, anthropogenic use and different views of the landscape as well as the idea of values associated with them. As sectoral environmental protection planning, LP is regulated by the Federal Law on Nature Protection and land conservation laws. Its mission is to guarantee protection, maintenance, development and restoration of nature and landscape, contributing to the achievement of environmental protection objectives. Such objectives are long-term conservation of biodiversity; habitat productivity and performance, which include regenerative abilities and opportunities for sustainable use of natural resources; diversity, originality and beauty as well as the recreational value of nature and landscape. In essence, LP is land use planning in terms of environmental protection, which may contribute to environmentally non-depleting (accompanied by minimal environmental pollution) economic territory development. It also makes a contribution to the overall environmental spatial planning (urban, regional), to other sectoral plans; for example, transport or water, agriculture and forestry (Rudenko et al. 2014). LP in Germany is implemented on four territorial and administrative levels as a hierarchical system of landscape plans (documents which consist of inventory and evaluation maps, maps of conflicts and goals, explanatory texts) on the federal lands level (landscape programme, scale 1:100,000–1:300,000), regional (landscape framework plan, scale 1:50,000–1,100,000), at the community level (landscape plan, scale 1:5000–1:50,000) and part of the community (landscaping plan, 1:500–1:2000).

The main objective of the landscape programme, which is the upper hierarchical level of landscape planning, is allocation of core functional areas of the territory use along with presentation of the overall objectives of the development use and definition of requirements for the nature protection and landscape maintenance; it is a framework for development of the lower level plans.

The Framework Landscape Plan contains medium-scale characteristics of natural resources potential, nature conservation and the real territory use tasks, recommendations for ecologically justified environmental management and development goals of the planned territory (Antipov et al. 2002). FLP presents nature conservation and landscape maintenance requirements at the regional level and specifies, thus, target propositions listed in the landscape programme.

Using the landscape plan, a community receives information regarding nature protection requirements when using its territory. In content it is ‘a set of maps and texts which are similar to a Framework Landscape Plan by components, but is designed to reconcile the challenges of nature conservation and land use by specific business entities with the low administrative level authorities’. Therefore, the development of specific environmental goals and measures for their implementation based on detailed studies of the area is planned. Also a plan of greening is developed for part of the territory, as needed; for example, when there is a construction site development plan.

Thus, implementation of landscape planning is carried out through the landscape plans at various levels. Assessment, planning provisions and objectives at all levels of landscape plans do not contradict each other, but complement each other, by the principle of ‘contradictions accounting’. At the same time, the Framework recommendations (offers from ‘above’) are not only guidelines for more detailed instructions on the lower levels of landscape planning, but they themselves are being formed by propositions ‘from below’.

In Ukraine, the concept of landscape planning is in its formation stage; however, it is not about the birth of a fundamentally new type of development. The desired result is achieved faster by improvement, optimization and integration of methodology which has been formed within such directions as landscape science, territorial planning, environmental management and sustainable development. In addition, while developing specific recommendations for a particular place and time interval, the pragmatic function of geography and its complexity, aimed at harmonizing society-nature relationships, significantly enhances.

In the draft of the Law of Ukraine ‘On Landscapes’, it is referred to as activities aimed at landscape improvement, restoration and shaping to ensure their conservation and steady (sustainable) use and optimization of society–nature relationships within specific areas, which is reflected in the city development planning documentation.

The main sets of issues, which needed attention and were taken into consideration during the project implementation and the concept development are the following:

1. The concept of landscape. In Ukraine, until recently landscape was interpreted as a natural complex, the definition of cultural landscape and the perceptive view of it is being integrated into scientific discourse only in recent years.
2. Objectives and functions of landscape plans. Traditionally, Soviet and post-Soviet territorial plans had an environmental (natural) part. At the same time, it was and still remains poorly integrated into conclusions regarding economic activity and is perceived primarily as a list of restrictions, instead of a search for the best options.
3. Advanced application of expertise and broad interdisciplinary collaboration.
4. Research of landscape planning legislative supports potential within the environmental legislation and legislation in the field of spatial planning and regional development.
5. Development of cooperation with the public in the landscape plans development.

The extensive range of landscape plans, data detailization, degree of the generalization of results, and, accordingly, specification of objectives and measures, which depend on the local government, have been considered according to the German approach, which, in its turn meets the concept of national spatial planning. In Ukraine they are oblasts (regions), districts and territories of local government (village and town councils).

Thus, the following assumptions have been laid into the foundation of LP introduction in Ukraine:

- Integration of European (German) methodological fundamentals with the methods and approaches of national schools;
- Original methodology (considering works from Germany and Russia) with careful consideration of the spatial specifics;
- Collection and interpretation of various data (limited by quality and access) considering the importance of expert opinion, balanced combination of mapping and textual parts of the developments;
- Orientation towards the interested governmental and public bodies with corresponding agreement on achieving the development objectives and overcoming the identified conflicts;
- High practical significance of the results directed at solving specific problems caused by the national legislation development.

Thus, the LP is seen as a tool which opens up the opportunities of spatial specifics considerations, developing of specific recommendations for management and planning, creating a platform for cooperation with public and other interested parties and, like nothing else, fosters sustainable development of the territories.

Landscape Planning Methodology

The key issues of methodological provision for landscape planning are as follows: The object of research in the planning; sequence of landscape planning tasks; development system and results of implementation into practical activities.

Recipients of the landscape planning are a number of administrative bodies which exercise their powers within the administrative unit at the regional, district or community level. Therefore, the scope of landscape work and planning is defined by administrative boundaries. However, the focus is on the landscape, which in landscape planning is considered in a broad sense; its interpretation depends on the type of assessment. Landscape planning deals not only with the natural and territorial terms but also with the territory use by people, taking into account the different views of the landscape (Heiland and May 2009), according to the provisions of the European Landscape Convention of the Council of Europe. Article 1A of the Convention defines landscape as ‘a territory whose original nature is recognized by people and is the result of the action and interaction of natural factors and/or human activity’ (European Landscape Convention 2000). The first part of this definition highlights the importance of understanding the landscape through human perception influenced by both individual and social factors; landscape in this context can be understood as an ‘object of perception’. The second part highlights the physical and spatial dimension of landscapes, which is determined by natural factors and human activities.

Landscape planning is carried out by sequential execution of several stages. Each stage is focused on specific tasks, whose solution relies on the use of appropriate methods. The integrity of all landscape planning stages is provided through the use of geographic information systems as a tool for the creation of an output data database, landscapes analysis and assessment, interpretation and visualization of the results. The main stages of landscape planning are as follows:

1. Definition of landscape planning framework objectives.

The basis for their formulation—clarification of socioeconomic and environmental issues in a certain area and generalization of community expectations on the development of their territory. The main methods—total area spatial analysis to determine the institutional, social, economic, natural and environmental conditions of a particular area’s development. Aims and objectives of landscape planning are determined by the results of the preliminary analysis of the area during the discussion with the participation of managers, researchers and the public.

2. Inventory and data assessment stage.

Task of the stage—collection and systematization of data on the studied area’s natural and socioeconomic conditions and target analysis of this information. It is necessary to collect information on all nature components: Air quality and climate conditions, surface and ground water, the soil cover, flora and fauna, landscapes; along with the current land use and socioeconomic characteristics of the area.

Such data is obtained by processing many different types of sources: Archive, mapping, literature, statistics and remote sensing data. It should be emphasized that general information about all components of the environment and use of its resources is contained in the National Atlas of Ukraine (2007).

Evaluation in landscape planning is used (Auhagen et al. 2002; Riedel and Lange 2002; von Haaren 2004) first to determine the importance of spatial differentiation of landscape features; and second, to identify the areas most vulnerable to the negative impacts of human activities. Accordingly, two evaluation categories are used—the significance and sensitivity. Sensitivity is generally regarded as the intensity and speed of the natural component's reaction to certain impacts (chemical pollution, soil ploughing, carrying out recreational activities, etc.), the elasticity with respect to its return to the initial state (the state in which the natural component was prior to activity or before anthropogenic impact intensification) (von Haaren 2004). The category 'significance' refers to the degree the natural component's condition corresponds to its standard state due to the necessity of optimal implementation of a certain objective usage function to each individual nature component (e.g., the importance of soil for growing grain or other crops depending on natural fertility of soils) (Rukovodstvo po landshaftnomu planirovaniyu 2001).

The significance of the same area is usually different for different landscape functions (Heiland and May 2009). Important criteria for determining significance are such component characteristics as productivity, diversity, rarity, uniqueness, historical significance and aesthetic appeal. Evaluation criteria should meet the following requirements: Orientation towards the framework intended for area use; correspondence to the current state of the environment; presentation of possible changes in the natural components during implementation of the main use directions of the territory and the acceptable level of such use (Rukovodstvo po landshaftnomu planirovaniyu 2001).

To determine the significance and sensitivity of the landscape, a wide range of methods developed in geomorphology, soil science, geobotanics, climatology, hydrology, landscape ecology and landscape science, geochemistry and landscape geophysics are being used.

3. Identification and assessment of nature management conflicts.

To determine the environmental protection objectives, existing and potential conflicts should be identified which depend on either inability of the environment to satisfy human needs, leading to the degradation of landscapes, or competition among individual users. The base for conflict identification is the results of the inventory and assessment stages. Comparison and analysis of data on the sensitivity and importance of landscapes as well as the contemporary and future state of nature in the investigated area are being carried out.

4. Development of the environmental protection goals and measures concept.

The goals of landscape planning are guidelines that indicate the optimal and most desired state of landscapes developed with the purpose to overcome and prevent conflicts. The framework for the development goals is set at the beginning of work. The formulation of objectives itself is based on the results of the evaluation and the landscape importance and sensitivity to existing and planned types of economic activity.

There are several approaches to the formulation of goals (von Haaren 2004). In our work, they are given from the point of view of action content—*support, conservation, rehabilitation and development of the landscape.* Formulation of the purposes by the meaning of actions and corresponding presentation in the legends of the target map enables experts, officials or citizens to focus clearly on the proposed areas of activity to ensure ecologically sustainable environmental management.

Branch objectives and the integrated concept of objectives are to be developed. Branch objectives outline the main areas of sustainable use of natural benefits: Surface and ground water, climate, air, soil, flora and fauna, as well as landscapes as a medium for recreation activities. The integrated concept is based on a combination of objectives (integration) and comparison of the industrial purposes—use of certain landscape components. In the target concept the objectives of the nature and landscape protection, care and development should be developed and presented on the map.

The integrated concept of goals aims to:

- Select the territories recommended for natural environment and socioeconomic development protection;
- Identify areas with the most acute environmental problems, where special measures for their rehabilitation have to be offered and implemented;
- Clarify directions of the development of territories, specify the basic structures of this development.

With the help of measures, goals are operationalized, that is interpreted by listing specific actions needed to achieve objectives. In landscape planning types of actions and measures are formulated based on the intended use and development of the area (Fig. 13.1). Localization of actions and measures is carried out based on the integrated map of appropriate level purposes.

5. Adoption, implementation and monitoring.

This stage consists of a series of steps aimed at practical implementation of landscape plans, tracking results of their implementation and timely adjustments.

A practical study of landscape planning as a tool for sustainable development in Ukraine was carried out based on the example of the Cherkasy region. In order to maximize the results' representativeness and following the methodological guidelines and requirements for landscape planning, the work was carried out at three levels: Cherkasy region—landscape programme; Kaniv district—landscape framework plan; Stepanetska village council—landscape plan.

Common for the three levels of landscape planning in the Cherkasy region was the content of the work as part of the inventory phase. Understanding the importance of the output data for further research, this stage was given particular

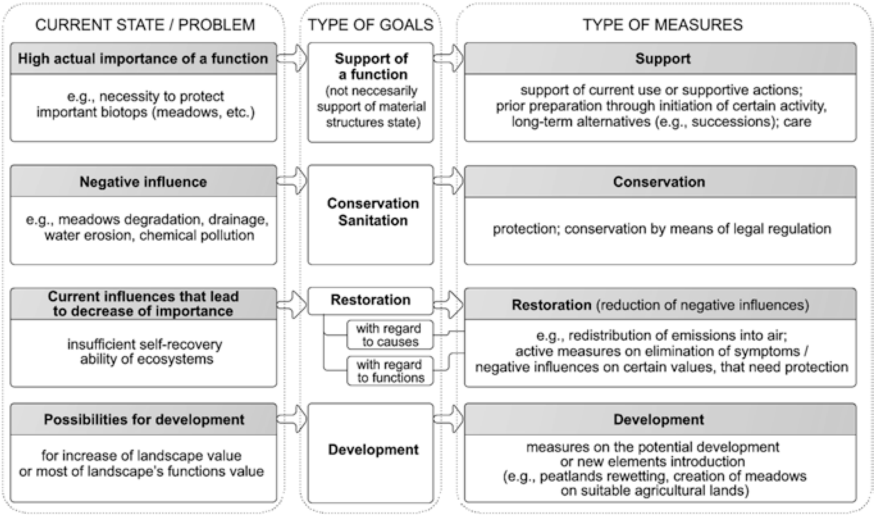

Fig. 13.1 Decision making for the purposes of support, care, sanitation and development of landscapes (von Haaren 2004)

attention. At each level of landscape planning, with detail according to the scale of works, the data was collected on the following:

- Characteristics and structure of natural resources potential, land use structure, pollutant emissions, waste disposal, hazardous objects and so on. These data are the basis for the determination of anthropogenic pressures on landscapes, determining conflicts between the environment and human activities, finding ways to optimize the structure of agricultural properties, expansion of protected areas and other measures;
- Climatic conditions: Solar radiation; circulation of the atmosphere; atmospheric pressure, wind direction, air and soil temperature, precipitation, atmospheric phenomena, the local climate (mesoclimate) and mesoclimatic zoning;
- Surface and ground waters: The reserves of underground and surface waters, depth of underground waters, relative levels of water-bearing horizons and their characteristics (distribution, power, chemical composition, etc.), quality of surface waters, amounts of water consumption;
- distribution of flora and fauna species; main biotopes types; concentration areas of rare plant and animal species listed as endangered;
- Soil: Distribution of soils and soil components, physicochemical properties of soil (grain size, cations exchange capacity, humus content, pH, permeability), areas with the presence of processes unfavourable for business (salinization, waterlogging, washed away soil); radioactive contamination as a result of the Chernobyl accident;
- Landscapes–preserved in their natural state and modern ones; territorial localization and characterization of cultural and historical heritage.

The main result of the inventory stage of work at each level was a geoinformation system of the region, district and village councils, in which the above indicators were coordinated and systematized (basic scale—1:200,000, 1:50,000, 1:10,000, respectively). Organization of geospatial data in GIS format greatly simplified the process of area analysis and assessment, as well as the visualization of results. Cartographic materials are accompanied by texts of the relevant characteristics of nature and society.

However, the content of all other phases of landscape planning largely differed at each level of landscape plan development. This was caused not only by different detailization of the output data, but also by features of natural and socioeconomic conditions of a particular area. This led to the formulation of various framework planning purposes, implementation of corresponding landscape assessment types and, consequently, adjustment of environmental protection objectives. Below we present the features of the landscape planning work content and the results of the landscape programme development for Cherkasy Oblast, the Framework landscape Plan of Kaniv district and landscape plan of Stepanetska village council.

Framework Conditions of Landscape Planning in Ukrainian Regions

In assessing the framework conditions, for work with LP, a few stages should be highlighted. The first is the legislative level, the second set parameters of institutional cooperation with ministries and regional administrations and the third the realities of Ukraine socioeconomic development.

It should be noted that today in Ukraine, an extensive list of legislative acts has been developed in the area of environmental protection and conservation as well as territorial development planning. The effort to bring national legislation in line with European and international standards is important. Particularly, the special role played by the adoption of the Ukraine Law ‘On Fundamentals (strategy) of the Ukraine State Environmental Policy to the year 2020’ and the Cabinet of Ministers decrees ‘On the National Action Plan on Environmental Protection to the year 2015’ aimed at its implementation. The measures identified in the action plan created a wide field of possibilities for the LP implementation but, unfortunately, much of it remains unfulfilled. The similar situation also exists with territorial planning. In 2001 the Law ‘On the General Scheme of Ukraine Territory Planning’ was adopted, and in 2011 the Law of Ukraine ‘On Urban Development Regulation’ came into force which determines the levels and content of the planning work. But even at the beginning of 2013, the overall share of the territories provided with up-to-date planning schemes is as follows: For regions—48 %; for districts—12 %; general plans for regional centres, cities of Kyiv, Sevastopol and Simferopol—85 %; for cities of regional (national) scale—62 %; towns of district scale—42 %; townships—21 %; villages—1 %. Thus in addition to the greening plans problems, the problem of their absence for many areas is also acute.

A significant negative point is that there is no law which defines the levels, the context of LP, its executors, or the relationship with other types of planning.

A complex issue remains the interaction with state and local government. First of all, because of the lack of understanding by their representatives of the essence of sustainable development, the practical mechanism of planning recommendation implementation for various sectors, and the priority of the short-term benefits. The most effective is cooperation at the local level.

Meanwhile, Ukraine, with its unbalanced structure of nature management, rapid deterioration of the nature components' natural properties, socioeconomic disproportions and low living standards and environmental awareness, as well as the reluctance to respond to global challenges requires very efficient and environmentally friendly planning solutions.

As has already been mentioned, the Cherkasy region in Ukraine was selected as a model region for work on the LP. The following three levels of work have been performed within it: Landscape programme (region territory, 1:200,000), framework landscape plan (Kaniv district territory, 1:50,000) and landscape plan (Stepanetska village council territory, 1:10,000). The area of the region is 20.9 thousand km^2 (3.46 % of the country's territory), the population as of 2013 is 1267.3 thousand. Like other Ukraine's territories, the region is experiencing the consequences of acute social and economic crisis and deterioration of state and quality of the environment.

The Cherkasy region is an agro-industrial region where natural ecosystems are still preserved, including forests, wetlands and steppe areas which are not part of a nature reserve fund or which have only regional significance. There are areas classified as international facilities (Ramsar Convention), and old-protected areas (Kaniv Nature Reserve). The area of the nature reserve fund has been legally expanded in recent years, which at the moment is the source of numerous conflicts with local communities and village councils. Historical and cultural heritages represented by archaeological sites (including settlements relating to Trypillia culture), architectural features, historical monuments and sacred buildings are also significant.

At the same time, there is a high degree of anthropogenic pressure (ploughing, emissions, waste), which should be reduced in order to protect the ecosystem and population health, and provide for effective economic development. The potential danger lies not only in the high degree of depreciation of enterprises' fixed assets or the functioning of individual objects. The structure of agricultural land use is irrational, with the continuing increase in soil depleting crop areas; there are multiple examples of unauthorized construction within river floodplains, where there is a high probability of the construction of new large industrial facilities. In the structure of the region's natural resources potential, there is no balance in the availability of certain types of components, primarily, in the ratio of such components: 'land—water'; 'mineral resources—water'; 'agricultural use of land resources—forest resources'. So far in the region, no such nature management guidelines have been formed as the priority use and conservation of the valuable agricultural land potential; development and expanded use of the recreational resources potential, resources of tourism development; preservation and expansion of forest areas.

There are also chances of the occurrence of adverse environmental processes such as water and wind erosion and flooding, and climate change consequences. The latter threat due to its virtual ephemeral character for such a homogeneous and stable climate region of central Ukraine is absolutely real in its relation to the key features of the territory. The problems of water availability in certain areas, intensification of droughts and tornadoes, degradation of wetlands, changes in species composition in the areas of natural reserve fund, emergence of alien flora species—this is only a basic list of potential consequences.

Based on this situation, the main directions of the work on landscape planning and criteria why the region was selected as a model one are the following:

- The need to reduce anthropogenic pressure on the region (ploughing and inefficient land use, the impact of industrial facilities);
- Preservation of natural ecosystems and developing of a network of landscape and biodiversity protected areas (prerequisites defined by law);
- Preservation of historical and cultural heritage (primarily within the existing historical and cultural reserves);
- Effective use of the recreational activities potential;
- Resolving a number of conflicts in land use;
- Upgrade of the region's territorial planning schemes;
- Integral objective is to solve the problem of optimal balance between environmental and economic activity, raise efficiency of recreational potential use and comprehensive (sustainable) territory development.

LP in the region should be focused on the specification of the environmental objectives and principles of the region's territorial development, depending on the specifics of the environmental conditions and prevailing economic and social features of the development, as well as on development of proposals to seek balance of interests among various natural resources users. Therefore, the key theme is landscape and biodiversity conservation, development of cultural landscapes and sustainable development, climate change accounting and its consequences. In particular, among the main priorities within the Cherkasy region landscape programme the following were identified:

1. Justification of proposals for preservation and use of the protected areas fund.
2. Preservation of biodiversity.
3. Preservation of historical and cultural heritage, including valuable cultural landscapes, as well as identification of landscapes according to the European Landscape Convention.
4. Eco-friendly land use.
5. Use of the recreational potential.
6. Balance of interests between different land users.
7. Harmonization of environmental, economic and social interests (sustainable development).
8. Prerequisites for consideration of the landscape plan recommendations for different territorial and sectoral plans.

Landscape Programme

Creation of the Cherkasy region landscape programme began with the analysis of the studied region's socioeconomic characteristics, which is important for defining the general directions and possibilities of its development. The foundation of the analysis is data on the industry and agriculture structure, transport infrastructure, international trade, demographics, labour market, and social infrastructure development level. It is stated that the Cherkasy region is affected by acute social and economic crisis, while deterioration in the environment state and quality can be observed. Therefore, the framework objectives of the landscape programme in the Cherkasy region has been defined: Reduction in the excessive anthropogenic pressure on the region's landscape; conservation of natural ecosystems and development of a protected areas network, conservation of landscape and biodiversity, cultural heritage; increase in recreational potential efficiency. One of the primary landscape planning goals was to prepare proposals for improvement of the region's spatial planning scheme (This item still has not been fully realized because the mechanism for the integration of planning documents is not developed).

While evaluating the sensitivity and importance of natural benefits in the landscape programme, the main attention was paid to those types of assessments that meet the framework goals of landscape planning: Development of agriculture, recreation and tourism, optimization of water supply and consumption and protection of biological and landscape diversity (Table 13.1). The logic behind the choice of

Table 13.1 Assessment of sensitivity and ecological importance of components in the landscape programme of the Cherkasy region

Sensitivity	Ecological importance
Climate and air	
Air sensitivity to chemical contamination	Climate importance for human habitation
	Climate importance for recreation
	Climate importance for agriculture
	Climate importance for solar and wind energy
Groundwater and surface waters	
Groundwater sensitivity to chemical contamination	Groundwater importance for water supply
	Water resources availability
	Surface waters quality
Flora, fauna, biotopes	
Biotopes sensitivity to anthropogenic and natural impacts	Importance of the component 'species and biotopes'
Soils	
Soils sensitivity to chemical contamination	Soils' natural fertility (importance for crop)
Soils sensitivity to water erosion	
Soils sensitivity to wind erosion	
Landscapes	
	Landscapes importance for tourism and recreation

the necessary area assessment type can be illustrated by the following example: Based on the production structure (predominance of agriculture) and employment data (high unemployment), one of the landscape programme framework objectives is the development of the recreational potential in the region as an alternative to traditional industries; respectively, landscape attractiveness for tourism and recreational activities has been estimated.

The basis for defining the conflicts between existing and planned human activities and landscape functioning was the data on today's land use and materials of the region's territorial planning schemes. In the Cherkasy region, there are a number of nature management problems and conflicts whose solution is vital for ensuring sustainable development of the region. The main problem of the Cherkasy region is excessive land ploughing and its intensive use for arable land. In addition, violation in rotation, unjustified use of fertilizers, etc., can be often seen, which leads to landscape degradation due to water and wind erosion over large areas. There are problems at the national level and scale in the region: radioactive contamination from the Chernobyl accident, ecological state of water resources, especially the Dnieper River floodplains and surrounding areas, as well as ageing of manufacturing assets and infrastructure.

The most essential potential conflict at the national level in the region is associated with the plans to build several blocks of the new nuclear power plant, whose a possible location area is in Chyhyryn district. This project contradicts the objective needs of the region's development. Chances to implement its huge potential to increase agricultural production contradict its development directions, which are based on the use of considerable natural and recreational resources potential.

A conflicts map, which takes into account two main categories, existing and potential conflicts, has been developed within the landscape programme. This made it possible to take into account the existing regional nature management conflicts and problems, and highlight the areas with their highest intensity display in the present and the future.

The integrated concept of objectives based on the results of the Cherkasy region territory assessment and analysis of existing and potential conflicts associated with nature management has become the main resulting document of the landscape programme. Development of the sector objectives which outline the main areas of sustainable natural resources use: Surface and ground waters, climate, air, soil, plants and animals, and landscapes, preceded the map's final creation. At the final stage of landscape planning, sector objectives are integrated in the resulting map 'Integrated concept of objectives'.

The main directions of prospective nature management in the Cherkasy region, consistent with sustainable development principles, are presented in the map 'Integrated concept of objectives', along with the selected functional areas with priority objectives for future actions regarding landscapes: Conservation, development or improvement (Fig. 13.2). It should be emphasized that any type of goals for a relatively large area within the landscape programme with the scale 1:200,000 should be considered as a priority recommendation for the area, which does not exclude other uses (types of goals) for smaller areas. Practice shows the

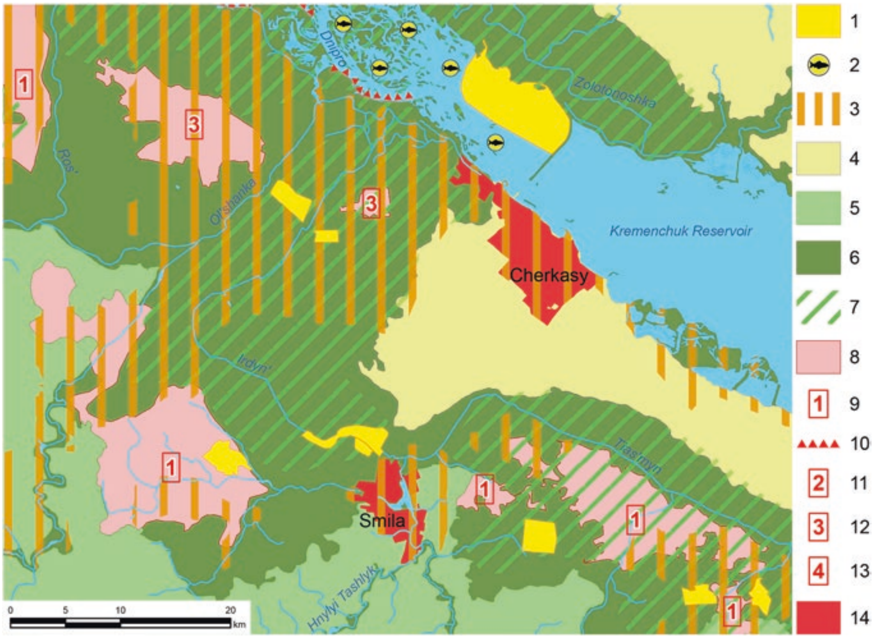

Fig. 13.2 Integrated concept of objectives (Cherkasy region, fragment). Legend: *1* Nature conservation. Ensuring and monitoring of existing protected areas status. *2* Spawning fish. *3* Natural and cultural heritage protection. *4* Sustainable agriculture. *5* Sustainable land use with a focus on ecosystem services which need protection. *6* Sustainable land use with a focus on tourism and ecological networks; special attention: *7* Areas of the concentration of rare species of plants and animals, in future—the core of the ecological network; particular mode of nature use and regulated tourism. *8* Remediation of negative impacts on the landscape to improve ecosystems. *9* Water erosion. *10* erosion of riverbanks. *11* Wind erosion. *12* The consequences of radioactive contamination of soils, highly sensitive to chemical pollution. *13* Permanent flooding. *14* Remediation of negative impacts on the landscape to improve the population living conditions

types of landscape planning in the landscape objectives of the programme are not always clearly separated from each other. However, fundamental differences between them should be known, as these differences play an important role in determining priorities for connected purposes at future levels of planning.

Framework Landscape Plan

Kaniv district occupies a unique place not only in the Cherkasy region, but also in the whole of Ukraine, due to the concentration of a large number of natural, historical and cultural monuments within a relatively small area. Here there are all kinds of typical field landscape and unique natural features available, such as Kaniv glacial-tectonical deployment. A number of natural reserve fund objects have been created for their protection the main one of which is the Kaniv Nature Reserve. Numerous monuments of cultural heritage are spread throughout the district: Taras Shevchenko Historical and Cultural Reserve, Trypillya culture sites, etc. At the same time, there are a number of problems associated with environment deterioration, land use conflicts, and relationship harmonization between society and nature in general. Accordingly, as FLP frame design goals, including landscape programme recommendations, the following is determined: Conservation of natural ecosystems and cultural landscapes; reorganization of the conservation fund; development of ecologically oriented recreational activities; sustainable use of territory in agriculture.

Natural conditions of the territory and negative impacts experienced by the landscape area were analyzed in more detail within the Kaniv region framework landscape plan. As already noted, the basic scale of the landscape framework development plan is 1:50,000. A data inventory has been carried out based on indicators, similar to the landscape programme; they are summarized and organized in a geographic information system.

Given the framework landscape planning aims, landscape assessment was directed at obtaining the basis for developing recommendations for landscape and biodiversity conservation as well as reforming the network of environmental fund facilities associated with them; development of recreational activities; and improvement of the farmland structure to prevent destructive processes. Therefore, the following estimate materials are presented within the Kaniv district framework landscape plan:

- The importance of landscapes for the formation of local climatic conditions;
- Sensitivity of landscapes to climate change, which can have negative consequences for both the human and natural environment (increased risk of forest fires, extended dry season, the deterioration of biota living conditions in small ponds and shallow water, etc.);
- Sensitivity of groundwater and soil contamination with heavy metals and pesticides;
- The ability of the landscape to retain moisture and evaluation of the flood probability;
- The importance of soils by their natural fertility;
- Soil susceptibility to water and wind erosion;
- The level of biodiversity, habitats conditions and specific biotypes development potential;
- The value of landscapes for science, education, and regional identity formation;
- Tourist and recreational potential of landscapes.

At the district level, the impact of a poor socioeconomic situation in the perception and the dynamics of nature manifests itself especially intensively. Low wages and unemployment lead to the formation of an attitude to environmental issues as 'secondary'. A positive factor is readiness to run recreational and tourist activity, and its standardization, which can be used to correlate environmental and economic interests. Typical of the Cherkasy Region is a conflict caused by agricultural land use: ploughing of soils susceptible to erosion. There are certain risks associated with the operation of obsolete infrastructure objects—pipelines and power lines. A potential source of conflict has become the extension of the Kaniv Nature Reserve borders, caused by inability to understand the issue by the residents of some communities.

The concept map of the landscape framework plan objectives and measures is developed to do the following:

- Select the areas recommended for natural environment protection and further socioeconomic development of the area;
- Identify areas with the most acute environmental problems, where it is necessary to adopt special measures for their rehabilitation and to offer such activities;
- Clarify territory development directions; specify the basic structures of this development.

These three basic components of the concept maps, as a result of their integration, make it possible to divide the environmental and socioeconomic problems on the territorial level, assigning its territory to address each of them, and further developing a plan of action to optimize the activity in each of these zones. This division is performed based on comparison of purposes using certain natural components—habitats, soils, surface and ground waters, landscapes and climate. Relevant sector objectives maps were developed within the Kaniv district framework landscape plan.

Thus, within the Kaniv district landscape framework plan, the goals offered at the highest hierarchical level of landscape planning—the Cherkasy region landscape programme—have been specified. Development of goals and measures for certain areas are based on a detailed review and analysis of water importance and sensitivity, climate, air, soil, plants and animals and landscape indicators. For each of these components, certain sectoral targets and measures integrated in the resulting map «Integrated concept of objectives and measures» are designed.

According to the developed 'Concept of objectives and measures', Kaniv district management activities regarding sustainable development of the area should focus on the following objectives (Fig. 13.3):

1. The main advantage and feature of Kaniv district—the presence of unique natural and cultural landscapes (Kaniv 'mountains', the floodplain of the Dnieper and Ros rivers) which have high significance in terms of environmental protection and cultural heritage. For such landscapes, some current state protection and preservation goals, support of the proper functioning of nature conservation objects, which are created for landscape and biodiversity protection, are recommended. Forest plantations are also the subject of preservation.
2. The decisive economic development factor for Kaniv district is its fertile soil which covers the right and the left bank plains. Depending on the natural characteristics of these soils, mainly the degree of their sensitivity to activation of

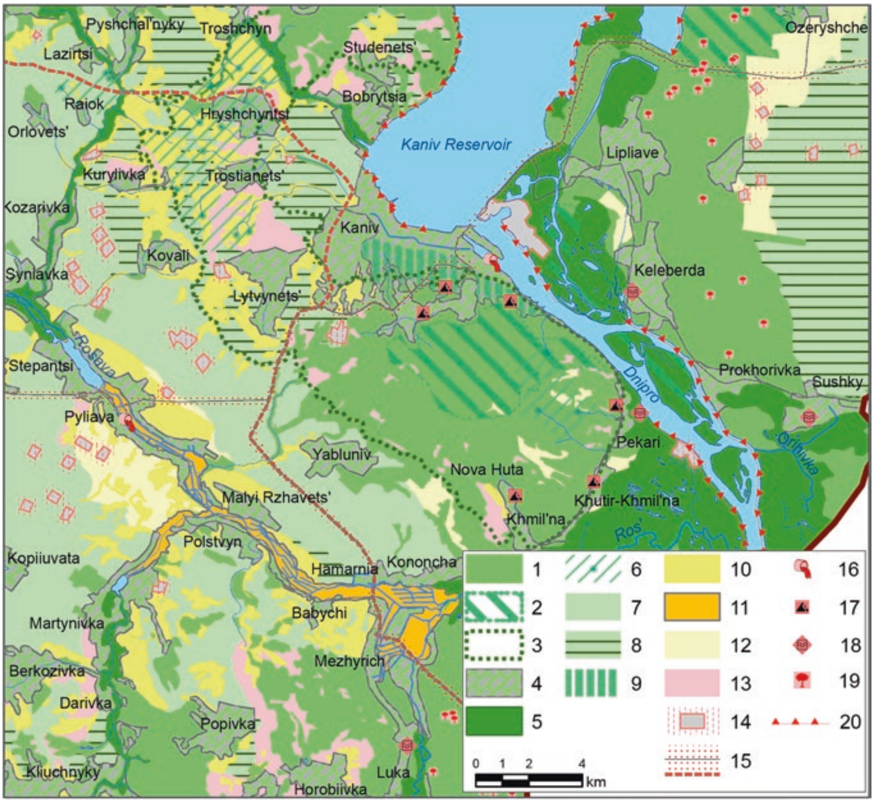

Fig. 13.3 Integrated concept of objectives in the Framework Landscape Plan of Kaniv district (fragment) (Rudenko et al. 2014). Legend (objectives of conservation, development or improvement of Kaniv district landscapes): *1–3* Conservation and protection of landscapes with a high level of landscape diversity and biodiversity as well as areas with rare species (*1* biotopes of forests and dry meadows; *2* nature conservation territories and objects; *3* landscapes of Kaniv dislocations). *4* Conservation and support of high level of biodiversity and quality of landscapes (scenery) in urban and rural settlements. *5–6* Conservation of natural state of floodplains (*5* meadow and marsh landscapes of floodplains; *6* springs and areas of their concentration). *7* Maintenance of intensive arable farming on very fertile soils. *8* Maintenance of farming on fertile soils with special attention to conservation to forest belts and forest plantations. *9* Conservation and protection of Kaniv's cultural heritage. *10* Development of landscapes with low level of biodiversity. *11* Development of reclaimed floodplain landscapes. *12* Development and restoration of natural biotopes on agricultural lands. *13* Improvement and reclamation of eroded soils. *14–16* Improvement of state of landscapes with high technogenic influence (*14* zones of highways' influence; *15* zones of industrial objects' influence; *16* zones of waste discharge). *17–20* Overcoming of negative consequences and prevention of conflicts, caused by destructive natural and anthropogenic processes (*17* landslides, *18* impounding; *19* places of final harvest, tree felling, forest fires; *20* abrasion of the Kaniv Reservoir's banks)

negative erosion processes, the following goals are proposed—preservation of modern heavy farmland exploitation using a number of mandatory supportive measures, or development of innovative methods of sensitive soils management or even a ban on the use of the most endangered lands.

3. Based on landscape planning work for developed areas in the villages and town of Kaniv, it is necessary to maintain a high level of biodiversity, caused by a large number of plantations of trees, including fruit, grassed lots, etc. Saving the current state of the habitat will help create and maintain a comfortable microclimate (important for well-being and health and attractive settlement landscapes. The historic centre of Kaniv should be separately identified as an attractive tourist site and the preservation of its historic urban landscape should be ensured.
4. The objectives of the use of floodplains are divided into two parts: (a) the preservation and maintenance of biodiversity in floodplains, which have not undergone drastic rearrangements due to land reclamation; (b) development of reclaimed floodplains to restore or bring them closer to the natural state.
5. Improving landscapes associated with overcoming or preventing various negative impacts: restoration of land affected by erosion, landslide prevention, erosion of Kaniv Reservoir banks; restoration of vegetation after forest fires or at felling sites, or after flooding. Also some measures are necessary to limit transport of chemicals and noise impact on adjacent areas.

As a result of landscape planning in order to support the sustainable development of Kaniv district, it is recommended to create a Biosphere Reserve (47 % of the territory) on the territory of Kaniv Natural Reserve (Golubtsov and Chornyi 2014). The creation and operation of Kaniv Biosphere Reserve (if established) will contribute to the sustainable development of the region and the formation of ecological awareness. The cooperation between government, business and civil society to implement conservation objectives will intensify significantly. The project implementation will contribute to management structure optimization and development of joint protected area management programs and unify scientific research plans. Local people will receive new opportunities and benefits for image development and support of economic activity, especially in tourism and recreation, as well as agriculture.

Landscape Plan

Given the limitations and problems that occur in the Ukrainian realities at the local level, including lack of planning documentation, the Stepanetska village council landscape plan was originally oriented to reach the maximum number of themes and targets. The general context, obviously, remained the demonstration of a sustainable community development model (in the extension of the development performed for the district and region).

Framework planning purposes:

- Preservation of highly productive agricultural landscapes with fertile soils in the context of their sensitivity to water erosion and chemical pollution;
- Preservation and improvement of the forest conditions;
- Minimizing the negative impacts of poultry farms' economic activities;
- Saving comfortable living conditions in the settlements;
- Nature maintenance scenarios in the Rosava river floodplain;
- Prospects of the area development in context with the Kaniv Biosphere Reserve creation.

To process those directions of the Stepanetska village council territory development based on the available input data, a set of evaluative work on the sensitivity and importance of natural components—micro-climatic conditions, surface and ground waters, species of flora and fauna, soils, landscapes—has been carried out. In general, the list of the estimates corresponds to the one contained in the Framework landscape plan. However, the more detailed results have been obtained with a clear localization of evaluation judgments about the natural fertility of soils and habitat development conditions, of soil and ground water sensitivity to chemical pollution; landscape water regime regulation, conditions of the local microclimate formation and landscape attractiveness and possibility of their use for recreation (Fig. 13.4).

Analysis of existing and potential conflicts between environmental management and the natural environment makes it possible to point out the problems, the effect from which is or may become quite noticeable:

1. Operation of a poultry complex, leads to excessive use of water resources and possible surface water contamination by the run off. Additional chemical and noise impact on landscapes is provided by commercial transport, the traffic of which is quite heavy. Distribution of the smell creates discomfort for the local population. Besides that the poultry farm buildings stand on the most productive soils.
2. Separate farmland areas are located in places which are highly sensitive to soil erosion.
3. Within the village council there are forests with the highest level of forest fire risk which are in Class I of fire protection and require additional fire protection measures, especially in the hot summer period.
4. Potentially acute conflict may arise between land users in the case of the road construction, which has to run through the territory of the village council. Its construction may bring up a set of issues associated with land appropriation, increased levels of noise and chemical pollution.

At the level of the landscape plan, there must be utmost detailed and specified purposes of landscape preservation, development and improvement which have been developed at the highest hierarchical levels of landscape planning. In contrast with them, in the landscape plan (protected area or village council) aims are focused not on the general problems of the territory development, but on specific priority tasks identified by the framework requirements of the higher level plans (Antipov 2006).

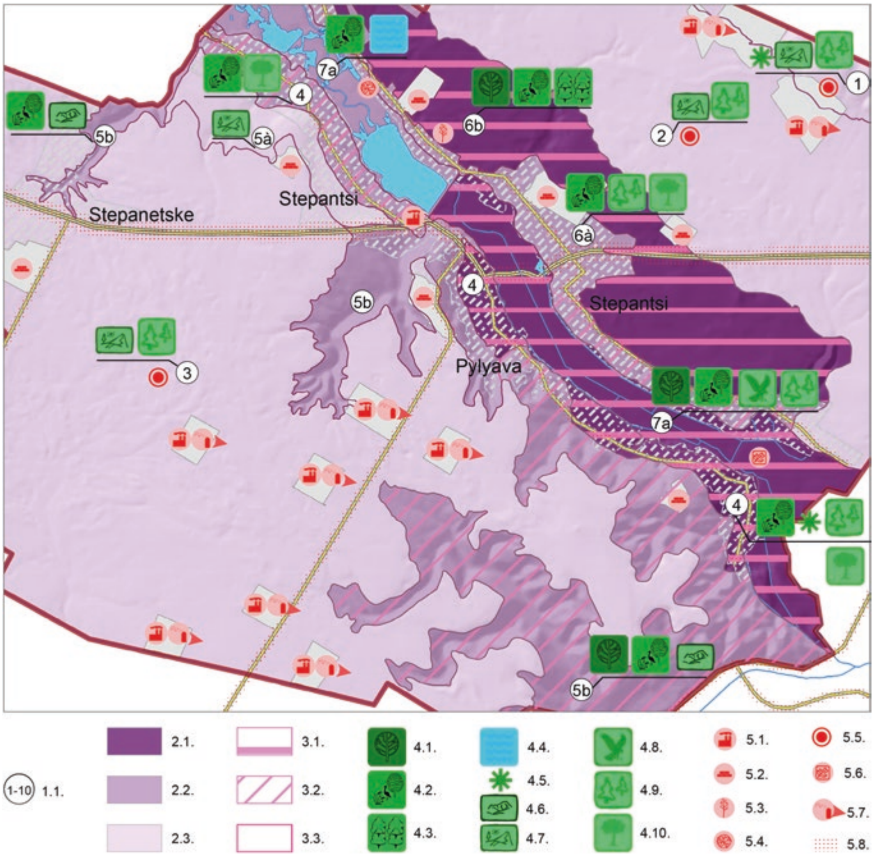

Fig. 13.4 Landscape plan of the Stepanetska village council's territory. The attractiveness of landscapes and their importance for recreation. Legend: *1.1* Modern landscapes: *1* edge part of the upland slopes occupied by agricultural lands and dry meadows; *2* terrace loessial plains occupied by agricultural lands; left bank of the Rosava River; *3* terrace loessial plains occupied by agricultural lands; right bank of the Rosava River; *4* terrace loessial plains, lowered, occupied by rural housing (fragments on the right bank of the Rosava River). Slopes of terrace loessial plains: *5a* with gullies and ravines, forest-covered; *5b* tilled slopes, deforested, occupied by dry meadows. Sand terrace above the flood plain: *6a* occupied by rural housing; *6b* occupied by planted pine forest. The Rosava River floodplain: *7a* flooded by the pond (periodically drained); *7b* the drained floodplain occupied by meadow. Attractiveness of the landscapes: *2.1* high; *2.2* medium; *2.3* low. Importance of the landscapes for recreation: *3.1* high; *3.2* medium; *3.3* low. Characteristics and elements of landscapes that determine their attractiveness (ranged by importance): *4.1* forest biotopes with vegetation corresponding to the natural one; *4.2* high diversity of forest and meadow vegetation and fauna; *4.3* large woodlands; *4.4* large water bodies; *4.5* places of landscape panoramic view; *4.6* undulating land; *4.7* wide open spaces; *4.8* places of birds observation; *4.9* separate trees or groups of trees, forest belts; *4.10* orchards. Factors of negative influence on landscapes and their recreation features—visual: *5.1* industrial buildings, *5.2* abandoned and destroyed buildings; *5.3* fallen trees; *5.4* the pond banks littered by household rubbish and heaped by shrubbery; *5.5* domination of agricultural lands with monoculture; biological: *5.6* allergens presence (ambrosia); pollution: *5.7* sources and directions of odour nuisance spreading; *5.8* pollution with dust, gases, heavy metals, noise pollution

According to the Stepanetska village council landscape assessment results, the main asset of the local community is fertile soil which covers the plains on both banks of the Rosava River. On the other hand, clean air, landscape and biodiversity, aesthetically appealing landscapes are significant factors in the development of tourism, especially such popular areas as ecotourism, green rural tourism. Therefore, within the Stepanetska village council landscape plans, the objectives for each landscape present in the researched area, such as agricultural landscapes, forest landscapes, backwaters, rural landscapes have been clearly defined. To ensure the use of sustainable resources in the researched area, the purposes have been defined and recommendations formulated.

Specific measures to be implemented in clearly defined areas are in the first place in the landscape plan. Taking into consideration that the implementation of the objectives and measures on the landscape plan level lies primarily with local government and the budget may not be realized in full for objective reasons, the minimum necessary measures to achieve the objectives of landscape conservation, development or improvement have been proposed in the Landscape plan.

The feature of the Stepanetska village council landscape plan is that two scenarios of territory development have been proposed within the objectives and measures concept. This is attributed to the possibility of the Kaniv Biosphere Reserve establishment in the Cherkasy region, which should include a part of the village council land. However, both options have reasonable goals and ecologically friendly environmental management measures, although their implementation differs by the investment size. According to the first option, it is proposed to maintain the current state of the reclaimed floodplain of the Rosava river, pine plantations on sandy terraces of the river and preservation of mixed-forest plantations on the other side. Another option which is associated with the creation of the biosphere reserve involves reproduction of the Rosava river valley natural landscape and intensive development of recreational potential on both river banks. The availability of two alternatives of the territory development is the defining feature of landscape planning, which is designed to meet expectations primarily of the local population. The decision on the direction of the territory use has to be made by the local community.

Evaluation of How Plans are Perceived by Administrators and Communities in Ukraine

Experience of the 'Landscape Planning in Ukraine' project allows the obvious feasibility of attracting of experts and consultants from various agencies and branches of scientific and applied activities to be stated. Public opinion, which revealed a range of views on the issues of social and economic development, the accents of their importance ranking, level of the awareness of environmental issues also proved to be valuable. In the work process, the scheduler (Institute of Geography NASU), on the one hand, was inevitably faced with the need to harmonize the interests of very different subjects of social activities, and, on the other, was receiving information about the intentions and expectations ‘first hand’, which allowed it to find and retain practical outputs and value.

In general, there are three main stages of partnership development to design documentation in landscape planning which can be highlighted.

The first step is to discuss the needs and framework conditions of the chosen area from the point of view of positioning at the regional level and internal problems and resources. Such a procedure was launched in Cherkasy Regional State Administration and later on in Kaniv district state administration and Stepanetska village council. When developing the Cherkasy region landscape programme, the partnership was developed at national and regional levels. National level is represented by the Ministry of Ecology and Natural Resources and the Ukraine Ministry of Regional Development, Construction, Housing and Communal Services. The idea of landscape planning implementation was supported by both the Ministries as a potential contribution to the task of maintaining the landscape and biological diversity, ecological network development, improvement of spatial planning and execution of the laws ‘On the basic position (strategy) of the state environmental policy to 2020’, ‘On the General Scheme of Ukraine Planning’, and ‘On Regulation of Urban Development’. The regional (oblast) level was presented by Cherkasy Regional State Administration and the Directorate of Kaniv Nature Reserve as a protected area and which has international significance. Cooperation included a number of expert consultations, most of which in the Cherkasy Regional State Administration is within the sphere of the responsibility of the Department of Architecture and Urban Development. Specialists in this division became a sort of a connecting link between the developers and the administration as a whole and it was their efforts which largely defined and determined the fate of the document implementation. The importance of this interaction especially manifested itself at the final stage—the agreement of the landscape programme materials which were subsequently presented to the administration at the regional innovation forum. The framework landscape plan materials of Kaniv district and the landscape plan of Stepanetska village council were also presented to the administration. For Ukraine (as well as for other post-Soviet countries), the priority task remains in improvement of the framework planning conditions, i.e. reconciliation of legislation in the area of environment protection and spatial planning, introduction of additional laws (primarily the Law ‘On landscapes’), forming clear contours of a ‘niche’ in which any territory developer of any region in Ukraine will work in the future.

The second stage is cooperation with local departments aimed at disclosing of the planning documentation development objectives, information and data collection and content agreement of the maps and texts prepared by the developers. This stage was successfully implemented in the period of 2011–2013. Administrations and their departments of a certain level remained the main partner throughout the period. Moreover, here, as well as at the level of landscape programme development some consultations with experts were conducted on the activities of the Kaniv Nature Reserve, approaches and the situation on spatial planning at the district level, the problems of adaptation to climate change and biodiversity conservation, human rights guarantee on decision-making in the area of territorial development.

The third stage, which involves the implementation of texts and graphic applications into management activities, is currently in the process of implementation. Submitted materials are used at the level of regions and districts to justify a regional ecological network at the local level of the village council have become a roadmap for negotiations with investors, building cooperation potential within the future Kaniv Biosphere Reserve.

Conclusions and Implementation Prospects

Ukraine's period under the influence of the economic crisis did not contribute to the improvement of the nature components' ecological state. And at the present time, their pollution and changes to natural ecological properties have not stopped. Ukraine still occupies one of the first places in Europe in certain types of resources consumption per unit of GDP. Production based on outdated technologies continues, which leads to a further increase in hazardous waste. Prolonged exploitation of natural resources has led to environmental degradation. In its final version, it has a significant impact on human health and life conditions.

Unfortunately, frequent changes in the country's administrative structure did promote the development of paradigm awareness which is marked in the twenty-first century agenda as a paradigm of sustainable development. This greatly affects the structure of territorial planning work, carried out in Ukraine.

Introduction of LP in Ukraine is an important step which is aimed at prospective planning. Its objective is improvement, restoration and maintenance of the landscape as the main human life environment. LP is an important instrument directed at prevention of the degradation of nature components and creation of conditions for transition to sustainable development through the conservation of natural landscapes, maintenance of ecosystem functions, preservation of landscape and biological diversity.

The expected outcome of the 'Landscape Planning in Ukraine' project is not only creation of the plans which correspond to the different territorial levels. Geographers are interested in trying to find concrete solutions in the area of sustainable spatial development of the region, which provides and improves the state regulatory framework. Particularly it makes sense, in our view, to introduce such measures as integration of landscape planning into the spatial planning system, development and improvement of mechanisms to address issues of land use and as for implementation of other procedures, related to the protection, preservation and restoration of the environment, including strategic environmental assessment and measures of the National Action Plan. Landscape planning work at different levels for different model regions, including projects within the framework of the preparation of regional plans could become the basis for such actions.

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Chapter 14
Assessment of an Ecological Network at Local Scale in the Context of Landscape Changes: A Case Study from NE Poland

Michał Jakiel and Anita Bernatek

Abstract The main aim of the study is to assess the functioning of an ecological corridor in the context of landscape changes, especially planned land use at local scale. The analysis was conducted within the Northern Ecological Corridor in Poland, which was first determined at national scale, and then specified at local scale. 29 municipalities in NE Poland were selected for detailed analysis. These municipalities are situated within the Northern Ecological Corridor in Poland, which connects the Knyszyn Forest, through the Biebrza Marshes, with the Pisz Forest. Spatial planning documents developed at local scale were analysed. The research allows the identification of areas where conflicts between land use and landscape connectivity occur. These conflicts are mainly connected with housing development and tourism infrastructure. This study shows that in Poland, where no legal instruments to protect ecological networks exist, the development of ecological corridors at local scale requires not only conducting an analysis of the present land use and landscape permeability, but also a detailed analysis of spatial planning documents. Only a coherent ecological network with a perspective for the future will ensure effective protection of an ecological network and, thus, biodiversity.

Keywords Ecological corridor · Spatial planning · Land use · Landscape fragmentation · Local scale · Conservation

Introduction

In recent years, the concept of an ecological network consisting of core areas, buffer zones and ecological corridors is becoming increasingly popular (Van Der Windt and Swart 2008). On the one hand, this is due to the increase in the

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importance of protecting biodiversity in nature conservation and, on the other hand, the progressive fragmentation of the environment (Hess and Fischer 2001). The theoretical basis of the ecological network concept is provided by the theory of island biogeography and the metapopulation theory (MacArthur and Wilson 1967; Levins 1969; Hanski 1998). These theories emphasize that given populations may function properly if only ecological connectivity between individuals of the population living in adjacent areas is maintained (Jędrzejewski et al. 2009). Therefore, one of the main threats to the conservation of biodiversity is landscape fragmentation (Forman et al. 2003). The effects of fragmentation become visible not only through the population decline of certain species (e.g. Mazerolle 2004), but also by the reduction in genetic variation (e.g. Riley et al. 2006), reduction in dispersal capacity (e.g. Forman and Alexander 1998), and general behavioural changes of individuals (e.g. Mazerolle et al. 2005).

The concept of ecological networks as a tool for biodiversity conservation is closely related to spatial planning (Jongman et al. 2004; Szulczewska 2004; Opdam et al. 2006). On the one hand, this requires developing a coherent ecological network at all scales, from the landscape, through regional, to local ones. On the other hand, effective protection is only possible if there are legal instruments appropriate for it.

Throughout the world, many networks are developed at landscape and regional scales (Bennett 2004; Jongman et al. 2004; Bennett and Mulongoy 2006). In the European Union, the Natura 2000 network is to perform the function of an ecological network. According to the Birds and Habitats Directives in each EU Member State, Special Protection Areas (SPAs) are established for birds and Special Areas of Conservation (SACs) for species other than birds, and for habitats (Council Directive 1992, 2009). Moreover, pursuant to Article 3 and 10 of the Habitats Directive, ecological coherence should be preserved between Natura 2000 sites, which will enable the movement, migration and gene flow of wild species (Council Directive 1992). The Natura 2000 network is implemented in all EU Member States and is part of the national ecological networks. On the EU level, the legislation exists for the protection of ecological networks. Nevertheless, the implementation of this concept in spatial planning is extremely difficult. Most problems occur at the local level, where spatial policy is implemented. On this level, it is necessary to determine the specific boundaries of widely designed ecological corridors and core areas with respect for human needs.

Poland has been an EU member since 2004, and EU regulations which form the basis of the designation of Natura 2000 sites were introduced into Polish law by the Nature Conservation Act of 16 April 2004. Yet to this day there are no clear rules that might regulate the legal protection of ecological corridors in Poland, forming part of a pan-European ecological network. The Nature Conservation Act of 16 April (2004) contains only a definition of an ecological corridor; however, no ways of determining its boundaries, or rules of protection, have been indicated. Thus, the ecological network in Poland is protected only in areas where it overlaps with existing forms of nature conservation, or runs through woodlands, since the Forest Act of 28 September (1991) guarantees the inviolability of forest complexes

(Jędrzejewski 2009). Being a key element of the network, ecological corridors are not provided with effective legal protection and, thus, they are subject to normal planning processes and may undergo fragmentation.

One of the main international corridors running through Poland is the corridor in the northern part of the country (the Northern Ecological Corridor) linking Eastern and Western Europe. Owing to it, the continuity of Eastern European natural areas may be extended up to the western borders of Poland, and restoring its permeability will allow gradual recolonization of Western European countries by rare species of animals and plants, among others, the lynx (Jędrzejewski 2009). Therefore, the purpose of this study is to assess the functioning of a selected part of the Northern Ecological Corridor at local scale, in the context of landscape changes, especially planned land use. The specific objectives are as follows: (1) to present the planned land use within the corridor based on planning documents, (2) to identify the problem areas resulting from changes in land use within the corridor, and (3) to evaluate the implementation of ecological corridor conservation in the planning documents. This research work was conducted as a part of the project by the World Wide Fund for Nature (WWF) Poland.[1]

Study Area

29 municipalities in North-Eastern Poland were selected for a detailed analysis. The municipalities are located within two voivodeships, i.e. the Podlaskie voivodeship (24 municipalities) and the Warmińsko-Mazurskie voivodeship (5 municipalities). The course of the Northern Ecological Corridor, specified at local scale in the section connecting the Biebrza Marshes, the Knyszyn Forest, and the Pisz Forest, is located within the limits of these municipalities. This section is located within the limits of an international ecological corridor connecting Eastern and Western Europe (Jędrzejewski et al. 2005). It is a lowland area with a young glacial relief, varied by numerous glacial lakes and river valleys. The area is covered by extensive complexes of coniferous forests (mainly pine and spruce). Along the river valleys, there are large areas of wetlands and peatlands which, together with forests, constitute natural habitats and migration corridors of many species of mammals [including the elk (*Alces alces*), red deer (*Cervus elaphus*), European

[1] The project as a part of the "Active protection of the lowland populations of the lynx in Poland" project, implemented by the WWF Poland Foundation, co-financed by the European Union from the European Regional Development Fund, under the Operational Programme Infrastructure and Environment (OPIE) 05.01.00-00-341/10) and the National Fund for Environmental Protection and Water Management. Upon detailing the course of the ecological corridor, fieldwork was conducted. Also there were meetings with stakeholders in the region (including representatives of municipality authorities, forest district authorities, road administration). The final outcome of the project is the creation of a comprehensive programme to protect the Northern Ecological Corridor in Poland.

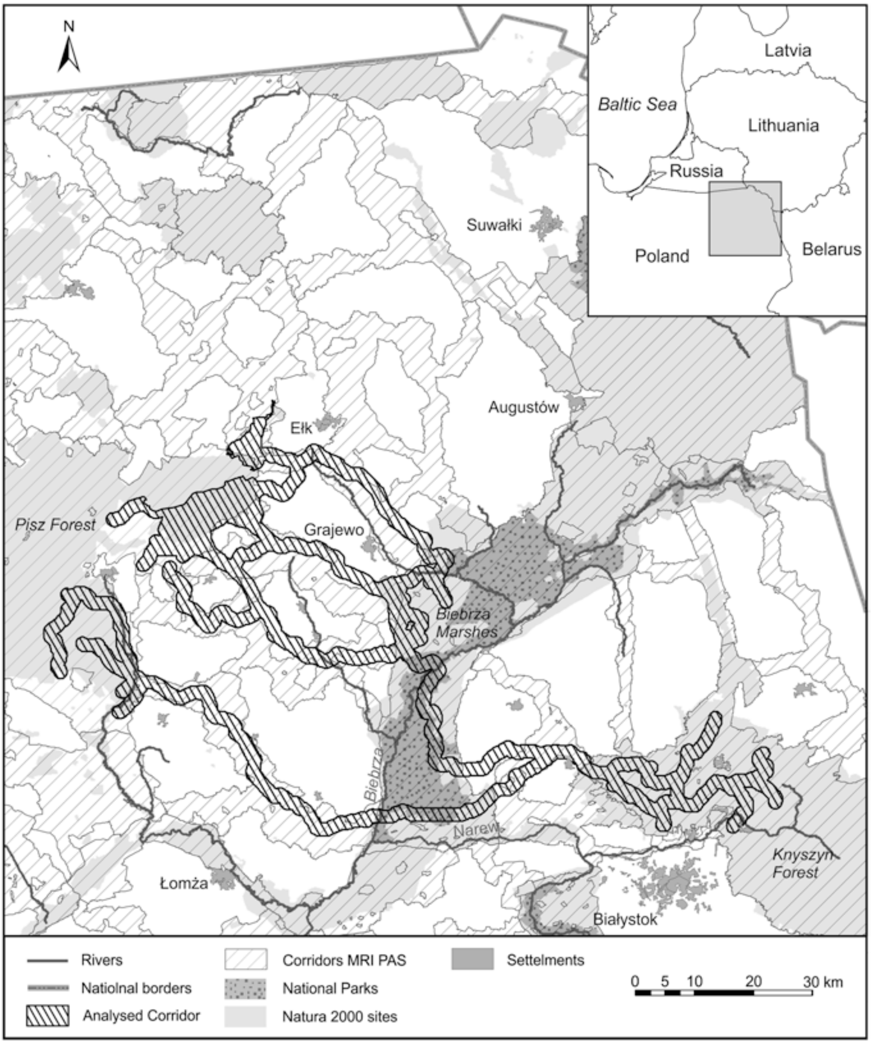

Fig. 14.1 The location of the research area

bison (*Bison bonasus*), grey wolf (*Canis lupus*) and lynx (*Lynx lynx*), and birds (including the Eurasian crane (*Grus grus*), heron (*Ardeidae*) and white stork (*Ciconia ciconia*)]. In the majority of these territories, protected areas such as the Biebrza National Park and the Natura 2000 sites have been established. They represent one of the key connections to maintain wolf populations and restore the populations of the lynx in the area of Northern Poland (Jakimiuk and Górny 2012). Areas between forestlands and river valleys are used mostly for agricultural purposes; there are several medium-sized cities, and dispersed settlements constitute the majority of human settlements (Fig. 14.1).

Materials and Methods

Planning documents drawn on the local (municipal) level, i.e. studies of conditions and directions of spatial development (SCDSD) and local spatial development plans (LSDP), were used to conduct an analysis of the planned spatial development within the ecological corridor. The study of conditions and directions of spatial development establishes the spatial policy at the local level by determining principles, objectives and directions of spatial development. Studies of directions are implemented by LSDP, which usually cover just a section of the municipality. The local plan establishes the land use (zoning) and determines the ways of development and locating buildings in a given area. This plan constitutes an act of local law and is the basis for issuing administrative decisions. In this paper, we analysed these documents for 29 selected municipalities, in terms of planned development within the analysed ecological corridor. We also examined whether the texts contained provisions for the protection of ecological corridors, and if their course was marked on the study maps.

All of the analysed municipalities have SCDSD. In 22 municipalities, the SCDSD has been adopted, amended or updated in the last 7 years, i.e. since the recent law on spatial planning in Poland has been in force.[2] There are only 37 LSDP in force within the boundaries of the ecological corridor (Table 14.1). In other areas (not included in the LSDP) buildings can be located without major restrictions, with the consent of the local authorities.

An analysis of the documents allowed us to determine the possibility of maintaining the permeability of ecological corridors that have been designated at the national level, and then specified at the local level, under the WWF Poland Foundation project. This project uses the ecological network developed at the national level by the Mammal Research Institute of the Polish Academy of Sciences in Białowieża (MRI PAS). The network was created in 2005, commissioned by the Ministry of the Environment in collaboration with the Association for Nature 'Wolf' and the PAS Museum and Institute of Zoology (Jędrzejewski et al. 2005). Existing forms of nature protection, including Natura 2000 sites, were adopted as core areas. The results of studies of indicator species (mostly the wolf, partly the lynx, elk and deer) were used, and an earlier concept of corridors, ECONET-POLAND, was taken into account (Liro et al. 1995). It is the most comprehensive and recent network of ecological corridors in Poland, which has been verified and updated since 2005. The MRI PAS network was developed at the national level, and thus its implementation in lower levels of planning requires specifying boundaries. Therefore, the course of the Northern Ecological Corridor was specified, under the project, using the least cost path method (Lewandowski 2014).

[2] The former Spatial Development Act of 7 July (1994) ceased to apply when a new law on spatial planning and development was adopted on March 27, 2003.

Table 14.1 A list of municipalities in the section connecting the Pisz Forest, through the Biebrza Marshes, with the Knyszyn Forest, together with information on planning documents

No.	Name of municipality	Number of LSDPs within the corridor	Year of adoption of the study/change to the study	Protection of corridors in the SCDSD	
				Map	Text
1	Biała Piska	3	2011	No	No
2	Czarna Białostocka	3	2006	No	No
3	Dobrzyniewo Duże	0	2005	No	No
4	Ełk (city—municipality)	2	2013	No	No
5	Ełk	8	2013	Local corridors	Protection
6	Goniądz	1	2011	No	No
7	Grabowo	0	2012	Local corridors	Protection
8	Grajewo	3	2012	No	No
9	Janów	0	1999	No	No
10	Jedwabne	0	2012	No	Protection
11	Knyszyn	0	2000	Local corridors	Protection
12	Kolno	5	2012	Local corridors	Protection
13	Krypno	0	2000	No	No
14	Mońki	1	2012	No	No
15	Piątnica	0	2012	Local corridors	Protection
16	Pisz	4	2010	No	No
17	Prostki	1	2012	Local corridors	Protection
18	Radziłów	1	2013	MRI PAS corridors	Protection
19	Rajgród	0	2009	No	No
20	Sokółka	0	2011	Local corridors	Protection
21	Stawiski	0	2012	Local corridors	Protection
22	Supraśl	1	2011	No	No
23	Szczuczyn	1	2012	Local corridors	Protection
24	Trzcianne	1	2000	No	No
25	Turośl	0	2002	No	No
26	Tykocin	0	2000	No	No
27	Wasilków	1	2010	No	Protection
28	Wąsosz	0	2012	No	Protection
29	Wizna	1	2010	Local corridors	Protection

Source own study

Results

Based on the analysis of planning documents, it can be stated that most of the areas within the boundaries of the ecological corridor will be used in the same manner as before, in the next few years (Fig. 14.2). The greatest threat resulting from the planned spatial development is a large increase in investment areas intended for housing and holiday buildings planned in the studies of many municipalities. Three problem areas can be distinguished where, if the spatial development policy of a municipality is implemented, the permeability of the corridor will be seriously undermined:

1. North-east of the Pisz Forest (the Ełk municipality)—almost the entire area of the ecological corridor is planned for development; the corridor runs at a close distance to the city, whose nearby location makes it an attractive area for single and multi-family housing, and holiday and recreation buildings; a large part of the area has already been invested in;
2. West of the Biebrza Marshes—a threat to the functioning of the corridor is the residential, as well as production and service development planned around some villages, especially in the Grajewo municipality, the implementation of which will lead to dispersed development;

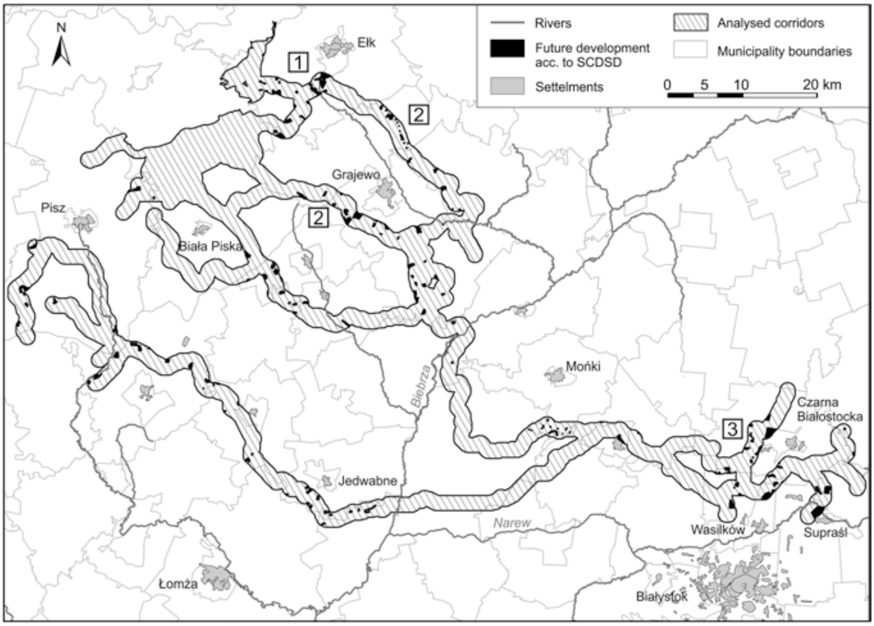

Fig. 14.2 Changes in land use and development within the ecological corridor analysed, according to the study of conditions and directions of spatial development of municipalities

3. The western part of the Knyszyn Forest:
   (a) the Czarna Białostocka municipality: in this section, the corridor extends partially within the town limits of Czarna Białostocka, where extensive development has been planned, which, together with existing and planned development in nearby towns, can cause significant fragmentation of the ecological corridor;
   (b) the Wasilków municipality: the main threat to this section is the planned development of single and multi-family housing; a large part of the corridor is located within the town boundaries and, thus, areas attractive for investors and inhabitants;
   (c) the Supraśl municipality: the areas intended for development, designated in the study in the north-western part of Supraśl, fragment the corridor to a considerable extent.

It is worth noting that in the planning documents of several municipalities in the area of the designated corridor, also positive steps, such as afforestation, have been planned. These include the municipalities of Jedwabne, Wizna, Biała Piska and Ełk. Such actions can improve the functioning of the ecological network.

The majority of municipalities do not have LSDP within the boundaries of the analysed section of the Northern Ecological Corridor (Table 14.1; Fig. 14.3). One problem area, where the implementation of LSDP can significantly affect the

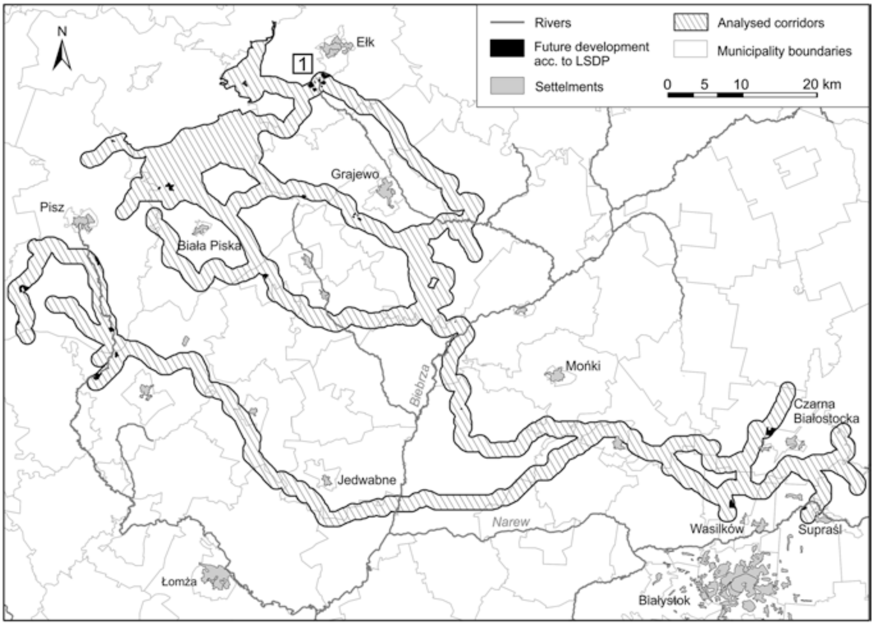

Fig. 14.3 The areas covered by the range of local spatial development plans within the ecological corridor analysed

functioning of the corridor, has been distinguished. It is the municipality of Ełk, where the ecological corridor runs within the city limits, and in the vicinity of it. This area is intended for development. Currently, 10 LSDPs in the Ełk municipality are being implemented, in which only a small portion of land has been allocated for green areas. Therefore, in the next several years, the permeability of the corridor in this section may be lost.

Under the law currently in force, municipalities must include in each SCDSD provisions for the protection of ecological continuity. However, in most of the documents, the provisions are insufficient (15 out of 29 municipalities); so, there is no real protection of corridors at the local level (Table 14.1). The exact course of corridors is not determined, nor are there any specific provisions (bans, orders) how to protect them. The need to protect corridors was included in the documents of the remaining municipalities (14), mostly by protecting river valleys (treated a priori as corridors), and maintaining the current land use within the corridor. In most of these cases (11 municipalities), corridors are marked out on maps, but their course is usually confined to river valleys, and mostly does not refer to the networks designated at the regional and national levels.

Discussion and Conclusions

Anthropogenic land use in Europe has a long history. Therefore, the impact of land use changes on the composition, structure and function of landscapes, and thus species, habitats and the ecosystem is obvious (Edman et al. 2011). Some authors (e.g. Angelstam et al. 1997) state that biodiversity, connected to the naturalness of forest, decreases from the eastern to the western part of Europe, which is a result of different history. Nowadays, the possibilities of recolonization of Western European countries by rare species of animals and plants are being considered. As mentioned, the continuity of Eastern European natural areas may be extended up to the West if the permeability of the ecological network is maintained (Jędrzejewski 2009).

However, our study shows that the permeability of the key part of the Northern Ecological Corridor in Poland is, at local scale, in some places endangered. Although most of the area covered by the ecological network is to remain in its current use, several areas that are subject to strong pressure from urbanization have been identified. This applies especially to the western part of the Knyszyn Forest, and the areas between the Biebrza Marshes and the Pisz Forest where, alongside a planned increase in housing areas, holiday buildings have been developing intensively. The development of urban areas in these regions will affect the functionality of the entire ecological corridor, and therefore, the possibility of connecting Eastern European natural areas with Western Europe. It should be emphasized that ecological corridors fulfil their function only when they are permeable over their entire length. The development of building areas, and accompanying infrastructure, in the areas of corridors causes disruption or interruption to their continuity (Jędrzejewski 2009). The threat is not only this interruption of continuity, but also dispersed development. All these actions lead to the fragmentation of the environment (Keys and McConnell 2005), which has three major components: loss of the original habitat, reduction in habitat patch size and increasing isolation of habitat patches (Andrén 1994).

Maintaining ecological connectivity is increasingly seen as one of the key tasks facing contemporary nature conservation. Owing to tools such as GIS, it has become possible to model them, and techniques such as least cost (Adriaensen et al. 2003), and friction analysis (e.g. Joly et al. 2003; Nikolakaki 2004) are most frequently used. Models developed using these techniques are based on the analysis of landscape structure, vegetation type, elevation, slope and other landscape features. All these elements are assigned weights or resistance values, which correspond to the conditions of migration of individual species (Epps et al. 2007). These methods were also used during the development of the ecological network of Poland, both at the national level, and during specification at the local level. However, despite the fact that there is a hierarchical system of spatial planning in Poland, which enables the implementation of an ecological network from the national level, through the regional, to the local (municipality-based) one, it is not effective. There are no sufficient legal instruments that would provide the protection of ecological corridors (Bernatek 2013). The municipality authorities have no real legal obligation to protect ecological corridors, so they do not pay much attention to it. The areas of ecological corridors are subject to pressure from urbanization and, hence, fragmentation of the environment. In the current legal situation in Poland, it can only be encouraged that action be taken to maintain the functionality of the ecological network.

As we can see, the increasing urbanization requires a new approach to landscape planning, including the creation of an ecological network. There is a need to integrate interactions between ecosystems and human activities. The landscape has to be understood not only from an ecological point of view but also from the view of human activities. Our study shows that creating an ecological network without human needs is ineffective. It can be seen that the ecological network developed only on the basis of environmental factors (without taking into account the planned spatial development and future investment) will not be effectively protected. Many authors emphasize that only close cooperation between scientists and authorities can provide effective protection of ecological continuity and, further on, biodiversity (Hanski 2002; Nassauer and Opdam 2008; Van Der Windt and Swart 2008; Deodatus et al. 2013). Deodatus et al. (2013) presented the model for ecological corridor creation based on the study conducted in the Ukrainian Carpathians. It was proved that the creation of ecological corridors should be based not only on ecology and landscape, but also on the administrative process. The engagement of all stakeholders is a key to the successful inclusion of corridors to the land management system. Recently, De Montis (2014) confirmed that land management is believed to be an appropriate instrument for implementing landscape policy.

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Chapter 15
Landscape Management Within the Moscow City Protected Areas

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Abstract Nowadays, 118 urban natural protected areas of Moscow occupy more than one-fifth of the city territory. They are mostly located in urban peripheral areas which appeared within the city borders in 1960 and 1984. Their major role is provided for recreation and sports activities of the urban dwellers along with the protection of natural landscapes. The number of visitors of the Moscow city protected areas is about 5 million people annually. The analysis of the current situation shows several problems, including insufficient availability of protected areas in particular districts of the city; poor transport access, including that for disabled persons; incompleteness of the protected areas network and their weak connection with protected areas in the Moscow suburbs; absence of the general management programmes for the forest belt of the region; space discrepancy of the urban protected areas to the world city green standards and ecotourism. The actual experience of landscape planning in the urban protected areas of Moscow reveals different methodological difficulties. One of them is the contradiction between strict protection status of some protected areas and necessity of special regimes of landscape management. For example, it is impossible to maintain areas which are suitable for recreation without tree cutting. Another one is the erroneous point of view that urban protected areas are a virgin space. In fact, the majority of Moscow city protected areas have a long history of land use/land cover changes reflected in their present-day state. Landscape reconstruction for the Moskvoretsky Park

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demonstrates several stages of landscape evolution during the last 150 years. On the base of that history, the plan for landscape management was elaborated. The main aim of the plan is to define the desired state of landscape depending on landscape vulnerability and capacity and human perception.

Keywords Landscape planning · Protected areas · The Moscow city · Land use/land cover changes

Introduction

Regions and national republics, cities and municipalities of Russia develop their territories in accordance with several types of planning regulations. The most common and large scale are city and regional planning and forest planning (in the Russian traditional legislation, 'forest management'). The first one covers the lands of settlements and municipalities, the second one the lands of the state forest fund.

According to the 2006 Town-planning Code of the Russian Federation, city and regional planning does not cover the lands of protected areas (PA). In master plans, the PA network is defined as 'an ecological framework of the territory' and shown on special maps of 'Restrictions of city-planning development'. The positions on the development of such a network are of an advisory nature and not 'a guide to action'. The current situation makes it necessary to develop a special planning procedure for the PA network as a whole and for particular protected areas as well. Since the 2000s, the Russian geographers have suggested several options for landscape planning. However, the initiative was not supported at the legislative level for a number of reasons, one of which is the extreme complexity of the Russian concept of natural landscape (Kolbovsky 2013b).

Unlike traditional nature reserves, urban protected areas are quite a new phenomenon for the Russian nature protection system (Ivanov and Kachnova 2010). As of September 1, 2014, there are 118 protected areas in the city. Prior to the expansion of the city territory in July, 2012, the PA network accounted for about 20 % of the city area. And if we consider the area of protected green territories within the so-called 'New Moscow' the figure becomes even higher. The most numerous PA in Moscow are natural and historical parks (10 in total); the largest PA is the Losiny Ostrov National Park. Both categories correspond to the IUCN Category II (Klimanova 2012).

In Moscow, the area of urban green and open spaces per capita is above 15 m^2. This means that Moscow is quite comparable with other European capitals (London–8, Paris–10 and Berlin–24). The forests of 'Great Moscow' occupy now more than 102 thousand hectares, of which 23 thousand hectares are within the 'old' territories (mainly on the periphery), and 79 thousand hectares are located in the territories annexed into the Moscow city limits. For Great Moscow in its new

Table 15.1 Principal land use types in Great Moscow

Great Moscow	000 ha	%
Forested areas	102	40
Open spaces	44	17
Built-up territories	109	43

borders, the percentage of forested areas is almost the same as that of built-up territories (40 and 43 %, respectively[1]) (Table 15.1).

All forests of the newly annexed territories, which were part of the forest fund until July 1, 2012 and then annexed into the Moscow city territory, became part of the urban green fund and were declared a protected green territory. Protected green territories of the city of Moscow are created to perform protection, climate regulating, sanitary-hygienic and recreational functions having a positive impact on the ecological situation and living conditions.

Along with other territories of the natural complex, protected areas form the 'green infrastructure' of the city. The PAs are a special group in its structure, because they have predominately environment protection functions (unlike other territories of the natural complex) and a special protection regime (unlike other green areas) (Klimanova and Kolbovsky 2013). The present-day situation within the urban PAs is characterized by the expansion of recreational services demand and offer, presence of third-party users (up to 30 % of the PA area), reduction in the number of employees, etc.

The PA system of Moscow is based on forest biogeocenoses—small-leaved forests (about 40 %); broad-leaved forests (oak and lime groves)—28 %; and pine and spruce forests—about 25 % of the forested area. Besides forests, other types of natural communities are preserved in the city, i.e. meadows, bogs and inundated grassy and shrubby associations in the valleys of small rivers, which were partially set aside as PAs. The largest massifs of meadow vegetation are in the Stroginsky and Krylatsky flood plains of the Moskva River, in Kolomenskoye, and in the flood plains of the Setun, Gorodnya, Serebryanka, Yazvenka, Khimka, Likhoborka and other rivers. The most valuable ecological corridor within the New Moscow territory is the Pakhra River valley that stretches from west to east, and its left tributary—the Desna River. Due to the limited area, rich species variety and high recreational potential open meadows, wetlands and aquatic natural communities are of the greatest value for biodiversity conservation and development of recreation in Moscow (Report on the state… 2013).

Against the existing built-up landscapes, protected areas of Moscow seem to be 'islands of untouched nature'. However, for a long time, all of them have been developing under the anthropogenic influence evidenced by archaeological findings in the Moskva River valley and later archival records (Gunova et al. 1996; Nizovtsev and Shchurkina 1997). Their current state is the result of both

[1] Calculations were made by A. Kvasha for her diploma paper (2013) under the guidance of M.A. Arshinova.

natural landscape-forming processes and the history of cultural landscape formation (nature adaptation for human needs during the long-term development) (Kolbovsky 2013b). Therefore, the urban protected areas are not only valuable ecosystems, but also natural-anthropogenic, and, probably, even historical, or cultural, landscapes. If so, the landscape management within their territories becomes a necessary prerequisite of their sustainable development.

The concept of landscape management fully agrees with modern approaches of territorial planning and the principles of landscape ecology (Forman 2008; Hall 2005). Because the urban PAs are an important part of the green infrastructure of the city, they could be effective only within the general context of city development and needs of citizens. Such quasi-natural landscapes are managed with consideration given to their historical environment transformation, interdependence between the landscape features and actual land use, and the system of goals that people have developed in relation to these landscapes (Beer and Higgins 2008; Turner 1996).

Today, the most important instruments of spatial management within Moscow PAs are planning and forest management projects. The former, along with other questions, provide for PA special zoning, e.g. zones of strict protection, recreational zone, etc. Forest management projects detail economic activities targets, first of all, improving the state of forest vegetation and, eventually, increasing the percentage of forested lands within the urban PAs.

Unfortunately, the current projects of forest management are not capable of providing the adequate management of urban PAs under modern conditions, mainly because they fail (and even reject) to consider the values of cultural (historical) landscapes. A possible way to overcome this collision is the development of a landscape management plan that would consider both past and current trends of territory development in the context of the long-term anthropogenic influence. Hence, the purpose of this paper is to develop the algorithm of such planning and test it in the territory of the Moskvoretsky Natural and Historical park.

Object of the Study

The Moskvoretsky Natural and Historical Park is situated in the northwest and west of Moscow and mainly occupies the undeveloped territories on both banks of the Moskva River from the Moscow ring highway to the Filevsky flood plain.

The unique natural settings, i.e. a medium-size river with tributaries, terraces of several levels, high valley-side slopes and floodplains with a variable hydrological regime, as well as the presence of transition zones between landscapes, were the prerequisites of the early development and intensive use of the territory of the present-day natural and historical park. By the end of the sixteenth century, the land use and settlement structure in the Moskva River valley was formed and it generally remained unmodified until the beginning of the nineteenth century (Nizovtsev and Shchurkina 1997). Later, an essential factor of landscape transformation was the Moscow-Volga canal (or the Moscow Canal), whose construction began in 1932. In the 1950s, the territory within the present-day park borders partially became part of the city. In the southern part of the park, avenues and tree rows were made and they remain in some places until now. In the 1980s, the areas adjacent to the park were intensively built up with multi-storey buildings, inhabitants of remaining villages were moved to other districts of the city, and the agricultural activities terminated.

The current state of the park territory varies considerably. Some landscapes still provide environment stabilization while others obviously need reclamation and eco-rehabilitation. Several sites underwent uncontrolled recreational development and show the extreme stage of recreational digression, others are turned into well-developed leisure areas, while some do not experience any recreational pressure. There are numerous archaeological monuments, cultural heritage sites, nature sanctuaries (geological, biological, biocenotic) within the park territory (Report on the state… 2013), as well as valuable city-planning objects, such as historical country estates and the sports facilities constructed for the 1973 European Rowing Championship and the 1980 Olympic Games.

The southern portion of the park was studied in more detail. Its western part is occupied by the Krylatskiye Hills, the slope of a moraine-fluvioglacial plateau, cut through by three large gully systems (partially protected) with permanent or temporary watercourses. To the east, the hills are adjoined by the elements of a river valley complex, i.e. the Mnevnikovskaya and Tatarovskaya flood plains with preserved fragments of the second and first terraces of the Moskva River (Likhacheva et al. 1997).

Research Methods

The landscape plan was developed using methods of geoinformation mapping. Its algorithm can be described as three interrelated sub-models, each of them suitable for an independent application.

The first sub-model describes the natural matrix of the territory. Its thematic layers reflect the geologic and geomorphologic structure of the territory, as well as its soil and vegetation cover. The main operational-territorial unit (OTU) of this sub-model is a landscape site. A map of landscape sites was produced by modelling based on the elevation matrix through a number of intermediate procedures using the ArcMap 10.1 tools. At the first stage, a vector matrix is interpolated into a raster field of elevations, which is, in turn, classified by ‘natural borders’ and transferred to the attributive raster by the interval code conversion. Then the attributive raster is vectorized (map of polygons) for assignment of values (indexes) to geomorphologic surfaces through semi-automated selection and editing. The result is a ‘semi-finished’ map of geomorphologic surfaces, which considers the distinctions in relative elevations of particular types of surfaces in different parts of the territory (e.g., the first terrace in the upper reaches of the river lies higher than in its middle and lower courses).

At the second stage, the raster field of elevations is used to create a raster of slope gradient (Spatial Analyst tool), which is also classified by natural borders and vectorized. As a result, we have obtained a vector map of surfaces with different slope gradients (sub-horizontal, flat, sloping, steep) and a map of slope directions.

At the third stage, the raster field of elevations is used to create rasters of curvature, both horizontal and vertical, each of them is additionally processed by extraction, reclassification, and generalization. The results of processing and vectorization are vector maps of the trough network and summits and sags.

At the final stage, the vector overlay allowed differentiation of the geomorphologic surface into ridge-top surfaces, slopes, or slope fronts, to be more exact, and superimposed elements of the trough network. The resulting objects of the modelling are landscape sites (using the terms of the traditional Anglo-American geography).

Because of the profound transformation of vegetation cover, it is the landscape sites map that specifically represents the arrangement and interrelations of the basic elements of relief and gives an idea of the original territorial landscape structure. The detailed version of the map stores in the attributive table information about soils, vegetation, actual land use, forest/meadow ratio, third-party users (if any) and landscape units (according to the site planning and forest management system).

The second sub-model deals with the reconstruction of history of a cultural landscape formation based on historical maps, i.e. plans of the general land surveying (the end of the eighteenth century), F. Schubert's map (the middle of the nineteenth century), first Soviet RKKA maps of the 1930s, and the maps of the General Staff (1960–1980s). Aerial photographs taken by the Luftwaffe in 1941 proved to be an additional and highly informative source. An operational territorial unit (OTU) of this sub-model is the area of a particular land use/land cover type. The sources of information allow localization of settlements, agricultural lands (arable lands and pastures), forests and other objects, such as quarries, hollows, ponds, shrubs, roads, etc. For each historical period, a vector map of land use/land cover was compiled. Data on the modern structure of land use/land cover were obtained through interpretation of satellite images (public Google Maps service) and from the public cadastral map. For easier comparison and representation, more than 30 land use/land cover categories of the initial maps and images were generalized and grouped into six categories: (1) forests; (2) meadows; (3) park vegetation (including groups and rows of coniferous and deciduous trees and lawns); 4) elements of river valley complex (including wetlands); (5) settlements and paved areas (including those under residential houses, sports facilities and office infrastructure) and (6) industrial sites, waste grounds and derelict lands.

The main OTU within the third sub-model (landscape management measures) is a landscape plot. Landscape plots are the areas of modal landscapes (corresponding to the landscape sites map) that underwent similar stages of development. At present, they belong to the same functional zone and experience rather uniform influence. The state of particular components (lithogenic basement, relief, soil cover and vegetation) is compatible and the appearance of landscapes (open, half-open, half-closed and closed) is uniform within a landscape plot. As a rule, lands of a landscape plot belong to one owner; hence, it is easier to apply regulations (protection regimes) (Kolbovsky 2013a).

The database contains information on the actual state of landscapes, degree of their disturbance and recreational and aesthetic values, as well as the target group of landscape management measures ranked by priority for each landscape plot. Landscape maintenance is aimed at achievement of its optimal (target) state (Kolbovsky 2013a). Taking into account the main functions of urban PAs, the optimal state of landscape provides for its environment stabilization functions in combination with the recreational ones. The target state of landscape plots was described using a number of parameters: openness/closedness, horizontal structure (bio-groups and separate trees and bushes), vertical structure (layers), bioecological function (forest, shrubby, meadow, wetland, etc.).

Results

GIS-mapping and field surveying make it possible to identify 18 types of landscape sites within the area under study.

The present-day landscape structure of the Krylatskiye Hills is characterized by well-defined slope urochishches of the moraine-fluvioglacial plateau and those of the gully network elements, such as lateral slopes of ravines and balkas, ledges, lower and top parts of ravine slopes, trapezoid bottoms of balkas, etc.

At the foot of the Krylatskiye Hills, fragments of the second terrace (128.5–131.5 m a.s.l.) and the extensive Tatarovskaya flood plain are well pronounced. The main surface of the flood plain (127.5–129 m a.s.l.) has a number of small hilly ridges (130–133.5 m a.s.l.) and extensive depressions (126–127 m a.s.l.) with reservoirs of semi-natural (retaining) origin. The near-channel flood plain of the convex part of the meander (129.0–130.5 m a.s.l.) is also well defined.

The Mnevnikovskaya flood plain has well-defined residual and levelled elements of flood plain relief, i.e. low ridges and dunes (127.5–129 m a.s.l.). Fragments of the first terrace (128.5–130.5 m a.s.l.) are preserved and divided by high floodplain plots (127.5–129 m a.s.l.) with a levelled gently sloping surface and slopes with minor landslides. Fragments of the second terrace with gently undulating surfaces and gentle and steep slopes with few erosion forms and minor landslides are typical of the northern part of the area.

Both the character and duration of the economic development of landscapes within the 'Krylatskoye-Mnevniki' study area depend largely on their natural properties. Localization and changes in the anthropogenic influence indicate the following five main stages of the territory development:

1. extensive agricultural land use—from the end of the eighteenth century (as it is possible to judge according to the general land surveying plans) to the

beginning of the twentieth century, when the greater part of the flood plains were grazed and mowed while the slopes of watersheds and high terraces were still covered with natural forests;

2. intensive agricultural land use with elements of quarrying—the first quarter of the twentieth century, when many slopes of terraces and surfaces of floodplains were ploughed, in some places ground was extracted for various purposes, and industrial facilities were constructed in the vicinity of former villages;
3. hydraulic engineering—1930s–1940s, when the natural regime of floods and accumulation in the Moskva River valley was disturbed, and then new water areas were formed as a result of water level rise. Islands and peninsulas inherited the positive forms of the original floodplain relief; during the same period, many former closed depressions of low floodplains turned into inner reservoirs of the dead-lake type and the lower reaches of ravines were inundated and became gulfs;
4. post-war years—beginning of tree planting on the surfaces of flood plain and terraces. First, mainly fruit trees, then soft-wood broad-leaved species and locally, coniferous;
5. the present—mass housing construction on surrounding watersheds, construction of hard-surface roads and organization of recreation and leisure sites.

During the whole period under consideration, the pattern of land use was becoming increasingly fractional and the structure of land cover became more complex as well (Fig. 15.1).

The surfaces obviously suitable for the main types of land use, such as primary cultivation, grazing and construction of rural settlements, were developed from the very beginning. Elements of cultural landscape complexes were gradually formed. For the area under study, these were fields, stone quarries, pastures and hayfields and settlements. The development of such a type resulted in the mosaic pattern of land and nature management and differentiation of the cultural landscape (Kolbovsky 2013b; Roberts 2003). In some cases, the differentiation was caused by the ecosystem response. For example, the long-term cultivation of land accelerates the linear erosion and deeply cut elements of a gully network are formed.

The process is the most obvious where natural heterogeneity of the territory is high. For example, the development of cultural landscapes on the slopes of the Krylatskiye Hills has uncovered practically all forms of the natural mesorelief, such as slopes of a gully network with different gradients and directions, as well as particular slope fronts. By the beginning of the twentieth century, the development of the Mnevnikovskaya flood plain had resulted in the differentiation of the areas of low ridges and in-between depressions of primary (mean-stage) flood plain, as well as the depressions of dead lakes.

Since the middle of the twentieth century, land use pattern has been increasingly fractional; however, the process has become more complicated. Within the Mnevnikovskaya flood plain, for example, the mosaic increases in line with the growing uniformity of the morpholitogenic basis of landscapes. Construction of the Moscow Canal stopped the natural flooding of the floodplain

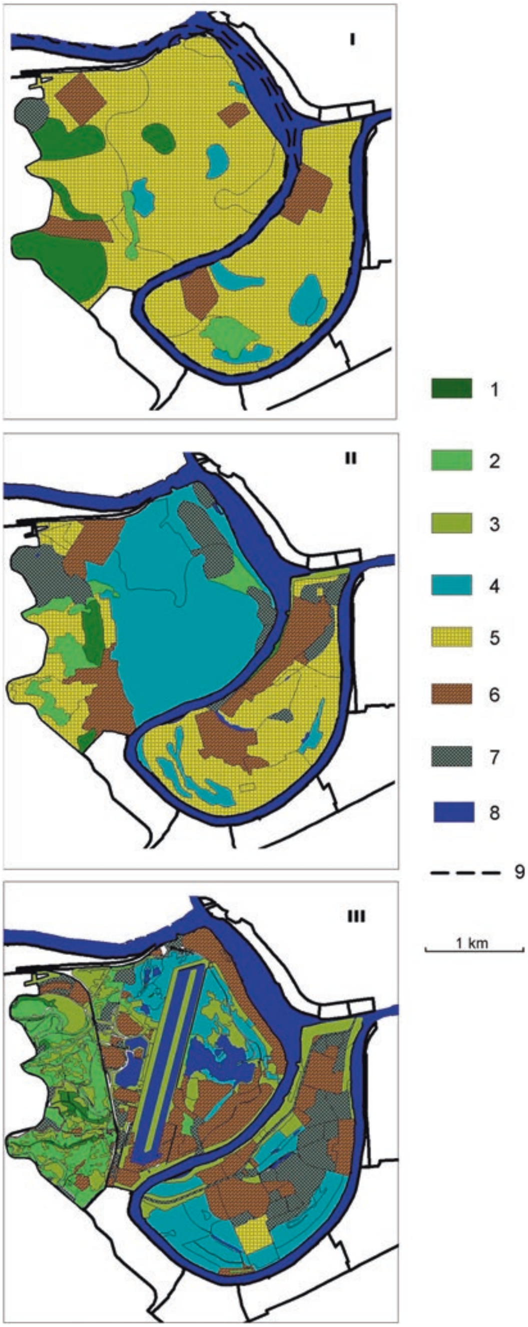

Fig. 15.1 Types of land use of the 'Krylatskoye' study area in : (I) the eighteenth century (extensive agricultural use), (II) the middle of the twentieth century (post-war years), and (III) the beginning of the twenty-first century. *1* Forests; *2* dry meadows; *3* parks (tree groups and rows, lawns); *4* elements of river valley complex, including floodplain meadows; *5* agricultural lands; *6* built-up and paved areas; *7* wastelands, industrial sites, dumps; *8* open water surface; *9* mean-stage river bed (prior to canal construction)

surface, which made it possible to fill up some dead lakes and construction began over the whole area of a new ‘island’ formed because of the artificial straightening of the channel. Since the 1950s, the areas of development have been almost independent of the primary natural structure of the territory and reflect, to a greater extent, different types of competing land use, i.e. greenhouse agriculture, construction, uncontrolled agro-recreation (‘dachas’), etc.

The Mnevnikovskaya flood plain is among the key territories of the Moskvoretsky Natural and Historical park, which have undergone adverse technogenic impact (Kolbovsky 2013b). For a long time, this territory lacked adequate protection; therefore, numerous dumps of garbage and construction waste were formed, floodplain lakes were polluted, and ‘wild’ motor-racing tracks developed there. The total amount of buried and piled garbage is estimated at 750,000 and 65,000 m^3, respectively (Kotlov et al. 1997).

If the situation remains ‘as it is’ (as the conservation regime of natural and historical park prescribes), a number of adverse ecological consequences could occur, including the pollution of aquifers and the Moskva River water, disturbance of the normal complex of soil fauna, violation of the demutational successions, etc. Thus, the following principal measures for the landscape management of the Mnevnikovskaya flood plain could be suggested:

- biodiversity conservation through providing habitats and conditions of reproduction for birds, small mammals, amphibians, fishes (in flood plain reservoirs) and invertebrates;
- preservation of the valuable semi-natural elements of the alluvial relief, i.e. depressions with ‘active’ oxbow reservoirs;
- maintenance of the variety of alluvial soil bodies;
- provision for conditions for recovery of (allogenic) successions of floodplain (meadows and broad-leaved plantings) and terrace (pine forests) vegetation.

It is obvious that in order to perform the eco-service functions, the landscapes need the restoration of their environment stabilization potential by means of large-scale reclamation of the territory and application of landscape planning and design techniques, namely:

- recultivation of modified relief;
- removal of superficial and buried dumps;
- disposal of polluted soil;
- restoration of soil and ground layer within former dumps and polluted soil plots;
- removal of weed and non-valuable tree stands;
- restoration of meadow biocenoses by seeding;
- restoration of pine-forest biocenoses and soils.

Today, the low-value small-leaved species (willows, ash-tree and maple) prevail within the floodplain, as well as the fragments of cultural plantings near the abandoned dwellings (lime-trees, poplars and remains of the orchards). For the most part, they grow on the garbage dumps or close to them and should be inevitably cut down during the reclamation. Together with the long-term noisy operation of vehicles and mechanisms, this will certainly result in a decrease in the numbers of indicative species, particularly birds. However, it is by no means an argument against the reclamation and for the status-quo of the PA boundaries. Restoration of landscape diversity will obviously contribute to the restoration of the numbers and diversity of birds, which requires multi-layered and complex tree plantings, as well as high-quality meadows.

Discussion and Conclusions

The investigation of the Moskvoretsky park territory has revealed a number of conflicts in the landscape management of this protected area, which are typical of other urban protected areas as well.

The **first** conflict—between the growing investment pressure and the availability of undisturbed territories within the PA—is the most obvious and remains urgent, despite the expansion of the capital territory by 24 times. Within protected green territories of New Moscow, several plots have already been cleared for construction purposes. These forests require higher protection status and some of them could be included in the urban PA network.

The **second** conflict is between recreational and nature protection functions of PAs. According to the approximate data, the total number of people visiting the Moscow PAs exceeds the population of the capital three times. Along with the increase in visitor numbers, the diversity of recreational activities becomes wider, including not only walking and swimming, but also bouldering, mountain biking, jogging and Nordic walking. Thus, a more accurate zoning of PA territories is necessary to ensure the interests and safety of various categories of vacationers.

Foreign experience shows that PAs are perfectly suitable for environment-friendly recreation if the recreational infrastructure considers landscape features and advantages of the territory. If it is possible to use green territories for 'balanced' recreation, the PA system is no more an 'ecological restriction to development' and becomes an important resource highly esteemed by the population, who correlates it directly with comfortable living in the megalopolis, and with the quality of life as a whole.

The **third** conflict is between nature conservation, socially significant accessibility of landscapes, and social justice. Forests within many urban PAs are practically inaccessible for the majority of Muscovites. The desire to keep forests with a special protection status within the territory of the megalopolis paradoxically helped those investors who need 'closedness' to achieve their purposes. Field surveys show that vast areas of protected forests within the Moskvoretsky Natural and Historical park in the west of the city are fenced to host the state dachas, religious facilities of the Russian Orthodox Church and cottage complexes.

The **fourth** conflict is between the nature protection status of some sites within the PA and their actual environment stabilization potential. As was noted above, there are more than 36 dumps of industrial and household waste on the

Mnevnikovskaya flood plain, which is part of the Moskvoretsky Natural and Historical park. Such areas need to be reclaimed first so they can carry out the eco-service functions demanded by society.

The **fifth** conflict is between conservation nature protection regimes of PA sites and the need to maintain the landscapes. As a rule, the PA status eliminates any intervention not aimed at nature conservation. However, for example, the removal of a dump with the area of several hectares and 2–3 m deep polluted soil will need mechanized cleaning with powerful vehicles. Extradition of some invasive species from the PA territory is only possible if herbicides are applied and this is also forbidden by the protection regime of the natural and historical park. In fact, not only badlands and critically disturbed (for example, burned) areas, but practically all territories within the urban PAs need active human interventions.

In relation to PA, the above conflicts could be grouped into external and internal. The first group includes the conflicts resulting from the priorities of city development, increase in investment pressure, proximity to surrounding residential quarters and industrial facilities, development of transport infrastructure and PA accessibility, and finally the attitude of the local population towards the protected area and the understanding of its value. The second group of conflicts stems from what is authorized and what is forbidden within PAs and how to combine these regulations with the need to maintain the landscapes for supporting their target state. Despite the 'ideological' character of the first group of conflicts and the 'technological' nature of the second one, the authors of this paper are aware that the above-discussed conflicts could be solved not only by the development of special measures of the nature protection policy or a plan of nature protection activities, but by reconsidering the very approach to landscape management within urban PAs.

The practice of forest management, which is the traditional form of forest use planning and regulation, within the PA boundaries as well, faces a number of complications in the territory of the megalopolis. The forest management a priori considers the urban territory as 'wild nature' and inevitably ignores the 'man-made' value of cultural landscapes. Aesthetic properties are generally correlated with the scale of the forest area 'openness/closedness'. In this case, other properties of particular importance in the megalopolis, such as visual communications, points with a panoramic view, etc., are not considered. In urban forests, the long-term maintenance of tree stands in a sub-climax state should be the main goal rather than the expansion of tree cover.

The 'forestry experience' inevitably classifies any open territories as objects of the 'second rank'. However, in the realities of urban space, wet and boggy meadows around preserved floodplain dead lakes are of higher priority for biodiversity maintenance than tall forest. The open territories require such actions as control of species composition of meadows by means of seeding and a special regime of mowing.

Thus, the most adequate instrument of PA management in the megalopolis territory is the full-scale landscape planning. It includes identification of the target state of landscapes, assessment of their recreational and aesthetic value and development of actions for achievement and maintenance of the target state.

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Chapter 16
Renaturalized and Recultivated Landscapes as a Result of Sustainable Landscape Management

Małgorzata Luc and Jacek Bogusław Szmańda

Abstract Polish literature in the field of landscape architecture and geoecology describes several stages of landscape changes depending on the proportion of natural and anthropogenic elements. In order of increasing impact of anthropopression on the environment, these are: (1) primary landscape, (2) natural landscape, (3a) cultural harmonic landscape, (3b) cultural dysharmonious landscape, (3c) cultural degraded landscape, and (4) devastated landscape. The first three, in line with the pronciples of sustainable landscape, can be considered sustainable landscape. One of the goals of landscape management is restoration of balance within it. This occurs through processes of renaturalisation and efforts towards recultivation. They result in the creation of renaturalized and recultivated landscape. These landscapes can be included in the category of sustainable landscape. Examples of landscape management leading to renaturalized and recultivated landscapes have been described and include areas of disused quarries within the city of Krakow.

Keywords Landscape evolution · Sustainable landscape · Renaturlized and recultivated landscape · Landscape management

Introduction

In the words of Crutzen (2002) the environment has been transformed so severely by human activity that the geological period spanning the last two centuries has been termed Anthropocene.

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This period is characterized by the clash between naturally occuring (natural and environmental) and anthropogenic (anthropogenic environment) factors and the resulting landscape is the product of these inputs. A landscape under the influence of both groups of factors constantly evolves in a more or less chaotic manner (Antrop 1998). The increased input of anthropogenic elements into landscape gradually leads to imbalance between natural and anthropogenic factors. In result, the harmony of landscape is distorted and the landscape becomes degraded (Bogdanowski 1988) and eventually devastated (Degórski 2005; Luc and Szmańda 2014).

Human intervention is not only a destructive power but it holds the ability to shape and protect dominant values of a landscape and its elements. The process of conscious, planned landscape shaping, altering and working towards sustainability is termed landscape management. Depending on the direction of change processes, Borkowski (2008) differentiates three main landscape families: (1) progressive (modern), (2) constant, and (3) regressing (conservative). Most landscape classifications which take into account the degree of anthropisation show a progressive trend of landscape changes in line with increased anthropisation. It is usually of destructive character and leads to landscape devastation. Man can also create new landscapes in which landscape harmony is restored; however, it does not always resemble the original state.

Regressive changes on the other hand lead to the formation of conserved landscapes (traditional or styled) similar to the original appearance. Regardless of the character of changes (progressive or regressive), the process of landscape regeneration is based on restoring natural (renaturalisation) and cultural (recultivation) values (Luc and Szmańda 2014). Resulting landscapes never return to their original state, they may however become balanced according to the rules of sustainable development (Luc 2014). This phenomenon leads to an increase in geodiversity defined as 'the natural range (diversity) of geological (rocks, minerals, fossils), geomorphological (land form, processes) and soil features. It includes their assemblages, relationships, properties, interpretations and systems' (Gray 2004: 8) and 'links people, landscape, biodiversity and culture, and is a vital natural resource' (Lawrence et al. 2007: 6).

Assuming, after Hawking (2002), that with the evolution of the universe enthropy increases with time, increase in geodiversity follows the nature of the universe. This does not contradict the fact that in result of renaturalization and recultivation of a landscape the balance between natural and anthropogenic factors is restored. Actions following the rules of sustainable landscape may also cause the domination of anthropogenic factors to be replaced by that of natural factors.

Renaturalization contributes to the formation of renaturalized landscape and recultivation–to recultivated landscape (Luc and Szmańda 2014). The position of these two types in the classification of landscape is associated with the degree of sustainability. There are many definitions of sustainable landscape. In this publication we use the definition of a landscape which has not undergone degradation, is characterized by structural stability under conditions of constant land utilization and is shaped by environmental and anthropogenic processes (Degórski 2009; Luc

2014). An example of such landscapes in Poland is some quarries classed by Nita (2013) as cultural, post-mining, post-exploitational, opencast working. For the purposes of this study, we have chosen disused quarries for analysis. They have served as a template for classification of landscapes formed in result of renaturalization and recultivation processes in the environmental and functional sense. The role of urban landscape management in terms of newly created landscape types in environment, culture, society and appearance has also been underlined.

Classification of Landscape in Light of the Level of Anthropisation of Geographical Environment

In modern studies of the geographical environment, landscape is most often treated holistically. This approach is based on three classic definitions: (1) Humboldtian, where landscape mirrors the general character of the region (von Humboldt 1845–1862), (2) the systemic concept of Rosenkranz (1850) which considers landscape as a relative whole comprised of hierarchically integrated systems, and (3) the Hettnerian concept defining landscape as a picture of related processes within geographical environment, determined by abiotic and biotic elements of the environment as well as the impact of man (Hettner 1927). In the geoecological sense landscape, holistically, mirrors the processes occurring within the geographical environment (Degórski 2005). However, in the understanding of landscape architects it is a spatial form created by man in an effort to adapt the natural environment to his needs (Bogdanowski 1988), and is therefore an image of human activity (Guterson 1956). In the ongoing discussion about the understanding of the term 'landscape', it is worth commenting on the summary of a thorough synthesis of the topic by Myga-Piątek (2001). The author, citing the views of Bogdanowski (1988), states that the interdisciplinary meaning of landscape suggests a synthetic understanding of landscape genesis not only in the environmental but also the cultural aspect. This view has not been questioned so far as evidenced by the introduction to the landscape convention. This reads as follows: 'all landscape has a social, economic, cultural and *ecological function* (…) landscape, through its physical composition and its psychological dimension, meets important social and cultural needs' (ELC 2000). From this it follows that the condition of landscape can be evaluated through complex studies of the relations between natural and anthropogenic processes, shaping the appearance of the surrounding space. These relationships can be analyzed by the evaluation of the degree of human impact on landscape, i.e. anthropisation, as shown in Fig. 16.1. Attempts to classify landscape which take into account the increase in anthropisation of geographical environment have been described in environmental protection, architecture and ecology literature multiple times. Having analyzed this literature we have assumed four types of landscape as described by Szczęsny (1982) and Degórski (2005): (1) primary, (2) natural, (3) cultural, and (4) devastated. Additionally, however, in a chronological oder, we

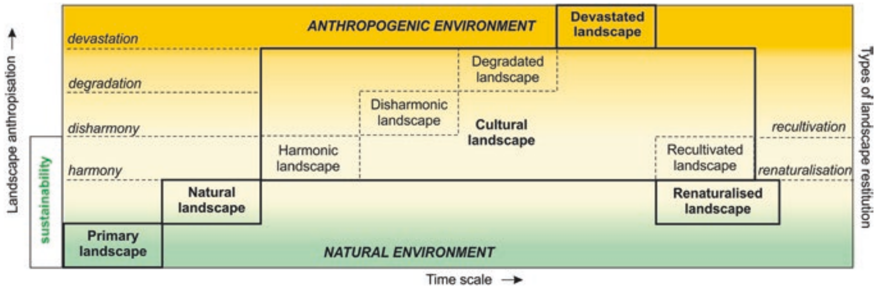

Fig. 16.1 Model of landscape typology in a context of the anthropisation degree and landscape sustainability (after Luc and Szmańda 2014 modified)

suggest differentiating a subtype of cultural landscape, recultivated landscape; and also a fifth type, renaturalized landscape (Luc and Szmańda 2014).

Primary Landscape

Landscapes which are products of nearly exclusively natural factors, unchanged by man, are termed primary landscapes (Isaczenko 1976; Bogdanowski 1976; Szczęsny 1982; Degórski 2005). According to Bogdanowski (1976) in Poland, the spatial extent of primary landscapes, or rather, due to the global extent of anthropopression *quasi* (almost) primary landscapes is limited to a few small protected enclaves existing within other types of landscapes. A similar situation occurs in many Central and Western European countries. On the other hand, Walczak (2007) differentiates the 'similar to natural' type in his classification of landscapes within protected areas. This author analyzes regulatory processes controlled by environmental and anthropogenic factors within areas protected by law and in result within a type of landscape similar to natural she describes three landscape subtypes: (1) woodland including more or less concentrated forest complexes with natural features, including preserved larger forest fragments within river valleys; (2) natural river valleys with wooded and shrub areas, old river beds, water basins and rushes, and (3) meadows, peatbogs and swamps.

In the present publication, we assume that primary landscape has been transformed in result of natural catastrophic processes or has been influenced by anthropogenic factors to such a small extent that it has not caused changes to its functioning. It is therefore a most highly sustainable landscape.

Natural Landscape

Natural landscape is defined as an area temporarily transformed by man and visibly used, comprised of adapted primary landscape forms (Bogdanowski 1976).

Natural landscape, also described by Szczęsny (1982) as an environmental or a man-made with the use of environmental elements, is shaped ‘under the deterministic influence of environmental landscape systems with a minimal influence of anthropogenic environmental systems’ (Degórski 2009: 57). Chmielewski (2012: 45) describes an ‘environmental primary-like’ landscape as separate from primary and defines it as an environmental primary landscape which with time underwent ‘various anthropogenic transformations so short-lived and insignificant that they later became almost entirely neutralised by natural environmental processes’. Also in the category of natural landscape is the harmoniously utilized landscape distinguished by this author as a subtype of environmental landscape characterized by the components of natural terrain features (rocks, lakes, peatbogs and natural woodland). This landscape is extensively utilized by man in a way that does not disturb the ecosystems and harmonious appearance of the landscape.

Natural landscape has an unspoilt balance. The progressive process of anthropisation is considered a natural development associated with environmental evolution.

Cultural Landscape

From all the landscape types mentioned here, the most extensive one is cultural landscape. Its character is most concisely described by Bogdanowski et al. (1981) as permanently anthropogenically transformed landscape which is maintained by continuous human intervention. According to Degórski (2009) cultural landscape is shaped under the influence of processes occurring both within the systems of environmental landscape as well as anthropogenic environment. The influence of either of the two systems decides the degree of naturalization or anthropization of landscape (Degórski 2005; Kistowski 2008a).

Myga-Piątek (2012) has analyzed multiple types of cultural landscapes. She states that existing classification of cultural landscape is characterized by the extensive use of multiple adjectives which creates chaos within terminology. Therefore, she proposes ordering existing types using three approaches: (1) genetic, classifies based on the leading landscape shaping factor, e.g. agricultural and industrial; (2) chronological, based on evolutionary stages depicting progress of the civilizational development of society; (3) evolutionary functional, based on differentiating landscape according to human activity (environmental, herding, agricultural, settlement, industrial, religious, etc., landscape); (4) historic and conservational, relates to chronologically changing aesthetic and composition features of a landscape; (5) appearance and perception, takes into account multisensorial perception of a landscape (transitory, ephemeral, changeable by evolution or revolution), and (6) degree of transformation, describing the degree of landscape transformation in relation to its primary state.

The base of the landscape classification accepted in our study is the last approach presented above, i.e. the historical and conservational approach to architectural research originating from Bogdanowski et al. (1981) and Bogdanowski (1988).

These authors differentiated two basic types of cultural landscape: (1) harmonious, where landscape elements resulting from human activity are composed within elements of the environment and (2) dysharmonious, or degenerated, characterized by the lack of adaptation of environmental and anthropogenic components with simultaneous destructive impact of the latter. In a harmonious cultural landscape the means of management follows the principles of nature and, depending on the character of anthropogenic forms, is divided into (1a) monumental and (1b) modern. Degenerated (disharmonious) landscape depicts the breakdown of balance of landscape components due to the activity of man. Bogdanowski (1988) states that progressive harmful changes within dysharmonious cultural landscape lead to its evolution into (2a) devastated landscape or (2b) pathological landscape.

Chmielewski (2012) in his analysis of landscape from the aspect of quality indicators differentiates the aforementioned (1) environmental landscape as well as a novel (2) cultural–environmental and (3) cultural landscape. All of these types are sub-divided and the two new additions divide into: (2a and 3a) harmonious, (2b and 3b) dysharmonius, (2c and 3c) degraded, and (2d and 3d) regenerating.

The term 'regenerating' used above is not, in our opinion, appropriate. In opposition to remaining nomenclature used in landscape subtypes, which describes the processes occurring in an anthropogenic environment, this name relates to processes leading to renewal of environmental and cultural values. Therefore, there is a lack of logical continuity in this classification. Borkowski (2008) in his views on changes in harmony of landscape names this landscape conserved, an environmental landscape undergoing renaturalization or modern landscape, which seems to us a more accurate term.

We also had reservations about the term 'renaturalising landscape' used by Chmielewski (2012) to distinguish a subtype of environmental landscape. Environmental landscape is, after all, a natural landscape, therefore is it correct to name the process which returns its harmony renaturalisation, if anthropogenic factors have not altered its natural (environmental) character?

In the context of studies into the relationship between elements of environmental and anthropogenic surroundings in landscape, it is worth mentioning the research of Wyrzykowski (1991) and Parzycka (2005). They present detailed criteria for classification of cultural landscape which take into account point-based assessment of saturation with environmental and anthropogenic elements, including urban and industrial. Chmielewski (2012) on the other hand sets the following criteria to evaluate harmony in landscape:

1. similarity of shapes and materials building landscape forms;
   proportions of forms, i.e. Adjustment of size and proportions of cultural forms to natural forms and other cultural forms to each other;
2. harmony of colours of environmental and cultural elements;
3. buildings appropriate for terrain utilization, e.g. (1) huts in shepherding landscape, (2) storage facilities (barns, silos) for the storage of agricultural products in agricultural landscape;
4. traditions of an area in line with characteristic, culturally embedded architecture, building colour, building materials.

The landscape type descriptions shown in our study aim to link human activity with balance in landscape. As seen on Fig. 16.1 this state is tightly bound with landscape harmony, the greater the harmony the more realistic sustainability becomes. Lack of harmony on the other hand unequivocally means lack of sustainability. Is it possible then to facilitate the restoration of balance by purposeful changes? We think that in some cases it is by means of recultivation. In particular, however, in the case of devastated landscapes it is imperative to aim for harmonious landscape in the process of recultivation. The finest example of this is recultivation of the landscapes of disused quarries.

Devastated Landscape

The type of landscape where as a result of industrial development and urbanization there is an imbalance of environmental and anthropogenic factors, demonstrated by derangement of one or more elements in qualitative or quantative terms, has been termed devastated landscape by Szczęsny (1982). Degórski (2005, 2009: 57) also differentiates devastated landscape as a type of landscape and describes it as ‘the result of processes taking place within a megasystem of geographical environment under the influence of anthropogenic environment which distorted the functioning of the natural environmental system’.

Kistowski (2008b) on the other hand delineates five classes of landscape in the context of the problem of balance within landscape in relation to the degree of sustainability of natural and anthropogenic factors. In order from the most to the least sustainable these are: (1) natural, (2) semi-natural, (3) harmonious cultural, (4) dysharmonious cultural, and (5) degenerated. Similarly, Chmielewski (2012) describes cultural degraded landscape as a landscape with the highest degree of anthropogenic transformation. Bogdanowski (1976) and Bogdanowski et al. (1981) names the landscape with the highest level of anthropisation as pathological degenerated landscape. Finally Maciak (1999) treats degradation and devastation synonymously. It ought to be mentioned that it transpires from the analysis by Kistowski (2008b) that in planning studies the term most frequently used to describe negative processes of anthropogenic transformation is degraded landscape, as opposed to devastated.

When discussing the topic of nomenclature of landscape types with predominant anthropogenic factors it is worth mentioning that, according to Szczęsny (1982), degraded landscape is only subject to distortion of aesthetic values and proportions of environmental and anthropogenic elements. However, devastated landscape is characterized by major aesthetic dysharmony and is largely devoid of environmental elements. A similar grading scale for terrain degradation of both landscape types is also used in the Bill of protection of agricultural and woodland areas (*Ustawy o ochronie gruntów rolnych i leśnych*). According to this bill, degraded terrain includes such areas where utilization value (for agriculture or forestry) has decreased and devastated areas are those which have completely lost any utilization potential. According to Mironowicz (2009: 25), ‘degradation of an area is the process of deterioration of land use'. This author assumes that evaluation of the level of degradation takes into account forms of land use which are the most appropriate for a given area as assessed by the evaluating researchers or by criteria used in the field. With regard to the requirements for spatial planning, which relate to landscape, evaluation of degradation involves:

1. material degradation involving technical condition of buildings and areas;
2. functional degradation i.e. The state of transformation of terrain function as a system;
3. moral degradation relating to the image of an area and social acceptance of the continuation of a given form of use;
4. compositional degradation including evaluation of spatial structure of the area.

As mentioned above, the term degraded landscape can relate not only to cultural landscape but also environmental degraded due to environmental, natural factors such as fires, tsunami or hurricanes (Chmielewski 2012). For the above reasons and also to preserve criteria of uniformity, separation and completeness of logical classifications (Solon 2008) it seems justified to follow in the steps of Szczęsny (1982) and Degórski (2005) and acknowledge devastated landscape as a separate class of landscape with the highest degree of anthropogenic transformation.

Recultivation, Revaluation, Renaturalization or Revitalization?

Discussions about the relationships between natural and anthropogenic factors and processes shaping landscape often touch on the problem of renaturalisation and recultivation of landscape (Szczęsny 1982; Bogdanowski 1988; Solon 2004; Degórski 2009; Chmielewski 2012; Nita 2013). As mentioned above, attempts to include these processes in landscape classification have been undertaken by Chmielewski (2012) who described the subtype of landscape undergoing renaturalization in the type of environmental landscape and the subtype of landscape undergoing renewal in the types of environmental and cultural as well as cultural landscape. However, these distinctions include landscapes undergoing the processes of renaturalization and recultivation and not landscapes formed in result of these processes. The author also describes various recultivation, revaluation, renaturalisation and revitalization efforts as man's attempts to restore degraded cultural landscape.

Authors representing various fields of science involved in the problems of landscape have different ways to define these terms. In landscape architecture, landscape restoration signifies revaluation with the intention to restore past landscape condition by means of reconstruction in cultural landscape, and recultivation in natural landscape (Bogdanowski et al. 1981). In environmental protection (Ciołek 1964) efforts to reinstate natural and cultural values to devastated landscapes (areas) are collectively termed recultivation (in environmental sense) and revitalization (in cultural terms). In mining industry, recultivation, in line with Polish law, means restoration of productivity to old mining areas (Maciak 1999). According to Szczęsny (1982) recultivation is the most important stage of landscape restitution which involves also its shaping and nurturing. Kasprzyk (2009) and Ostęga and Uberman (2010) differentiate nine directions of recultivation:

1. environmental—including protected areas as well as woodland and shrubland;
2. forest—including areas of biotic, productive and protective significance, woodland of aesthetic, recreational value and parks;
3. aquatic—with ecological, recreational, economical (retention reservoirs) and fishing significance;
4. agricultural;
5. recreational—used for tourism, recreation, sport andcultural activities;
6. cultural—of contemplational character, sites of historical or religious importance;
7. educational—themed trails, museums and reconstructions;
8. residential—including habitable buildings, holiday lets and social institutions;
9. economical—industrial parks, service buildings, and areas of communal use.

Revitalization and restoring value to post-mining areas includes the process of recultivation and of reinstating management of the land which enables further utilization. Revitalization of urban areas, on the other hand, refers to mainly efforts to restore degraded urban landscape, post-industrial, post-military and waterfront areas (Jadach-Sepioło 2009; Kocaj 2009). In summary, it can be said that revitalization has broader meaning than just association with landscape. It encompasses processes which ought to lead to the impvovement in quality of life by removing threats from natural environment and crime, and by creating new workplaces as well as conserving cultural heritage and restoring function to devasted terrain (Starzewska-Sikora 2007).

According to guidelines for open cast mining (PN-G-07800:2002) renaturalization is understood as spontaneous re-entry of flora and fauna onto transformed land, which signifies natural succession and restoration of nature (Ostęga and Uberman 2005). In studies in the field of landscape ecology this process returns original character to negatively transformed ecosystems (Chmielewski 2012) and not only includes natural plant succession but also technical operations to enrich natural ecosystems, also known as renaturization Nita (2013). In case of rock quarries Nita (2013) distinguishes 5 stages of renaturisation:

1. ending exploitation—the quarries are fully developed, they have a clear-cut basin with steep embankments and exposed rock walls and abandoned mining infrastructure;
2. intensive processes—erosion, mass movements including collapse, sudden plant succession with shrubs and trees differentiated according to slope exposure;
3. mid-renaturalization—most rock is eroded, geological structure poorly differentiated, most terrain forms are levelled by erosion, remaining vertical walls resemble natural escarpments and island mountains;

4. advanced renaturalization—slopes are nearly disappeared with delineation of the basin and its edges, inside the basin is filled with loose scree and perennial plants;
5. end stage—lack of definitive elements of the quarry, gentle slopes, clear differentiation of the flora within the quarry compared to surrounding plant formations.

The term renaturalization, recultivation, revitalization and revaluation are, as exemplified above, understood variably; however, according to Ostęga and Uberman (2005), the most frequently used term is revitalization.

Renaturalized and Recultivated Landscape

Landscape evolves and human intervention into the environment throughout centuries has caused chronological arrangement of different landscape types according to increase in anthropization (Bogdanowski et al. 1981). This arrangement takes into account progressive anthropopression related to decreasing balance. According to aforementioned authors, it is possible to arrange this starting from primary, to natural, harmonious cultural, dysharmonious cultural, degraded cultural to devastated landscape (Fig. 16.1).

For the past decades, planned human intervention based on restoring landscapes and reinstating previous aesthetic and functional values has been observed. This aims to return balance within landscape. These processes are supported by broadly understood politics of sustainable development described in Commission Communication of the Sustainable Development Strategy (CC 2005). The result is new landscapes which depict the processes of renaturalization and recultivation. However, the original natural and cultural values of a landscape can not be restored which is especially well evidenced in exploited areas such as quarries, mines or disposal sites. Land forms, considered by geoecologists as a superior relic of landscape (Sołncew 1965; Kondracki 1976), responsible for its structure (Kostrowicki 1976), have also undergone significant and irreversible changes. For this reason in a chronological sense landscape as an effect of renaturalization and recultivation is never the same natural or harmonious cultural landscape from the past, it can, however, be a sustainable landscape.

Due to multiple meanings of these terms, we have decided to form our own definitions of landscape renaturalization and recultivation and these have previously been published in the paper by Luc and Szmańda (2014). Renaturalization of a landscape is the restoration of the values of a natural landscape, i.e. a landscape dominated by environmental components and processes. In this sense, the only of the directions of recultivation mentioned by Ostęga and Uberman (2010) which are forms of renaturalization are forest, aquatic and environmental. Renaturalization of landscape can therefore include processes of restitution of environmental conditions in a cultural and devastated landscape occuring both in the case of natural selection as well as renaturization (Nita 2013), i.e. purposeful, rational, sustainable and man-controlled introduction of environmental elements.

On the other hand, landscape recultivation means restoring harmony in a degraded cultural landscape (as understood by Chmielewski or Kistowski) and/or in a devastated landscape. Therefore, landscape with restored features od natural and harmonious landscape has been termed by us renaturalized and recultivated cultural landscape, respectively (Luc and Szmańda 2014).

Examples of renaturalized and recultivated landscape in Poland can be found amongst others in papers about recultivation or revitalisation of post-exploitational areas of coal mining (Kasztelewicz et al. 2007; Kasztelewicz and Sypniowski 2011) as well as rock resources of Śląsk and Małopolska (Nita and Myga-Piątek 2006; Myga-Piątek and Nita 2007; Pietrzyk-Sokulska 2009; Świercz and Strzyż 2009; Nita 2013).

Quarries in Krakow: A Case Study

Examples of renaturalized and recultivated landscapes within the area of the city of Krakow comprised mainly of disused quarries in Jurassic limestone which had been exploited for as long as since the early medieval ages and were terminated between the nineteenth century and the 1970sof the twentieth century (Sermet and Rolka 2013). According to various authors quarries can be part of cultural landscape (Nita and Myga-Piątek 2006), devastated landscape (Degórski 2005) or cultural landscapes undergoing restoration (Chmielewski 2012). In this study, we classify quarries in Krakow as examples of renaturalized and recultivated landscape.

Renaturalized Landscape

Renaturalized landscape in Krakow quarries has been formed mainly in result of natural plant succession onto the devastated quarry areas. The most familiar of these are the examples of Zakrzówek and Bodzów quarries (Fig. 16.2). The area of the current Zakrzówek lake (Fig. 16.3) with a surface of around 23 ha started filling up with water after the water pumps were sqitched off in 1992 (Sermet and Rolka 2013). The lake now has a recreational function as a training area for divers. The neighbouring quarry ‘Skałki Twardowskiego’ is an excellent rock climbing site (Fig. 16.4). Both quarries as well as several smaller breaches within the area of Zakrzówek are areas of landscape protection and part of the Bielańsko-Tyniecki Landscape Park.

Within the park lies another large post-exploitational area, the Bodzów quarry (Fig. 16.5). It is an example of a dual character of partly renaturalized landscape and partly devastated area. In relation to the views of Chmielewski (2012) it can

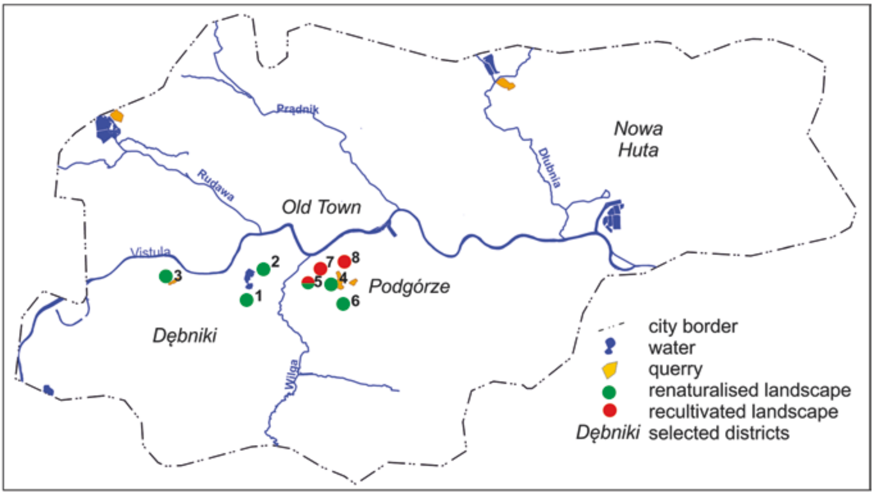

Fig. 16.2 Location of the selected renaturalized and recultivated landscapes in Krakow: *1* Za- krzówek Lake, *2* 'Skałki Twardowskiego' quarry, *3* Bodzów quarry, *4* 'Liban' quarry, *5* Quarry under the TV tower, *6* 'Bonarka' quarry, *7* Bednarski Park, *8* 'Pod św. Benedyktem' quarry

Fig. 16.3 Renaturalized landscape of the Zakrzówek Lake

Fig. 16.4 Renaturalized landscape of the 'Skałki Twardowskiego' quarry

Fig. 16.5 Landscape in a renaturalization process in the area of the Bodzów quarry

Fig. 16.6 Renaturalized landscape in the South part of the 'Liban' quarry

serve as an example of cultural landscape undergoing renewal, in result of natural plant succession. The Bodzów quarry area is currently the site of motorcross sports.

Another of the Krakow examples of renaturalized landscape resulting from environmental processes are fragments of two quarries localized within the area of Krzemionki Podgórskie. The first is the South side of the 'Liban' quarry (Fig. 16.2) where limestone had been mined from the fourteenth century up to 1986 (Ostęga and Uberman 2010). This wet and wooded part of the quarry (Fig. 16.6) lacks signs of previous devastation, as opposed to its North side (Fig. 16.7). Its appearance is not only affected by old industrial buildings but also by the remains of the film plan for Steven Spielberg's 'Schindler's List'.

Another example of landscape renaturalization is the south aspet of the Redemptorysci quarry under the TV mast (Figs. 16.2 and 16.8). An example of renaturalized landscape created as a result of environmental recultivation (Ostęga and Uberman 2010) is the Bonarka quarry (Figs. 16.2 and 16.9). In 1961, this quarry became the Inanimate Nature Reserve 'Bonarka' due to its unique geological value.

Fig. 16.7 Landscape in a renaturalization process in the North part of the 'Liban' quarry

Fig. 16.8 Renaturalized landscape of the South part of the quarry under the TV mast

Fig. 16.9 Renaturalized landscape of the 'Bonarka' quarry—Inanimate Nature Reserve

Recultivated Landscapes

Recultivation of the recreational type can be exemplified by recultivated landscapes of the Krzemionki Podgórskie Horst which lies on the North slopes of the Lasota Hill: (1) 'Szkoła Twardowskiego' quarry and (2) 'Pod św. Benedyktem' quarry (Fig. 16.2). Within the 'Szkoła Twardowskiego' quarry where limestone and flint had been mined from early medieval ages to 1884; thanks to the initiative of a teacher and local politician called Wojciech Bednarski between 1884 and 1896, a recreational park had been created (Fig. 16.10). This park was believed to be the first example of recultivation of post-industrial areas (Górecki and Sermet 2010). The parks infrastructure is modest. Within an area of 9 ha, amongst deciduous woodland lies a network of paths, a small game pitch and a playground. The surrounding limestone outcrops undoubtedly add to the visual value of this place.

The 'Pod św. Benedyktem' quarry is the oldest of Krakow's quarries exploited from the medieval times to the twentieth century (Górecki and Sermet 2010). Its modern appearance, next to some playground equipment, is enriched by one of the few preserved fragments of the Krakow ghetto wall (Fig. 16.11). The presence of this wall can decide about the contemplational character of recultivation in this

Fig. 16.10 Recultivated landscape of the ‘Szkoła Twardowskiego’ quarry—the Bednarski Park

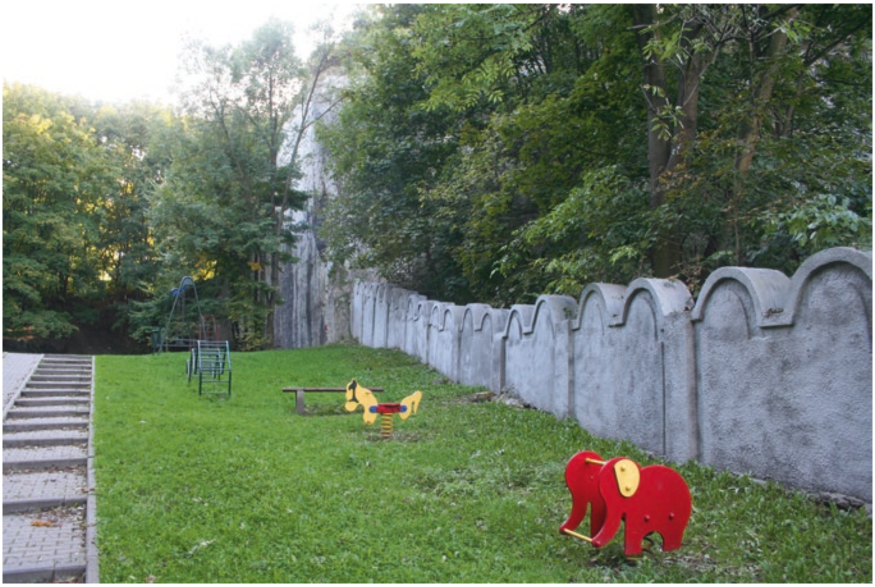

Fig. 16.11 Recultivated landscape of the ‘Pod św. Benedyktem’ quarry

Fig. 16.12 Recultivated landscape (car park) in the North part of the quarry under the TV mast

area (Ostęga and Uberman 2010). An example of recultivated landscape of economical character can be the North aspect of the aforementioned Redemptoryści quarry, which has been converted to a car park (Fig. 16.12).

Summary

Renaturalization, recultivation and revitalization processes aim not only to restore visual, economical and ecological values of landscape devastated by human activity but also to balance the features of dysharmonious (degraded) landscape. In dysharmonious landscape shapes and materials used in building anthropogenic forms are incompatible with natural elements and local traditions grounded in social consciousness through many years of human cultural activity. Both dysharmonious and devasted landscapes distort the balance of a landscape, although both enrich its variety. In the case of devastated landscapes of disused quarries, examples of which are described in this paper, active management of the landscape by means of recultivation processes has led to the creation of recultivated landscapes with recreational and economical functions. Examples of this are urban parks and car parks created in the area of Krakow's quarries. On the other hand, effects of passive management are represented by landscape renaturalization. It is associated with plant succession and ecological autoregulation as exemplified by the filling of basins created by rock mining with ground water. Renaturalized landscapes of

these quarries have regained not only ecological functions by becoming part of landscape protected parks or nature reserves, but have also gained recreational function as sites of sport and leisure for inhabitants. It is a matter of discussion whether renaturalisation and recultivation of landscape reinforce its geodiversity. On one hand, they lead to restoration of environmental features of a natural and cultural landscape and a decrease of geodiversity via the dimnishing of devastated landscape. On the other hand; however, renaturalized and recultivated landscapes are not the same as previously occurring natural and cultural landscapes which have been created in evolution of landscape according to the model presented in Fig. 16.1. Therefore, they form a new quality and should enrich geodiversity. Even if we assume that liquidation of devastated landscapes is a process leading to a reduction in geodiversity, it is clear that creation of renaturalized and recultivated landscapes leads to sustainability of landscape which is the main aim of spatial management in line with sustainable development politics. Excessive geodiversity not always positively impacts on the functioning of geosystems and aesthetic social feelings due to the distortion of landscape harmony through spatial defragmentation.

In our opinion renaturalized and recultivated landscapes as effects of management lead not only to landscape sustainability but also enrich its diversity through introducing a new feature which positively impacts the functioning of the geographical environment.

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