An Integrative Framework for Re-thinking 2nd Generation Sustainable Development (SD2.0) Projects, Education and the University as Catalyst

Timothy J. Downs and Nikita Golovko

Abstract

The University is poised to serve as the catalyst for an integrated, multi-sectoral, multi-scale approach that builds the requisite collective social and technical capacities of primary stakeholders to enable 2nd generation sustainable development (SD2.0). A synthesis of empirical evidence will be used to inform and justify a new *integrative framework* to design local and regional-scale projects, informed by the UN's SD21 Sustainable Development for the 21st Century report and the post-Millennium Development Goals (2000–2015) era. It will also be used to situate "education for sustainable development"—the theme of this book—in the integrative framework, to navigate the degree to which other additional components/aspects need to be considered for education to be impactful at the systems level. The framework involves five main axes of integration within which the University's role is shown to be central and catalytic: (1) socio-political stakeholder interests and influences; (2) development sectors (e.g. water, energy, health, food, the economy and climate resilience); (3) knowledge types (scientific and indigenous); (4) socio-technical capacities, including—but not limited to—education, research and information resources;

T.J. Downs (✉)
Department of International Development, Community and Environment, Clark University, 950 Main Street, Worcester, MA 01610, USA
e-mail: TDowns@clarku.edu

N. Golovko
Department of Philosophy, Novosibirsk State University, Novosibirsk 630090, Russia
e-mail: golovko@philosophy.nsc.ru

N. Golovko
Institute of Philosophy and Law (Siberian Branch of the Russian Academy of Sciences), 2 Pirogova Street, Novosibirsk 630090, Russia

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and (5) connections among sites with SD2.0 projects, forming an innovation network. This process recognizes integration and social innovation to be primary for success, technology secondary, and education to be but one key component. We argue that this integrative approach does not require a reshaping of the University's primary role—as others have argued—rather an amplification of its commitments and responsibilities. By integrating within and across these five dimensions during the design phase for projects, programs, and formal curricula, a new path to transformational sustainability emerges practical and compelling. Three illustrative examples of SD2.0 work are given.

Keywords
Integration · Capacity building · Socio-technical innovation

1 Introduction

As we prepare to enter the 2nd generation of sustainable development work (**SD2.0**), 25 years on from the first Earth Summit in 1992, critical reflection on what has worked and what has not needs to inform a fully revised approach. The United Nations' own reflection is given in "Sustainable Development for the 21st Century"—the SD21 Project (UN/ESA 2015). Above all, SD21 highlights the need to recognize and engage the fact that SD is "inherently political", and calls for a more central role to be played by civil society and community groups. It also calls for the consideration of multiple sectors that overlap—a multi-sectoral frame of reference—in recognition of the interdependence among sectors/issues/topics, and mindful of the need to be both effective and resource-efficient, especially in the severely resource constrained settings of so-called "developing countries". Likewise, as we enter the post Millennium Development Goals era (UN/EN/ECOSOC 2015; UNGA 2014), and the stark realities of a climate-changing world (IPCC 2014), the same basic recommendations apply. We have created and we inhabit a new geological era marked by the global-scale changes humans have made to the Earth: the age of the *Anthropocene* (Griggs et al. 2013). Thus, how we organize to conceptualize, frame, design, do baseline assessments, plan, implement, and monitor human development projects and public educational programs is at a threshold moment, one that encourages creative, critical, reflective, integrative thinking. This chapter has three goals: (1) to present an integrative organizing framework for SD work; (2) to situate the University centrally within this framework; and (3) to present three case studies—two domestic US (Central Massachusetts) and one international (Fijian Islands)—to illustrate the approach and the University's role. The chapter simplifies the socio-political and technical complexity of SD work in a pragmatic way, and it re-imagines the role of the University as pivotal, almost a thousand years after the first university—University of Bologna—wrote its founding charter in the mid-12th Century.

1.1 Complex, Compelling Context

Domestically in the United Sates we are living through an era of unrivalled political discord and partisanship, while internationally our world is confronting powerful destabilizing forces on three fronts:

- Economically: an unstable, unfettered global financial system beyond the reach of responsible public regulation has placed economic stress on a shrinking 'middle class' and exacerbates the vulnerability of the 'working class' in the US and many other countries.
- Socially: societal unrest in the face of rising social, political and economic inequities, with the gap between the 'haves' and 'have-nots' growing ever wider (recent uprisings like the Arab Spring in Egypt, and widespread public protest like the Occupy Movement in the US are expressions of this unrest and the issues they embody remain unresolved).
- Environmentally: anthropogenic climate change is already adversely impacting the capacity of the agricultural system to feed a growing world population, amplifying drought and wildfires in arid and semi-arid regions (including the South Western US), and driving more frequent and severe flooding in humid regions. More frequent and severe storms—hurricanes and tornadoes—are a likely scenario for the US, in places unaccustomed to such events and ill-prepared to mitigate their effects. At the same time, the burden of toxic chemicals and the risks of exposure to them grow in spite of gains in laws and regulations in the US, and in the absence of adequate protections for the vast majority of the world's rapidly urbanizing population of 7.2 billion.

There is also another global context that needs our consideration in terms of social and environmental changes. In 2007 the world officially became an "urban planet" with the majority of people inhabiting urban settings for the first time in human history. The trend is strongly upward, with the most rapid growth happening in so-called 'mid-sized' cities.[1] Rapidly urbanizing, rapidly industrializing settings in so-called 'transitional' and 'developing' countries are the places where pollution burdens and health impacts, for example, are potentially very large because of inadequate sanitation capacity and environmental regulation (Downs 2001). Such business-as-usual development is top-down, favors elites, and is having adverse impacts on human health and wellbeing (though little is known about their magnitude and extent), as well as accelerating climate change through the emission of greenhouse gases.

[1]The size of a 'mid-sized' city varies by country and needs to be placed in a country context; it is several million people in China for example.

1.2 "Sustainable Development" Versus "Sustainability"

Since the first Earth Summit in Rio in 1992 there has been a struggle to define and enact *sustainable development* and the term '*sustainability'* in a meaningful, practical way; many are disillusioned with the misuse of the term, while at the same time it is being applied as an organizing principle for key US agencies like the Environmental Protection Agency (USEPA), Housing and Urban Development (USHUD) and Dept. Agriculture (USDA), and is used extensively in corporate propaganda. Overuse, misuse, abuse and confusion about the term *sustainability* are both apparent and problematic. On the other hand, it does offer up the opportunity to be aware of these things, and for collaborative efforts and social enterprises/networks to go back to philosophical guiding principles of *sustainable human development*—as distinct from the *vague term sustainability*—that center on social equity (fairness and fair access to resources and opportunities for health and wellbeing) within and across generations, ecological stewardship and integrity, and economic vitality and a much more equitable distribution of the positive and negative impacts of development, and a most favorable tradeoff between the two.

One useful global reference document is the UN's "Back to Our Common Future: Sustainable Development in the 21st Century (The SD21 Project)" (UN/ESA 2015).[2] In preparation for the Rio+20 conference in 2012 it stated: "Knowledge must inform action—knowledge of what has and has not worked for sustainable development in the past 20 years, knowledge as well of important changes and new challenges that have emerged in the past generation. Only on this basis can we develop a clear vision of sustainable development for the 21st century. That vision needs to incorporate and build upon the rich output of various global assessments—including climate change, water, energy, and ecosystems—as well as the policy lessons from experience, respond to the evolving nature of the challenges, and draw upon the latest research on integrating sustainability and development into a common agenda. It also needs to recognize and motivate the contribution of all inhabitants of planet earth." Griggs et al. (2013) argue strongly for a more intentionally integrative SD agenda that combines protection of ecological life-support systems with poverty reduction as twinned priorities.

2 Framework for SD2.0 System Design

Given the aforementioned context, and the opportunities and urgent need for innovation, it is appropriate to pay close attention to the thoughtful, reasoned *design* of SD2.0 projects, in the same way that we would design a new generation of exploration and discovery technology based on lessons so-far learned and new knowledge about human-environment system interactions. Griggs et al. (2013) have laid out six 'Universal Sustainable Development Goals' for the next generation of

[2]See: sustainabledevelopment.un.org/sd21.html.

SD and post-MDG work, goals that cut across economic, social and environmental domains. This re-imagining of the SD science-policy agenda is helpful and clearly calls for an innovative, integrative approach that the University is well positioned to promote and to model. In the climate-change science arena, models of plausible future scenarios are improving all the time: four representative concentration pathway (RCP) scenarios consider the range of radiative forcing values in the open literature, and were compiled through technical collaborations among integrated assessment modelers, climate modelers, terrestrial ecosystem modelers and emission inventory experts (van Vuuren et al. 2011). However, while the science is improving, public discourse and policy leading to appropriate societal responses is chronically weak and under-nourished. One of the most pressing agenda items for SD2.0 and for the University is how to create vibrant integration among science/research, public education, public discourse, policy and concerted action on climate-change mitigation, adaptation, and resilience-building.

2.1 Axes of Integration

Drawing on this global context, empirical evidence from 25 years of SD1.0 work and 15 years of MDGs work, as well as experiential knowledge, five main axes of integration serve as a pragmatic socio-technical framework for integrative SD2.0 work, and possess logical interrelationships (Fig. 1):

1. ***Socio-political stakeholder interests, influences and relationships***—The primary axis of integration is across stakeholder and social actors—especially local ones—recognizing that the relationships among them are governing of success (Downs 2007), that these actors and their relationships are the source of knowledge types that help define and understand complex issues and problems, as well as the source of societal capacity to address them. Unless this dimension is given priority—and it rarely is—simple logic shows SD work will tend toward top-down, technocentric approaches that bias knowledge about, and responses to, issues and problems. Such are the traditional approaches to

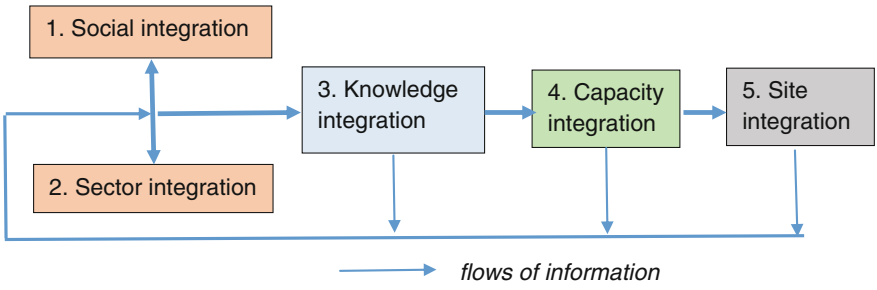

Fig. 1 Simple functional hierarchy of SD2.0 axes of integration. Logic shows that social innovation and integration are governing of success, and technical aspects are secondary

international development and also disaster relief and post-disaster reconstruction, for example in Haiti after the 2015 earthquake.

2. ***Development sectors***—Linking across different sectors, topics and issues—e.g. water, energy, health, food, the economy, climate resilience, social justice—forms the second major axis of integration for SD2.0 work. Sectors and issues tend to be interdependent, often in powerful ways, and comprise complex social, political, cultural, economic and technological human systems. These systems interact with natural environmental systems, often depending on their ecological integrity, and it is this human-environment systems interaction that ultimately governs the viability of sustainable development (Griggs et al. 2013).
3. ***Knowledge types*** *(incl. scientific and indigenous)*—The next axis of integration is at the level of knowledge, 'science', and experience, formal 'ways of knowing' and comprises three main types: (1) Academic knowledge (the domain of the University)—including disciplines in the Social sciences, Natural sciences, Engineering, Management sciences, Law, Information science and technology, the Arts and Humanities; (2) Indigenous and experiential knowledge—derived from ones lived experience, and the shared experience of groups of people often defined in terms of a place and a culture; (3) Professional knowledge—derived from the experience of professional work, including training, skills and competencies.
4. ***Socio-technical capacities***—The ability of societies and communities to conceptualize, understand and address complex environment-development issues and problems, and to imagine and pursue a more sustainable human development path, depends on six levels of capacity (Downs 2001, 2007): (i) political and financial seed capital to initiate and catalyze projects; (ii) human resources, education and training; (iii) shared information and knowledge resources (see 3 above) to understand and respond to problems; (iv) policy making, governance and regulation; (v) appropriate, affordable, technologies and infrastructure (e.g. water supply and sanitation systems); and (vi) enterprise development, especially local provision of products and services to support human health and wellbeing.
5. ***Networking of SD2.0 Sites***—The fifth dimension to inform the design of projects and educational programs, and re-imagine the role of the University—is the connecting together of SD2.0 demonstration and innovation projects at different sites. The value here is that information is shared among projects with a diversity of topical foci and stakeholders, operating with diverse settings and conditions. Such networks are to be encouraged to operate at overlapping scales, from local to regional, regional to national, national to international.

2.2 SD2.0 System

The five axes do enjoy a simple functional hierarchy (Fig. 1): axes 1 and 2 inform and enable axis 3, while axis 3 enables axis 4 and axis 5. Such a model also shows the social innovation aspect to be the driver of integration, and thus governing of success. Feedbacks make the system adaptive. This integrative framework informs all stages of an SD2.0 project: conceptualization, framing, designing, baseline assessment, planning, implementing, and monitoring (that re-informs earlier stages as an adaptive process). *How are these axes themselves connected into a system that can operate at any geographical and/or geopolitical scale?* What is the nature of the 'flows' that connect them? The answer is: flows of knowledge via communication and collaboration. Stakeholders interrelate by sharing knowledge and communicating their ideas, interests and concerns to others; specific sectors and topics also interrelate by sharing knowledge and information; integrated capacity is built by exchanging and leveraging shared knowledge, data and information. The networked system can operate at any scale, and move up and down scales: local, regional, national, international, global. Stocks and flows of information/knowledge form the life-blood of a socio-technical SD2.0 network. They are sustained by vibrant, trusting and mutually beneficial relationships among the network members: the relationships among people are the 'beating heart'. One can argue that this process constitutes education at the level of society—multiple stakeholders—or social learning, and that this is the essence of the dynamics (Downs 2007). Thus, the potential impact of the University on education in this framework extends well beyond its traditional reach of degree programs and research findings, becoming an engine of social learning.

Trencher et al. (2013) have described five 'channels' by which entrepreneurial universities the world over are collaborating with other actors to further sustainability, using empirical data on cases: (1) knowledge management—academics create, process and diffuse knowledge to stakeholders; (2) demonstration projects and experiments for unproven technologies; (3) technology transfer and economic development centered on low-carbon, 'green' technologies; (4) restoration and/or transformation of degraded urban areas; and (5) socio-technical innovation processes, e.g. food system innovation driven by social learning by multiple actors in concert. These channels each have some degree of integration at their core, and social as well as technical innovation processes at work. Each of these empirical approaches can be mapped onto the SD2.0 System which provides a useful conceptual framework for thinking about multiple ways in which the University can model and stimulate innovations.

3 The University for the 21st Century

We pose a basic question, as others are beginning to do: What *is* the role of a "university of consequence" in the 21st Century? In academia, the number of academic programs with 'sustainability' in the name is increasing and market research indicates that it is now a widely-used search term by prospective environment-development students, supplementing the simple term 'environment'. However, to realize its full potential in the SD2.0 domain, a serious re-imagining of roles, missions, structures, programs and processes is called for – and this can be informed by the proposed framework (Fig. 1).

3.1 Re-imagining the University

The word *university* comes from the Latin *universitas magistrorum et scholarium*, meaning "a community of teachers and scholars". Traditionally, the university is an institution of higher (or tertiary) education which educates students and undertakes research. It grants academic degrees in a range of disciplines at the levels of undergraduate and postgraduate study. In the context of sustainable development, and other priority areas of societal concern like climate change impacts and responses, and health problems and health care, the university is uniquely positioned among stakeholder groups because of its relatively unbiased role as multi-faceted societal educator and researcher. Universities the world over are beginning to re-think their traditional role in part because they are attempting to be more competitive for students in the higher education marketplace and research dollars from grants, but also in an attempt to amplify their impact on society and the complex issues of our time. There are two main complementary ways that the university can evolve and be more impactful: (a) look internally at the development of more integrative, impactful degree programs and professional certificate programs, ones that focus on understanding and responding to complex issues of the 21st Century; (b) look outwardly to work in partnership with other societal groups—community based organizations, non-profits, public agencies, policy makers and businesses. There is a discernable global trend for the University to collaborate with government, industry and civil society on sustainable development issues—to "co-create" sustainability transformations—and for the mission of such entrepreneurial institutions to evolve in step (Trencher et al. 2013). In essence, *universitas* simply (in theory at least) needs to be re-imagined to create more integrated 'whole' learning experiences on campus and off-campus—focused on understanding and responding to problems/issues. Faculty from relevant disciplines, using inter-disciplinary frames, should design environment-development programs and curricula to involve more students in practicums, team research projects, and community-centered pilot projects that are strongly and inter-connected with a diversity of stakeholder groups.

3.2 University Roles for SD2.0

The last decade of the 20th century was predictably productive for new theories and approaches re-imagining the role of the university, trying to describe and explain a new social contract between the university and society. These attempts included: (a) a new vision of knowledge production called *Mode-2 Science* (Gibbons et al. 1994); (b) the importance of university–industry–government partnerships called *Triple Helix Theory* (Etzkowitz et al. 1997); (c) the adaptation of a corporate-style culture inside the university called *Academic Capitalism* (Slaughter and Leslie 1997) and (d) a set of "empirical" parameters (like the strengthened steering core, the expanded developmental periphery, etc.) that characterize the *Entrepreneurial University* (Clark 1998). However, none of these theories were developed in the context of sustainable development and the integrative power of the university.

In this context, we can stress one significant change to how we understand the attitudes and roles of stakeholders. Within the *functionalism* perspective (e.g. Stinchcombe 1968), the realization of a common societal goal is impossible without adequate attention to the functional roles stakeholders play. What can be argued herein is not the need for the redistribution of such roles, rather the need for an amplification of stakeholder "zones of commitment and responsibility" related to the human-environment domain. This disagrees with the common understanding that we should change those roles or redefine them in order to engage with important emerging topics, like SD or climate change. Using our integrative approach, the functional roles of stakeholders essentially remain the same: the role of the university is still primarily to provide education and conduct research. What we argue is that the *commitment* not the role be re-imagined in the context of an integrative SD2.0 framework. This approach has already made innovations in pedagogy, for example helping students choose among courses according to their interests and direction, involving them in use-inspired research, etc. The contemporary professor is now as much a facilitator and helper as she is a teacher. She is still (and always will be) an expert in the field, but her "zone of responsibility" has extended. Students are now not only recipients of knowledge, but also active self-learners who model the practical impacts of higher education. From this perspective the new ethos of the university is composed and shaped corresponding to the changes in the original "commitment setups" of all the stakeholders in question. Moreover, we argue that the very idea of an integrative SD2.0 System is to inform a constructive change in commitment setups, in terms of the axes of integration.

Much has already been written about new roles for the university: innovation driver, catalyst and knowledge creator/integrator, or the partner providing technical and research support. During the first generation of SD work—SD1.0—we argue that the university was mainly considered in terms of the functional roles that it was supposed to play in the sustainable development context. However, within the SD2.0 frame the university is considered in terms of the quality of "commitment setups" of primary stakeholders. How do we gauge quality? Each stakeholder occupies a space within the multi-dimensional frame (Fig.1) and we can compare

Table 1 Comparing the university with other actors in an integrative framework

Actor	Axes of integration from Fig. 1				
	Social actors	Sectors	Knowledge	S-T[a] capacity	Sites
Business	L (L)	L (L)	L (L)	L (L)	L (M)
Government	M (M)	M (H)	L (M)	M (H)	M (H)
Donor	M (M)	L (M)	L (M-H)	L (M)	M (M-H)
Non-profit	L (M)	L (L-M)	L (L-M)	L (L-M)	L (L-M)
Civil society	L (M)	M (M)	L (L)	L (M)	L (M)
University	M (H)	M (H)	M (H)	M (H)	M (H)

The level of existing and (desirable potential) capacity to integrate in these five domains: H high; M moderate; L low. Assumes that all entities are nominally interested in innovation for sustainability, collaborative work, and the building of their capacity. The University is the only one with M (H) across the board.

[a]Socio-technical, aspects of social and technical innovation that interrelate to each other

this space with what is both desirable and reasonable to expect in terms of integrative potential (Table 1).

The university is uniquely positioned within stakeholder dynamics and politics – see its Table 1 ratings of M (H) across the board – because in most cultural contexts it is relatively neutral politically (in terms of its positions and the exercising of its power), is generally regarded with respect and as an independent thinker, and often expounds a mission embracing of the values of sustainability and social justice. Formative for SD2.0, from 1998 to 2000, Downs worked with the United Nations University's International Network for Water, Environment and Health (UNU/INWEH) in Mexico to facilitate and promote sustainable water supply and wastewater sanitation systems in three pilot cities (Downs 2001). The project brought together diverse stakeholders and built trust and a shared vision where they would not otherwise have existed because of a predominance of mistrust and a prevailing model of non-productive, even conflictual social interactions. The project worked well for three reasons: (1) the UNU was seen as an independent, trustworthy, and well-qualified facilitator/promoter; (2) the issues of water and wastewater were a shared priority with stakeholder interests converging on the sustainability of the sector; and (3) the project was framed positively as a capacity-building social enterprise in which participants' contributions were valued and the benefits of knowledge integration and mutual capacity building outweighed the costs.

4 Illustrative Cases

4.1 Holliston Health Project, Central Massachusetts

We advocate placing *human health and wellbeing* at the core of SD2.0 work especially *children's health and wellbeing* because they are fundamental to human development, and resonate with all stakeholders. The Holliston Health Project (H2)

began in Fall 2013 when concerned mothers came to Clark University to share their concerns that pollution in the Town of Holliston, Massachusetts, may be contaminating local groundwater used as the municipal drinking water supply source, and affecting the health of their children, neighbors and community members. Researchers were inspired to collaborate to explore these concerns scientifically. Thus, H2 was begun, and has been designed and developed as a *community engaged/community based participatory research (CEnR/CBPR) project*—an approach which is also entering its second generation of practice, is well established but has room to evolve, and is being increasingly recognized as desirable by major public health and environmental agencies like the U.S.National Institutes of Health (NIH) and the US Environmental Protection Agency (USEPA). Preliminary research showed 4–6 pollution sites acting as legacy and existing sources of about 15 toxic chemicals of interest, and health issues (mainly anecdotal to date) ranging from cancer and neurodevelopmental issues to birth defects and chromosome abnormalities (Trisomy 18, 21). The technical complexity of potential environmental exposures to chemicals and the health implications, coupled with a classic social complexity of non-productive interaction between concerned residents and town officials (officials assume a defensive, dismissive posture in the face of citizens concerned about the water supply) informed the design of H2 as a multidimensional, multi-stakeholder adaptive research-meets-action project (M2ARA). The design facilitates the coupled goals of: (a) understanding if exposure to polluted drinking water is associated with adverse health outcomes; and (b) if it is, comparing alternative solutions to the problem. We prefer the term "multidimensional" to multi-disciplinary because it connotes looking at a complex issue from logical vantage points determined by the issue itself rather than forcing disciplinary lenses onto the issue. In this way, the 'whole' is revealed, the problem drives the analysis, and a better model of what is happening is crafted. The "adaptive" aspect is important because issues and problems are dynamic and societal responses to them need to be adaptive to changes in contexts and conditions. The part of the label "research-meets-action" acknowledges that there needs to be a feedback loop between science and policy so they inform and re-inform each other.

M2ARA is an example of using the integrative framework to design a health-centered SD project, and it also illustrates the pivotal socio-technical innovation role and catalytic role of the University in the face of a complex human-environment issue. At the beginning, when researchers listened carefully and respectfully to impassioned community concerns, and throughout collaborative project development, the University represented itself as a knowledge resource providing technical support, as well as a social actor who could potentially engage productively with all stakeholders and help align the interests of groups of residents (those concerned, those unconcerned and those neutral), town officials, and local, state and national public agencies of public health and environmental protection. H2 exemplifies the driving influence of the two primary axes of integration for SD2.0 work: (1) Socio-political stakeholder interests, influences and relationships; and (2) technical sectors/issues. Interdependencies among key sectors (axis 2) are becoming obvious to all: drinking water systems engineering, how drinking water

wells alter groundwater flow, the environmental dynamics of pollutants (incl. whether supply wells capture plumes of pollution), industrial activities as sources of pollution, exposure scenarios and health risks, public policy and regulation where public health and environmental protection intersect. The third axis of integration—(3) Knowledge types (incl. scientific and indigenous)—rounds out the primary influences on the project design and deployment. Paying attention to these first three axes of integration drives the fourth—development of socio-technical capacities to understand and respond to problems in an adaptive fashion presently, and going forward.

4.2 Sustainable Agriculture, Central Massachusetts

In another example of placing human health and wellbeing at the core of SD2.0 work, Clark University is the innovation driver, catalyst, enabler and knowledge creator/integrator for a partnership to further sustainable agriculture and food systems in Central Massachusetts. The main partners are: Central Massachusetts regional Planning Commission (CMRPC), a public regional planning agency with an agriculture and transportation focus; Regional Environmental Council of Central Massachusetts (REC), a community-based organization with an environmental justice and food security focus; and Lettuce-be-Local (LBL), a non-profit with a focus on promoting the production and consumption of healthy, locally grown organic food. The partnership is working to assemble secondary data on regional-scale food production, distribution, and consumption, and is creating an interactive information resource using cloud-based GIS. The goal of the work is to understand the existing food and agriculture system (baseline or business-as-usual scenario), and its relative social, economic and ecological sustainability, and to compare it—using those same sustainability indicators—to alternative system designs that increase the connectivity among producers, distributors, retailers and consumers. Results so far reveal very low supply-chain connectivity exists and very low sustainability, with many large-scale consumers (10 colleges and universities, 2 major hospitals, and a growing biotechnology sector) in the City of Worcester (population 180,000 in 2010), sourcing almost all their food from outside the region. This occurs despite the fact that the Central Massachusetts Region has one of the highest densities of small and mid-sized organic farms in the US (USDA 2015). Sectoral integration is happening, with explicit interactions being explored among the following: food and agriculture; public health; water resources; ecology; climate change; transportation; energy; local and regional livelihoods and economies. All five of the axes of integration are being used as the organizing framework for project design and execution. Among the socio-technical capacities, Seed Political and Financial Capital (capacity i of axis #4), is being built in the form of grant-writing and applications for funding. In some of these applications, the University is the lead applicant (e.g. in federal research funding), while in others

CMRPC, REC or LBL are the lead applicants, with the University as the partner providing technical and research support.

4.3 Climate Resilience Project, Fijian Islands

To illustrate the international context for SD2.0/Climate-Change Resilience using this approach, we turn to the Fijian Islands. For the past decade or so, Fiji has been experiencing more frequent, intense flooding each year, representing a significant change in their weather and climate. Island nations are among the most vulnerable places on Earth to the adverse impacts of climate change and climate instability, because of inundations from sea-level rise, flooding from intense, prolonged precipitation, and from severe storms that wreak havoc on populations, vital infrastructure and settlements (IPCC 2014). The good news is that development funders like the UN, World Bank, Asian Development Bank, European Union and others are making *climate-change resilience* a priority. However, at the same time more funding is being made available to island nations to become 'climate-change resilient', this is exposing the urgent need to build sufficient socio-technical capacity (axis #4) to design and execute resilience projects that can work and be adaptive to highly dynamic and uncertain conditions. As always, the first task has been to understand existing approaches to development (incl. governance), development sectors and socio-technical systems (food, water, energy, transportation, health/EMS, telecommunications, flood mitigation, disaster preparedness and response etc.) and their relative resilience/sustainability. In addition, climate-change scenarios of the future and recent climate data are being used to better come to terms with climate stressors that have occurred or are likely to occur, even though exactly when and at what precise intensity are irreducibly uncertain. This can be thought of as the *envelope of plausible futures* to which Fiji needs to become more resilient, where climate resilience is being defined as: the ability to bounce-back from climate shocks to the system, to mitigate, avoid and/or reduce adverse impacts.

The Fiji case exemplifies the need to integrate socially, technically, and across sectors to build a socio-technical system with sufficient climate-resilience capacity at the scale of the whole nation. The kind of SD2.0 System shown in Fig. 1—integrating across stakeholders and sectors in each location, and across locations through knowledge cores (capacity iii of axis #3)—represents such an innovative SD2.0/Climate Resilient system design. Presently, as in many places around the world, development projects tend to be top-down, single sector/issue based, not networked and driven by technology, leading to a fragmented compromised socio-technical system with inherently weak resilience and sustainability. In economic terms, this means that development funding is not being used in ways that yield cost-effective, sustainable solutions to complex socio-ecological problems that have major social, economic and ecological implications. Funding is not the limiting factor in these cases, it is the inability of donors and recipients to think and act

in sufficiently creative, integrative ways. The roles of the University as innovation driver in this context are essentially the same as before—catalyst, enabler and knowledge creator/integrator—but there is a particular emphasis that needs to be placed on its socio-political role in bringing donors, policy makers, agencies, civil society and local communities, and businesses together to create innovation networks. Given the socio-political complexity of development policies, programs and projects on a global scale—which the Fiji case exemplifies—the most effective driver and catalyst for such SD2.0/Climate Resilience work would be a *core partnership* comprising the University (or a focused network of colleges and universities), the Donor(s), Government Agencies, and a new generation of NGO—NGO2.0—that has a socio-technical integration mission (and networks with the NGO and CBO community).

5 Conclusion

A 'university of consequence' in the 21st Century must carefully and strategically consider its role in how society understands and responds to the inherently complex challenges and opportunities for 2nd generation sustainable development—SD2.0—in an unstable, climate-changing world. The University's traditional role of educator and researcher needs to be amplified, not fundamentally changed, because no stakeholder group is better qualified to play the crucial role of catalyst and facilitator of SD2.0 innovation work, knowledge integrator and translator, and connector among diverse stakeholder interests and capacities to create socio-technical innovation networks. Five axes of integration serve as a useful organizing framework to frame, design, deploy and assess SD2.0 projects: (1) socio-political stakeholder interests and influences; (2) development sectors/issues; (3) knowledge types; (4) socio-technical capacities; and (5) connections among sites with SD2.0 projects, forming an innovation network. Thus, the University's role also extends to project designer—in partnership with other key actors in civil society, non-profits, public policy and the business sector. Perhaps the most important contribution it can make, however, is exercising the creative imagination of its faculty and students to exemplify the underlying principles of sustainable development—integrative social justice, ecological stewardship and economic vitality—and to demonstrate that paths to a sustainable future are both compelling and practical.

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Author Biographies

Timothy J. Downs is a specialist in environmental science and engineering with over 25 years field experience designing and managing collaborative projects in the UK, the United States, Latin America and Africa. His research focus is on how humans change the environment, and how those changes impact their health, wellbeing, and the ecosystems they inhabit. He works with diverse social actors to innovate through collaboration, both socially via new networks, and technically via new applications of science and technology. Downs applies risk and vulnerability science to identify priority problems with stakeholders, GIS and analytics to understand existing social and technical systems, then innovation theory and capacity building practice to design, implement and monitor more sustainable solutions. In a variety of settings—New England, Mexico, East and West Africa—he works with affected communities, NGOs, governmental agencies, public sector providers, the private sector and donors, applying multi-stakeholder, interdisciplinary approaches within and across multiple sectors: health, energy, water supply and sanitation, food and agriculture, land-use, transportation, urban planning, climate-change adaptation and mitigation, biodiversity conservation and ecosystem stewardship.

Nikita Golovko is associate professor of philosophy at the Novosibirsk State University (Novosibirks, Russia). His main research interests are in political sociology of science (context-dependent science, public understanding of science, science policy), research university

(third mission, stakeholder governance, academic capitalism) and climate change (ethics and policy). His recent publications include articles on functionalist interpretation of social ontology with an applications and examples from philosophy of education, public good theory and feminist studies. He is the author of Weltanschauung and Methodological Realism (2007) and Academic Science in Contemporary Society: Recruitment Reproduction, Adaptation Processes and Neoliberal Values (2012), co-authored with Anatoly Ablazhey. He is a long-time associate editor-in-chief of Siberian Journal of Philosophy.