



Review

Science in support of systematic leadership towards sustainability



Göran Broman ^{a,*}, Karl-Henrik Robèrt ^a, Terrence J. Collins ^b, George Basile ^c,
Rupert J. Baumgartner ^d, Tobias Larsson ^a, Donald Huisingh ^e

^a Blekinge Institute of Technology, Karlskrona, Sweden

^b Carnegie Mellon University, Pittsburg, USA

^c Arizona State University, Tempe, USA

^d University of Graz, Graz, Austria

^e University of Tennessee, Knoxville, USA

ARTICLE INFO

Article history:

Received 12 September 2016

Accepted 12 September 2016

Available online 14 September 2016

Keywords:

Leadership

Strategy

Sustainability

Sustainable development

Sustainable innovation

Sustainable societies

Transitions towards sustainability

ABSTRACT

The un-sustainable course of our societies is the greatest threat humanity has ever confronted. The biophysical systems upon which we are totally dependent have not been challenged by human activities at the global scale before and our impacts upon those planetary systems, as well as upon our social systems, cannot be adequately addressed by ad hoc solutions. Science and leadership will be required to address this threat and transform our current societies into sustainable societies. This Special Volume presents an evolving, yet increasingly cohesive, science-based perspective on leadership towards sustainability. Examples of crucial, overall questions addressed by authors of articles in this Special Volume are: How can science help to clarify sustainability as a foundational platform for success for society's core institutions (e.g. business, governance and education), and how can this platform inform envisioning, planning, monitoring, communication and decision making to accelerate the needed transitions? The conceptual framing of sustainable development in this Special Volume is based upon the logic that it is only if we can *define* sustainability in a scientifically solid way, as a frame for any vision, that we can analyze current situations in relation to such sustainable visions, and design strategies to close the gap to such visions. In moving from current situations towards possible sustainable futures, specific support in the form of leadership concepts, methods, tools, and requirements are also essential, i.e. given clarity around *what* needs to be achieved, effective leadership then requires knowing *how* to achieve it. Both the *what* and the *how* questions are addressed in this Special Volume. The research described provides a foundation for moving from ad hoc activities to systemic, systematic and strategic transitions towards sustainability.

© 2016 Elsevier Ltd. All rights reserved.

Contents

1. Introduction	2
1.1. The leadership development challenge	2
1.2. The role of science in supporting leadership for sustainability	3
1.3. Sustainability as an overarching success and leadership platform	3
1.4. Integrating facts with values and norms	3
1.5. Sustainability science - an international democratic language	3
2. Organization and contributions of this special volume	4
2.1. Motivation to act proactively and strategically	4
2.2. Strategic framing of sustainability	5
2.2.1. Engagement and know-how mutually re-enforcing	5
2.2.2. Social sustainability	5

* Corresponding author.

E-mail address: goran.broman@bth.se (G. Broman).

2.2.3.	Cross-disciplinary, cross-sector collaboration	5
2.2.4.	Strategic management in business	5
2.3.	Education	5
2.3.1.	Developing new courses – chemistry as the case	5
2.3.2.	Climate cooperation across universities	6
2.3.3.	Leadership philosophy among business students	6
2.4.	Leadership psychology and behavior	6
2.4.1.	Psychology of sustainability leadership	6
2.4.2.	Importance of role models	6
2.4.3.	Personal ambitions and behavior in politics	6
2.5.	Developing new business models and leadership approaches	6
2.5.1.	Informing business model development	6
2.5.2.	Relational leadership and implementation	7
2.5.3.	Cross-boundary governance	7
2.6.	Sustainable products and services	7
2.6.1.	Sustainability in early product innovation phases	7
2.6.2.	Product-service systems	7
2.7.	Advancing system dynamics	7
2.8.	Specific applications and supplementary support	8
2.8.1.	Personal transportation	8
2.8.2.	Leadership in the construction sector	8
2.8.3.	Material challenges	8
3.	Conclusions	8
	References	9

1. Introduction

The un-sustainable course of our societies is the greatest threat humanity has ever confronted. The biophysical systems upon which we are totally dependent have not been challenged by human activities at the global scale before and our impacts upon those planetary systems, as well as upon our social systems, cannot be adequately addressed by ad hoc solutions. (e.g. Steffen et al., 2004, 2015; Robèrt et al., 2013). The threat touch every aspect of human existence and require people to co-work systematically and strategically, everywhere and globally, to accelerate the transitions to sustainable societies.

From a systems perspective, this predicament can be looked at through a series of questions, all requiring a *yes* or at least *possibly* for success: Do we have scientific means by which we can model sustainable futures where nations, regions and organizations comply *together* with basic sustainability tenets? Do we have sufficient resources for such societies to be possible? Do we have the technical know-how to transition to such sustainable societies? Will it be possible to avoid crippling social discord during the transformation journey?

In the context of the industrialized world's current paradigm of narrowly defined economic growth as the overall success criterion, another question is often asked: Would significant sustainability efforts and changes in society not harm our economy?

Given how significant the changes are that must be made, the urgency for making those changes, and how much work that is needed to transition to sustainable societies, these questions highlight tensions and strategic challenges between ethics and economics and between short-term and long term, in the continuum from individuals, families, organizations, regions, and nations to the global scale.

In this Special Volume (SV), these questions are addressed scientifically. The objective is to seek help from science to develop a systems perspective, which can help us to create robust and cohesive knowledge of where we are today and visions of the opportunities that lay ahead of us. The challenge is dire because much of humanity is preoccupied with surviving or thriving in the

present with little emphasis on the longer-term perspective. Even well-defined near-term sustainability crises appear to be beyond general comprehension. Confounding this is the reality that the concept of sustainability is often bounded by local norms, values and perceptions. Globally, the ideas, attitudes and rituals that serve as local foundations for social organization are as varied and distinctive as the histories of locally developed beliefs, languages, priorities, competencies, and fortunes. Sustainability crosstalk between independent societies runs into this diversity of perceived realities and modes of thinking, operation and goal setting. Moreover, sustainability priorities must often run the gauntlet of incongruous politics, active disinterest and deliberately fostered confusion. These barriers impede communication and collaboration across disciplines, sectors and cultures. Yet day-by-day, the accelerating injuries of un-sustainability are plaguing all societies.

Thus, sustainability will require the co-creation of knowledge platforms that are empowered by global diversity and, at the same time, are cohesive on an overall level. The present authors argue that such cohesion can only occur by using science. Our senses do not perceive, e.g. how carbon dioxide is increasing in concentration in the atmosphere, nor what a further increase in concentration may cause in the complex system of which humanity is an integral part. Scientists must help to identify the challenges of un-sustainability, and also assist in developing overall strategies for success that are effective in the context of differences in values, norms and belief-systems.

1.1. The leadership development challenge

If one were to identify the single most important component for building 'future-safe' options, it could be the expansion of leadership, which is competent in promoting scientifically verifiable sustainable development (e.g. Metcalf and Benn, 2013). Informed and effective education is central to achieving this (e.g. Basile, 2011; Karatzoglou, 2013; Lozano et al., 2013a, 2013b; UNESCO, 2015). Similarly, business—the applied-side of human economic activities and, perhaps, the owner of the largest interface between humanity and the global biophysical and social systems—must develop and

apply new leadership competencies and concomitant management and organizational models for utilizing sustainability as a success platform (e.g. Christensen et al., 2014; Upward and Jones, 2016). Within each of these broad arenas, governance must be developed to match the sustainability challenge and to help transform it into opportunities (e.g. Ostrom, 2010). Leadership development, in all domains, must integrate the application of systemic, systematic and strategic thinking and efforts.

1.2. The role of science in supporting leadership for sustainability

The responsibility of the scientific community to support the transformation of society to sustainable development has been discussed by many scholars (e.g. Kates et al., 2001; Matson, 2009; Miller, 2013). This SV was planned and developed based upon the insight that we need a new type of science with the focus upon providing knowledge for developing and implementing comprehensive and systematic leadership for the full scope of sustainability. The motivations for this were given in the call for papers as:

- The majority of sustainability related impacts happen gradually over time as consequences of utterly complex interrelationships between ecosystems and human societies, and are not directly perceived by our senses. So we need science to help us to develop and use relevant knowledge for supporting a culture of global and societal stewardship;
- It is not enough for science to respond to the question *What is happening?* i.e. acquiring more and more empirical evidence of sustainability related impacts. An example could be the science on determining the negative societal consequences of climate change, and the evidence for the level by which human activities cause these dire problems;
- Nor do responses to the question *What will happen?* suffice, i.e. making predictions of impacts should humanity fail to put a halt to unsustainable development. Examples are all the trajectories into the future that build on the modeling of climate change;
- Nor are responses to the question *Why is this happening?* sufficient, e.g. descriptions of the tragedy of the commons and other psychological or sociological theories aiming at explaining why more is not done to stop unsustainable development; and
- It is not enough to explore responses to questions singularly of *How can we change?* i.e. to attempt to develop various solutions in isolation from other sustainability related problems and their presumptive solutions.

There is a strong need for making *much more and much better use of the results from the above types of research* and for evolving our research efforts in new, more cohesive and systematic ways. This is the next big challenge and opportunity in systems science for cross-disciplinary and cross-sector leadership and innovation for sustainability (Broman et al., 2014).

1.3. Sustainability as an overarching success and leadership platform

Emerging sustainability-science knowledge has often been perceived as bad news or even no news within today's organizations and institutions; improved understanding of climate change, biodiversity losses or the impacts of economic disparity, are usually not empowering to leadership, especially for business (Weber, 2010). The negative perception has hampered development of organizations and leadership capable of proactive actions aimed at sustainability (Hockerts, 2015). While currently the norm, the broadly negative response is not immutable as more organizations seek ways to use sustainability knowledge positively in value

creation (BSR, 2015). To allow for plurality and to spur creativity and positivity, scientifically robust conditions for sustainability should be defined, without being prescriptive with regard to the precise and detailed scenarios that can comply with such conditions. This mindset is based on an understanding of what leadership inherently is all about: to co-create an attractive vision of where to be; to identify key-areas and actors that should jointly comply with the vision, as well as current challenges and strengths from this success-perspective; and to design step-wise programs of change to get from where one is to where one wants to be, while continuously coaching, inspiring, and adapting through community building around such transformations. Articles in this SV speak directly to this.

1.4. Integrating facts with values and norms

While a critical first step in strategic sustainable development is identifying the overall sustainable vision of success using a systems-science lens, that alone is not sufficient. For complex goals, such as sustainability, in complex systems including organizations and societies in the biosphere, pragmatic contextualized know-how is also required. For example, analyses of the current situation, modeling of possible sustainable scenarios in the future, planning, management of trade-offs, choice of indicators, and inclusive and innovative community building and communication must also be performed for efforts to be effective and perceived as legitimate and credible (Larson et al., 2015). It is important to integrate emotions, values and social norms as essential elements for relevancy and motivation of action, both in their own right and for societal transformations to be sufficiently powerful (Kerkhoff and Lebel, 2006; Rauschmayer et al., 2011). Yet, we agree with Ostrom's (2009) point that generic facts and empirical evidence, when functionally contextualized, have the potential to provide a common platform for leadership in sustainable development.

The conservation laws, gravity, and the biogeochemical cycles on Earth are consistent. Scientific knowledge can be used to determine basic conditions for survival of humanity on a finite planet (e.g. Steffen et al., 2015). When used as a shared mental model for cooperation across value systems and cultures, such an approach is not a threat to our freedom to innovate and create, nor is it a threat to such polarities of opinion that are truly anchored in different values. On the contrary, the *sharing* of basic scientific knowledge used to create an adequate world-view could help us see *the true bases for polarities*, since the polarities are then not obscured by misunderstandings of basic facts and lack of basic knowledge. This can be a source of creativity, quality, trust and community building and support the successful meeting of sustainability requirements (Janssen, 2015). A shared understanding of basic knowledge of this kind (elaborated more in the next section) helps to avoid disruptive polarities that are based on misunderstandings. Differences in values and norms can then not only help processes be more cautiously scrutinized until common strategies towards shared goals are determined, but can also support more dynamic and innovative processes. Several articles in this SV directly address these dimensions and the implications for leadership development and overall success in transitioning to sustainable societies.

1.5. Sustainability science - an international democratic language

The scientific methods, developed to facilitate as unbiased studies as possible of a complex world, are shared across nations, belief-systems, norms and cultures. However, modern science not only has much to share about theory building using empirical evidence from studies of the physical world, but also about theory

building around, and experience on, how to effectively include and work with value-based differences to enrich creative and inclusive community-building processes. The collection of articles in this SV mirrors both perspectives and provides leaders, at all levels in society, with a valuable scientific foundation for their thinking, planning, operationalizing, coaching, community-building and monitoring in support of transitions to attractive sustainable futures. Using science to understand the big picture of complex goals in complex systems while the management of details is undertaken, is not only a way of avoiding reductionism and creating cohesion. Understanding and acting on something important together can be highly inspirational too.

2. Organization and contributions of this special volume

The articles in this SV represent a spectrum of new knowledge in a set of areas critical to leadership towards sustainability (see Fig. 1). The articles in the beginning of the flow address the foundations of strategic sustainable development including the motivational aspects. Several articles expand upon the social dimension of sustainability. A set of articles explores novel approaches and institutional evolution within education when leadership towards sustainability is a primary objective. Complementing educational evolution, a set of articles more directly describes the leadership context (needs and challenges) when a sustainability lens is applied.

Following this foundation of strategic sustainable development, a breadth of business and organizational model evolutions are

described, including real-world lessons of their efficacy (see boxes below in the figure). Also, specific methods, tools and approaches for product and service development, as well as a set of exemplary applications in areas from transport to fisheries, are described. Overall, the articles frame sustainability as a scientifically robust success platform linking knowledge and potential impacts at global-system scales to everyday decision-making and leadership development. Once the gap to sustainability is exposed, and an overall strategy to bridge it is established, choices informed by this overall picture can be made regarding the use of a growing diversity of supporting tools, methods, and concepts as well as more sector-specific empirical knowledge required for success on various arenas.

2.1. Motivation to act proactively and strategically

Through a framing of our current context, and in addition to this editorial, Robèrt and Broman (2016) focus on the question 'What is in it for us? i.e. the self-benefit of sustainability proactivity, or as often described, the 'business-case of sustainability'. The case is essential upfront to get leaders into the room to start learning *how* to work strategically with sustainability. The article discusses one of the most cited, yet questionable, bases for policy making around sustainable development – the prisoners' dilemma. The authors outline, in depth and in contrast to the case built around the prisoners' dilemma, the *self-benefit* of sustainability proactivity of individual actors, over and above the common benefits of sustainable development. It is not prescribed in laws regulating business how

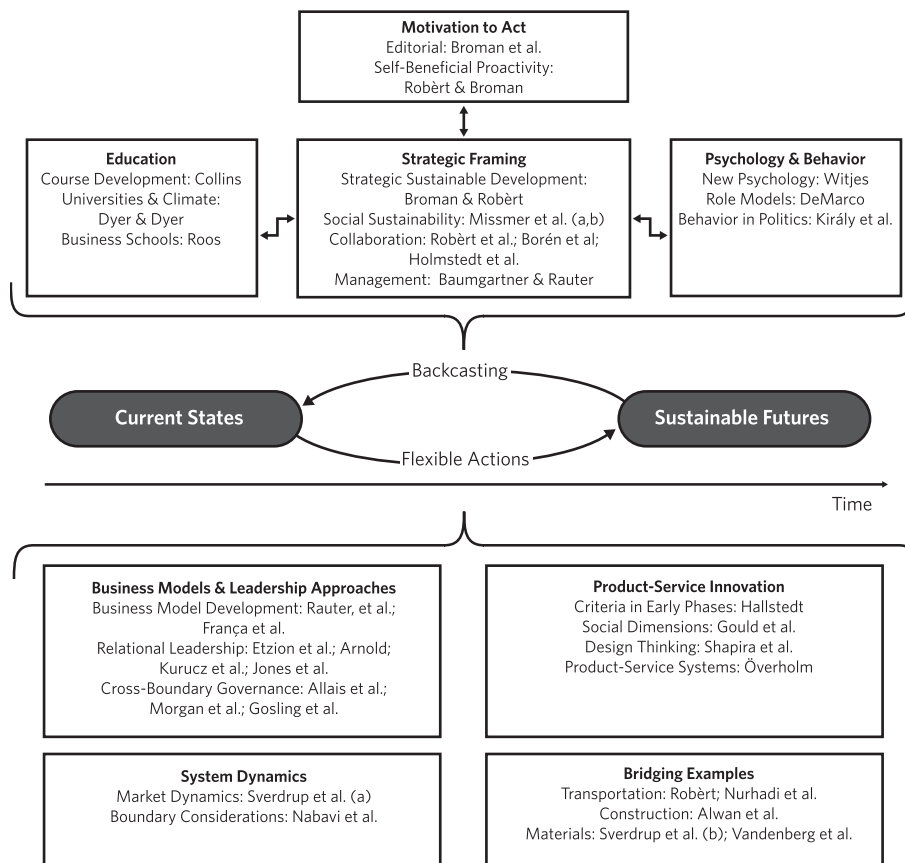


Fig. 1. Organizational overview of this SV. The top four boxes represent articles highlighting the overall sustainability-planning context, with strategic framing of sustainable success as the central element. The middle layer shows the overall process of using a definition of sustainability to frame future success, backcast from such visions and assess the current states, and develop effective strategic plans of actions towards the visions. The bottom four boxes highlight different concepts, methods, tools and other forms of support in a variety of areas that are useful for the above process.

responsibilities to future generations should be operationalized. But economic responsibilities to shareholders are. The authors argue that working strategically with sustainable development is a foundation for businesses to be able to honor those economic responsibilities. This is motivated both theoretically and by real-life examples in the article.

2.2. Strategic framing of sustainability

Once leaders understand the 'business case of sustainability' more in depth, it is of interest for them to also learn *how* to, hands-on, plan and act strategically from this big-picture perspective.

2.2.1. Engagement and know-how mutually re-enforcing

The acceptance and enthusiasm for the *why* is also intimately connected to the *how*. No matter how well understood and deeply felt the *why* might be, it is likely hard to mobilize widespread enthusiasm for acting on it if the understanding and feeling is not matched by functional know-how. The greater the competence for successfully executing in practice, the more engaging a challenge is likely to be. The Framework for Strategic Sustainable Development (FSSD) is designed to aid an understanding of the global sustainability challenge and the self-benefit of sustainability proactivity as well as hands-on co-creation of attractive sustainable futures and concrete step-wise transformations to such visions. It is the result of a comprehensive consensus process among scientists and practitioners across disciplines and sectors in an attempt at developing a unifying and structuring framework for strategic sustainable development. The third article in this SV describes the most recent version of this framework and provides many examples of its application (Broman and Robèrt, 2016).

2.2.2. Social sustainability

By far, the largest volume of studies and articles related to strategic sustainable development focus on the ecological and economic dimensions. This is despite the conceptualization of sustainability as a three-pillar concept that integrates ecological, social and economic considerations. In this SV, Missimer et al. (2016a; 2016b) present an attempt at a scientifically robust, operational definition of social sustainability. The authors examine the social system from various angles – complex adaptive system studies, human needs theory, political science and other social sciences, and insights from these fields are woven together. Certain aspects of the social system are identified to be essential and necessary to sustain, i.e. they cannot be systematically degraded if it is to be possible for people to meet their needs (Missimer et al., 2016a). By identifying overriding mechanisms by which these essential aspects of the social system can be degraded, the authors propose a hypothesis for a definition of social sustainability by basic principles, aimed to be operationally useful as boundary conditions for backcasting planning and redesign for sustainability (Missimer et al., 2016b). The definition is now being further tested in modeling sessions with social scientists, through comparisons with various protocols and codes of conduct, and through more extensive field studies in municipalities and business organizations.

2.2.3. Cross-disciplinary, cross-sector collaboration

Given the broader framing of strategic sustainable development above, individual leadership alone is not sufficient. Effective leadership is not only about intellectual and business-oriented perceptions of individual leaders per se, i.e. understanding the need and self-benefit of systematically moving towards sustainable futures. Sustainability leadership extends beyond internal organizational efforts of creating and coaching effective teams that move cohesively towards a shared objective of sustainability. It is about

iterative learning and co-creation across entire sectors, disciplines, value-chains, and other stake-holder groups. This leadership requirement too can be explored theoretically, tackled systematically, and tested empirically. Robèrt et al. (2016) present a new planning process model for repeated use of the FSSD across disciplines and sectors. The model includes four interdependent planning perspectives ('Resource base', 'Spatial', 'Technical' and 'Governance') that should be represented by respective experts and stakeholders. The model has been applied to transport system development, both as a way of developing the model and for the purpose of developing a multi-sector sustainable vision for electric vehicle systems in southeast Sweden, as described by Borén et al. (2016). In general, the new process model proved to be helpful by giving diverse stakeholders with various competences and representing various planning perspectives a common and easy-to-understand goal and a way of working that was adequate for each of their contexts. The new process model is now being further tested and developed in wider community development contexts. Holmstedt et al. (2016) also highlight the need for a shared systems perspective across stakeholder groups in community planning and development. The authors use the FSSD to guide the development of a template for district-planning analyzes, and apply this as an analytical lens for their literature review and their study of Stockholm Royal Seaport as a case. This case is likely representative for many proactive district development projects around the world. It is concluded that the vision and operational goals put forward in the Stockholm Royal Seaport program comply relatively well with the FSSD informed template. However, several important deviations are also identified. The authors assert that these deviations arise in the translation process between theory and practice and are due to a too narrow perspective on a 'sustainable urban district' among some stakeholders, as well as due to lack of structures for cooperation among stakeholders and conflicts between local and regional agendas.

2.2.4. Strategic management in business

As indicated above, business is most likely the largest interface between humanity and global biophysical and social systems and therefore play an important role in any transformation towards sustainability. Against this background, Baumgartner and Rauter (2016) use three dimensions of strategic management to explore the contributions of corporate sustainability management for the creation of value for businesses, society and nature. Sixteen propositions related to these three dimensions of strategy process, strategy content and strategy context are developed to clarify how corporations can create business value and societal value.

2.3. Education

As highlighted in the beginning of this editorial, higher education has a strong influence in shaping the mental models of many of society's professionals and leaders and is, therefore, a critical leverage point for creating sustainable societies. The Journal of Cleaner Production has published a great number of articles and eleven special volumes in the area of education for sustainable development. This is the perspective also of three studies in this SV.

2.3.1. Developing new courses – chemistry as the case

Collins (2016) reviews twenty-three years of evolution of a university course in green chemistry. Already in 1992, it was clear to the author that the challenge of transforming tertiary chemistry education to assist with leadership development for what is now called sustainability held important potential. So a course for upper level undergraduates and graduates, now titled 'Chemistry and Sustainability', was launched to build professorial and student

competence for advancing the relationships among commercial chemistry, human health and the environment. The course is outlined in a comprehensive and almost hands-on format to help interested teachers to design related courses.

2.3.2. Climate cooperation across universities

Dyer and Dyer (2016) discuss the American College & University Presidents' Climate Commitment (ACUPCC). The ACUPCC was launched in 2006 as a collective effort by higher education institutions to pursue climate neutrality in campus operations and integrate climate solutions and sustainability into their education, research, and community engagement activities. The authors conclude that the ACUPCC helped shift higher education sustainability initiatives in the U.S. from a collection of distinct programs to a strategic imperative for colleges and universities and promoted cross-disciplinary education, research, and practice needed for society to achieve sustainability. The authors note that the initiative aligns closely with the FSSD, in that (1) the system it aims to influence is global society over a long period of time; (2) success is defined by what is scientifically necessary in line with the sustainability principles of the FSSD; (3) a backcasting approach is employed as institutions set compelling visions of success by establishing a target date for climate neutrality, and evaluate their current reality in relation to that vision by completing greenhouse gas inventories and assessing education, research, and community engagement activities; (4) institutions take action and publicly report on their progress; and (5) a variety of tools are employed to support those actions.

2.3.3. Leadership philosophy among business students

Roos (2016) considers the very basis for business sustainability: The business education system. The author presents a philosophical study on a new framework for cultivating more responsible ways of thinking and acting in our current and future business students. The foundation of this framework seeks not only to complement, but to strengthen the two most common arguments for sustainability - the moral case and the economic case - with a third argument—the governance case based on Aristotle's concept of practical wisdom as the 'middle ground' of thoughtful action. The author states that practical wisdom stands between science and cunning and is the habit of acting in ways that are both ethically and economically effective, but, above all, that support the common good. The author proposes several fundamental changes of ways to educate students to start leading businesses beyond the profit motive and incomplete corporate social responsibility paradigms into responsible and sustainable practices that serve the common good.

As a whole, these articles provide a foundational context of where we find ourselves today from a resource management and institutional perspective and how a strategic sustainability lens in educational settings can create new pathways for leadership development and strategic actions.

2.4. Leadership psychology and behavior

Most of the articles in this SV have, naturally, psychological and behavioral aspects that may be hidden between the lines. Understanding the self-benefit of sustainability, stepping onboard steep learning curves to harvest such benefits, improving even more through various cooperative approaches, etc., are obvious examples of this.

2.4.1. Psychology of sustainability leadership

In one article in this SV, psychology is more directly addressed. It is a book-review by Witjes (2016) of the book *A new psychology for*

sustainability leadership; the hidden power of ecological worldviews by Schein (2015) on this interesting topic. In his book, Schein (2015) describes the outcomes of his PhD work on the identification of sustainability leadership. He presents the findings from 75 interviews of global sustainability leaders in more than 40 multinational organizations. These are used to analyze the psychological drivers of the actions of these sustainability leaders responding to 'deep sustainability initiatives'. The book is concluded with a proposition of how a new psychology for sustainability leadership can be cultivated.

2.4.2. Importance of role models

DeMarco (2016) provides the opportunity to learn from Rachel Carson's outstanding impacts to sensitize the whole world to the sustainability imperative. What kind of leadership made Rachel Carson's extraordinary impact possible, how can her strong impact on politicians, business leaders, mass-media and the general public be explained? The author argues that Rachel Carson most likely offers a role model for all generations of sustainability work to come. Through her gifted writing, she shifted public opinion to understand the interconnectedness of all living systems. She spoke out as a scientist and as an advocate in defense of the natural world. Her recommendations, based on sound science, helped to shape the initial environmental protections that evolved through the nineteen seventies. According to the author, Rachel Carson is a role model for the application of science in public policy, with an environmental ethic that can enlighten the debate over intergenerational and inter-cultural justice because the choices we face are a matter of ethics, not technology.

2.4.3. Personal ambitions and behavior in politics

Considering institutional contexts, Király et al. (2016) argue that the failure to implement sustainable politics is not merely due to the fact that successful political leaders often lack systems intelligence or foresight but that their ambitions - one of which is their motivation to survive politically - strongly influence their judgments. The authors suggest that political leaders' main focus is to increase the chances of their own political survival, drawing upon their systemic understanding. By analyzing how this motivation affects environmental policy-making, the authors promote a search for new avenues in thinking about more sustainable political leadership.

2.5. Developing new business models and leadership approaches

Having explored foundational ideas such as motivation, strategic framing for sustainability, education and leadership psychology and behavior, the SV now moves to more specific areas, relevant for diverse actors who want to align their specific areas and interests with an overall strategic sustainable development perspective. New models for businesses and their operations and new leadership approaches are explored first.

2.5.1. Informing business model development

Business models have received much attention in recent years due to their importance in the fundamental logic of every company. Rauter et al. (2016) present an empirical study conducted in cooperation with ten Austrian companies. The authors suggest that the results allow for a deeper understanding of the motivational aspects and drivers needed for developing business models for sustainability and serve as a basis for further research in this field. For example, the results imply a need to go deeper into the development of business models informed by the big-picture strategic sustainability perspective outlined in the early articles of this SV. França et al. (2016) argue that business models in general

fail to sufficiently embrace the strategic dimension of sustainability. The authors explore a generic and widely accepted tool for business model design, The Business Model Canvas (BMC), and show how the content and meaning of the building blocks of the BMC can be enhanced by using the FSSD to bring sustainability depth into the innovation and design of business models.

2.5.2. Relational leadership and implementation

New business built upon a sustainability foundation must be supported by further developing the means to successfully lead and manage within and between the businesses. Leadership founded upon the sociological concept of robust action, is presented by Etzion et al. (2016). This concept provides a broad canvas for new sustainability-informed leadership and management styles within business and other organizations. In this approach, leaders are encouraged to embrace ambiguity (rather than to strive for clarity), to focus on short-term accomplishments (rather than long-term goals), and to be satisfied with oblique movement (rather than linear progress). The authors explore three strategies - participatory architecture, multi-vocal inscription and distributed experimentation - and examine these in three sustainability related contexts: wind power, sustainability reporting and microcredit. Arnold (2016) proposes that co-creation and relationship management concepts should be linked to provide better support for sustainable value chain management. The author studied nine companies and conclude that co-creation processes are typically not yet focused upon the whole value chain, and thus, usually do not integrate different stakeholders to minimize negative ecological and social impacts. The author suggests that sustainability relationship management should be anchored in a specific department. Kurucz et al. (2016) also discuss relational leadership and how leaders should accept the role of bringing actors from different arenas together by implementing the FSSD as a shared framework to make cooperation effective. The article has similarities with the article by Robèrt et al. (2016) on a process model for repeated use of the FSSD across disciplines and sectors in community planning and development. The article by Kurucz et al. (2016) also suggests that their leadership perspective should influence business model development, which represents a link to the article by França et al. (2016). Specifically, for 'technical organizations', Jones et al. (2016) highlight that sustainability leadership and implementation rests, to a large part, with the many engineering teams responsible for meeting clients' needs and organizational targets. The authors conclude that project managers and line managers have to influence team members to adopt the moral characteristics necessary to engineer sustainable projects as part of everyday practice, and the authors propose a framework to orient and ground the reflective practices of engineering managers.

2.5.3. Cross-boundary governance

Also Allais et al. (2016) propose active leadership as the key element to bring sectors together, and the authors develop a governance maturity grid. The authors suggest that this grid enables both the assessment and the improvement of current strategic and operational practices regarding sustainability. In two implementation cases the authors learned that their maturity grid helped promote senior management's reflection on their current strategies regarding value creation systems, and that it supported the management in their definition of sustainable strategies and the means of achieving them. Morgan et al. (2016) adapt the FSSD and the Individual Social Material (ISM) framework to analyze how large retailers frame consumer behavior change-mechanisms. The results of the eighteen initiatives analyzed show that the vast majority were not well planned nor were they strategically coherent. The authors conclude that leaders of retail businesses and

policy makers could use the FSSD to ensure that processes, actions and measurements are comprehensive and integrated, in order to increase the materiality and impact of their initiatives to reduce consumer emissions in use. Furthermore, the authors conclude that retailers could benefit from exploring different models of behavior change by the ISM framework in order to access a wider set of tools for transformative system change. In a complementary study, Gosling et al. (2016) conclude that very few studies on sustainable supply chain management include both the leadership and learning perspectives. The authors propose a conceptual framework on how local companies assuming a leadership role can initiate and disseminate sustainable practices across actors in their supply chains.

2.6. Sustainable products and services

Much work has been done on integrating sustainability thinking into product and service innovation and much of that work has been published in the Journal of Cleaner Production. There are several articles on this theme also in this SV.

2.6.1. Sustainability in early product innovation phases

Hallstedt (2016) presents an approach for identifying and developing sustainability criteria based on the sustainability principles of the FSSD and product life-cycle phases. The author also provides a measurement scale for the criteria, called a Sustainability Compliance Index, intended to indicate to what degree a product or process concept performs in relation to a 'sustainable solution'. The general purpose is to provide support for including sustainability considerations in the early phases of the innovation process. Gould et al. (2016) also contribute to this field. Specifically, the authors apply the new social sustainability principles of the FSSD in a product innovation context, and present and discuss an attempt at using these new principles among product developers to analyse product concepts with respect to social sustainability. Shapira et al. (2016) use the FSSD as a lens to examine the potential of Design Thinking and suggest a prototype for an integrated approach.

2.6.2. Product-service systems

Överholm (2016) highlights that when developing product-service systems, cooperation need not be restricted to traditional value chains, but could and should also include other stakeholders, such as financial institutions and politicians. Wider multi-stakeholder cooperation generally allows for and catalyzes an increased focus on functionality of a product rather than the physical product itself. The provider might retain the ownership and control of the physical product, which implies a potential from a sustainability point of view. The author argues that a key to the growth of product-service system solutions and business models may be intermediary firms, purpose-built to create links among manufacturers and customers, and discusses the types of alliances and the alliance formation processes needed for such intermediary ventures.

2.7. Advancing system dynamics

Further process support that goes well with and supplements the FSSD and its repeated use is presented and discussed by several authors. Sverdrup et al. (2016a) show how System Dynamics modeling can be used to handle complexity across the public and private domains. The authors show how this tool can be applied to study interdependencies among actors. The Tragedy of the Commons is studied specifically in relation to a case of resource exploitation in shrimp farming in East Asia (Sverdrup et al., 2016a).

The authors conclude that a market economy can only be sustainable and really free, when embedded in a systemic and balanced interplay among private and public actors, and that the provision of the market arena with well thought-through rules of the game, offered by a well-functioning democratic society, is needed. Nabavi et al. (2016) also discuss System Dynamics and how it can be used and misused in the sustainability context. The authors specifically discuss the importance of system boundary setting when using System Dynamics modeling and exemplify this by some real examples.

2.8. Specific applications and supplementary support

Finally, a number of specific examples are given, which bridge theory and practice.

2.8.1. Personal transportation

Robèrt (2016) discusses how the macro-perspective of sustainable transport planning can be integrated with internal travel analyses at the organizational level. From a holistic global perspective, both these subsystems should share common visions and long-term targets for sustainability. At present, there is rarely mutual understanding among public and private parties, which risk creating tight bulkheads among providers and users in the transport systems. The author presents a case study of a local travel planning network in the largest business district of Sweden. Some major companies have effectively merged forces with public authorities in a joint venture for more sustainable personal travelling in the district. Nurhadi et al. (2016) develop and test a novel approach regarding car transportation in small town areas in Sweden. The approach is designed to compare sustainability effects (mainly approximated through carbon dioxide emissions) and total cost of ownership of various business models (Regular Purchase, Car Pooling, Car Leasing, and Taxi) applied to private cars with different energy carriers (Biogas, Ethanol, Gasoline, Plug-in Hybrid, and Electric). The results indicate that out of all the vehicles, the electric vehicles are the best—both from an ecological and economic perspective.

2.8.2. Leadership in the construction sector

Alwan et al. (2016) argue that many sustainability related impacts from the construction sector stem from ineffective leadership, ingrained cultures, outdated technologies and poor logistics. The authors recommend bottom-up approaches and propose the use of the Building Information Modelling tool, integrated with the FSSD, to support such approaches and with that more effective leadership in the construction sector.

2.8.3. Material challenges

Two articles highlight and exemplify current and future resource challenges and today's institutional contexts. The authors address the sustainability leadership opportunities that the challenges create—if proactive stances are taken. Sverdrup et al. (2016b) use modeling tools to assess metal supply from a sustainability perspective, as input to policy. The authors conclude that when supplies from mines dwindle, measures such as recycling from society's stock, substitutions to other materials than metals when this is possible, and reduced dissipative uses, will become important mitigation actions, calling for reorganization of resource policies world-wide. Vandenberg et al. (2016) consider plastics and their replacements using a broad sustainability lens. The authors explore questions of how plastics, and materials in general, should be developed and replaced when sustainability is a success platform. Together, these two articles provide a physical backdrop for

how leadership must evolve under the pressure of sustainability challenges.

3. Conclusions

The call for papers for this SV was designed to attract scientists with a wide perspective on the sustainability challenge and the related opportunities, and with an interest to help leaders in business and policy apply this perspective for envisioning, analyzing, planning, and monitoring of transitions towards sustainability. The included articles provide a diversity of helpful perspectives and support, all with some common denominators, inherent to the call.

First, science is a democratic language and a process, designed to help people avoid as much bias as possible and to distinguish between solid theories and empirical evidence on the one hand, and superstition on the other. We need this to bring cultures, nations, regions, sectors, organizations, and disciplines together for a common cause: to re-design societies so that humanity can prosper within sustainability constraints, and to find viable systematic approaches towards sustainability.

Second, the strategic imperative, although it is highly complex in nature, can be relatively easy to outline. It is important to not let complexity at the level of detail suffocate this same outline. Modern natural and social sciences can help us: (i) to define sustainability in an operational way and model futures where all actors comply with the sustainability definition *together*, (ii) to analyze the current situation of various organizations, sectors, regions and nations in relation to such visions, and after the big-picture visions and gaps are outlined, (iii) to model possible solutions and enter strategic approaches towards such visions.

Third, it is only when the gaps to full ecological and social sustainability are clearly outlined, and overall plans to overcome the gaps are developed, that various actors can make effective use of more specific know-how and support for sustainable development. The scientific community has provided extensive advice in topic-specific challenges, e.g. regarding energy- and transport planning, construction, and chemicals and materials use. The scientific community has also provided many instruments for decision-support and community building, e.g. system dynamics modeling, product development, business development and communication and education. Additionally, scientists have developed many insights regarding the governance of transitions, e.g. how to help representatives of different sectors and disciplines to work effectively *together*, and how to design laws and other incentives to support sustainable development.

Finally, rigorous norms for iterative learning and improvement are needed. The systemic, systematic and strategic approach to sustainable development provided in this SV implies that it must also itself be continuously scientifically scrutinized, challenged and refined, while being applied and tested in reality.

The articles of this SV jointly provide the above conclusions. In simpler terms: When it comes to sustainability, science cannot only help people solve specific problems, but it can also provide a solid, strategic systems-derived overview that is relevant to all of humanity as well as for each actor. The main contribution of the articles of this SV is to show how science can help leaders, at all levels in society, avoid reductionism and thereby become systematic and strategic when it comes to sustainable development. The editorial team welcomes your feedback on the articles as well as the SV as a whole. We also hope you will build upon the essence of these articles as you proceed with your research, teaching and implementation of the urgently needed changes.

References

- Allais, R., Roucoules, L., Reyes, T., 2016. Governance Maturity Grids: a Transition Method for Sustainability Integration into Companies? *J. Clean. Prod.* 140 (Part 1), 213–226.
- Alwan, Z., Jones, P., Holgate, P., 2016. Strategic Sustainable Development in the UK Construction Industry, through the Framework for Strategic Sustainable Development, Using Building Information Modelling. *J. Clean. Prod.* 140 (Part 1), 349–358.
- Arnold, M., 2016. Fostering Sustainability by Linking Co-creation and Relationship Management Concepts. *J. Clean. Prod.* 140 (Part 1), 179–188.
- Basile, G., 2011. What is the worth of a degree in sustainability? *Sustain. J. Rec.* 4 (3), 95–97.
- Baumgartner, R., Rauter, R., 2016. Strategic Perspectives of Corporate Sustainability Management to Develop a Sustainable Organization. *J. Clean. Prod.* 140 (Part 1), 81–92.
- Borén, S.G., Robèrt, K.-H., Ny, H., Nurhadi, L., Broman, G., Trygg, L., 2016. A Strategic Approach to Sustainable Transport System Development - Part 2: the Case of a Vision for Electric Vehicle Systems in Southeast Sweden. *J. Clean. Prod.* 140 (Part 1), 62–71.
- Broman, G., Robèrt, K.-H., 2016. A Framework for Strategic Sustainable Development. *J. Clean. Prod.* 140 (Part 1), 17–31.
- Broman, G., Robèrt, K.-H., Basile, G., Larsson, T., Baumgartner, R., Collins, T., Huisingsh, D., 2014. Systematic leadership towards sustainability. *J. Clean. Prod.* 64, 1–2.
- BSR, 2015. State of Sustainable Business 2015. BSR/Globescan. http://www.bsr.org/reports/BSR_GlobeScan_State_of_Sustainable_Business_2015.pdf (accessed 16.04.03).
- Christensen, L.J., Mackey, A., Whetten, D., 2014. Taking responsibility for corporate social responsibility: the role of leaders in creating, implementing, sustaining, or avoiding socially responsible firm behaviors. *Acad. Manag. Perspect.* 28, 164–178.
- Collins, T.J., 2016. Review of the Twenty-three Year Evolution of the First University Course in Green Chemistry: Teaching Future Leaders How to Create Sustainable Societies. *J. Clean. Prod.* 140 (Part 1), 93–110.
- DeMarco, P.M., 2016. Rachel Carson's Environmental Ethic - a Guide for Global Systems Decision Making. *J. Clean. Prod.* 140 (Part 1), 127–133.
- Dyer, G., Dyer, M., 2016. Strategic leadership for sustainability by higher education: the American College & University Presidents' Climate Commitment. *J. Clean. Prod.* 140 (Part 1), 111–116.
- Etzion, D., Gehman, J., Ferraro, F., Avidan, M., 2016. Unleashing Sustainability Transformations through Robust Action. *J. Clean. Prod.* 140 (Part 1), 167–178.
- França, C.L., Broman, G., Robèrt, K.-H., Basile, G., Trygg, L., 2016. An Approach to Business Model Innovation and Design for Strategic Sustainable Development. *J. Clean. Prod.* 140 (Part 1), 155–166.
- Gosling, J., Jia, F., Gong, Y., Brown, S., 2016. The Role of Supply Chain Leadership in the Learning of Sustainable Practice: toward an Integrated Framework. *J. Clean. Prod.* 140 (Part 1), 239–250.
- Goold, R., Missimer, M., Mesquita, P.L., 2016. Using social sustainability principles to analyse activities of the extraction lifecycle phase: Learnings from designing support for concept selection. *J. Clean. Prod.* 140 (Part 1), 267–276.
- Hallstedt, S., 2016. Sustainability Criteria and Sustainability Compliance Index for Decision Support in Product Development. *J. Clean. Prod.* 140 (Part 1), 251–266.
- Hockerts, K., 2015. A cognitive perspective on the business case for corporate sustainability. *Bus. Strat. Env.* 24, 102–122.
- Holmstedt, L., Brandt, N., Robèrt, K.-H., 2016. Can Stockholm Royal Seaport Be Part of the Puzzle towards Global Sustainability? - from Local to Global Sustainability Using the Same Set of Criteria. *J. Clean. Prod.* 140 (Part 1), 72–80.
- Janssen, M.A., 2015. A behavioral perspective on the governance of common resources. *Curr. Op. Env. Sust.* 12, 1–5.
- Jones, S.A., Michelfelder, D., Nair, I., 2016. Engineering Managers and Sustainable Systems: the Need for and Challenges of Using an Ethical Framework for Transformative Leadership. *J. Clean. Prod.* 140 (Part 1), 205–212.
- Karatzoglou, B., 2013. An in-depth literature review of the evolving roles and contributions of universities to Education for Sustainable Development. *J. Clean. Prod.* 49, 44–53.
- Kates, R.W., Clark, W.C., Corell, R., Michael Hall, J., Jaeger, C.C., Lowe, I., McCarthy, J.J., Schellnhuber, H.J., Bolin, B., Dickson, N.M., Faucheux, S., Gallopin, G.C., Grubler, A., Huntley, B., Jäger, J., Jodha, N.S., Kasperson, R.E., Mabogunje, A., Matson, P., Mooney, H., Moore III, B., O'Riordan, T., Svedin, U., 2001. Sustainability science. *Science* 292 (5517), 641–642.
- Kerckhoff, L., Lebel, L., 2006. Linking knowledge and action for sustainable development. *Annu. Rev. Environ. Resour.* 31, 445–477.
- Király, G., Köves, A., Balázs, B., 2016. Contradictions between Political Leadership and Systems Thinking. *J. Clean. Prod.* 140 (Part 1), 134–143.
- Kurucz, E.C., Colbert, B.A., Lüdeke-Freund, F., Upward, A., Willard, B., 2016. Relational Leadership for Strategic Sustainability: Practices and Capabilities to Advance the Design and Assessment of Sustainable Business Models. *J. Clean. Prod.* 140 (Part 1), 189–204.
- Larson, K.L., White, D.D., Gober, P., Wutich, A.Y., 2015. Decision-making under uncertainty for water sustainability and urban climate change adaptation. *Sustainability* 7, 14761–14784.
- Lozano, R., Lukmanb, R., Lozano, F.J., Huisingsh, D., Lambrechtse, W., 2013a. Advancing higher education for sustainable development: international insights and critical reflections. Special Volume *J. Clean. Prod.* 48, 3–9.
- Lozano, R., Lukmanb, R., Lozano, F.J., Huisingsh, D., Lambrechtse, W., 2013b. Declarations for sustainability in higher education: becoming better leaders, through addressing the university system. *J. Clean. Prod.* 48, 10–19.
- Matson, P., 2009. The sustainability transition. *Issues Sci. Tech.* 25 (4). <http://issues.org/25-4/matson/>.
- Metcalfe, L., Bann, S., 2013. Leadership for sustainability: an evolution of leadership ability. *J. Bus. Ethics* 112 (3), 369–384.
- Miller, T.R., 2013. Constructing sustainability science: emerging perspectives and research trajectories. *Sustain. Sci.* 8, 279–293.
- Missimer, M., Robèrt, K.-H., Broman, G., 2016a. A Strategic Approach to Social Sustainability - Part 1: Exploring the Social System. *J. Clean. Prod.* 140 (Part 1), 32–41.
- Missimer, M., Robèrt, K.-H., Broman, G., 2016b. A Strategic Approach to Social Sustainability - Part 2: a Principle-based Definition. *J. Clean. Prod.* 140 (Part 1), 42–52.
- Morgan, E., Foxon, T.J., Tallontire, A., 2016. Large UK Retailers' Initiatives to Reduce Consumers' Emissions: a Systematic Assessment. *J. Clean. Prod.* 140 (Part 1), 227–238.
- Nabavi, E., Daniell, K.A., Najafi, H., 2016. Boundary Matters: the Potential of System Dynamics to Support Sustainability? *J. Clean. Prod.* 140 (Part 1), 312–323.
- Nurhadi, L., Borén, S., Ny, H., Larsson, T., 2016. Competitiveness and Sustainability Effects of Cars and Their Business Models in Swedish Small Town Regions. *J. Clean. Prod.* 140 (Part 1), 333–348.
- Ostrom, E., 2009. A general framework for analyzing the sustainability of social-ecological systems. *Science* 325, 419–422.
- Ostrom, E., 2010. Polycentric systems for coping with collective action and global environmental change. *Glob. Environ. Change* 20 (4), 550–557.
- Överholm, H., 2016. Alliance formation by Intermediary Ventures in the Solar Service Industry: Implications for Product-service Systems Research. *J. Clean. Prod.* 140 (Part 1), 288–298.
- Rauschmayer, F., Omann, I., Frümman, J. (Eds.), 2011. Sustainable Development: Capabilities, Needs, and Well-being. Routledge.
- Rauter, R., Jonker, J., Baumgartner, R.J., 2016. Going One's Own Way: Drivers in Developing Business Models for Sustainability. *J. Clean. Prod.* 140 (Part 1), 144–154.
- Robèrt, M., 2016. Engaging private actors in transport planning to achieve future emission targets – upscaling the Climate and Economic Research in Organisations (CERO) process to regional perspectives. *J. Clean. Prod.* 140 (Part 1), 324–332.
- Robèrt, K.-H., Broman, G., 2016. Prisoners' Dilemma Misleads Business and Policy Making. *J. Clean. Prod.* 140 (Part 1), 10–16.
- Robèrt, K.-H., Broman, G., Basile, G., 2013. Analyzing the concept of planetary boundaries from a strategic sustainability perspective: how does humanity avoid tipping the planet? *Ecol. Soc.* 18 (2), 5.
- Robèrt, K.-H., Borén, S.G., Ny, H., Broman, G., 2016. A Strategic Approach to Sustainable Transport System Development - Part 1: Attempting a Generic Community Planning Process Model. *J. Clean. Prod.* 140 (Part 1), 53–61.
- Roos, J., 2016. Practical Wisdom: Making and Teaching the Governance Case for Sustainability. *J. Clean. Prod.* 140 (Part 1), 117–124.
- Schein, S., 2015. A New Psychology for Sustainability Leadership: The Hidden Power of Ecological Worldviews. Greenleaf Publishing Limited, Aizlewood's Mill Nursery Street, Sheffield S3 8GG, UK.
- Shapira, H., Ketchie, A., Nehe, M., 2016. The Integration of Design Thinking and Strategic Sustainable Development. *J. Clean. Prod.* 140 (Part 1), 277–287.
- Steffen, W., Sanderson, A., Tyson, P.D., Jaeger, J., Matson, P.A., Moore III, B., Oldfield, F., Richardson, K., Schellnhuber, H.J., Turner, B.L., Wasson, R.J., 2004. Global Change and the Earth System: a Planet under Pressure. Springer-Verlag, Berlin, Heidelberg, New York. ISBN 3-540-40800-2.
- Steffen, W., Richardson, K., Rockström, J., Cornell, S.E., Fetzer, I., Bennett, E.M., Biggs, R., Carpenter, S.R., de Vries, W., de Wit, C.A., Folke, C., Gerten, D., Heinke, J., Mace, G.M., Persson, L.M., Ramanathan, V., Rayers, B., Sörlin, S., 2015. Planetary boundaries: guiding human development on a changing planet. *Science* 347. <http://dx.doi.org/10.1126/science.1259855>, 1e10.
- Sverdrup, H.U., Koca, D., Belyazid, S., Ragnarsdottir, K.V., 2016a. Defining a Free Market: Drivers of Unsustainability as Illustrated with an Example of Shrimp Farming in the Mangrove Forest in South East Asia. *J. Clean. Prod.* 140 (Part 1), 299–311.
- Sverdrup, H.U., Koca, D., Ragnarsdottir, K.V., 2016b. An Assessment of Metal Supply Sustainability as an Input to Policy: Security of Supply Extraction Rates, Stocks-in-use, Recycling, and Risk of Scarcity. *J. Clean. Prod.* 140 (Part 1), 359–372.
- UNESCO, 2015. UNESCO's Education 2030 Incheon Declaration and Framework for Action (accessed 16.04.25). http://www.unesco.org/new/fileadmin/MULTIMEDIA/HQ/ED/ED_new/pdf/FAA-ENG-27Oct15.pdf.
- Upward, A., Jones, P., 2016. An ontology for strongly sustainable business models defining an enterprise framework compatible with natural and social science. *Organ. Environ.* 29 (No. 1), 97–123.
- Vandenbergh, L.N., Luthi, D., Quinerly, D., 2016. Plastic Bodies in a Plastic World: Multi-disciplinary Approaches to Study Endocrine Disrupting Chemicals. *J. Clean. Prod.* 140 (Part 1), 373–385.
- Weber, E.U., 2010. What shapes perceptions of climate change? *Wiley Interdiscip. Rev. Clim. Change* 1 (3), 332–342.
- Witjes, S., 2016. A New Psychology for Sustainability Leadership: the Hidden Power of Ecological Worldviews; a Book Review. *J. Clean. Prod.* 140 (Part 1), 125–126.