Article

The Sustainability Revolution: A Societal Paradigm Shift

Tom R. Burns [1,2,*]

[1] Department of Sociology, Uppsala University, Uppsala, SE-75126, Sweden
[2] Woods Institute for the Environment, Stanford University, Stanford, CA 94305, USA

[*] Author to whom correspondence should be addressed; E-Mail: tomburns@stanford.edu;
Tel.: +46-708247050; Fax: +46-184715170.

Abstract: This article addresses a question relevant to those interested in the achievement of greater sustainability: What are some of the ways that major societal transformations come about? Firstly, four key mechanisms are identified in the article. Then, I go on to focus on one of these, which has a prominent place in the sustainability revolution that it is argued is now taking place. The question of what are characteristic features of the sustainability revolution is addressed. The ongoing transformations are largely piecemeal, incremental, diffuse—in earlier writings referred to as "organic". Organic is a more encompassing notion than "grassroots", since the innovation and transformation processes may be launched and developed at multiple levels by collective agents that in some cases are very large and would not be understood as "grassroots" actors. The article argues that the sustainability revolution shares some features, in particular its organic character, with the early industrial revolution. It concludes by addressing the question of what are the similarities and differences between the sustainability and industrial revolutions.

Keywords: global environmental change; paradigm shift; sustainability; transformation; revolution

1. The Crises of the Planetary Environment and the Emergence of the Sustainability Paradigm [1]

There is a substantial scientific consensus that the major global environmental threats are the consequences of human actions: overconsumption of precious resources (such as water, forests, fossil fuels), destruction of ecosystem services, unsustainable land practices, the unabated release of toxic chemicals, and emissions driving climate disruption. Also recognized are the steps most scientists believe essential for addressing these threats: reducing greenhouse gases, establishing biosphere reserves, protecting endangered populations and species and other critical resources, regulating chemical releases, limiting human population growth, and regulating excessive consumption patterns, especially among the rich.

Despite these widely held scientific views, the policy decisions needed to deal with these threats have been disappointing—arguably not up to the level necessitated by the challenge. Meanwhile, the accumulation of greenhouse gases (GHGs) continues unabated (and humanity still lacks a clear agreement or strategy for enforceable reductions), species extinction rates accelerate to thousands of times "background" extinction rates, and more and more toxic compounds accumulate from pole to pole.

A short look backward—to the decades just before the current millennium—reveals the remarkable acceleration in the pace, scale, and spread of human impacts on the global environment [2]. Looking forward, greenhouse gases now in the atmosphere will remain there for a millennium; will increase by releases to which we are already committed, and will almost certainly contribute to weather extremes, flooding and drought, which will seriously affect agriculture. This, plus the spread of tropical diseases, increased vulnerability to vast epidemics, sea level rise, and more severe storms, will reduce (are already reducing) the welfare of many human communities and populations. A biosphere catastrophe (beyond one or more of several tipping points) threatens to wreck the economy and society as we know them [3].

Global environmental change touches upon every facet of human existence—health, diet, leisure, quality of life, every day practices; production, consumption, education, research, politics, and societal values. However grandiloquent it sounds, no human goods—life, love, liberty, the freedom to pursue a meaningful existence—can be enjoyed without the flourishing of life on earth.

The following Figures 1 and 2 show the exponential growth since the 1760s of "drivers" of environmental change (the systems producing increased garbage, cars, water consumption, fossil fuel consumption, tourism, *etc.*) and the physical impacts (also, exponential growth curves): gas emissions, fisheries collapse, tropical deforestation, bio-diversity loss, and much more.
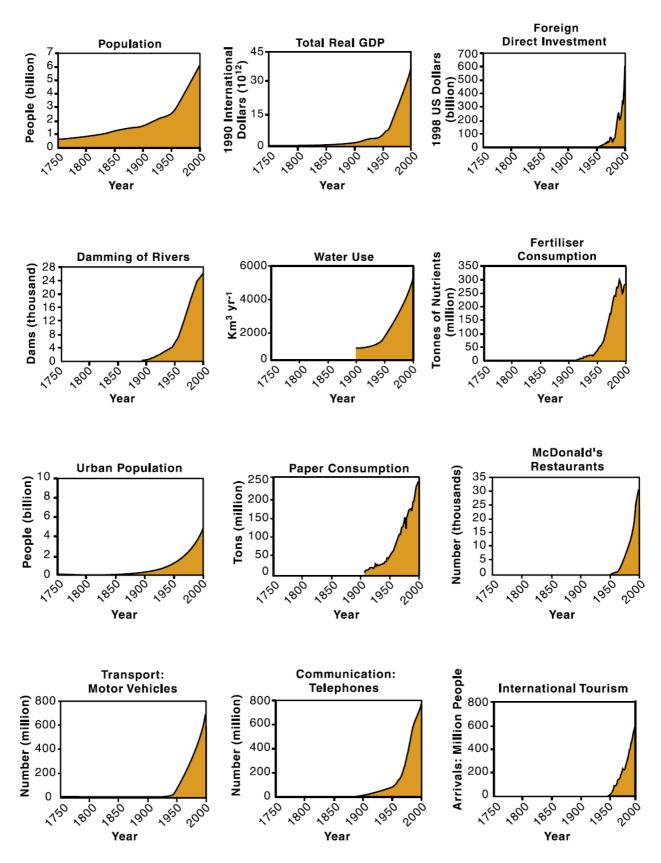
Modernization—whichever its current forms and however it is brought about—appears to make human life increasingly unsustainable on this planet. One of the issues—and challenges raised by contemporary research—concerns what possible forms of modernization are sustainable and how they might be accomplished.
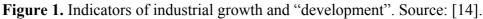
The "sustainability revolution" is exploring this issue in diverse ways. While the subject matter of this article shares much in common with Andres Edwards' important book, *The Sustainability Revolution* [4], my approach is that of sociological and social science analysis, grounded in theories of institutions and governance [5], paradigm shifts [6], and societal transformations [7,8]. It is important to stress that "sustainability" and "sustainable development" are political and normative ideas such as "democracy", "social justice", "equality," "liberty", etc. rather than precise and scientific concepts; as

such, they are contested and part of struggles over the direction and speed of social, economic, and political initiatives and developments [9,10]. Baker [9,10] emphasizes that they become particularly meaningful and effective in concrete settings where they are to be operationalized, put into practice—they thus serve constructive purposes.

In the face of the daunting problems and dilemmas there is an acute challenge to strive for significant reforms of our ways of thinking, organizing, and acting. How can societies slow down these processes, possibly mitigate them? Already, there are emerging new concepts, scientific efforts, policy schemes, a new language, an organic transformation of ways of thinking, judging, and acting, *etc.*, as discussed below. A societal paradigm shift is taking place—whether the transformation is fast enough or comprehensive enough to save the planet remains to be seen. Such a paradigm consists of a socially shared cognitive-normative framework—in values, norms, beliefs, and strategies—and typically entails new principles of social organization (see related work on public policy paradigms and their shifts [6]). It need not be coherent or complete.

The paradigm concept is of course most often associated with Thomas Kuhn's work, and it continues to be widely used in a manner closer to Kuhn's original usage [6] also, see Capra [11], among others. *How well suited the concept is to describe and analyze conceptual developments in the natural or social sciences has remained a subject of controversy, but that is a separate matter and not a debate to be taken up here.* My claim is that a paradigm concept is very suitable to the analysis of societal, institutional, and public policy developments which are shaped and governed by societal agents (scientists included) sharing and developing *cognitive-normative frameworks*. Elsewhere several of us have specified and empirically tested the "architecture of social paradigms" (see [6,12,13]). Capra [11] considers and argues for a "scientific revolution", and, in particular for a shift from a mechanistic to an ecological paradigm (grounded in scientific ways of thinking). He indicates that he believes society *requires* such a radical paradigm shift in its shared perceptions, values, judgments, and practices. Indeed, he believes this shift is already taking place. In this way, he also tries to extend Kuhn's notion: (i) from the scientific domain to society as a whole and (ii) from a descriptive tool to a normative one—what is required, *what should be done.* While the Captra's ecological paradigm shares some commonalities with the sustainability paradigm outlined in this article, my proposal entails a social scientific model (not a normative model) with a focus on the agents of change, the general mechanism whereby changes are taking place, and a stress not only on new values and cognitive frames but on social organizational and institutional changes taking place, for instance in the area of governance.
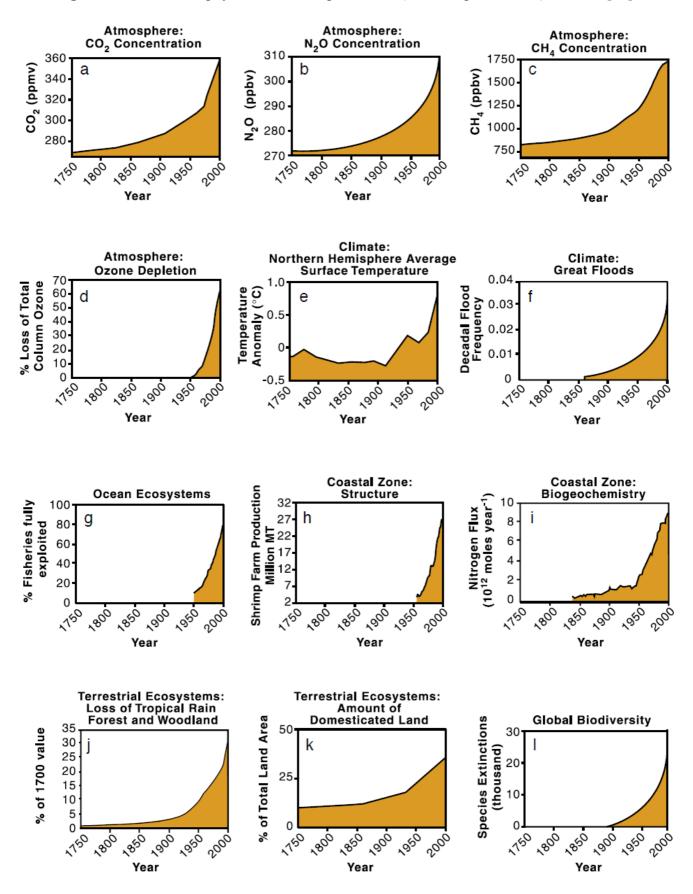
Figure 1. Indicators of industrial growth and "development". Source: [14].

Figure 2. Indicators of physical and ecological stress (and changes in stress). Source: [14].

2. Paradigm Shifts and Societal Transformations: Meta-Power and Social Structuring

How do major societal transformations come about, for instance in the case of systems of governance and regulation, which are key components of social paradigms? This section identifies several of the mechanisms of change All of them are observable in initiatives to reduce some of the impacts of "the human footprint" on local, regional, and global environments. One mechanism, on which we will focus because of its centrality to and extensiveness in the sustainability revolution, is what we refer to as "organic transformation" (in a certain sense, from bottom up, but this is very misleading since many collective agents involved are very large and should not be understood as "grassroots").

In spite of a great deal of excellent social science and sociological research on social change and transformation, there remain gaps and challenges. One of these shortcomings, which some of my collaborators and I have addressed in other theoretical and empirical research concerns several key mechanisms of social system formation and change, as presented below [8,13]. The research also identifies a few *key drivers explaining how social systems are established, maintained or changed through power, knowledge, and cooperation as well as contestation/conflict processes* [6,7,15].

3. Mechanisms of Social Order Formation and Transformation

Social systems are characterized by their institutional arrangements, populations of differentiated agents, organized forms of power, diversity of knowledge, and conflict/struggle within and over the systems [16,17]. Of particular interest in sociological and social science research are shifts from one system regime to another, for instance from state or public governance of goods to private (e.g., privatization of electricity or gas in the EU), or from a loosely regulated market regime (such as food in the EU) to a tightly regulated markets treated as a "commons" (for example, the security and public health aspects of food in the EU after the "mad cow" and other crises) [6].

There are several major processes whereby a societal regime may be formed or reformed [6,8]. Key factors concern not only power (and agents exercising power) and their values and interests but also the formulation and development of a paradigm concerning the design and functioning of societal and sectorial governance. The paradigm entails a type of "knowledge", although the knowledge need not be necessarily correct or contribute to effective performance of the governance regimes.

Conditions of power, knowledge (paradigms), and conflict are distinguished below in a consideration of the transition/transformation of social orders (with multiple governance systems).

3.1. Dominant Power (Autocracy) Combined with a Shift in the Agent's Cognitive-Normative Framework [18]

A hegemonic agent (or alliance) adopts or develops (as a result of a learning or persuasive process) a new governance paradigm, using its power to establish and maintain the paradigm. This may operate locally, regionally, or globally (e.g., the USA at Bretton Woods after World War II is a global example; a more local instance would be business firm headed by a powerful executive (see below)).

The hegemonic agent is able to launch a new paradigm by virtue of its position (although, typically, within some constraints). We have found in our investigations that this mechanism works in public

sector systems as well as in the private sector. For instance, in the latter case, when the CEO of BP became convinced (through the influence of an external ENGO (environmental non-government organization) of the effectiveness of a company emissions trading system, he introduced and implemented it [6].

In sum, under these power conditions, a dominant agent in a social system is able to initiate a new paradigm in order to deal with policy failures, problem-situations, or threats to regime power, or opportunities for gain [19]. Stinchcombe [20] stresses the structural factors (including the power positions of actors in social structures) which enable them to initiate developments of new organizational arrangements within existing social structures.

Of course, the agent may or may not have an interest in such initiatives or lacks sufficient political will (commitment to override other interests and values which she has).

3.2. Power Shifts

A shift in power takes place, and a new group or leadership assumes power bearing a different paradigm than the previous regime. The shift of power may occur through a democratic process (e.g., elections or a decision of a parliamentary body), a negotiation between elites, coup d'état, or revolution.

The pattern in a transformation with elite replacement is typically one of more or less open struggle for, and ultimately a shift in, domination relationships. A group, organization, or movement with a new paradigm of social order takes political power. These shifts may take place through the replacement of elites with relatively few persons or groups involved; or they may take place with substantial public participation, as in popular revolutions. Elsewhere several of my collaborators and I have considered transformative *coup d'état, popular revolutions including the 1989–1990 "Velvet Revolutions" as illustrations of paradigm change associated with major power shifts* [7,8].

3.3. A New Order Is Established Through Multi-Agent Negotiation (Possibly with Mediation or Some Arbitration in Relation to Conflicting Parties)

The negotiation may be a rather simple bilateral negotiation, or it may be a complex multi-agent negotiation process. Coleman [21] and others [6] have demonstrated that, for instance, corporatist governance arrangements lend themselves to the cumulative, negotiated, problem-solving trajectory in bringing about policy paradigm changes, for instance in Canadian agricultural policy and programs. Norwegian and Swedish economic and labor-market policies and programs set up through neo-corporatist tri-partite bargaining (business, labor, and government) functioned in similar ways, capable of establishing new regimes (reforms) but ones which were accomplished through multi-lateral negotiation and compromise rather than dramatic shifts in power.

Coleman [21] contrasts, for instance, governance shifts based on negotiation with shifts based on power replacement: "Following Risse-Kappen and Scharpf, we demonstrated that corporatist policy networks lend themselves to the cumulative, negotiated, problem-solving trajectory to paradigm change whereas state-directed or pressure group pluralist networks are more likely to be associated with crisis-driven changes…" Elsewhere several collaborators and I have empirically investigated and analyzed paradigm shifts through multi-agent negotiation (exemplified by the Kyoto Treaty, the

establishment of the international Sustainable Palm Oil Roundtable involving multiple stakeholders, among others) [6,13,22].

3.4. Paradigm Shift Through Diffusion and Emulation ("Organic" Transformation)

The first three types of paradigm transformation are characterized typically by a few identifiable, more or less organized agents, whether with few or many participants, and substantial scope of power. The transformations, even if drawn out over considerable periods of time, have a decisive character. Through particular collective actions, a new order is "legislated" and constructed, provided there are sufficient resources and a feasible design.

A contrasting modality is observable when a new type of social system is established through processes of diffusion and emulation (mimetic function) under decentralized conditions in which a multiplicity of agents make autonomous, yet similar decisions to shift to a new paradigm. On an aggregate level, there is an emergent development—the process results in transformations of prevailing governance paradigms with different agents, goals, methods, and technologies.

Such organic types of transformation entail multiple actors initiating change at local, meso-, and macro-levels, without obvious coordination or direction, although the actors are typically embedded in communication and other types of networks. The participating actors—in the purest case—have no intention to bring about the global transformation that they produce together. And the processes of transformation are diffused in time and space. It is difficult, if not impossible, to define a moment of change or transition. There are spatial and temporal continuities, at the same time that in a larger perspective, transformation emerges accomplished through the "spontaneous", uncoordinated actions of many social agents at different levels. Although an organic revolution is not directed or determined at a global or macro-level, macro-institutional conditions and polices (forming a context) are likely to affect the course of the transformation, and may provide a certain directedness for many "spontaneous processes".

4. Organic Transformations: The Case of Sustainability

This section leads off with a brief reference to the "industrial revolution" in its early organic phases. This provides a backdrop for characterizing the emerging sustainability revolution.

4.1. Early Industrial Revolution (Toward the End of the Eighteenth Century) [23]

This revolution entailed many small and medium initiatives in the emergence and transformation of technologies, institutional arrangements, social relations, and values such as those relating to the formation of factories, built environments, and entire industries. Such transformations could occur without any single agent or group of agents planning or even negotiating the overall pattern.

Much of the early industrial revolution involved then multiple agents initiating and developing a variety of innovative technologies and socio-technical systems. The transformations encompassed not only major innovations in technologies and technical systems, e.g., the invention of the steam engine, the development of mining, textile manufacturing, metal tools, optics, advances in transport, among other developments, and, of course, the shift from human/animal power to water and to coal. Critical to

all these engineering advances was the development of organizational and institutional means to govern and develop the varying technical possibilities: factory systems, methods to coordinate and control large numbers of workers, ownership arrangements, regulatory agencies, legal innovations, the ideas—and realizations of the ideas—of mechanization and of standardized mass production, and new research and educational organizations, among other constructions. The revolution encompassed also to a high degree new governance arrangements in diverse sectors combined with machines to make use of, for example coal, iron ore, and cotton on a scale and with a rapidity never achieved (or imaginable) before. In other words, there were not just machines and material technologies but organizational, legal, conceptual and normative innovations. Almost all aspects of everyday life came to be affected, but without any direct or central coordination (although later variants of industrialization (for instance, in the cases of Germany, Japan, and the Soviet Union) entailed more a top-down development guided by an overall design or blueprint)

Inventors, innovators, entrepreneurs, scientists and engineers, business leaders, and government officials took a multitude of initiatives not only to make money but to gain fame and respect, to experience the power of changing and developing themselves and the world around them, and to advance the national power of Great Britain. Tens of thousands were involved in these developments over the decades when industrialization took off. The revolutions in mining, manufacturing, transport, chemicals, and agriculture were followed by those in electricity, electronics, and communications.

The development of the industrial social order—with its technologies, experts, and governance and regulatory systems—spread from England to North America and the rest of Europe and eventually to most corners of the globe. It was characterized by, among other things, the widespread application of engineering, science, and systematic knowledge to production, products, technology and technological development, standardization, and economies of scale; the environment was exploited to the fullest for economic and related purposes, "unspoiled areas" would be defined as "wasted" and "should be effectively exploited" in the name of progress and "welfare" [24]. The great success of the industrialization paradigm reinforced the idea that humans could ignore or, at least, overcome, environmental detriments and resource problems. Consequently and progressively, industrial society engaged in a reckless and extensive exploitation of nature. This was done on the basis of faulty assumptions and conceptions of real impacts and in many instances, in ignorance of long-term consequences.

Nevertheless, historically there was substantial opposition to many aspects of industrialization: In a number of countries, for instance, in Europe and North America, concerns about industrial forms of production, pollution, water and air quality, and deforestation led to powerful reactions. NGOs were founded to promote environmental protection, conservation and wildlife protection—a whole battery of policies, programs, and parks were established. For workers, socialist and trade union movements emerged to fight for the regulation of work conditions, social protection, welfare, and justice. These movements and the governance and regulatory developments they helped bring about operated on many levels and with varying degrees of effectiveness.

4.2. The Emerging Sustainability Revolution

Today we are witnessing the initial stages of a new societal revolution comparable in scale and significance to the industrial revolution. Tens of millions of people are considering and adopting new conceptions, goals, techniques and technologies, and practices relating to a wide spectrum of environmental concerns and developments. The ongoing paradigm development—a gradual shift from the economistic, industrialization paradigm to one or more forms of a sustainability paradigm entail the establishment of new ways of thinking, acting, organizing, and regulating (in part, the establishment of a *new cognitive-normative discursive framework and context*). Sustainability ideas, norms, and values permeate an ever-increasing part of modern life and have a significant impact on everyday thinking and practices in substantial parts of the world. This is occurring not only in developed countries but also in developing ones such as China, India, and Brazil.
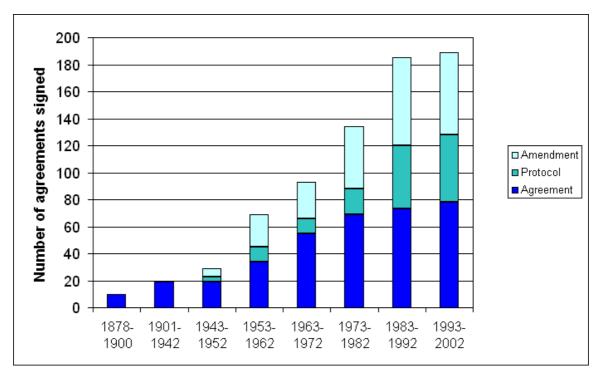
From the 1960s there has been rapidly increasing global awareness and concern about damage to the environment—Rachel Carson's book [25], the UN Stockholm Conference on the Human Environment (1972), the 1987 Brundtland report [26], the 1992 Rio de Janeiro "Earth Summit" (UN Conference on Environment and Development (UNCED)), and so on. The "Stockholm Declaration" was formulated at the 1972 Conference—a number of guiding principles for the protection of the environment were adopted. These have been critical in the successive development of other instruments [27]. For instance, in 1973 (elaborated 1978) there was global agreement on regulation of the pollution from ships (MARPOL). Also, the Convention on the Protection of the Marine Environment of the Baltic Sea Area (HELCOM) was signed in Helsinki in 1974 by all the Baltic coastal states. There were other major international agreements as well as national developments. Private initiatives also were launched. The International Council of Chemical Associations (ICCA) established "Responsible Care" in 1985. These and other private, voluntary initiatives did not lead very far, however (although arguably they contributed to the growing attention to and concern about chemicals) [6].

The Rio Declaration was published in 1992. The aims were to reduce unsustainable consumption patterns and to establish precautionary principles in relation to socio-economic and technological developments. Passage of the OSPAR Convention (1992) [28] also took place in this period—it was aimed at eliminating the pollution of the North-East Atlantic. Another important development was the launching of negotiations in the mid-1990s to eliminate releases of persistent organic pollutants (POP). The negotiations focused on the 12 most hazardous substances—the "Dirty Dozen". In a historic agreement (the Stockholm Convention or "the POPs Treaty) in Stockholm in May 2001, the nations of the world for the first time agreed to eliminate *all releases of a number of highly hazardous chemical substances* [29]. Earlier at Kyoto, 1997, three of the greenhouse gases that were agreed to be regulated are man-made chemicals (HFCs, PFCs, and SF6). Figure 3 indicates the rapid growth of international environmental agreements, some more enforced (and enforceable) than others.

From the 1960s, processes of consciousness raising, defining threatening environmental realities, mobilizing agencies, enterprises, and citizens *etc.* have been taking place, and continue to do so [30]; these processes relate to a cascade of private and public initiatives and accomplishments in addressing environmental issues and challenges. The UN, environmental agencies, many enterprises, public "intellectuals", researchers, NGOS, and media have succeeded to a greater or lesser extent in

convincing multitudes of people that the environment and human life as well as life generally are threatened on planet earth and action is necessary (this is not to overlook the deniers and opposers who make for formidable resistance (see later)) [9,10,31]. Some instances of radical steps have been accomplished such as the EU chemical directive REACH (2006) in which Swedish EU agents and pressure groups played a significant role in passing it over the opposition of the European, American, and Japanese chemical industries as well as the political leadership of Germany, France, and the UK [6].

Figure 3. Time trends of international multilateral environmental agreements by agreement type (1879–2002)**.** Diagram source: [32].

Today we are witnessing the early stages of a new *societal revolution* comparable in scale and import to the industrial revolution. This "sustainability revolution"—*sustainalization*—implies a new type of society—or family of societies. It is being forged, piece by piece ("organically", so to speak). Masses of "sustainability" designs, plans, and initiatives at different levels have been developed as people try to forge new orders (local, meso-, and –macro) as occurred in the case of industrialization. Another way of thinking about this transformation is that a "green" or sustainalization world is emerging—just as an industrial world perspective emerged in and through the industrializing process. In the "green revolution", one finds:

- The increasing stress on green values: that is, articulation and development of new values, norms, standards, in a word, the "green" normative perspective.
- An ever-growing generalized judgment that "green" patterns of action and developments are "good." And patterns and developments which are "non-green" or "anti-green" (use of high gas consumption vehicles, overuse or wastage of water or other critical resources, *etc.*) are "bad".
- New practices, for instance new accounting conceptions and standards such as "triple bottom line".

- The growing role of "green thinking, conceptions, standards and practices" in many areas of social life; there are also increasing narratives about green ideas, values, and standards, which circulate in wider and wider circles.
- The growing role of "green" entrepreneurs (for whatever reasons, they initiate projects—beliefs in a green future, profitability, pressures of competition, or combinations of such motivators).
- Green governance; new regulatory mechanisms: distinguishing "good" (green) *versus* "bad" (non-green) innovations and developments.
- Institutionalization of green standards and considerations in decision and policymaking settings in government agencies, corporations, and associations.
- Increasing stakeholder involvement in the corridors of economic and policymaking power (Friends of the Earth, Greenpeace, WWF).
- Green technological developments; design and production of new "green" technologies, development of "green" (or "greener") policies and systems [33,34].
- Greening of consumption.
- Massive experimentation (accompanied by failures, of course) with "green" initiatives. These concern not only businesses but NGOs, other private agents, government agencies, *etc.*
- New alertness and readiness to experiment or innovate with green ideas, designs, technologies and practices.

The emerging sustainability paradigm is being established then by a process of multiple initiatives facilitated by diffusion and collective learning of new values, ideas, and practices through associations, communities, business, and political networks [35]. There are not only values and beliefs shifting—and some reordering (up to now, still limited) of priorities—but governance reforms and innovations, and changes in many daily practices. The conditions of initiative and innovation encompass multiple agents who enjoy some power and means of structural control over their own situations and are able to make relatively autonomous independent decisions. This process results on an aggregate level in adaptations and shifts in the industrial paradigm complex and its particular institutional and cultural arrangements. The latter with its massive nexus are being challenged piece-by-piece by elements of the sustainability paradigm [36].

The transformation process is an organic one with many different agents at different levels driven by diverse motives and interests. Gradually, blueprints will be developed specifying standardized designs and strategies for the sustainability transformations. Industrialization was also characterized first by such a highly organic phase followed later by more blueprint-like modalities: where, for instance, Germany, Japan, the Soviet Union, and others adopted and imposed designs.

Social science research has identified some of the drivers and facilitators of the sustainability revolution: (1) normative pressures and resource and power mobilization; (2) open, new sectors are able to develop quickly on green dimensions by utilizing innovative ideas, models, methods, technologies and techniques where there is often less resistance from, or resilience in the institutionalized arrangements and agents of established sectors; (3) some strategic sectors—such as energy and chemicals—are subject to particular attention and pressures to transform themselves, because in the case of energy—as is increasingly recognized—some forms such as fossil fuels are becoming increasingly scarce and also because these fuels contribute significantly to pollution, GHGs, and climate change.

In the sustainability revolution we see hybrid cars, re-development of the electric car, solar energy innovations and other renewable energy developments, "smart switches," recycling systems, banning or tighter regulation of chemicals, increased controls of many pollutants, movements to protect forests and threatened species. These changes take place more in some parts of the world than others, but there is a powerful and sustained general thrust, involving many thousands of initiatives and innovations. The emerging social trend is manifested in the plans and actions of thousands of international regimes, international bureaucracies, national agencies, local and transnational activist groups and expert networks. At the same time, "earth system governance" can be understood as a political project that engages more and more actors who seek to change the current architecture of institutions and networks at local-, meso-, and global-levels in order to advance the cause of sustainability [37].

The "green revolution" represents then multiple paradigm shifts, not only in production, technologies, consumption, and lifestyles, *etc.* but in governance and practical ethics and related normative areas. The new paradigm (or family of paradigms) is spreading readily—horizontally—new knowledge, values, and practices. "Green modernization" entails "green re-industrialization", "green capitalism", "green governance", "green thinking and lifestyles".

5. Conclusion

This article has suggested that a "sustainability revolution" is already taking place on multiple levels: (1) a moral-cognitive level; (2) a level of action and the establishment of new practices on the part of individuals, groups, and organizations; (3) an institutional level as "green" institutional arrangements and policies are promoted, often cautiously, but sometimes boldly—with varying degrees of success.

Several key factors explain why the sustainability revolution is likely to continue and even to accelerate:

- continuing environmental crises (that will not go away)
- continual outpouring of critical analyses and prognoses about the current failings and hazards
- normative ethos and collective pressures
- sustained creative challenge; the excitement of innovating, experiencing the new, its opportunities as well as exhilarating risks and uncertainties
- the paradigm shift itself entails new ways to frame, think, judge, and act that are challenges to be mastered and developed
- diffusion and imitation mechanisms through diverse social networks

While the sustainability revolution shares the organic character of the industrial revolution, the two differ significantly in a number of ways, as would be expected given their obviously very different historical, institutional, and cultural contexts as well as the difference in levels of scientific and technical knowledge.

- *Complexity*: sustainalization is taking place in a much more developed and complicated world in terms of institutions, cultures, and technologies including of course communications; for instance, the infrastructures of agriculture, manufacturing, government, science, education, *etc.* are very different.

- *The numbers and diversity of stakeholders and regulatory and governance systems* that must be taken into account is much greater (partly a result of democratization and partly learning to deal with modern complexity).
- Our modern world has *its established expectations about consumption levels, lifestyles and welfare* (this is also increasingly the case in developing countries).
- There are greater explicit concerns about *issues of general welfare, justice, human rights* (see Stockholm Memorandum [38]).

In spite of the complexity and the many institutional and cultural as well as power constraints, sustainalization is likely to proceed much more rapidly than industrialization did in large part:

- because of the resources and capabilities of modern science and technology
- because of the availability of more rapid and widespread advanced communications (scientific and technical associations, the WWW, twitter, facebook, blogs linking people concerned about environment and sustainability and facilitating the spread of sustainability ideas and accelerating rates of innovation and application).
- because of the large numbers of people and collective agents already mobilized and acting to drive sustainability improvements and transformations.

While "sustainability" initiatives continue to grow and spread by the many tens of thousands, the ongoing transformation will be no walkover. There is a formidable opposition (including deniers and opposers) among the powerful, for instance, many in the established industrial-commercial-banking complexes and their allies. The struggle will be long and difficult. But most of the established systems they represent will be replaced or radically reformed in the medium to long-run. Whether the sustainability revolution will be fast enough or comprehensive enough to save the planet remains to be seen. History provides numerous examples of great societies that collapsed, and visions that failed or were never realized [7,39].

References and Notes [40]

1. Earlier versions of this article were presented at Plenary Sessions of the International Sociological Association's Forum of Sociology, Barcelona, September 2008, and The International Sociological Association's World Congress, Gothenburg, July 2010. During the preparations of this article, Burns has been a Visiting Scholar at the Woods Institute for the Environment, Stanford University; he has also been partially funded by CERES21 at the Center for Development and Environment (SUM), University of Oslo, Norway.
2. Rosa, E.; Diekmann, A.; Dietz, T.; Jaeger, C. *Human Footprints on the Global Environment: Threats to Sustainability*; MIT Press: Cambridge, MA, USA, 2010; pp. 1–45.
3. The Greenhouse effect is transforming global and local weather patterns, 100 year floods become frequent events, as do the frequency of powerful hurricanes, continental forest fires, and other disasters; all of these draw down the reserves of insurance companies and the emergency funds of even the most prosperous states. The poor states suffer their fates or receive some relief through international aid.

4. Edwards, A.R. *The Sustainability Revolution: Portrait of a Paradigm Shift*; New Society Publishers: Gabriola Island, Canada, 2005.

5. Burns, T.R.; Flam, H. *The Shaping of Social Organization: Social Rule System Theory With Applications*; Sage Publications: London, UK, 1987.

6. Carson, M.; Burns, T.R.; Gomez Calvo, D. *Public Policy Paradigms: The Theory and Practice of Paradigm Shifts in the EU*; Peter Lang Publishers: Frankfurt and Berlin, Germany and New York, NY, USA, 2009.

7. Burns, T.R.; Hall, P. *The Meta-Power Paradigm: Causalities, Mechanisms, & Constructions*; Peter Lang: Frankfurt and Berlin, Germany and Oxford, UK, 2012.

8. Burns, T.R.; Dietz, T. Revolution: An evolutionary perspective. *Int. Sociol.* **2001**, *16*, 531–555.

9. Baker, S. The Evolution of EU Environmental Policy: From Growth to Sustainable Development. In *The Politics of Sustainable Development: Theory, Policy and Practice Within the European Union*; Baker, S., Kousis, M., Richardson, D., Young, S.C., Eds.; Routledge: London, UK, 1996.

10. Baker, S. Between Commitment and Implementation: Tensions in Sustainable Development Policy of the European Union. In *The International Handbook of Environmental Sociology*; Redclift, M., Woodgate, G., Eds.; Edward Elgar: Cheltenham, UK, 1997.

11. Capra, F. *The Turning Point: Science, Society, and the Rising Culture*; Simon and Schuster: New York, NY, USA, 1982.

12. Burns, T.R.; Stöhr, C. Power, knowledge, and conflict in the shaping of commons governance: The case of EU baltic fisheries. *Int. J. Commons* **2011**, *5*, 233–258.

13. Burns, T.R.; Stohr, C. The architecture and transformation of governance systems: Power, knowledge, and conflict. *Hum. Syst. Manag.* **2011**, *30*, 173–194.

14. Steffen, W.; Sanderson, R.A.; Tyson, P.; Jäger, J.; Matson, P.; Moore, B., III; Oldfield, F.; Richardson, K.; Schellnhuber, H.J.; Turner, B.; Wasson, R. *Global Change and the Earth System: A Planet under Pressure*; Springer-Verlag: Heidelberg, Germnay, 2004.

15. Burns, T.R.; Carson, M. Actors, Paradigms, and Institutional Dynamics. In *Advancing Socio-Economics: An Institutionalist Perspective*; Hollingsworth, R., Muller, K.H., Hollingsworth, E.J., Eds.; Rowman and Littlefield: Oxford, UK, 2002.

16. Burns, T.R. System Theories. In *The Blackwell Encyclopedia of Sociology*; Blackwell Publishing: Oxford, UK, 2006.

17. Burns, T.R.; DeVille, P. Dynamic Systems Theory. In *The Handbook of 21st Century Sociology*; Bryant, C., Peck, D., Eds.; Sage Publications: Thousand Oaks, CA, USA, 2007.

18. The domination may be based on administrative power, coercion, wealth, charismatic authority, etc. Of course, the resources and control activities differ significantly with the different modalities of power. Their limitations and vulnerabilities to erosion or collapse differ as well.

19. The paradigm(s) of modernization has been imposed selectively—a recurrent pattern of social transformation since the Industrial Revolution: Among others, the Meiji revolution in Japan (1868), Haile Selassie's transformation of Ethiopia (1930-1974), Pahlavis Shahs (1925-1979) restructuring of Iran, and Gorbachev's initiatives launching *glasnost* (opening) and *perestroika* (restructuring). Transformations characterized by re-orientation of a ruling elite entail then *processes of learning, conversion, and entrepreneurship. Under the direction of the elite adhering to a new paradigm, a new institutional order is launched and unfolds*. A major structural feature of such transformations is the more or less intact domination by a ruling elite, at least initially (unintended developments take place, including erosion of elite power as an unintended consequence of some promising innovations).

20. Stinchombe, A. *Constructing Social Theories*; Harcourt, Brace & World: New York, NY, USA, 1968.

21. Coleman, W.E. From protected development to market liberalism: Paradigm change in agriculture. *J. Eur. Public Policy* **1998**, *5*, 632–651.

22. Nikoloyuk, J.; Burns, T.R.; de Man, R. The promise and limitations of partnered governance: The case of sustainable palm oil. *Corp. Gov.* **2010**, *10*, 59–72.

23. Industrialization became a "development" concept which was more than a description. It became as well a metaphor of progress and advancement and a powerful normative idea (to be "developed", "industrialized" was good, to be undeveloped or underdeveloped was backward, a failure).

24. The USA's greatest dam-builder, Floyd E. Dominy, was involved in many of the initiatives in the Western U.S. that led to 472 dams. He aptly represented the "spirit of the times". In 1966, he called a Colorado River without dams "useless to anyone… I've seen all the wild rivers I ever want to see". (cited in New York Times (NYT) Obituary. F.E. Dominy, who harnessed water in the American West, is dead at 100. Page B 13, April 29, 2010).

25. Carson, R. The Silent Spring;Houghton Mifflin: Boston, Mass, 1962

26. The World Commision on Enviornment and Development. *Our Common Future*; Oxford University Press, London, UK, 1989.

27. Another important outcome of this conference was the agreement to create a new programme for global environmental protection under the United Nations: Then United Nations Environmental Programme (UNEP).

28. This Convention concerned the Protection of the Marine Environment of the North-East Atlantic (from Gilbraltar to northern Norway and Russia).

29. Lind, G. *REACH: The Only Planet Guide to the Secrets of Chemicals Policy in the EU*; Affarstryckeriet: Norrtalje, Sweden, 2004.

30. There has been growing and widespread concern with conservation, environmental pollution and degradation long before there emerged a "sustainability" concept, as suggested above.

31. Lafferty, W.M. The Implementation of Sustainable Development in the European Union. In *Contemporary Political Studies. Proceedings of the Political Studies Association*; Lovenduski, J., Stanyer, J., Eds.; Political Studies Association: Belfast, UK, 1995.

32. Mitchell, R.B. International Environmental Agreements Database Project (Version 2007.1). 2002–2009. Available online: http://iea.uoregon.edu/ (accessed on 7 August 2009).

33. Baumgartner, T.; Burns, T.R. *Transitions to Alternative Energy Systems: Entrepreneurs, Strategies and Social Change*; Westview Press: Boulder, CO, USA, 1984.

34. Woodward, A.; Ellig, J.; Burns, T.R. *Municipal Entrepreneurship and Energy Policy: A Five Nation Study of Politics, Innovation, and Social Change*; Gordon and Breach: New York, NY, USA, 1994.

35. A subsequent article will specify and analyze several of the key mechanisms in organic transformation such as innovation, imitation processes, influence mechanisms, collective learning, and communication processes and their technologies.

36. But the ongoing sustainability revolution is much more than a "Third Industrial Revolution" to which Jeremy Rifkin refers in a book (*The Third Industrial Revolution: How Lateral Power Is Transforming Energy, the Economy, and the World)* that has recently (2011) appeared. But significantly Rifkin recognizes the organic character of the transformative processes.

37. The Earth System Governance (ESG) Project (http://www.earthsystemgovernance.org/) is the largest social science research network in the area of governance and global environmental change. It is a core project of the International Human Dimensions Programme on Global Environmental Change (IHDP).

38. Stockholm Memorandum 2011. Tipping the scales toward sustainability. Available online: http://globalsymposium2011.org/wp-content/uploads/2011/07/memorandum-signed.pdf (accessed on 23 May 2012).

39. Diamond, J. *Collapse: How Societies Choose to Fail or Succeed*; Viking-Penguin: New York, NY, USA, 2005.

40. The reference list does not do justice to the many researchers whose work has contributed to the theoretical and empirical underpinnings of this article. This will be accomplished in a book to appear in 2013.