Sustainability: an interdisciplinary field

Valdir Fernandes [1]
William Bonino Rauen [2]

ABSTRACT

Discussed herein is the interdisciplinary nature of the sustainability sciences field. Through a critical historical account of so-called rationalisation of life and science, it is recognised that the economic growth model that prevailed over the last few centuries led to a disjunctive dissociation of our social systems from the natural systems, which now figures as a root cause of unsustainability. The same rationalisation arguably provoked the fragmentation of knowledge into more and more specialised disciplines, as part of a scientific framework that cannot now be readily applied to deal with current pressing socioenvironmental problems. It is argued that interdisciplinarity is the only academic response capable of achieving the reintegration of knowledge required to address the sustainability paradigm, as compromises are sought between what is essential, desired and possible, both within and without academia.

Keywords: Sustainability; Interdisciplinarity; Applied Science.

[1] Universidade Tecnológica Federal do Paraná (UTFPR). vfernandes@utfpr.edu.br
[2] Universidade Positivo (UP) e Universidade Federal do Paraná (UFPR). wbrauen@gmail.com

The development of the research field of sustainability sciences has become an exemplary case of science driven by big questions and problems, particularly those related to nature. By the 1960s it had become clear that important connections between social and environmental systems had been severed or altered, as a result of the socioeconomic development process. Such connections are associated with the availability of natural resources to sustain the pace and style of development since the Industrial Revolution, with the resulting poverty and inequality in wealth distribution, and with the scientific and technological development linked to the production of goods.

The context of sustainable development encompasses global, social and human systems. The current crisis of sustainability can be associated with the failure of such systems and their connections (Komiyama & Takeuchi 2006), which may bring about serious impacts globally (Diamond 2005). Despite recent advances in investigating this crisis (e.g. Sidle et al. 2013, Satanarachchi & Mino 2014), we have only begun to understand what is required to address it (e.g. Miller et al. 2014, Sandifer et al. 2015). There is no consensus about what to do in local actions in everyday life, public policy, science and laws (Jerneck et al. 2011), and the sustainability concept itself can be interpreted in different ways, serving more as a regulative guide than as a testable concept (Frodeman 2014).

The field of sustainability sciences was developed as part of a reaction against the fragmentation to which science was submitted over the last three centuries, an approach known as scientific reductionism. This relatively new research field focuses on the dynamic interactions between nature and society, with equal attention paid to how changes in one affect the other (Clark & Dickson 2003). It has risen naturally as an interdisciplinary field due to its complex and systemic character, and transdisciplinary for requiring interactions between scientists and several other social stakeholders in the processes of diagnosing problems and developing relevant practical solutions (Komiyama & Takeuchi 2006, Costanza et al. 2007). The field is characterised more by the purpose of its research than by a group of methods or objects (Spangenberg 2011). The diversity of knowledge areas involved led to it being regarded as a metadiscipline (Mihelcic et al. 2003), in the sense that it transcends disciplines. Its nature is adaptive, as it is not possible to conceive all-encompassing methods and solutions for socio-environmental problems due to their diverse range of spatial and temporal scales. The research undertaken in the realm of this generic and transversal field is located at the interface of knowledge areas, as interlinkages between earth, biological, agrarian, engineering, health, applied social and human sciences.

In this context, interdisciplinarity is more than just an assumption; it is an essential part of the dynamics involving the demands of the sustainability paradigm. An interdisciplinary approach is

required to structure sustainability problems in such a way as to confer treatability and comprehension, both in depth and diversity. It allows knowledge to be useful in the search for robust solutions to such problems (Komiyama & Takeuchi 2006). Interdisciplinarity may be considered the soul of sustainability science, by conferring its very existence and enabling its operability and dynamism.

In the approach adopted here, sustainability is a social and scientific paradigm through which the perspective of human development is perceived beyond economic growth. It is perhaps best defined as 'relative sustainability', in being related to the concept of resilience, where the goal is to create the conditions for 'a relatively smooth transition to a new and hopefully improved state' (Frodeman 2014 p. 72), while managing to avoid catastrophic collapses of our socio-environmental systems. It is not conceived as an instrumental basis that shaped the global society and wrongly transformed the global production chain to meet objectives which were/are primarily economic and short-termist. With effect, one can see interdisciplinarity as the innovation and the advancement required – albeit insufficient – for contemporary science to meet sustainability challenges.

The instrumental logic has shaped science, which quickly subdivided itself into dozens of specialities, each one generating many others. Universities and other research and educational institutions organised themselves around such logic, by creating and recreating departments to host the new disciplines being born. The experience of departmentalising institutional management – in an attempt of hosting the countless new disciplines born out of the demand for new fragmented knowledge – often resulted in the compartmentalisation of knowledge itself. In such dynamics of specialisation and departmentalisation, 'what remained was the scientific specialist that knows more and more about less and less' (Durant 2000 p. 10), and a gap between life and the knowledge about the contemporary world (Fernandes 2008).

The number of voices defending a sustainability paradigm is growing in importance in the scientific community. In this paradigm, Interdisciplinarity is an alternative and needed innovation to the conventional knowledge production process, because it allows reflection and comprehension missed in fragmented and isolated knowledge.

RATIONALISATION OF LIFE

The literature about interdisciplinarity is vast and often uses the limits of methodological reductionism and of Cartesianism as a starting point for discussion and critique. In this sense, reductionism and the advancement of modern science are criticised, particularly the technoscience that developed with little regard for its implications and attached political and socio-environmental risks.

Such a lack of reflection had already been unveiled by Mannheim (1962), Habermas (1994), Horkheimer (2002) and other representatives of the Frankfurt School, besides Illich (1976), Ramos (1989), Polanyi (1994) and Gorz (2003). Despite not dealing directly with interdisciplinarity, they criticised deeply the hegemony of science in modern society, which is fundamentally based upon instrumental rationality, as part of the production chain of industrialism. According to these authors, there is a historical unbalanced advancement of technical knowledge in relation to moral capacity and discernment about its use. Technology and all scientific development became 'medicine', lacking the moral and ethical directions of how to prevent collateral damage. This lack of philosophical reflection about technical knowledge and its consequences is blamed as the source of many contemporary problems. Reflection has been replaced by facilities offered by science itself, leading individuals to become almost fully occupied in using the technological artefacts without, however, questioning why they are using them, or the individual and collective benefits and damages of such usage. This can be defined as a process of rationalisation of life (Fernandes 2008). As a result, beliefs, moral and ethical convictions became nullified or enslaved to an external goal of fulfilling a role, as a cog in a machine, just striving to make a living.

Industrial rationalisation enhanced functional rationality while proportionally reducing the independent judgement capacity of individuals and society. Thus, as pointed out by Ramos (1989) technical and economic development can correlate to a worrying low ethical and moral development[3]. According to Ramos, this does not mean that functional rationality should be abolished, only that its prevailing, at the expense of more substantive values takes away from individuals and societies the capacity of making ethical and moral choices. This leads to what Mannheim described as a disproportionate development of human faculties, i.e. an unbalance between technical development and the moral capacity and social control associated with it: '... human beings utilise the most sophisticated products of inventive genius to serve and satisfy the most primitive impulses' (Mannheim 1962 p. 52). In other words, the development of a society cannot be measured solely by its technical development; the ways in which it socialises and uses technology should also be considered for its central role in the achievement of an integral development, where technology usage promotes an ample advancement of social relations.

According to Horkheimer (2002 p. 29), 'reason has become completely harnessed to the social process. Its operational value, its role in the domination of men and nature has been made the sole criterion'. Only what is functional is rational, not what is reflected upon. It is as if the difference

[3] Accordingly, Horkheimer (2002) states that even democracy without its rational basis becomes exclusively dependent upon the so-called people's interests, which are subjected to blind economic drivers.

between thought and action were completely nullified, thus making all thought an act. Not an act that has been thought of, originating in reflection, but an automated act, formalised, functional in the context of industrialism where life is rationalised, but not reflected upon.

Such a conception of reason, which abounds in mechanisation and lacks in reflection has been essential for the development of modern science and technology itself, fundamentally grounded on the notions of more and less, but which does not know the notion of enough (Gorz 2003). Hence, reason became a part of industrialism's production chain, in capitalist development. Only an almost absolute lack of reflection, in the sense of thinking of the ends to which science and 'development' were being constructed could have allowed for a concept of development so grounded on economic growth, with science figuring merely as a sector of such development for having been stripped of its rational, substantive and political pillars. At the very least, science should reflect upon the ends for which the means are constructed, its consequences and meanings. The development of modern science, as a technoscience, took place almost exclusively in line with the utilitarianism of economic drivers. This was based on the logic that something is rational only if it serves some purpose, thus subtracting the intrinsic value of reason.

According to Illich (1976 p. 23), in such a process 'men's domination of the tool was substituted by the tool's domination of men'.[4] For more than a century mankind's development was grounded on the hypothesis that the 'tool' could substitute the slave, without realising, however, that it was becoming enslaved to the 'tool'. This idea was also explored by the Frankfurt School, as evidenced by Horkheimer (2002) statement that the more we invent artefacts to explore and dominate nature, the more we shall submit to these very artefacts of domination and to the consequences that they generate in nature. Horkheimer named such consequences as 'the revolt of nature'. This paradox is due to mankind having reached an unthinkable ability of instrumentalising human action, while it is more and more difficult to recover spontaneity and personal control of our own actions.

Besides increasing the distinction between work and interaction, as noticed by Habermas (1994), this process transcends the borders of factories and becomes instilled in society as a whole, resulting in the rationalisation and technicising of social relations. It is what Habermas defined as the colonisation of life by market mechanisms.

Furthermore, as originally observed more than a century ago (Simmel 2005), the perfect context for a society whose life is totally rationalised is the city – the metropolis, in which men becomes a mere

[4] Illich uses the word 'tool' as a category that encompasses all instruments of human action and in the sense of rational 'means', as justified by the goals of industrialism, coherently with the above rationalisation concept.

cog in a system that he cannot comprehend, but in which he is forced to take part. Changes have been taking place at an ever growing pace, which increases the nervous activity required to adapt to the mismatch between internal sensations and environmental cues. Such a scenario has become disjunctive (UNESCO 2003), for the speed of change is far greater than the human natural capacity of adaptive genetic evolution. The stress thus caused contributes to alienate the individual. This growing alienation together with the dissociation from the natural world caused by urbanisation can contribute to perpetuate the problem, for impairing the ability of the social system to adapt and respond to the challenges of sustainability. In essence, a negative feedback mechanism has formed that causes even more rapid change and degradation in the global and social systems (Imberger 2005).

The prevailing objective, practical and instrumental spirit suppresses our more substantive and subjective aspects, leading to what Simmel defined as the total alienation of the individual. The central cause of such alienation, according to him, is the division of work after the invention of the machine, when men became part of the production process. In such a system, men no longer recognise themselves as authors and lose consciousness of their own activities[5]. The more rationality is detached from subjective consciousness and attached to automatisms and material support (such as money and the production process itself), the more the individual risks being emptied of his prerogatives, through the formalisation of social relations. That means that the formalisation of material rationality, which is a condition for the rationalisation of productive processes, subverts economic and production relations, as well as their meaning and consciousness. However, 'absolute objectivity is a meaningless notion' (UNESCO 2003 p. 19).

RATIONALISATION OF SCIENCE

Among the consequences of the process of rationalisation of modern life is the fact that science, encastled and monopolist in the production of knowledge ever since Illuminism became part of the production chain of industrialism. Science has inherited the fragmentation and uselessness of holistic thinking as typical features of the reductionism and departmentalisation of the production chain Era.

According to Gorz (2003), science could only develop from the moment its rationality became free from all other principles of rationality, to subdue them to its sole formal, functional and instrumental dominion. The ensuing development, apparently dominated by science through its rationality principles, paradoxically led it to lose grasp of the whole and consequently become instrumentalised in the formalising and fragmentary process of industrialism.

[5] This topic was later approached by Mannheim and by Horkheimer, as discussed further below.

The matter is that science was not only fragmented on the inside, departmentalising knowledge through disciplines; its utmost impact was in the disciplines themselves, with excessive specialisation forming professionals at the expense of knowing the purpose of the discipline itself and ignoring interactions with closely related disciplines. Modern science, supported by modern reason did not develop detached from the historical process of rationalisation of life, but is an integral part and consequence of such a process, albeit deeply criticised for the prevailing paradigm and totalitarian model divorced from any other kind of knowledge that was not based upon its epistemological principles and methodological rules (Santos 1995). According to Morin (2010), such features – supported as they are by the Cartesian principles of order, separation, decomposition and reduction of phenomena in order to solve them through measuring and quantifying – enabled a science grounded on determinism and mechanicism. This has driven the appearance of countless specialities, and consequently disciplines, and led to the loss of the notion of wholeness and to the separation between subject and object. Besides, according to Morin (2010) the development of formal logic plays a key role in this process, which is here understood as resulting from the characteristics outlined above, from which gradually 'facts replaced comprehension' (Durant 2000 p. 10). In other words, there has been a loss of the consciousness of wholeness – not so much as a scientific object, but the wholeness of science and of society, of which science is a part.

Scientific terminology contributed to the separation process between science and society, since, despite the greater knowledge of the world acquired by scientists, they became less capable of communicating with society. In the Era of utilitarianism, through erudition and ineffective communication – mainly in the social, economic and political sciences – such knowledge became less useful, which has led to the need for a mediator or 'translator' between the specialist and society (Durant 2000).

As the specialist becomes detached from society and confined in a community where only *peer* dialogue is possible, science separates from itself and from society. It undergoes fragmentation and devolution in its capacity of political reflection about itself and about society. Knowledge production then takes place without a need even for its 'consumption' by peers, let alone for social usage (Frodeman 2014). It becomes merely a useful part in the rationalised process of economic development. The rationalisation of science is, thus, its objectivation, based as it is on the economic rationality established in contemporary society. Its advancement is mistaken for economic advancement, in a similar manner as the development of countries is mistaken for the growth of their Gross National Product, even despite low cultural, political and social development normally associated with low political reflection capacity.

In Academia, this scenario is made more complex by the often turbulent and bureaucratic political-administrative context, the respect of specialists for disciplinary borders and traditions (often for well justified competence and security reasons), funding structures that are not adapted to current socio-environmental demands – such as sustainability – and academic performance metrics that induce a technical-scientific productivism. Consequently, the current scenario induces the perpetuation of problems generated by an excessive departmentalisation. We ought to recognise the importance of continued production of fundamental knowledge in the disciplinary basis, but the assumption that all fragmented knowledge produced will eventually be used at all, and particularly in a way that justifies the resources that went into its production, is proving more and more elusive (Frodeman 2014). At best, fragmented science can only assist in diagnosing aspects of sustainability problems, and has limited capacity to develop effective solutions to such problems. On the other hand, disciplinary or multidisciplinary research targeted at the solution of sustainability problems can contribute to improve the cost-effectiveness of resource usage (Clark & Dickson 2003), provided that their results can be integrated with the results of studies in other areas – i.e. that they are 'interdisciplinarity-ready' (Spangenberg 2011). In a similar manner as the economic development model is now urged to adapt to the reality of natural resource limits (e.g. Neumayer 2013), it seems that the scientific pursuit disengaged from our socio-environmental reality will gradually become more constrained by economic as well as moral issues.

INTERDISCIPLINARITY OR DE-RATIONALISATION OF SCIENCE

Any attempt to define this polysemic concept may contribute to increase further the existing polysemy, and lead to more neologisms. It must be stated, nonetheless, that interdisciplinarity is understood here as a more efficient way to generate knowledge than the reductionist model, in agreement with its usual representation in the literature. It can contribute to the reintegration of science through restoring its capacity of political reflection and social integration.

Interdisciplinarity encompasses a group of principles that facilitate dialogue among disciplines, in such a way as to restore a more ample and integrative vision of knowledge and of its objects. Such bridge building among disciplines leads to the construction of a method capable of seeing complexity and connections amongst phenomena overseen by the disciplinary myopia. Hence, interdisciplinarity occurs at the interfaces of disciplines, and responds for aspects that, hidden in such interfaces, escape the dominion of disciplines. Revealing such aspects amplifies our ability to understand and represent real phenomena under investigation, deal with the complexity of the world, of society and so forth. This dynamics depends upon the temporal and spatial scales in which a given approach is built, in the

context of the global, social and human systems, which are the object of study of the sustainability sciences as a research field.

Furthermore, more than being a way of connecting knowledge areas together to reach a better comprehension of the scientific object, the outcome of interdisciplinarity should assist in revealing the complexity of whole systems, with their countless inner and outer connections. This requires the deconstruction of knowledge structures – of a disciplinary basis – in such a way as to enable the reformulation of problems (Jerneck et al. 2011) to reach better identification of their elements and representation of interlinkages amongst them. Such more integrated knowledge can lead to substantial new knowledge and a more integrated science which can, in turn, contribute to form a more integrated society.

Mannheim (1962) and Horkheimer (2002) pointed out that science's abdication of reflection and submission to the economic and political powers made it a mere part of the production chain, at the service of development – understood as economic development. In this sense, interdisciplinarity is not just an alternative way to produce more autonomous and effective knowledge aimed at the same goals of isolated disciplines. On the contrary, it figures as a way of breaking free from the rationalisation of life and the rationalisation of science, able to reconnect science to society and the various forms of knowledge within it, as suggested by Morin (2010). It also re-establishes dialogue between disciplinary knowledge and disciplinary specialisations, moving away from the hegemony of the search of efficiency for efficiency's sake in knowledge production. The starting point of this exercise must be political reflection, in an ample sense, recovering the notion of rationality not as a purposeless and unconscious optimisation, but as reflective capacity – the same reflection subtracted by industrialism and its rationalisation of life. It has, thus, a key role in the process of reinventing the social wholeness. Overcoming the inertia produced by the rationalisation of life and by economic rationality, interdisciplinarity offers science the self-reflective exercise required to find connections amongst disciplines, and eventually counteract some of the crippling effects of excessive departmentalisation.

However, it is illusory to think that the fragmentation of knowledge caused by such departmentalisation will be reverted solely by the creation of non-departmentalised Universities and campuses. The opposite of that which was efficient in producing fragmentation will not necessarily suffice for its reintegration. It is advocated, in this context, that the reintegration of knowledge and of science itself should start by science overcoming its condition as a sector of the production chain and industrialism, to recover its autonomy and critical capacity. It is necessary to de-rationalise science to make it more than a part of a production chain, immersed in the automatism that characterises

industrialism. It should become capable of contributing to develop the reflexive ability in society. The rationalised science should be transformed into a science with consciousness (Morin 2010), capable of dialogue with society and with other, non-scientific knowledge and perspectives. Such a change in attitude may foster or come together with a much needed reversion of the sacrifice of sustainability being made in favour of the ever increasing production of consumption goods – a short term objective that is in conflict with the long term objective of sustainability (Costanza et al. 2007).

SUSTAINABILITY, OR DE-RATIONALISATION OF LIFE

From the 1970s and under various definitions – ecodevelopment (Sachs 2000), sustainable development (WCED 1991), ecosocioeconomy (Sampaio 2010) – sustainability became an emergent agenda, hotly debated primarily in the scientific realm. The pursuit of sustainability has led various sectors of society to mobilise in favour of a higher level of consciousness in the construction and spread of knowledge in such a way as to contribute to mitigate the impacts of contradictions caused by compartmentalisation of knowledge and rationalisation of life.

As observed by Barbieri (2009), the concern with environmental problems due to growth and development processes appeared slowly and in distinct ways amongst stakeholders, individuals, governments, international organisations and civil society bodies. Firstly, the environmental cause was met by ignorance, negligence and indifference from most consumers and producers of goods and services. Actions to deal with the consequences of environmental problems had a reactive, corrective and repressive nature, involving fines, prohibitions and pollution control measures associated with industrial and consumption activities. As time went by, the matter became more noticed but attempts to tackle it remained confined in countries, which turned to the resolution of environmental issues with measures such as stimulus for modifications of polluting production processes, environmental impact assessments and licensing of new developments, among others. It was only in the third stage that the environmental cause was perceived as having widespread impacts and for its global seriousness, as a result of the prevailing development model spearheaded by developed western economies. That scenario led to probing of existing development policies and goals, as well as the underlying rationality and the very notion of development based on economic growth. The concept of sustainable development emerged by linking other dimensions to the economic, such as the environmental, ecologic, territorial, political, cultural and social – now seen as inseparable elements of the notion of socio-environmental development. As defined in the report 'Our Common Future', also known as the Brundtland Report, sustainable development is '... development that meets the needs of the present without compromising the ability of future generations to meet their own needs' (WCED 1991 p. 46).

This concept, according to the Brundtland Report is grounded onto two other key concepts: the concept of needs, particularly the basic needs of the world's poor, which should receive top priority; and the notion of limitations imposed by the stage of technology and social organisation to the environment, preventing it from meeting present and future needs (WCED 1991). In this sense, the Report infers on how the distribution of economic benefits should occur, in stating that 'sustainable development requires meeting the basic needs of all and extending to all the opportunity to satisfy their aspirations for a better life' (WCED 1991 p. 47). Such a challenge could only be met through a substantial change in the concept of development, by institutional and legal restructuring and educational processes. In this sense, strategies are needed to replace degrading processes by cleaner ones, promote better distribution of economic benefits aiming to eradicate poverty, and advancing programmes to manage the population dynamics, amongst other measures.

Sachs (2000) suggests that sustainability can be expressed as a balance amongst interdependent dimensions and with deep transdisciplinary relations. This refers to nature conservation (i.e. of ecosystems) by taking into account its biological, physical and chemical elements. Sustainability requires parsimony, i.e. consideration of the supply capacity and resilience, and prioritisation of renewable resources usage (Neumayer 2013). Accordingly, Dansereau (1999) defended that ecological prospecting should take into account ecological criteria and limits, in contrast with economic, historical, cultural, political and territorial construction criteria. A similar reflection should be made in the realm of the corresponding disciplines, leading to a review of their schemes from the perspective of ecological limits. From this point of view, it is of paramount importance to modify the current consumption patterns and its sustaining cultural model, which involves an excessive consumption of resources and waste generation. This dimension is associated with economic sustainability, for its reliance upon natural resources. It also relates to the notion of objective needs, in contrast with the socially constructed subjective needs.

As stated by Merico (1996 p. 30) 'the biosphere does not grow' and is the origin of all resources that feed the economy and the receptacle of waste. Hence, two basic principles should be respected: not to extract from an ecosystem more than its regeneration capacity; and not to release onto an ecosystem more than its carrying/depuration capacity (Neumayer 2013). From this viewpoint, the biosphere is the end product of human activities, but is also dynamic and subject to its own natural cycles. Ecosystems and populations are constantly adjusting to reach metastable equilibrium states. In this context, the anthropogenic footprint on the lithosphere, in particular, has become so significant that part of the scientific community supports the idea that we are in a new informal geologic era – the Anthropocene (Jerneck et al. 2011).

Sustainability also depends upon social equilibrium, in environmental, economic and political terms, with fair wealth distribution, full employment, access to basic services such as housing, transport, health, education and food, guaranteed democratic participation in political and decision making processes, with free speech, right to information and the possibility of mobilisation to defend such rights. Cultural traditions should be respected by mitigating discrimination and valuing so-called non-modern cultures, such as found in rural and traditional communities. With such elements in mind, Sachs suggested national projects of endogenous development, as opposed to the dependent mimetic model copied by Latin-American countries from Europe and the United States.

In this sense, the occupation of space should be planned with respect to the ecological limits. Territoriality construction should aim at achieving a balance in the distribution between the urban and rural environments, in particular. Public policies should control urban expansion, contrary to the current situation in which it is privileged in government funding allocation for infrastructure and production, favouring the rural exodus. Hence, achieving spatial or territorial sustainability requires an adequate valuing of sustainable rural production and living, including with policies to improve technical education for related activities and bearing in mind the conservation of ecosystems and biodiversity. There is evidence to suggest that this is a win-win scenario, for both human and ecosystem health, contributing to improve socio-environmental resilience (Sandifer et al. 2015). The economic feasibility of development should be promoted by fostering a production model that provides for social needs and eradication of poverty, without exhausting the sustaining natural resources – a model that has social, cultural and environmental balance. Economic development should be diversified, intersectorial and open to innovation and continuous modernisation of production instruments – in short, recognising economy as the human activity that provides for social needs.

Finally, sustainability requires political action in two spheres: national and international. Nationally, democracy should be the practical expression of human rights and the State as the collective expression of the various sectors and interests of society, maintenance of democratic institutions and a robust regulatory system. This requires stable and long lasting rules encompassing the three governmental levels, i.e. federal, state and municipal. In the international sphere, there should be a relentless effort for peace and cooperation amongst peoples, mitigation of the north-south asymmetry, responsibility sharing, adequate control of the international financial system, and establishment and effective application of the precaution principles of environmental and natural resource management. Key goals are to prevent global climate change, biodiversity conservation, respect to cultural diversity, effective management and preservation of world heritages, scientific and technological cooperation. In

facing the great challenge of sustainability, as outlined by Sachs (2000), the role of the sciences of sustainability unfolds.

SUSTAINABILITY SCIENCES FIELD, OR APPLIED DE-RATIONALISED INTEGRATION OF SCIENCES

As observed by Clark and Dickson (2003), from the 1990s a number of movements were formed to promote an approximation between science and technology in favour of sustainability. Two such perspectives are highlighted herein, which occur in different levels but are not in opposition to each other: a more technicist perspective, and a more holistic one. In the first, technology assists in developing ways to use natural resources better and reduce the impacts of social activities on the environment. In the second, science itself is rethought from the perspective of sustainability. The first maintains a pattern of domination of nature that is essentially instrumentalist and has a disciplinary basis. The focus of the second is on the dynamic interactions between nature and society, and their two-way influences whereby society shapes the environment and is shaped by it.

The holistic perspective rescues the fundamental calling of science that was subtracted by the industrialist rationalisation of life, namely, to think of development and socio-environmental processes considering their intrinsic interdependency. This 'discovery' of interdependence and of the complex processes involving society and environment, and the outlining of a sustainability paradigm put science in a crisis. It is now threatened by its distancing from society and excessive disciplinary fragmentation, to the point of seeing two of its cornerstones – the disciplinary University and peer review as virtually the sole academic governance instrument – becoming obsolete, at least in terms of how they have traditionally operated (Frodeman 2014).

The field of sustainability sciences is aimed at facilitating and accelerating the transition to sustainability, by operationalising this very concept (Spangenberg 2011, Miller et al. 2014). It is intended to significantly influence the direction of socio-environmental change, by creating new knowledge to support decision making on the sustainable development pathway. Its success will be assessed primarily for such an influence and the social impact of its products and solutions, rather than by its ability to predict future scenarios (Costanza et al. 2007) – implying that the sustainability sciences field should point the way towards building a future that we want and can achieve. This is in line with the concept of 'good enough governance' (Fonseca & Bursztyn 2009), as a remedy to the discrepancy between political correctness and the effectiveness of practical actions focused on sustainability. In this sense, one of the challenges of this field is identifying compromises between what is essential, desired and

possible. There is, clearly, a lot to be done to influence socio-technological change in a meaningful way (Miller et al. 2014).

At the same time, scientists may have to resist the tendency of maintaining the academic *status quo*, built upon the rationalisation drivers that led to excessive departmentalisation. Overcoming the inertia of such a system requires significant improvements and incentive to interdisciplinary and transdisciplinary practices. For instance, special attention should be paid on promoting more opportunities that are sufficiently broad, long lasting and financially supported for the interchange and translation of information, experiences and understandings amongst researchers from different areas – a prerequisite for the exercise of broad interdisciplinarity (Spangenberg 2011). Academics may also have to recognise that 'new' academic governance instruments, such as social controls and demands on what gets funded or not, are here to stay (Frodeman 2014). More than ever, science must be relevant, accountable and cost-effective. It is a clear wake up call to interdisciplinarity – internal reorganisation of academia – and transdisciplinarity – 'co-production of knowledge between academic and non-academic actors', as put by Frodeman (2014 p. 61). The required shift in perspective is perhaps analogous to that of an actor or actress used to taking centre stage being content with supporting act roles in his or her future plays – but important roles, nonetheless. This seems true both for the scientist and for science as a whole.

The quest for sustainability has never been so imperative, as there are warnings that the consequences of us not doing enough and in time can be the collapse of our current way of life on Earth, together with parts of the biosphere (Diamond 2005, Costanza et al. 2007, Sidle et al. 2013), thanks to rapid and irreversible changes to socio-environmental systems. Science, which took charge of the production of all relevant knowledge and answers, now faces its greatest challenge: how to collaborate in reducing the damaging effects of human activity on the planet by solving problems which are not sufficiently understood (Komiyama & Takeuchi 2006), while attempting to develop adaptation mechanisms to such changes. Whether or not science and technology can meet such a task, at least in part, we still do not know. If it does, the field of sustainability sciences will probably have had a key role in the process, first and foremost for its potential for reflection and commitment with the development processes, owed to its interdisciplinary and transdisciplinary nature.

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Sustentabilidade: um campo interdisciplinar

RESUMO

Discute-se aqui a natureza interdisciplinar do campo das ciências da sustentabilidade. Por meio de uma análise histórica crítica da assim chamada racionalização da vida e da ciência, reconhece-se que o modelo de crescimento econômico que prevaleceu nos últimos séculos levou a uma separação nociva de nossos sistemas sociais dos sistemas naturais, que hoje é uma das causas da insustentabilidade. A mesma racionalização teria provocado a fragmentação do conhecimento em disciplinas cada vez mais especializadas, como parte de uma estrutura científica que não pode ser diretamente aplicada para tratar

das urgentes questões socioambientais atuais. Argumenta-se que a interdisciplinaridade é a única resposta acadêmica capaz de alcançar a reintegração do conhecimento requerida para lidar com o paradigma da sustentabilidade, à medida que se busca a justa medida entre o que é essencial, desejável e possível, tanto dentro quanto fora da academia.

Palavras-Chave: Sustentabilidade; Interdisciplinaridade; Ciência Aplicada.

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