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Sustainable landscape development and value rigidity: the Pirsig's monkey trap

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Abstract

New broader, adaptable and accommodating sets of themes have been proposed to help to identify, understand and solve sustainability problems. However, how this knowledge will foster decisions that lead to more desirable outcomes and analyses necessary to transition to sustainability remains a critical theoretical and empirical question for basic and applied research. We argue that we are still underestimating the tendency to lock into certain patterns that come at the cost of the ability to adjust to new situations. This rigidity limits the ability of persons, groups, and companies to respond to new problems, and can make it hard to learn new facts because we pre-select facts as important, or not, in line with our established values. Changing circumstances demand to reappraise values like in the case of Pirsig's monkey and its rice. There is an urgent need to go beyond such local, static and short-term conceptions, where landscape sustainability has been incorrectly envisioned as a durable, stable condition that, once achieved, could persist for generations. We argue that to manage a global transition toward more environmentally efficient and, therefore, more sustainable land-use we have to reappraise societal values at the root of overregulation and rigidity.

Keywords:
landscape sustainability, value rigidity, rigidity traps, societal values

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1 Introduction

New broader, adaptable and accommodating sets of themes have been proposed to help to identify, understand and solve sustainability problems (Leemans and Solecki 2013). They span from environmental change issues (e.g. past, present and future trends), environmental change assessments (e.g. defining, quantifying or attributing change, vulnerabilities and risks), system dynamics and sustainability (e.g. transitions, thresholds, feedbacks and tipping points), sustainability governance and transformation (e.g. societal change over time, public–private partnerships, green economy), to sustainability challenges (e.g. planetary boundaries, solutions, vulnerabilities, adaptation versus mitigation and environmental security), and sustainability science (e.g. analytical frameworks to assess sustainability, interdisciplinarity and transdisciplinarity, capacity building, and science communication and outreach).

However, how this knowledge will foster decisions that lead to more desirable outcomes and analyses of the processes necessary for the transition to sustainability remains a critical theoretical and empirical question for basic and applied research (Miller et al. 2014). We are still underestimating the tendency to lock into certain patterns that come at the cost of the ability to adjust to new situations and occur on levels varying from the cell and the mind to societies (Scheffer and Westley 2007). This resulting rigidity limits the ability of persons, groups, and companies to respond to new problems, and some of them may have contributed to the collapse of ancient societies. This is well surmised by the famous Albert Einstein quote "we cannot solve our problems with the same thinking we used when we created them."

While sustainability scientists acknowledge the importance of the societal values as a subject of inquiry of sustainability research (Clark 2007), those values are, however, widely neglected (Miller et al. 2014).

The need to consider changing societal values at the root of rigidity is well illustrated in Pirsig's (1974) book "Zen and the Art of Motorcycle Maintenance: An Inquiry into Values". There, the South Indian monkey trapper drills a hole in a coconut, puts a ball of rice inside and chains the coconut to a stake. The monkey smells the rice, inserts its hand to grasp the rice, and becomes trapped since its fist with the ball of rice is now too big to pass through the hole and it will not let go of the rice. Pirsig calls this trap "value rigidity". The usually high value the monkey places on rice needs re-evaluation in this life-threatening situation. If the monkey gave up a bit of rice it would save its life, but because of its consolidate value rigidity the monkey does not and results captured. In this metaphor, value rigidity skews the value we attach to facts and, because of value rigidity we might get stuck in a "rigidity trap" (Carpenter and Brock 2008). Such locks usually have an obvious evolutionary advantage for the monkey, even though locked attitudes and modes of behavior in individuals and groups can easily lead to undesirable lock-in situations (Scheffer and Westley 2007) like for the Pirsig's monkey.

The problem we presently face is to assess the implications from local to global scale of a "static" and "ordered" landscape condition in social-ecological landscapes (SELs), provided by the cross-scale intersections of land-uses, plans and norms (order), and how this can be made sustainable in face of predictable as well as unpredictable change and disturbance (disorder) (Zurlini et al. 2013). This is widely related to different lock-in situations. For instance, the current land-use planning system is insufficiently equipped to stimulate sustainable development (Diamond 1995), and the emergence of land overregulation and rigidity in some parts of the world can result in drastic changes in others, what may not be evident through traditional local and single scale-based approaches.

As land-use transformation is becoming a main global driver given the worldwide changes to forests, farmlands, waterways, and air (MEA 2005; Turner II et al. 2007), global analysis is required to determine the net effect of local land use decisions and assess implications for greenhouse gas concentrations and climate change. This is because regulations to protect natural and human-managed ecosystems

and world trade policies may merely shift land-uses from one country to another, by increasing imports, and mitigate climate change by the use of biofuels in one place increasing global greenhouse gas emissions due to the parallel response of land-use changes in remote locations (Lambin and Meyfroidt 2011).

This highlights the need to go beyond such local, static and short-term conceptions of landscape planning and management, where sustainability has been incorrectly envisioned as a durable, stable condition that, once achieved, could persist for generations (Ahern 1999). This can be seen in the shifting academic consideration of "sustainable" solutions to those of adaptation and resilience (e.g., Berkes et al. 2003; Nelson et al. 2007).

In this perspective, the purpose of this paper is to present the most important facets of values rigidity in order to achieve sustainable social-ecological landscapes (SELs). In particular, we argue that in order to manage a transition toward more environmentally efficient and, therefore, more sustainable land-use we have to consider changing societal values at the root of over-regulation and rigidity.

The paper is organized as follows: the next section provides an overview of several important components of values, their use in sustainability research and the role of values in shaping the SELs. Then, the concept of rigidity trap is introduced and, in the fourth section, few examples of socio-ecological concepts, which need re-evaluation to escape rigidity traps, are proposed. Finally, a general discussion on the significant changes in human values necessary to escape rigidity traps in the light of sustainable development is presented. The paper ends proposing a possible solution to achieve sustainable landscape planning and management.

2 Defining values

Many authors have defined values as beliefs, either individual or social, about what is valuable and important in life (e.g. RCEP 1998; Slootweg at al. 2001; Stolp et al. 2002; Adger at al. 2009; O'Brien and Wolf 2010) and that function as important guiding principles and influence behavior and perceptions across a variety of situations (Feather 1996; Rokeach 1973; Swartz, 1994). One mode of defining sustainability is through the values that represent or support it (Kates et al. 2005). Various statements supporting sustainability are all expressions of values, such as the Millennium Declaration that is an explicit statement founded on a core set of important values that are essential to international relations: freedom, equality, solidarity, tolerance, respect for nature, and shared responsibility. Abstract values, such as peace, freedom, equity, justice, are of great importance to humanity, because they suggest essential principles for societies that guide our current actions and shape our vision for the future (Wu 2013) and explain the motivational bases of attitudes and behavior (Rokeach 1979; Karp 1996; Rohan 2000; Bardi and Schwartz 2003; Leiserowitz et al. 2006).

The Schwartz's value theory (Schwartz 1992) provides one of the most widely cited value frameworks identifying ten universal values (power, achievement, hedonism, stimulation, self-direction, universalism, benevolence, conformity, tradition, security) according to the motivation that underlies each of them. Although the nature of values and their structure may be universal, their hierarchy and the type of goal or motivation that they express could change among levels of organization and over time. We can say that human values are scale dependent and may be viewed in a nested context: individuals focus on local, short-term interests (e.g. power, achievement), communities focus on longer-term intergenerational interests (e.g. tradition, security) and nations focus on global issues (universalism).

Considering the temporal scale, the importance attributed to values may change when new motivations emerge. For example, at the individual level, as people grow older, they tend to become more embedded in social networks, start a family and attain stable positions in the occupational world. This implies a change in their value's priority, becoming less preoccupied with their self-enhancement values (power, achievement) and more concerned with the welfare of others (benevolence, universalism values). At the societal level, as proved by Inglehart

and Welzel (2005), socioeconomic development tends to produce generation value differences and a shift from survival values toward self-expression values.

The construction of a system of values, analyzing motivations, can be also traced to Maslow (1943), who developed a holistic-dynamic theory of motivation, well-known as 'Maslow's hierarchy of needs' (Figure 1). It represents a pyramid of basic human needs in five levels (physiological needs, safety needs, love and belongingness needs, self-esteem, and self-actualization) that motivate and drive behavior and are sequenced in order of priority from lowest to highest.

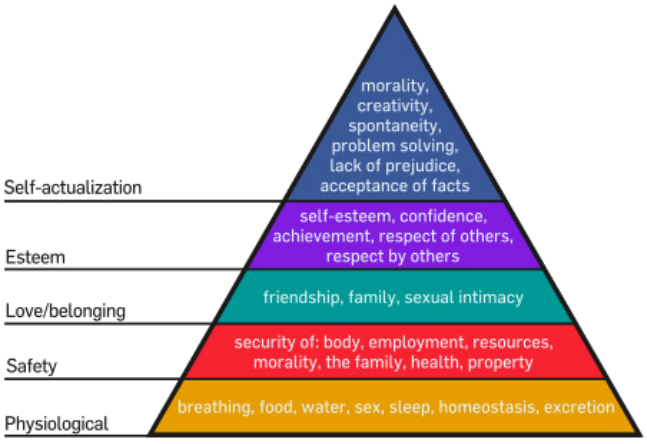

Figure 1: An interpretation of Maslow's (1943) hierarchy of needs, represented as a pyramid with the more basic needs at the bottom (from Maslow's 1943).

The Maslow's theory suggests that first we need to satisfy basic physiological needs, such as food, air, water, then our needs for safety (e.g. security of environment, employment, health, law), belongingness (e.g. love, friendship, family), esteem (e.g. achievement, self-esteem, respect,) and lastly self-actualization (e.g. personal growth, self-fulfillment, morality, creativity). In this perspective, if basic (physiological and safety) needs are not met, it is unlikely that other higher values at the top of the pyramid (democracy, social justice, equity) will be prioritized (Hagerty 1999; Tischler 1999; Yawson et al. 2009; O'Brien and Wolf 2010, Tay and Diener 2011). The ability of humans to satisfy these needs arises from the opportunities available and constructed from social, built, human and natural capital (and time) (Costanza et al., 2008, Petrosillo et al. 2013). In this viewpoint, in the sequence of Maslow's pyramid the human motivations connect the human being primarily to the natural capital and then to the built, social and human capital evoking the framework suggested by Meadows (1998) which relates natural wealth to ultimate human purpose through technology, economy, politics and ethics.

Several researchers pointed out that the opportunities for sustainability increase as more of Maslow's human needs are met (Kofinas and Chapin 2009; Sidiropoulos 2013). In the perspective of environmental sustainability, Udo and Jansson (2009) have demonstrated that poorer nations that are struggling to survive are less concerned with environmental sustainability than advanced and stable nations at higher levels in the hierarchy of needs. This confirms the hypothesis of the environmental Kuznets' curve that provides an inverted U-shape relationship between economic growth (income per capita) and the environment. In particular, at low incomes a trade-off between economic growth and environmental quality exists, while at higher incomes economic growth is complementary to improved environmental quality. This could be explained in terms of lax environmental regulations and low ability to pay for conservation during initial phases of economic development, followed by greater public concern for the environment leading to more stringent regulatory standards and greater ability to pay for environmental issues as incomes rise (Dasgupta et al. 2002). However, as mentioned by Etzioni (1998) and Stobbelaar and van Mansvelt (1999), the continuous consumption by societies long after their basic needs are met is affecting the ability to be environmentally sustainable.

The review of the sustainability literature by the U.S. National Resource Council (1999) identified that the most cited value to be sustained was "life support systems", highlighting that the environment is a source of goods and services essential for the life support of humankind. Thus, ecosystem services are inherently related to human needs and values (Wallace 2007; Dominati et al. 2010) because ecosystems provide goods and services like food, fiber for clothing, sources of energy, support for infrastructures, clean air, clean water,

flood mitigation, recycling of wastes, which are useful for the fulfillment of physiological and safety needs. Moreover, aesthetics, spiritual and cultural human experiences are important components of cultural ecosystem services that are crucial for meeting human needs in the upper part of Maslow's hierarchy (Wu 2013). In addition, Termorshuizen and Opdam (2009) have re-conceptualized the idea of ecosystem services as landscape services in order to better recognize the link between values and local landscape patterns and processes. Thus, landscape becomes conceptualized as a value delivery system, through a value chain of structure–function-value.

However, societal values contribute to landscape condition by encouraging or limiting human activities (Rapport et al. 1998). For example, in communities where forests are valued more as timber production than as habitats for wildlife, one might expect an increase in deforestation. Furthermore, societal values can play a key role in judging the acceptability of landscape conditions, as in the case of permissive policies that, to achieve short-term economic benefits, have resulted in environmental consequences affecting the long-term societal goals of landscape sustainability (Rapport et al. 1998).

Finally, the same socio-ecological landscape could be valued differently by different stakeholders because of different needs and perceptions (Aretano et al. 2013). For example, the same agrarian landscape may offer utilitarian and symbolic values for a group of farmers and aesthetic values for a group of non-farmers. Also the scale can affect the values perception of stakeholders involved (MEA, 2005). Consider, for instance, the values of wetland services in the Netherlands for stakeholders at different jurisdictional levels: recreation, reed cutting and fisheries are seen to be of value at the municipal scale, whereas at the provincial scale, main concerns are recreation, but also nature conservation. At the national level, nature conservation is by far the most important service (Hein et al. 2006). However, a clear understanding of scale can lead to development of more effective landscape policies and management at all scales (Zurlini et al. 2010).

3 Values and Rigidity traps

Rigidity is a well-known psychological notion. Psychologists speak about a social trap (Cross and Guyer 1980) when individuals operating for short-term positive gain ("reinforcement") had a tendency to over-exploit a resource, which led to a long-term overall loss to society. Cross and Gruyer (1980) and Costanza (1987) recommended transforming social traps into trade-offs by charging a tariff or other financial contribution on the participants liable for initiating and causing long-term harmful and hazardous situations. Funds gathered this way can be employed to study and ameliorate environmental effects. Odum (1997) has used rigidity in an ecological sense.

Maslow's hierarchy of needs (Figure 1) is a concept to be considered here as the basis of rigidity in values. The essential needs near the bottom of the pyramid produce values that have to be correspondingly rigid. We cannot live without food, for example, and our social systems cannot exist without security. We cannot reevaluate those needs and related values because they are essential to us. However, we are also living at the top of the pyramid, in a realm where needs and related values could be much less rigid and be bent to serve our changing needs. The social puzzle considered daily by law, psychology, education and marketing experts, rest with the motivational factors and forces capable of inspiring self-realization.

In socio-ecological systems, after a phase of growth, followed by a phase in which that growth was conserved, there seemed to be the need for release. Failure to release the creativity for the next phase created a rigidity to the systems, which Holling (2001) described as the "rigidity trap" where institutions become highly connected, self-reinforcing, and inflexible and cannot change or adapt to new conditions, nor escape from a trajectory toward an undesired regime (Gunderson and Holling 2002). These systems are characterized by high capital (accumulated wealth and abundant social and natural capital), high connectivity (efficient methods of social control in which any novelty is ejected) and,

in contrast to the phase where those conditions exist in an adaptive cycle, high resilience (the system has a great ability to resist external disturbances and persist, even beyond the point where it is adaptive and creative (Holling 2001). Although some level of "rigidity" is useful, and obviously essential for providing structure to society (civil rights, norms, land-use planning, maintaining values, and fostering resilience to short-term changes), it can exist at the expense of creativity and adaptability and rigidity may also result in overexploitation, or force trades-offs that may become maladaptive over time (Gunderson and Holling 2002).

Escape from this trap is always difficult, because it often means stopping doing something that we have done for years as leaving a job, ending a program, abandoning an approach. But the adaptive cycle tells us that unless we release the resources of time, energy, money and skill locked up in our routines and our institutions on a regular basis, it is hard to create anything new or to look at things from a different perspective. Without the continuous infusion of novelty and innovation in our lives, our organizations and our systems, there is an increase in rigidity. For example, Nielsen and Reenberg (2010) argued that the Fulbe ethnic group in rural Burkina Faso has been less successful in adapting to extreme climate events because they prioritize values such as personal integrity, worthiness, and individual freedom. Prioritizing such values lock them into such pattern that makes them more reliant on climate sensitive activities and gives them less access to embracing alternative successful livelihood strategies.

There are cases where fostering specified resilience of particular parts of a SEL to specific disturbances may cause the system to lose resilience in other ways (Cifdaloz et al. 2010). And this can also occur at global scale, where fostering resilience of particular countries may cause the global interconnected system to lose resilience in another. The ability of our institutions to move at multiple scales along more sustainable trajectories will depend on their aptitude to learn from experience and inform and adapt future sustainability visions, values and transition strategies (Norton 2005). Understanding why rigidity can sometimes make sense may help in finding ways to avoid traps in situations where flexible response and innovation are needed.

Moving this metaphor to the landscape perspective, a "rigidity trap" is formally characterized by low heterogeneity and higher aggregation and connectivity of entities (e.g., land-uses, land-covers), a great capacity to focus on a singular approach, and low capacity to explore alternatives, with consequent little capacity to dissipate stress, which may accumulate to high levels through the panarchy (Holling 2001; Carpenter and Brock 2008). Value rigidity of Pirsig's monkey is at the root of the rigidity trap. Value rigidity can make it hard to learn new facts and to recognize important facts because we pre-select facts as important, or not, in line with our established values. Changing circumstances demand to reappraise values like in the case of Pirsig's monkey and its rice. We have still to change beliefs, analyses or hunches that can immobilize us far more effectively than preparedness to live with uncertainty and surprises.

One interesting example of rigidity trap in SELs is highlighted through the cultural strategies for resource management within different Oceanic islands, where the small islands inevitably reached resource limitations. Initial settlement and growth occurred with little or no resource constraints. Over time growing population lead to the approach of each island's carrying capacity. Kirch (1984) laid out six theoretical models for the long term population growth of these islands, the cultural equivalent of the r/K selection model of island biogeography (MacArthur and Wilson 1967) to include (1) extinction, (2) exponential, (3) logistic, (4) overshoot, (5) oscillating, and (6) step models. While examples exist showing the range of development pathways (see Kirch 1984; Kirch and Rallu 2007), the islands that avoided extinction or overshoot developed stringent cultural standards in order to live within their resource limitations. Some directly curtailed population – such as infanticide, human sacrifice, or more frequent wars – while others indirectly controlled growth rates through strict ownership and enforcement of natural resources. In all cases the values of the populations would be considered overbearing from a modern perspective because they inherently must limit unrestricted freedom to pursue higher 'needs' in order to preserve the

essential needs of people the society. While many paths were taken once the resource scarcity was acknowledged, and all of them limiting in their own way, it is very clear that those that did not react came out the worst. This is the case of Easter Island (Rapa Nui) that has become widely known as a case of "ecocide", where the ancient Polynesians recklessly destroyed their environment and, as a consequence, suffered collapse (Hunt and Lipo 2009).

Although in Collapse, Jared Diamond (2005) attributes the demise of island groups primarily to their size and resource diversity, the importance of cultural response was given little attention. The 'Law of Evolutionary Potential' – 'the more specialized and adapted a form in a given evolutionary stage, the smaller its potential for passing to the next stage (Service 1975)' – speaks to the value of rigidity in solving short term or localized problems and to the disadvantage rigid polities incur when faced with new challenges or external or competing pressure. The successful society in this model becomes locked into their adaptations under the assumption that success at adaptation breed conservatism. In Oceania the rigidity of the successful polities, particularly on the smaller islands where competition for power was limited, likely played a role in the success or failure of island populations; rigidity and conservatism resulted from the investment in controlling the current polity system. Therefore, the more complex and interconnected a society and its polities become, the more investment is needed to maintain it and the more rigid and conservative, as well as vulnerable to change, it will become (Gunderson and Holling 2002). It is to be noted that environmental limitations relate to the potential of political complexity, with greater resources allowing for increased competition and corresponding complexity. In Oceania the ability to adapt to resource limitations was an essential element to long-term stability, but what is less clear is how Oceanic islands would fare in the face of continuous change.

Success breeds rigidity and, therefore, consequently lowers potential success under different conditions and constraints. This theory is often presented as an explanation of why new regimes can often out-compete established ones. Although not presented under the same 'law,' this concept is applied to the success and failures of businesses over time, with new, innovative businesses out-competing established, but rigid, cooperation. As highlighted in the oceanic example, the moral of the paradox is that there are hard choices to make, but that those choices must be made. Restrictions of needs higher on Maslow's pyramid (Figure 1) were restricted or controlled in order to ensure the ability to provide the more essential needs at the bottom. It may be argued that the global community is approaching resource limitations for continued growth and that, at least at the decision making level, is in denial about the need to make difficult, restrictive decisions. Instead we often take decisions that reinforce the rigidity of the current system (Holling and Meffe 1996) that places equivalent value on disparate 'needs'.

4 Examples of socio-ecological concepts that need re-evaluation to escape from rigidity traps

The usually high value the monkey places on rice needs re-evaluation in this life-threatening situation. Changing circumstances demand to reappraise a number of leading concepts like biodiversity, ecological corridors, society's techno-social systems, and the privatization of value, as an example.

Humans trying to understand the current state or predict the future condition of complex systems regularly resort to simple, easily interpreted surrogates like biodiversity as parts of the whole complexity, which can be understood and even used by non-scientists to make planning and management decisions. Yet, the overall information we can gain from a set of indicators either structural and/or functional (e.g. biodiversity) will never match that of the whole system, since each individual indicator carries only partial information.

Fortunately, the complexity of living systems emerges not from a random association of a large number of interacting factors, but rather from a smaller number of key-controlling processes (Holling 2001; Gunderson and Holling 2002). Thus, despite the

infinite complexity, much of the fundamental nature of systems can often be captured and described by single key-state variables, as many features of the system's state tend to shift in concert with them. We can argue whether and how biodiversity, as it is currently conceived and pursued, is still one of them. However, the problem is that each complex system is rather unique with nonlinear behavior and sudden shifts and surprises, and not always and anywhere the same key-state-variables are in operation and in the same way. Large studies of land-use and land-cover change, for example, have not found evidence for any single, ever-present driver of change (Ostrom et al. 2007). Yet the challenge is still to identify such single key-state variables, based on the best knowledge we have, as representative of the many features of the system's state that tends to shift in concert with them. In more extensive terms, the same applies to sustainability science of complex adaptive systems.

Furthermore, there is a need to recognize the evolving values in light of our changing situations; that is to not hold too tightly to our current notion of a "biodiverse" system and recognize that in our situation we may have to make hard decisions in cutting certain systems away in order to maintain anything at all. We have lost many species, and will continue to lose many more. As the systems we attempt to protect lost critical species for maintenance, such as the large mega-fauna, our notion of what that system is must also change. The notion of biodiversity is already changing from what it was just a couple decades ago. Species richness, the number of different species in an ecosystem, was for a long time the predominant measure of global biodiversity; this is now changing rapidly as researchers are realizing that rather than considering the sheer number of species, it is which specific species that are present that is crucial for ecological functions (Stuart-Smith et al. 2013). Furthermore, the realization that saving a species does not really work without the conservation of a critical mass of habitat has begun to alter the way we think about species conservation (Noss and Cooperrider 1994). We think this is an important change that needs to continue happening. While biodiversity is important it is not the right level to focus our management on. Biodiversity, at least how we think of it, is a positive benefit of healthy, intact ecosystems but is simply too complex to be managed directly.

In some cases, the rigidity of protecting individual species has resulted in the degradation of habitats that may, ultimately, further result in losses of biodiversity rather than in an increase. For example, the protection of green sea turtles in Hawaii through the endangered species act has been wildly successful, with huge increases in numbers and nesting (Balazs and Chaloupka 2004; Chaloupka et al. 2008). While the recovery of the green sea turtle has been wildly successful given the population increase, the green sea turtle is not considered "recovered" because their populations are still below historical levels (Kittenger et al. 2013). The recovery to historical levels, however, is not a realistic goal due to the concept of the "shifting baseline syndrome" (Pinnegar and Engelhard 2008; Papworth et al. 2009) given that the ecosystem has changed drastically through introduced and invasive species, degradation through human impacts and land runoff, and over-exploitation and harvesting. Thus, considering the historical population of sea turtles as a baseline is no longer relevant under the new paradigm. This is an example of how our attachment to a value (number of turtles) results in mismanagement; although the turtles are not up to historical numbers, they appear to be overly abundant in the modern ecosystem. The conservation of this single species has resulted in unexpected environmental and social consequences; sea turtles may now be over grazing native seaweeds and competing against other seaweed eating species, and an increase of shark attacks in the past few years may be another unintended side effect. Other well-known examples of mismanagement and consequences caused by shifting baselines exist such as the Kaibab deer in Canada and the US (Binkley et al. 2006).

The complete knowledge of biodiversity will remain an unknown for humanity as many other things and, however, even if we know all the elements (species), along with the interactions between taxa and with other communities, and the external forcing from environmental factors we could not yet be capable to reasonably predict what we are really interested in, that is the whole functioning, and this because of the complexity and intrinsic uncertainty of social-

ecological systems. Furthermore, the values we place on biodiversity are entirely based upon the complexities of humans' cultural norms, societal structures, and the interaction with the environment. There are many layers of value consisting of both tangible and intangible benefits, and the changing levels of biodiversity or changing relationship of a society to that biodiversity can change a biota from a nuisance to a valued rarity very quickly.

As to corridors, an accepted goal of conservation is to build a conservation network that is resilient to fragmentation and environmental change (Zaccarelli et al. 2008). However, fragmentation is a relative concept as well as connectivity. Effective corridors should provide suitable and reliable connectivity among habitats across spatiotemporal scales for species mobile or less mobile for gene exchange under uncertainty and change. However, often a "static" vision of landscapes is adopted (i.e. the cartography of land-uses/covers) whereas landscapes (habitats included) are dynamic. Indeed, they do change either under different seasonal conditions, or under multiple driving forces like, for instance, climate change. As a result, what we are looking for, i.e. fragmentation or effective corridors, can systematically change on the map, and what is fragmented or suitable as corridor under certain conditions could not be suitable or fragmented when season, conditions or the set of focal species are changed. This is an example of how our attachment to valued spatially explicit mapping of land uses/covers can result in mismanagement of conservation networks.

Just because we are not so good in predicting the future and what could be a suitable network sustaining functional diversity and gene exchange, we should rely on past time series (at a suitable scale) to define the trajectory of every landscape piece to see whether it is predictable or not, that is, if it is persistent or not. Once you get a "predictability" map (e.g., Zurlini et al. 2013) then you can think of applying different modeling tools to derive, under uncertainty, what possibly could be an effective corridor network and a suitable fragmentation for the future (Zurlini et al. 2014a). So one could discover that along with "classical" green and blue ways other elements in the landscape could be crucial for the network based on their predictability. One could also discover which unpredictable landscape pieces are crucial for the maintenance of the overall connectivity in the face of climate change and search to transform them in "persistent" through planning and management efforts.

The same principle should be applied to fragmentation/connectivity for marine systems (Treml et al. 2008). Indeed, in the case of many marine species and population, connectivity is determined largely by ocean currents transporting larvae and juveniles among distant patches of suitable habitat. So, connectivity relies on the persistence of ocean currents suggesting areas that might be prioritized for marine conservation efforts and that are working like "stepping stones" in the maintenance of the overall network. In this case, you might identify "new" candidate stepping stone areas in case of predicted changes in the oceanic current pattern following the ongoing climate change. Unfortunately, most of marine biologists and ecologists involved in marine conservation do not consider the importance of ocean currents.

Another example refers to society's techno-social systems that are becoming ever faster and more computer-orientated generating faster versions of the existing human behavior, as humans lose the ability to intervene in real time in the global financial market (Johnson et al. 2013). This is a kind of global techno-social trap where a behavioral response is constantly dictated by value rigidity of pre-established competitive necessities of profit and is characterized by large numbers of sub-second extreme events. The proliferation of these sub-second events shows a significant correlation with the onset of the system-wide financial collapse in 2008 (Johnson et al. 2013).

The housing bubble in the US is one example of how the valuation that we rely on became so skewed from reality that it caused a global "catastrophe" (e.g., Baker 2008). We attempt to counterbalance private valuation with laws and statutes that protect public values. The Environmental Protection Act essentially says that we (as a society) value certain aspects of the environment as a public good over the private value that individuals might be able to extract from

that good (for example Sax and DiMento 1974). Often, these are viewed in opposition (protection of environment vs. private value) rather than complimentary (balancing of two different values to maximize total value). Ostrom (2009) discusses how value derived from shared spaces is not the simple response dictated by the tragedy of the commons. The tragedy of the commons is fundamentally flawed if there is communication and cooperation; the fair and just solution to the tragedy (as it is proposed with the shared pasture) should be reached through shared values that are communicated within a group. Yet, rather than allow communities or other social blocks to find a fair and just solution, our current norm is to sell the common pasture to a single entity, who (more often than not) will manage it for individual private benefit. This illustrates how an initially beneficial concept, the privatization of value, may have become a burden and potential detriment to our society. While it may not be necessary to abandon concepts as they evolve into traps, they will need to adapt or be regulated in order to avoid the development of rigidity traps.

5 Discussion

The long-term goal for scholars of sustainability science is to recognize which combination of state variables in complex adaptive systems tends to lead to relatively sustainable and productive use of particular resource systems operating at specific spatial and temporal scales and which combination, instead, might get us stuck in the Pirsig's monkey trap leading to resource collapses and high costs for humanity.

We all just seem to be concerned with trying to grab the biggest handful of rice we can rather than thinking about how we – as individuals, communities, and a global society – are going to get our hand out of the hole. In order to escape the value rigidity trap, the very first value that would need to change is to acknowledge that we are in a trap. We perceive that this will be the hardest value to change, and that the rest would come relatively simply after that. We would argue that many people (monkeys), particularly the one's with power in the decision making process, tend to think that there is no trap. People feel this way for different reasons – be it a belief that technology will solve any confronted problem or be it an unawareness of our dependence on natural systems – which complicates the messages needed to change values. Indeed, many people feel that the trap is actually a blessing because after all they do have a handful of rice (if they can just pull their hand out).

The classic work of Donella Meadows (1941 – 2001), provides insight into how do we change the structure of systems to produce more of what we want and less of that which is undesirable in the light of sustainable development. She proposed a list of places (leverage points) to intervene in complex systems in increasing order of effectiveness (Meadows 2009) as reported in Table 1.

Table 1: A list of leverage points to intervene in complex systems in increasing order of effectiveness (modified from Meadows 2009).

Order	Leverage points to intervene in complex systems
12	**Numbers**: Constants and parameters such as subsidies, taxes, and standards.
11	**Buffers**: The sizes of stabilizing stocks relative to their flows.
10	**Stock-and-Flow Structures**: Physical systems and their nodes of intersection.
9	**Delays**: The lengths of time relative to the rates of system changes.
8	**Balancing Feedback Loops**: The strength of the feedbacks relative to the impacts they are trying to correct.
7	**Reinforcing Feedback Loops**: The strength of the gain of driving loops.
6	**Information Flows**: The structure of who does and does not have access to information.
5	**Rules**: Incentives, punishments, constraints.
4	**Self-Organization**: The power to add, change, or evolve system structure.
3	**Goals**: The purpose or function of the system.
2	**Paradigms**: The mindset out of which the system — its goals, structure, rules, delays, parameters – arises.
1	**Transcending Paradigms**: no paradigm is right.

As one can see the most effective leverage points are paradigms and transcending paradigms, apparently very difficult to change but the most effective for a real change. Mostly, the numbers are not worth the sweat put into them. Our discussion on value rigidity falls largely within those highest two leverage points. In the words of Donella "…the shared ideas in the minds of society, the great big unstated assumptions,

constitute that society's paradigm, or deepest set of beliefs about how the world works. These beliefs are unstated because it is unnecessary to state them—everyone already knows them. Money measures something real and has real meaning; therefore, people who are paid less are literally worth less. Growth is good. One can "own" land. Those are just a few of the paradigmatic assumptions of our current culture, all of which have utterly dumbfounded other cultures, who thought them not the least bit obvious" (Meadows 2009). Notice that most of the current sustainability research, even the most advanced on complex systems, instead, is focused on least effective leverage points.

Societal value shifts occur in front of us and the response of public attitude to an increase in perceived problem size is expected to be abruptly discontinuous (Scheffer and Westley 2007). In societies with little difference among individuals, if the problem is perceived to be small (and the perceived pay-off of taking action is low), the attitude of most individuals is passive, but if the perceived severity of the problem has grown sufficiently to a critical point then society abruptly shifts to a predominantly active attitude (e.g. creating political pressure to solve the problem) (Scheffer and Westley 2007). What awareness or pain (quantitative and qualitative) is sufficient to provide the realization of letting go of the rice, extracting the hand from the coconut and rethinking the problem of getting to the rice without sacrifice of life? For each individual the awareness or pain (discomfort) is different. It requires a major portion of the population to realize the need for change in order to precipitate a paradigm shift. How many monkeys will need to be captured before the remaining monkeys realize the coconut with the rice in it is a trap (paradigm shift)?

The values expressed by China in 1995, for instance, were very different than those being expressed now. The melting of Mao Zedong's value rigidity gave way to a massive paradigmatic change in only one generation. What are the discomforting values being left behind, and what level of awareness or discomfort was required to birth the societal value change for a society or a troop of monkeys? The monkey population with the value flexibility should increase as the value rigid monkeys are decreased by the consequence of their rigidity and the trap; eventually, the societal value will change (behavior imitation, learning and sharing).

Self-sealing beliefs can be self-correcting when extreme events such as wildfires or hurricanes (e.g. Katrina) foster change in long-established rules and practices like planning and management (Scheffer and Westley 2007). This can give us hope on our adaptive capacity, but we must not rely on extreme events like that for a change. On the contrary, we have to foster our ability to schedule and plan in a collaborative way. However, extreme events may also provoke other feedback processes working to maintain the status quo, such as the financial and/or political support that accompanies continued crisis management. Thus, things might remain the same or even worse through the pathological cycle of resource degradation even when resource managers recognize that things would improve if they approached their work differently (Repetto and Allen, 2006). It would be really hard to escape such lock-in situation like in the Oceanic island case.

However, there are some barriers that enhance such trapped situations and impede the transition of values into concrete actions for the achievement of sustainability (Blake 1999; Kollmuss and Agyeman 2002; Leiserowitz et al. 2006), and the strength of a particular value could also affect the real attainment of a sustainability goal. For instance, environmental protection, that is widely recognized by many people as a key value, it is considered to be a low priority if compared to other values (e.g., economic growth), as evidenced by the current relationship between society and nature that is undoubtedly unsustainable. Furthermore, changing values would also require changes in lifestyles and in economic and social institutions. People often, lack the time, money, or literacy to translate their values into action or to overcome bad lifestyles and the social, economic, and political context (social norms, laws, infrastructure, available technologies) may affect how individuals order their values, giving precedence to some values over others, and obstructing sustainability across multiple contexts.

Thus, it is clear that significant changes in human values and priorities are required to achieve

sustainability. Societal value shifts occur in front of us, and thus we can only hope that the degree of awareness will increase to make paradigms shifts with the fewest possible pains of any kind.

6 Conclusions

Human values and motivations that are experienced in landscapes determine the value system that guides land use. The reflection on the way society and we ourselves handle our motivations is particularly relevant when the shift to a sustainable development of the landscape is at stake, a shift that requires turning from maximum tolerable consumption levels to minimum required consumption levels of all limited resources (VanMansvelt e Van der Lubbe, 1999). Especially in the rich countries, the perspectives for a change to achieve sustainable landscapes as the basis for human livelihood should be taken seriously.

In this perspective, adopting management practices and interventions over the short term only to meet current societal needs may be short-sighted. For example, if for a given region a current primary societal value is agricultural production, maximizing production, although can be perceived to be beneficial, may compromise future ecosystem services, such as a diversity of gene pools and water quality, indicating a clearly unsustainable pathway of development.

As highlighted by Zurlini et al. (2014b) an overregulated planning and management of land use along with intensive agricultural systems can lead in the Mediterranean region to a rigidity trap. This can occur through a pathological cycle of resource degradation and stress (soil and water), followed by social-economical response aimed at reestablishing or maintaining productivity of the resource-degrading activity, with consequent further degradation and erosion of system adaptive capacity to cope with shocks and surprises. This can dramatically enhance desertification processes and be detrimental to the necessary adaptability of landscape elements and biodiversity and can alter the vegetation and the patterns of regional climate variables like temperatures and precipitation (Pielke, 2005; Makarieva et al., 2014) with adverse effects on the ability of ecosystems to support the water cycle on land. These are examples in which the adoption of strategies for adaptability that are socially desirable may lead to vulnerable social–ecological systems and persistent undesirable and unsustainable states. In a rigidity trap there is a tendency to lock management and governance into their existing attitudes or worldviews, making it difficult to respond to changing conditions. Moving out of this trap requires not only a shift in the social and economic dimension, but also active stewardship of ecosystem processes (Folke et al. 2009). In this context, the well-informed landscape managers and decision makers should focus particular attention on ways to sustain the all forms of capital, without which actual and future generations cannot meet their needs (Folke et al. 2009) and must take into account that they inevitably change over time and that people differ through time and across space in the value they plays on different forms of capital. For this reason, an effective landscape management is a critical issue that requires both resilience and adaptability, because the losses of many forms of human, social and natural capital are especially problematic because of the impossibility or extremely high cost of providing appropriate substitutes.

Furthermore, landscape managers must consider that societal values fluctuate over time in response to population patterns, economic opportunities, ethics and environmental conditions and are scale dependent. For this reason, over the long term, successful sustainable landscape management should include planning and design considering local and broader-scale perspectives (Jones et al. 2013) that must be flexible to respond to changing ecosystem processes and societal needs and values.

Moreover, stakeholders have different, and often conflicting, values and worldviews that they bring to decision-making processes. In this respect, we need improved social networking and we do believe that a potential solution could be the development of cooperation through hierarchies of stakeholders and decision makers (monkeys). Cooperation will be necessary for multiple stakeholders in the panarchy

of SELs in social networks within and between organizational levels for managing SEL resilience under uncertainty and change (Walker et al. 2002; Olsson et al. 2004) to make adaptive plans and management of landscape patterns (Jones et al. 2013). The ultimate goal is to determine if there are a set of landscape design options that will help sustain multiple ecosystem services, but especially in areas under rapid land-use conversion or that are being affected by broad-scale drivers such as climate change. Can a landscape with relatively large amounts of developed/converted land be still designed to function more like a landscape dominated by natural land cover? What landscape features and elements provide the greatest benefit to ecosystem services? How do those opportunities change with biophysical setting and scale?

However, cooperation to this end is not easy, the emergence of cooperation in nature and human societies depends crucially on how the benefits from cooperation are divided and whether individuals have complete information about their payoffs (Fischer et al. 2013). A "social trap" can emerge where individuals, groups or organizations are unable to cooperate owing to mutual distrust and lack of social capital, even where cooperation would benefit all. Examples include civil strife, pervasive corruption, ethnic discrimination, depletion of natural resources, and misuse of social insurance systems (Rothstein 2005).

Cross-scale collaborative planning networks such as the U.S. Fire Learning Network (Butler and Goldstein 2010) can facilitate overcoming the rigidity traps that prevent resource management agencies from responding to complex cross-scalar problems in SELs. Yet, changing circumstances demand to reappraise values like in the case of Pirsig's monkey and its rice. The intentional induction of cooperation could be promoted across the panarchy of SELs through the establishment of social initiatives that increase the perception of similarity within and among stakeholders to reach a minimal level that makes cooperation advisable (Fischer et al. 2013). In other words, we must be fully aware that we might get stuck in a rigidity trap to be aware of the similarity of our common condition, to overcome mutual distrust to change some paradigmatic assumptions of our current culture, and to start real cooperation regardless of which kind of monkey we are.

A great help for fostering this awareness is coming from Internet and Social Media exchanging information and new ideas that can possibly change our way of decision-making, for example, Avaaz (http://www.avaaz.org) with over 27 million members worldwide. We have become networked minds, social decision-makers, more than ever before, and this has several fundamental implications. Our social values, and economic theories and practices must change accordingly in our SELs, and new institutional requirements must be developed for global-scale network interactions and highly interdependent decisions to support the social decision-maker, the "homo socialis", rather be tailored to the perfect egoist called "homo economicus" (Helbing 2013).

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