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ARTICLE

The Principle of Resilience

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I. INTRODUCTION

Scientific findings have often concluded that environmental quality levels are getting worse despite efforts towards environmental protection. Such findings demonstrate the need for a change in strategy towards conservation. However, changing the way humans act towards conservation is not an easy task because (1) environmental protection deals with very complex structures, the ecosystems; (2) conservation cannot be addressed solely by one field of knowledge, it requires an interdisciplinary approach; (3) and because it will not be achieved through the efforts of only one sector of society, solely government, market, or individual citizens–it requires a conjugation of efforts among all sectors.

Since humankind started to get concerned about the degradation of nature, we focused our attention on the preservation of specific species of fauna and flora that, for whatever reason, inspired our attraction. Environmental laws also focused on the preservation of landscapes that distinguished themselves by their exceptional beauty, by their importance, or because they were the remains of an almost extinct ecosystem or the habitat of some almost extinct species.[1] By those means,

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1. In the United States, the preservation of specific ecosystems due to the presence of almost extinct species started in 1972, when the Endangered Species Act was enacted.

humankind thought that, by preserving at least samples of each ecosystem and its inhabitant species, they were conserving biodiversity. However, those samples continued to suffer degradation, despite the efforts to guarantee stability and to keep their original state. By studying the causes of this phenomenon, ecologists concluded that ecosystems preserved in only a few restricted areas were collapsing because they were too vulnerable to disturbances. They noticed that this increase in vulnerability has been occurring since human occupation of land around the world increased in extension and intensity, as a result of the expansion of industrialization.

But why did ecosystems get more vulnerable? Because, by eradicating species, by polluting the environment, and by changing environmental features humankind has reduced ecosystem resilience.[2] The increased vulnerability of ecosystems causes them to suffer unpredictable changes. These changes are generally also undesirable for humankind because all production of services and goods, and all the features of land use rely on the predictability of basic natural characteristics such as the frequency and intensity of rain, or the geological solidity of mountains over which cities are built, or the chemical composition of the soil. What increases the danger of loss of ecosystem resilience for humans and for the other creatures that inhabit these ecosystems is that, depending on the intensity of the alteration of an ecosystem, the change may turn out to be irreversible.

The concern about resilience is related to the questions: "how do we deal with sustainability?" and "how do we address climate change?" The concept of ecosystem resilience may be a new opportunity to achieve sustainability–which has been pursued without great success since 1987, when the World Commission on Environment and Development (also known as the Brundland Commission) popularized the term and the definition of "sustainable development."[3]

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2. Carl Folke et al., *Regime Shifts, Resilience, and Biodiversity in Ecosystem Management*, *in* FOUNDATIONS OF ECOLOGICAL RESILIENCE 119, 142 (Lance H. Gunderson et al. eds., 2009).

3. U.N. World Comm'n on Env't & Dev., *Our Common Future*, U.N. Doc. A/42/427 (Aug. 4, 1987) [hereinafter *Our Common Future*].

The concept of ecosystem resilience also affects how we address climate change. After all, if ecosystems are currently vulnerable, how are they going to resist disturbances such as climate change and the rise in sea level? In the face of the growing expectation and certainty that ecosystems will be seriously damaged[4] and that human inaction will only exacerbate the negative impacts of this event, humankind has begun considering what should be done to restore ecosystem resilience and to avoid consequences of even greater proportions.

Scientists concluded that, in order to restore ecosystem resilience, it is not enough to preserve the ecosystem in limited tracts of land–it is necessary to preserve the ecosystem functions, that is, the few natural mechanisms that continuously occur within an ecosystem and that are responsible for maintaining the subsistence of its inhabitant species and the function of the ecosystem as a whole.

The natural mechanisms on which an ecosystem relies are provided by the diversity of species;[5] thus the enhancement of ecosystem resilience requires the conservation of biodiversity. In fact, this finding does not bring new challenges for the regulation of human activities or for the relationship between humans and nature. In some way or another, humans have always sought to maintain biodiversity because the extinction of species is condemned both by a moral approach–which posits that we should protect species from extinction because we can do it and it is the right thing to do–and by the utilitarian approach, which stresses that the extinction of a species can cause disturbances in ecosystems, therefore harming humans, or can deprive humans of valuable services, such as the cure for mortal diseases that were hidden in some gene of the extinct species.[6]

In order to conserve ecosystem resilience, however, ecologists recognize that it is not sufficient to preserve samples of each species and ecosystem in limited protected areas. Presumably to

4. *See* WILL STEFFEN ET AL., GLOBAL CHANGE AND THE EARTH SYSTEM: A PLANET UNDER PRESSURE (2004).

5. Carl Folke et al., *Biological Diversity, Ecosystems, and the Human Scale*, *in* FOUNDATIONS OF ECOLOGICAL RESILIENCE, *supra* note 2, at 151, 154-58.

6. ZYGMUNT J. PLATER ET AL., ENVIRONMENTAL LAW AND POLICY 432-34 (4th ed. 2010).

preserve biodiversity ecosystems should be preserved everywhere.[7] That finding creates a huge impact in the relationship between humans and nature because humans are already reluctant to enforce conservation of nature in a few places, even more so to recognize conservation of nature everywhere.

Folke, Holling, and Perrings affirm that the reform of conservation institutions to make them more adaptable to the changing needs of ecosystems' management could contribute to the achievement of the objective of preserving nature everywhere.[8]

As for institutional reform, adaptive governance coupled with adaptive management is regarded as a strong tool to enhance the achievement of resilience when managing an ecosystem. Adaptive governance enhances an institution's capability to deal flexibly with new situations, thus preparing managers for uncertainty and surprise.[9] Adaptive management is the process of learning from experience by monitoring ecosystem responses to actions taken by institutions that manage ecosystems.[10]

Although adaptive governance and adaptive management can be useful tools to address resilience, they are not sufficient. The achievement of resilience requires a substantial change in the way humankind relates to nature because humans are not used to compromising their activities according to the capacity of the ecosystem to support them. Humankind is used to dominating, not to coexisting with, nature. The inversion of this setting cannot possibly be achieved by a simple change in management methodology: it requires a change of values.

According to Aldo Leopold, nature conservation should start first by understanding nature and by setting the values we want conservation to have.[11] As the law is the tool used to express,

7. Folke et al., *supra* note 5, at 160; ALDO LEOPOLD, A SAND COUNTY ALMANAC 190-94 (Ballantine Books 1970) (1949).

8. Folke et al., *supra* note 5, at 160.

9. Carl Folke et al., *Adaptive Governance of Social-Ecological Systems*, 30 ANN. REV. ENV'T & RESOURCES 441, 447 (2005).

10. Barbara Cosens, *Transboundary River Governance in the Face of Uncertainty*, 30 J. LAND RESOURCES & ENVTL. L. 229, 238 (2010).

11. LEOPOLD, *supra* note 7, at 210.

systematize, and implement the values of organized societies, we believe that law has a role to play in associating the concept of ecological resilience with values humankind should adopt when developing activities that impact nature.

This discussion has exceptional importance now, at the imminence of the United Nations Conference on Sustainable Development, held in Rio de Janeiro in 2012. The International Union for Conservation of Nature (IUCN) President Ashok Khosla mentioned that "Rio+20 needs to review 40 years of unfulfilled commitments and explore genuine alternatives to current practices."[12] The principle of resilience developed here is envisioned by this article as one of these alternatives.

The discussion on how the law can enforce new values of conservation is expected to go beyond 2012, in order to influence domestic law-making and decision-making in public and private institutions alike.

This article seeks to develop the role law could play in contributing to the achievement of ecosystem resilience. Therefore, adopting Aldo Leopold's view of conservation, by which the first step should be to understand nature, this article will begin with a brief explanation of the ecological background to the concept of ecosystem resilience. Next, the article will consider Aldo Leopold's *land ethic* in order to discuss the values we should look for when implementing conservation for resilience. Regarding those values and concepts, the following part of the article will be dedicated to consolidating and contextualizing the legal principle.

In order to carry out a more detailed analysis about how the principle of resilience can be pursued in the application of the law, this article will focus on certain sectors of environmental law and policy making. Those sectors are: adaptive governance, adaptive management, environmental impact assessment, land use and climate change adaptation, and market mechanisms for conserving ecosystem services. The article will be based on cases from different parts of the world. As the adoption of the concept

12. Keith Ripley et al., *Summary of the Nineteenth Session of the Commission on Sustainable Development*, 5 EARTH NEGOTIATIONS BULL. 1 (2011), *available at* http://www.iisd.ca/vol05/enb05304e.html.

of resilience by law seems to be incipient in the jurisdictions of most countries, such case studies will be helpful to any jurisdiction in the world where this concept is still not effective.

II. ECOLOGICAL CONCEPT OF ECOSYSTEM RESILIENCE

Resilience is the capacity of a system to absorb disturbance, to reorganize itself, and persist.[13] A system is resilient when, even under impacts, it is able to retain essentially the same initial conditions, tending towards a state of equilibrium. This stable state of a system is called the "basin of attraction,"[14] "domain of attraction," or "stability domain."[15]

Ecological systems have more than one stable state or basin of attraction.[16] The group of basins of attraction related to the same ecosystem is called the "stability landscape."[17] When the ecosystem is already vulnerable to disruptions, and therefore less resilient, and those disruptions force the ecosystem towards the boundaries of its current basin of attraction, the ecosystem may cross a threshold, after which the ecosystem will present a new basin of attraction.[18] When the ecosystem changes from one basin of attraction to another, or when the ecosystem moves towards the edge of one basin of attraction, it is understood that a "change in the stability landscape" has occurred.[19]

In the case of change in the stability landscape, the resilience of the system can be considered the amount of disturbance the

13. Folke et al., *supra* note 2, at 121.

14. Brian Walker et al., *Resilience, Adaptability and Transformability in Social-Ecological Systems*, 9 ECOLOGY & SOC'Y (2004), *available at* http://www.ecologyandsociety.org/vol9/iss2/art5/.

15. Folke et al., *supra* note 2, at 119, 121.

16. Walker et al., *supra* note 14; Craig R. Allen et al., *Commentary on Part One Articles*, *in* FOUNDATIONS OF ECOLOGICAL RESILIENCE, *supra* note 2, at 3, 4.

17. Walker et al., *supra* note 14.

18. C. S. Holling, *Resilience and Stability of Ecological Systems*, *in* FOUNDATIONS OF ECOLOGICAL RESILIENCE, *supra* note 2, at 19, 29, 30.

19. Walker et al., *supra* note 14.

system can absorb before shifting into a different configuration, in other words, shifting to a new stability domain.[20]

Instead of moving to another basin of attraction, the ecosystem can also remain in a dynamic disequilibrium in which there is no global equilibrium condition and the system moves in a catastrophic manner between stability domains.[21]

Some basins of attraction are more desirable than others and, in view of this, human actors may be willing to influence the ecosystem's movement from one basin to another by reinforcing the resilience of the desirable ones–and thus preventing the ecosystem from reaching the threshold of change–or by reducing the resilience of the undesirable basin of attraction. This collective capacity of the human actors in the system to manage resilience is called "adaptability."[22] There are some circumstances in which the ecosystem will not be able to return to a basin of attraction, even with aid from human interference. These cases of *irreversibility* of the ecosystem status may occur because of changes in the composition of soil or air.[23]

Human management of natural elements is traditionally directed towards the maintenance of the ecosystem's stability.[24] This view of human interactions with the natural world focuses on equilibrium states, on "maintaining a degree of constancy by reducing natural variability."[25]

The relationship between stability and resilience represents the natural cycle of any ecosystem: the movement from a stage of slow accumulation of natural capital (stability) towards sudden changes, and releases and reorganization of that released capital

20. Lance H. Gunderson et al., *The Evolution of an Idea - the Past, Present, and Future of Ecological Resilience*, *in* FOUNDATIONS OF ECOLOGICAL RESILIENCE, *supra* note 2, at 423, 425.

21. C. S. Holling, *The Resilience of Terrestrial Ecosystems*, *in* FOUNDATIONS OF ECOLOGICAL RESILIENCE, *supra* note 2, at 67, 92.

22. Walker et al., *supra* note 14.

23. C. S. Holling, *Engineering Resilience versus Ecological Resilience*, *in* FOUNDATIONS OF ECOLOGICAL RESILIENCE, *supra* note 2, at 58; Folke et al., *supra* note 2, at 51, 132.

24. Holling calls this tendency "engineering resilience." Holling, *supra* note 23.

25. Allen et al., *supra* note 16, at 3.

(resilience).[26] Like two sides of a coin, both stability and resilience are essential to maintain the ecosystem. Besides providing the accumulation of capital, stability allows the different elements of the ecosystem (i.e. species of fauna and flora) to enhance their organization and connectedness. On the other hand, resilience reduces the connectedness and organization of the elements of the ecosystem and releases the stored capital, thereby providing opportunities for change, whereby species can reorganize themselves and find new connections among each other, resulting in the evolution of the ecosystem as a whole.

The dynamics of ecosystem organization are very similar to the dynamics of technological development, as pointed out by Brooks, "as a particular technology matures, it tends to become more homogenous and less innovative and adaptive. Its very success tends to freeze it into a mould dictated by the fear of departing from a successful formula. . . ."[27] The sudden change that occurs during resilience stimulates the ecosystem to "break the inertia" and to innovate.

As the interchanges between stability and resilience play such an important role in the maintenance of ecosystems, human management of ecosystems, which tends towards the abolition of disturbances, is greatly disadvantageous. By trying to avoid disruptions such as floods or fires, humans contribute to the construction of more vulnerable ecosystems, which are expected to suffer even greater crisis after longer periods of time. Holling mentions an enlightening example about the fire-combat in national parks in the United States.[28] According to him, the "[s]uppression of forest fire has been remarkably successful in reducing the probability of fire. . . . But the consequence has been the accumulation of fuel to produce fires of an extent and cost never experienced before."[29]

Along the same line of reasoning, it is also recognized by Leopold that human control over the health of the land has not

26. Holling, *supra* note 23, at 52.
27. Holling, *supra* note 21, at 105.
28. *Id.* at 83.
29. *Id.*

been successful.[30] Leopold understands *land* as the community that includes soil, water, plants, and animals,[31] and *health* as the capacity of the land for internal self-renewal;[32] therefore, very similar to the current meaning of *resilience*. According to Leopold, the land is sick when soil loses its fertility, or washes away faster than it forms, and when water systems exhibit abnormal floods and shortages.[33] The disappearance of plants and animal species without visible cause despite efforts to protect them, and the eruption of others as pests despite efforts to control them[34] are symptoms of the illness of the land.

The loss of biodiversity is both a symptom and a cause of land sickness. Every ecosystem contains a few functions which are essential for the maintenance of the ecosystem's main characteristics. Those few functions are developed by a wide range of species. Therefore, each function is developed concomitantly by several species, and is called *redundancy*.[35] Redundancy of function adds to the stability of systems because, even if the system loses one or a few species, it may keep functioning if at least one of the species responsible for that function remains. However, although the function remains and the ecosystem maintains its main characteristics, the ecosystem has lost resilience, because it is relying on only one species to develop that function. This phenomenon explains why the ecosystem keeps working although it is very vulnerable to disturbances. It also explains why an ecosystem that has survived the extinction of several species suddenly collapses when the last species developing a certain function becomes extinct.

The system also loses resilience by the loss of species because the range of possible connections among species is diminished as are the possible ways the system can reorganize after disturbance.[36] By presenting fewer possibilities to innovate, the

30. LEOPOLD, *supra* note 7, at 272.
31. *Id.* at 239.
32. *Id.* at 258.
33. *Id.* at 272.
34. *Id.* at 273.
35. Allen et al., *supra* note 16, at 14, 15.
36. Garry Peterson et al., *Ecological Resilience, Biodiversity, and Scale*, *in* FOUNDATIONS OF ECOLOGICAL RESILIENCE, *supra* note 2, at 167, 187.

system loses much of its capacity to adapt to changing circumstances.

Therefore, it is possible to conclude that humans reduce ecosystem resilience by removing whole functional groups of species; by altering the magnitude, frequency, and duration of disturbance regimes to which the biota is adapted; and by polluting the environment, thereby changing the dynamics of climate and the composition of water, soil, and air.[37]

However, just as human actors can interfere in ecosystems and reduce their resilience, in the same way they can contribute to the preservation of resilience by adopting a conservationist approach towards nature. According to Leopold, *conservation*

> is a state of harmony between men and land. . . . Harmony with the land is like harmony with a friend; you cannot cherish his right hand and chop off his left. . . . The land is one organism. Its parts, like our own parts, compete with each other and co-operate with each other. . . . You can regulate them–cautiously–but not abolish them.[38]

Therefore, Leopold considers "the first principle of conservation" to be the preservation of all the parts of the land mechanism.[39] In this context, "parts of the land mechanism" may be interpreted as "functions of an ecosystem." As scientific evidence points out that those functions are assured by biodiversity, Folke, Holling, and Perrings affirm that the conservation of biodiversity cannot be restricted to limited protected areas; it should be addressed everywhere.[40] The authors explain that, although preserving biodiversity through nature reserves may be an important short-term step, it is not sufficient to solve the problem of biodiversity loss, because nature reserves are embedded in larger environments and species depend on the reserves' surrounding area to maintain themselves. According to Askins, "[s]mall reserves will lose their

37. Folke et al., *supra* note 2, at 142.
38. LEOPOLD, *supra* note 7, at 189, 190.
39. *Id.*
40. Folke et al., *supra* note 5, at 160.

distinctive species if they are surrounded by a hostile landscape."[41]

Ecologists highlight some measures they deem efficient for the preservation of ecosystems' resilience. Leopold considers that the first step towards preserving ecosystem resilience is the collection of data about how a healthy land maintains itself as an organism.[42] By having this base datum of normality, science may detect what is occurring otherwise which might provide the causes for such change.[43] The author points out some characteristics of healthy lands already abundantly proved by paleontology: in healthy lands, wilderness maintains itself for immensely long periods; species are rarely lost; and soil is built by weather or water as fast as or faster than it is carried away to the sea.[44] The author also calls attention to the fact that each biotic province needs its own wilderness for comparative studies of used and unused land, as it is impossible to study the physiology of one landscape and apply those findings as a basis for comparison with the current status of a distinct landscape.[45]

Folke, Holling, and Perrings consider that, in order to conserve ecosystem resilience, it is necessary to identify the major social and economic forces that are currently driving the loss of functional diversity, and to create incentives to redirect those forces. They propose this to be done in two ways: by the creation of economic incentives that internalize the external costs of biodiversity loss; and by the adoption of measures that apply the idea of preserving biodiversity everywhere to an economic analysis. According to them, "we should be stimulating the development of institutions, policies, and patterns of human consumption and production that work in synergy with ecosystem functions and processes."[46]

Referring especially to institutions, Folke, Holling, and Perrings consider the development of effective institutions for

41. *Id.* (quoting R. A. Askins, *Hostile landscape and the decline of migratory songbirds*, 1957 SCI. 267).

42. LEOPOLD, *supra* note 7, at 274-75.

43. *Id.*

44. *Id.*

45. *Id.*

46. Folke et al., *supra* note 5, at 160-61.

biodiversity conservation as a precondition for the creation of incentives to prevent the loss of functional diversity. Those institutions should be adaptive, which means that they should be able to respond to environmental feedback before those effects challenge the resilience of the resource base and the economic activities that depend on it.[47]

III. THE LAND ETHIC

Aldo Leopold's *land ethic* opposes theories that consider nature as an object totally submitted to human scrutiny. According to François Ost, the idea of nature as an object dates back to Modernity, when Descartes and other philosophers of his time promoted a definitive rupture between humans and nature.[48] With the advancement of science, humans became able to overcome obstacles to their development posed by nature.[49] Humans acquired the belief in their superiority over other species and over nature.[50] From there on, humanity would use science to understand nature's secrets, dominate them, and submit nature to human will.[51]

According to Christian belief, by altering the land, planting, fertilizing the soil, and erecting buildings, humans are complementing God's creation and assuring prosperity.[52] It is by working the land that humans get title to property, both over the land and over the results of human work. According to this view, nature is no more than storage of resources,[53] whose use by humans is unrestricted.

As the transformation of nature by human interference achieved greater proportions, humankind became simultaneously

47. *Id.*

48. FRANÇOIS OST, A NATUREZA ÀS MARGENS DA LEI 30 (Joana Chaves trans., Instituto Piaget ed. 1995).

49. *Id.* at 37-39.

50. *Id.*

51. *Id.*

52. *Id.* at 64 (according to François Ost, when the biblical chapter *Genesis* says such statement, it is discretely authorizing humans to possess parts of nature).

53. *Id.* at 10.

a geologic agent, a climate actor, and a geo-chemical emitter, both influencing and disturbing nature as a whole.[54]

In the post-war world people became aware that the planet is vulnerable, that it contains limited resources, and that those resources are showing signs of exhaustion. François Ost mentions the first view of Earth from space, when satellites first photographed the planet, as the crucial moment for this realization.[55] This moment captures the final triumph of the human race over natural limitations and definitely sets humans in command of "Earth craft"[56] when, for the first time, they see the Earth as a fragile pearl in the vast universe. From then on, humans started to consider how vulnerable the planet they depend upon is and, consequently, also the vulnerability of the continued existence of the human race as a whole.

Aldo Leopold is one of the representatives of a generation which became aware of the harm humans can cause nature by its willingness to dominate it. Trying to combat the causes of human destructive behavior in relation to nature, Aldo Leopold advocates the adoption of an ethical treatment of nature, in which humans would express their love and respect for nature.

Leopold views this ethic as the "tendency of interdependent individuals or groups to evolve modes of co-operation," which ecologists call *symbiosis*.[57] This ethic started by being associated with the relationship between individuals. Later it evolved to include the relationship between individuals and human society. According to Leopold, a further extension of ethics to include the relationship between individuals and land, fauna, and flora is "an evolutionary possibility and an ecological necessity."[58] Land has been just a property to humans; their relationship has been

54. OST, *supra* note 48, at 297 (quoting C. ALLÉGRE, ÉCONOMISER LA PLANÈTE 292 (1990)).

55. *Id.* at 277-387.

56. *Id.* at 277 (quoting J.P. DELÉAGE, HISTOIRE DE L'ECOLOGIE. UNE SCIENCE DE L'HOMME ET DE LA NATURE 224 (1991)).

57. LEOPOLD, *supra* note 7, at 238; *see also* OST, *supra* note 48, at 290 (stating that the land humans exploit and pollute is much more than an object, in fact, it is the mother-Earth, with which we live in symbiosis).

58. LEOPOLD, *supra* note 7, at 239.

strictly economic, entailing privileges but no obligations, just as the relationship between citizens and slaves in antiquity.[59]

The extension of ethics to natural elements would, on the one hand, ensure the right of humans to manage natural resources, and on the other hand it would recognize the right of land, water, animals, and plants to continue to exist. Thereby, humans would be showing their respect for the other members of nature's community.[60]

According to Leopold, such a change of perspective requires a change in the human position: from conqueror of the land-community to plain member and citizen of it.[61] The conqueror selects which species he deems relevant and which he does not, thereby eliminating species whose function within the ecosystem he does not fully understand. The result is usually catastrophic, because often the realization that certain species had a main role within the ecosystem occurs when the species is already eliminated from that environment. By becoming members of the land-community, humans get in harmony with nature, and this is what Leopold considers to be the meaning of *conservation*.[62]

Leopold acknowledges that we probably are not going to achieve full harmony with the land. He places such a goal among other aspirations such as absolute justice or liberty for people, which are important to strive for, but not necessarily achievable.[63]

Leopold recognizes that modern people have lost much of their connection with the land, and this constitutes an obstacle in the way of conservation, as striving for harmony with the land cannot simply be injected into one who has no relationship with the land.[64] In order to solve this problem, Leopold recognizes the need for education in conservation, which should be primarily based on promoting curiosity about land mechanisms and building ethical support for land economics.[65] The author

59. *Id.*
60. *Id.* at 240.
61. *Id.*
62. *Id.* at 189.
63. *Id.* at 210.
64. LEOPOLD, *supra* note 7, at 210.
65. *Id.*

believes that, if this is set in place, conservation will naturally follow.[66]

The lack of education in conservation and knowledge about land mechanisms is also an obstacle for the development of a land ethic. For Leopold, the establishment of an ethical relationship with land requires love, respect and admiration, and a high regard for land's value. A person cannot love, respect, and admire something he or she does not know. That is why the land ethic requires some understanding of ecology. It also requires social approbation of right actions and social disapproval of wrong actions. According to Leopold, the path to determine the "right" and the "wrong" actions is the following:

> [Q]uit thinking about decent land-use as solely an economic problem. Examine each question in terms of what is ethically and esthetically right, as well as what is economically expedient. A thing is right when it tends to preserve integrity, stability, and beauty of the biotic community. It is wrong when it tends otherwise.[67]

Leopold says that, without an ethical relationship with nature, conservationists are obliged to look for economic values to justify efforts to conserve natural elements.[68] Therefore, people strive to identify how a function developed by certain species can help human economic activities and how the loss of such service provided by nature would harm the economy.

By recognizing the role of economic values in ecological functions in trying to conserve some species, Leopold calls attention to the conservation of species that are not useful to the economy, either because their function is still unknown or because their function supports the ecosystem as a whole, but not a specific human activity. According to him, conservation directed by the market does not cover such species, and this can result in their extinction and therefore increase the vulnerability of an ecosystem.[69]

66. *Id.*
67. *Id.* at 262.
68. *Id.*
69. *Id.* at 246.

Another problem of conservation as driven by markets is that it does not provide an education for conservation. People take measures towards conservation as long as they are going to receive something in return. As soon as the economic incentive is withdrawn, the conservation measure is discontinued. Market incentives for conservation also fail to promote a sense of right and wrong. Even though contributing to conservation, the individual who receives a payment to conserve a species or an ecosystem service is driven by self-interest, not by a sense of obligation or by the sense that it is the right thing to do.[70]

Leopold believes that economic incentives for conservation also present the problem of depending too much on governments for implementation. He believes that expecting that governments will be able to promote conservation everywhere through economic incentives or even with traditional regulation is to raise expectations to a level that exceeds governments' capabilities.[71] Governments have inherent limitations and cannot be everywhere all the time. In such a context, by internalizing in people the sense of right or wrong in relation to nature, the land ethic would promote conservation even where governments cannot reach.[72]

IV. ECOSYSTEM RESILIENCE IN THE LAW

The law is the system employed by organized societies to declare, systematize, and implement the essential values of a society. The law contains certain inherent characteristics and methods that can lead to innovative solutions to common problems. As mentioned by François Ost, the law operates by systematically considering all relevant points of view, putting them in proportion, and comparing them.[73] Most importantly, in an ideal situation, the law is capable of taking into account all

70. LEOPOLD, *supra* note 7, at 244-45.
71. *Id.* at 251.
72. *Id.*
73. OST, *supra* note 48, at 19-22.

pertinent facts and divergent interests, balancing them, and reaching a reasonable and just decision.[74]

The capacity to balance divergent interests is being introduced more and more in the elaboration of policies and decisions by agencies through the advent of "public participation in decision making." Although inserting public participation in such matters is necessary for democratic governance and for preventing social and environmental damage caused by the implementation of ill-planned policies, mechanisms for public participation are mostly non-binding and restricted to the procedural obligation of hearing divergent interests. Therefore, the agency is usually obliged to hear the interested parties, but not to take their concerns into account when reaching a decision; this obligation remains exclusively reserved to the judicial branch.

Even when agencies are able to provide substantive public participation in decision-making, they cannot accomplish the task of defending the interests of those who are not present in the process: nature itself and the future generations. In contrast, the law can ensure representation of those interests during its weighing and balancing process, especially if it is directed by a legal principle.

Given the need to enforce consideration of all the interests at stake, including the interest of nature itself and of future generations, management for resilience, so called *adaptive management*, cannot be implemented solely by agencies and executive planning and procedures; it requires the guidance of a legal principle and enforcement by the judicial branch.

This article analyzes how environmental law may influence human decisions guided towards the achievement of ecosystem resilience. It does so by consolidating a new principle of law, the principle of resilience, and by applying this principle to relevant areas of environmental law.

74. Corruptive legal systems do not reach such result. This article will assume the function of a non-corruptive legal system.

A. The Origins and Content of the Principle of Resilience

The concept of ecological resilience radically changes the manner by which humankind manages natural resources because it annuls the premise that management should seek stability. In order to guide the public administration and individuals in dealing with this change of mindset, this article proposes consolidation of the principle of resilience as a new principle of international law.

As will be demonstrated in this topic and in the topic "The Principle of Resilience in International Environmental Law," the foundations of the principle of resilience already exist in international environmental law. It is already buried within other principles of environmental law. However, it must be acknowledged and must become an independent principle in order to guide humankind on how to stop degradation of global nature and how to attend to growing population needs in the context of climate change and other natural disturbances.

The importance of systematizing a new principle to address ecosystem resilience relies on the function principles exercise in the international sphere. Principles of international law designate fundamental legal norms and values that should be pursued by the whole international environmental law system.[75] Principles also indicate essential characteristics of legal institutions, and provide the rationale for the law and the general orientation to which positive law must conform.[76] The principle may be included in States' practices and in national laws, and may be referenced by judges as guidance for interpreting or filling the gaps in national or subnational law.[77] It provides a framework for negotiating and implementing new and existing agreements and may be incorporated in legally binding international instruments. Moreover, it provides the rules of decision for resolving trans-boundary environmental disputes.

75. *See* ALEXANDRE KISS & DINAH SHELTON, GUIDE TO INTERNATIONAL ENVIRONMENTAL LAW 89 (2007).

76. *See id.*

77. *Id.*

Finally, the principle may assist the integration of international environmental law into other fields of international law.[78]

But what would be the meaning of the principle of resilience? Several factors would influence the shape of such a principle, including: the ecological concept of resilience; the link between management of ecosystems and resilience; the values that the human community wants conservation to have; and the existing principles and concepts of environmental law, especially the concept of intergenerational equity.

From the ecological concept of resilience we conclude that resilience requires the preservation of biodiversity and the preservation of nature everywhere. Keeping in mind that the goal of preserving biodiversity for resilience is to keep the functions of the ecosystem and the land mechanism working with their original quality, we conclude that resilience requires biodiversity to be preserved in its original habitat and that each species be represented by a quantity of individuals sufficient to ensure the execution of the ecosystem function they are responsible for.[79]

As previously mentioned, the goal of preserving nature everywhere brings quite a challenge to environmental conservation. Some may argue that nature conservation is already done everywhere, because environmental laws are applied in the whole territory of a country's jurisdiction. In favor of such argument, it is possible to assert that environmental law regulates not only reserved protected areas, but also the use of natural resources outside protected areas, in landscapes that have been intensively transformed by humans and where the emission of pollutants may threaten human health and environmental quality, or where the killing of a certain species can cause the extinction of that species.

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78. DAVID HUNTER ET AL., INTERNATIONAL ENVIRONMENTAL POLICY 469, 470 (2007).

79. Referring to the preservation of biodiversity, it is interesting to read a passage of Aldo Leopold speaking about the extinction of species: "When the species is gone we have a good cry and repeat the performance. . . . We console ourselves with the comfortable fallacy that a single museum-piece will do, ignoring the clear dictum of history that a species must be saved *in many places* if it is to be saved at all." LEOPOLD, *supra* note 7, at 194.

There is no doubt about the validity of such arguments. However, we should have in mind that when we discuss resilience we are not talking about the maintenance of *some* natural resources everywhere; we are talking about the preservation of the *whole* land mechanism everywhere. The concept of resilience is based on the idea that every land mechanism–that means, every ecosystem function and every natural element of an ecosystem (which includes fauna, flora, and inanimate elements)–is important to keep the ecosystem resilience. Therefore, such thinking requires a much more complex and broader view of conservation than the one currently applied to non-reserve-protected areas, where environmental law is applied in a segmented manner to preserve some individual endangered species or just the inanimate elements of the environment (soil, water, and air). As conservation seeks to preserve very complex structures such as ecosystems, it is not possible to attribute to conservation a simplistic or segmented view. Conservation for resilience must take into account the interconnections between the various components of an ecosystem and it must include in the concept of "land" not only the forests and preserved landscapes, but also the landscapes intensely modified by humans.

The dichotomy that determines a place for nature, where conservation is needed, and a place for humans, where conservation is not needed, must be abolished. Humans are part of nature and nature is everywhere. And if it is not everywhere, it should be. It should be in the cities, in the houses, in the industries, keeping the ecosystem functions alive, interconnecting the elements of the natural world. If every house in a city has a garden with the same species that compose the ecosystem in which the city is located, the fauna and flora present in each garden may interconnect with each other and keep the functions that make that ecosystem unique. The wider the area where nature is conserved and the more connections with fauna and flora are kept, the more resilient the ecosystem will be.

Along this line of reasoning, the concept of ecological resilience nurtured the concept of the "social-ecological" system, which emphasizes the interconnectivity between humans and nature, and stresses that the delineation between social and

ecological systems is artificial and arbitrary since social-ecological systems have powerful reciprocal feedbacks and act as complex adaptive systems.[80] The concept of adaptive governance is based on this premise.

In order to determine the values that conservation for resilience should have, this work will be based on the values promoted by Aldo Leopold in *land ethic*. Therefore, the principle of resilience is guided by the aspiration of getting in harmony with the land–*all* the land, not just some elements of it. According to the principle of resilience, humans are members of the land-community, not conquerors of it, and they should get to know the land mechanism as much as possible, in order to respect and love the land.[81] This principle also includes social approbation of actions that tend to preserve the integrity, stability, and beauty of the biotic community, and social disapproval for actions that tend otherwise. The principle refuses to address land-use as a solely economic issue and to rely only on the government or on the market to take conservation measures.

Aldo Leopold also believes that humankind should cultivate love and respect for the land mechanism.[82] Based on this statement, this article interprets the land ethic as requiring humans to *enhance* the land mechanism to the maximum extent they can, and not to merely *prevent and mitigate* the aggressions imposed upon nature that the law mandates individuals to address. That means that besides the legal obligation to do no harm to the environment, humans have the ethical obligation to improve environmental quality.

By improving the environment wherever possible, we humans demonstrate that we are conscious of the burden we inflict on the land mechanism; we respect the land mechanism that supports our existence; and we assume our ethical responsibility to aid the land mechanism in any way we can in return for what it provides us. This duty is not only individual, but also societal.

80. Folke et al., *supra* note 9.
81. LEOPOLD, *supra* note 7, at 210, 240, 261.
82. *Id.* at 261.

The ethical obligation to live in harmony with the environment and to improve environmental resilience characterizes an ethical principle. According to Taylor, to be considered so, a moral principle must present six formal characteristics: it must be general in form, meaning that its applicability is not restricted to a limited group of people, rather, it is addressed to the global audience; it must be universally applicable to all moral agents, meaning that the rule cannot defeat itself if everyone attempts to comply with it; it must be intended to be applied disinterestedly, meaning that compliance with the principle is required even when it is against the moral agent's interest; it must be advocated as a principle for all to adopt, meaning that whoever adopts it approves its adoption by all others; and it must override all non-moral norms or concerns.[83]

One of the major aims of the principle of resilience is to provide guidelines for a governmental policy pursuant to the maxim: "Do not solely mitigate: improve." In order to improve the environment and at the same time ensure essential economic activities, the principle of resilience will push governments towards innovative environmental management solutions that proportionately balance environmental and economic activities. Such solutions are called innovative because they provide new guidelines for the operation of the law; for example, stimulating different patterns of production and consumption, or governmental goals, or implementing unusual rules for land use and planning.

Incorporating the background provided by ecology and ethics, the principle of resilience can be established as follows:

- *The land mechanism has inherent value.*
- *Every person has the right to use natural resources as long as such use does not impair the use by others or the persistence of the original setting of mutually reinforcing processes and structures of an ecosystem.*

83. PAUL W. TAYLOR, RESPECT FOR NATURE 25-33 (Princeton Univ. Press Publ. 1986).

- *Every person has the moral duty to respect nature and to pursue a way of living in harmony with the land mechanism.*
- *In order to ensure ecosystem resilience to natural or human-made disturbances, the human management of natural or urban landscapes shall preserve ecosystem functions through:*
    - *the preservation of all species everywhere;*
    - *the preservation of natural cycles;*
    - *and the preservation of the chemical composition of soil, air, and water.*
- *The lack of scientific understanding regarding the function of land mechanisms and the role developed by single species in such mechanisms shall not be used as a reason for postponing cost-effective measures to enhance ecosystem resilience.*
- *States shall ensure that the younger generation receives education on the function of natural mechanisms and that the government officials receive training in identifying human activities and natural phenomena that may impact ecosystem resilience.*
- *Governments are responsible for identifying the factors that put ecosystem resilience at risk and addressing such factors.*
- *Management for resilience requires the adoption of adaptive management techniques, or other techniques that comprise monitoring of results, evaluation of policy performance, and review of policy measures according to the assessment of results and changes of circumstances.*
- *Patterns of production and consumption in synergy with ecosystem function shall be stimulated.*
- *The resilience of ecosystems shall be considered in the assessment of costs and benefits of any activity or policy that affects the environment.*

B. The Principle of Resilience in International Environmental Law

Basic elements of the principle of resilience are already present in international environmental law. The Preamble of the

Stockholm Declaration of the United Nations Conference on the Human Environment, 1972, recognizes that protection and improvement of the human environment is the duty of all governments.[84] The enhancement of resilience is a matter of protecting and improving the environment and that is why governments have the duty to consider resilience when managing natural resources.

Principle 1 of the Stockholm Declaration declares "[m]an . . . bears a solemn responsibility to protect and improve the environment for present and future generations."[85] Therefore, the duty to improve the environment is not solely governmental, but also individual.

The first part of Principle 19[86] of the Stockholm Declaration highlights the role education has to play in protecting and improving the environment through conservation.

The World Charter for Nature, 1982,[87] contains several elements of the principle of resilience. Among the principles of conservation, it proclaims that:

> Preamble: every form of life is unique, warranting respect regardless of its worth to man, and, to accord other organisms such recognition, man must be guided by a moral code of action
> 1. Nature shall be respected and its essential processes shall not be impaired. . . .
> 4. Ecosystems and organisms . . . shall be managed to achieve and maintain optimum sustainable productivity, but not in such a way as to endanger the integrity of those other ecosystems or species with which they coexist. . . .

84. United Nations Conference on the Human Environment, Swed., June 5-16, 1972, *Declaration of the United Nations Conference on the Human Environment Preamble*, U.N. Doc. A/CONF.48/14/Rev.1 (June 16, 1972), *available at* http://www.unep.org/Documents.Multilingual/Default.asp?documentid=97&articleid=1503 [hereinafter *Stockholm Declaration*].

85. *Id.*

86. *Id.* ("Education in environmental matters, for the younger generation as well as adults, giving due consideration to the underprivileged, is essential in order to broaden the basis for an enlightened opinion and responsible conduct by individuals, enterprises and communities in protecting and improving the environment in its full human dimension.").

87. World Charter for Nature, G.A. Res. 37/7, U.N. Doc. A/RES/37/7 (Oct. 28, 1982).

> 6. In the decision-making process it shall be recognized that man's needs can be met only by ensuring the proper functioning of natural systems. . . .
> 9. The allocation of areas of the earth to various uses shall be planned, and due account shall be taken of the physical constraints, the biological productivity and diversity and the natural beauty of the areas concerned.
> 10. . . . (d) Non-renewable resources which are consumed as they are used shall be exploited with restraint, taking into account . . . the compatibility of their exploitation with the functioning of natural systems.
> 11. . . . (d) Agriculture, grazing, forestry and fisheries practices shall be adapted to the natural characteristics and constraints of given areas; (e) Areas degraded by human activities shall be rehabilitated for purposes in accord with their natural potential and compatible with the well-being of affected populations. . . .
> 15. Knowledge of nature shall be broadly disseminated by all possible means, particularly by ecological education as an integral part of general education. . . .
> 19. The status of natural processes, ecosystems and species shall be closely monitored to enable early detection of degradation or threat, ensure timely intervention and facilitate the evaluation of conservation policies and methods.[88]

The Rio Declaration on Environment and Development, 1992, recognizes that human beings are entitled to a healthy and productive life in harmony with nature.[89] At Principle 4, the Declaration determines that "environmental protection shall constitute an integral part of the development process and cannot be considered in isolation from it," and at Principle 8, it guides States to reduce and eliminate unsustainable patterns of production and consumption.[90]

The need to build ecosystem resilience is not only to reduce the risk of disaster, but also its importance in providing sustainable livelihoods, flow of goods and services, and reducing

88. *Id.*

89. United Nations Conference on Environment and Development, Rio de Janeiro, Braz., June 3-14, 1992, *Rio Declaration on Environment and Development*, U.N. Doc. A/CONF.151/26 (Vol. I), Annex I (Aug. 12, 1992) [hereinafter *Rio Declaration*].

90. *Id.*

vulnerability to climate change. This notion is unambiguously expressed in international documents, such as the United Nations 2009 Global Assessment Report on Disaster Risk Reduction.[91] Foundations of the principle of resilience can also be found in other principles of international environmental law.

The principle of sustainable development requires the current generation to meet its needs "without compromising the ability of future generations to meet their own needs."[92] This idea requires humankind to stop exploiting natural resources at a rate greater than their capacity for regeneration, the so-called sustainable yield. However, despite the recognition of sustainable development as a basic principle of environmental protection and national planning, humans still consider that they have the right to take from nature a little more than the sustainable yield threshold, thereby gambling with nature.

The sustainable development movement did not succeed in inserting in peoples' minds the idea that ensuring continuity of natural resources is more important than individual short-term profit. Nor did it convince people that personal ambition has to yield in the face of environmental limitations or the survival of future generations will be at risk.

By trying to please all interests at once, the sustainable development movement did not make it clear that, in order to keep the "health of the land," humans often need to prioritize values and goals, which will likely result in restricting economic activities and economic growth where the land mechanism cannot support it any longer. The implicit meaning commonly attributed to "sustainable development" by business and even by countries is that private initiative will protect the environment as long as such protection does not impair economic activity. While the sustainable development movement succeeds in raising awareness about the need to conciliate environmental protection and development, it fails to provide guidance on the following ethical questions: when economic activity and environmental protection cannot be conciliated, which interest should be

91. U.N. INT'L STRATEGY FOR DISASTER REDUCTION SECRETARIAT, 2009 GLOBAL ASSESSMENT REPORT ON DISASTER RISK REDUCTION (2009).

92. *Our Common Future*, *supra* note 3.

prioritized and under what circumstances? The vacuum left by the concept of sustainable development is repeatedly filled by business interests that have a quick answer at the tip of the tongue to the abovementioned question: economic growth *always* has priority over environmental protection concerns.

Such an omission leaves the establishment of priorities to be determined on a case-by-case basis, with no overarching directive guideline. Thereby, the legal framework has assigned an equal treatment both to environmental and economic interests. However, such equal treatment hides a fundamental injustice when one considers that environmental and economic interests are not balanced because the latter counts on much greater political power. Therefore, following the lesson given by Aristotle, the aspiration for justice requires the law to treat equally the equals and unequally whoever is in an unequal position.[93] This primary function of the legal system can be developed by the application of the principle of resilience, which fills the vacuum left by the sustainable development concept by advocating that ecosystem resilience and continual provision of ecological functions must be preserved, even if it requires a reduction of economic growth and economic profits. Thus, the principle of resilience prioritizes environmental protection, artificially balancing a situation that is naturally unbalanced. By this mechanism, the principle of resilience improves the legal system as a whole by correcting an ongoing injustice in the management of natural resources and planning for development.

The principle of resilience does not acknowledge rules for prioritizing interests solely because it is necessary to enforce sustainable development under an ethical and legal point of view: it does so also because it is a necessity. Several works affirmed that human society has to learn how to develop socially and manage natural resources without relying on economic growth.[94]

93. JOSÉ AFONSO DA SILVA, CURSO DE DIREITO CONSTITUCIONAL POSITIVO 213 (25th ed. 2005) (quoting Aristotle, *Éthique à Nicomaque*, *in* 6 POLITIQUE 1131a (Marcel Prélot trans., PUF Publ., 1950)).

94. *See generally* PETER A. VICTOR, MANAGING WITHOUT GROWTH: SLOWER BY DESIGN, NOT DISASTER (2008); TIM JACKSON, SUSTAINABLE DEVELOPMENT COMMISSION, PROSPERITY WITHOUT GROWTH? THE TRANSITION TO A SUSTAINABLE ECONOMY (2009); ANDREW SIMMS & VICTORIA JOHNSON, NEW ECONOMICS

Such works reinforce the need to give priority to environmental protection when it is not possible to conciliate it with economic growth. Considering the green economy's goal to generate wealth through sustainable exploitation aimed to eradicate poverty,[95] the idea of developing without growth should apply to developed countries and countries that have already accumulated enough wealth to combat poverty. The green economy cannot be green if deprived of the understanding that the economy should be kept in a steady state if economic growth cannot be achieved within the limits imposed by the sustainable yield of natural resources.

The concept of the *common concern of humankind*, for example, determines that, as the planet is ecologically interdependent, humanity has a common interest in protecting the environment and may have a collective interest in certain activities that take place, or resources that are located, wholly within State boundaries.[96] Therefore, as a consequence, States share the responsibility of protecting and addressing issues of common concern.[97] By attributing common responsibilities and interests to all States, this concept creates obligations *erga omnes* both to prevent and to address the harm done to common concerns. Those obligations have procedural implications, as explained by Kiss and Shelton:

> In traditional international law, only an injured state could bring a claim against the state which caused the injury in violation of international law. Where the common interest is infringed, however, all states may be considered to have suffered a legal

FOUNDATION, GROWTH ISN'T POSSIBLE (2010), *available at* http://neweconomics.org/publications/growth-isnt-possible.

95. U.N. ENVTL. PROGRAMME, TOWARDS A GREEN ECONOMY: PATHWAYS TO SUSTAINABLE DEVELOPMENT AND POVERTY ERADICATION 548 (2011), *available at* http://www.unep.org/greeneconomy/GreenEconomyReport/tabid/29846/Default.aspx.

96. HUNTER ET AL., *supra* note 78, at 489-90.

97. U.N. ENVTL. PROGRAMME, TRAINING MANUAL ON INTERNATIONAL ENVIRONMENTAL LAW 36 (Lal Kurukulasuriya & Nicholas A. Robinson eds., 2006) *available at* http://www.unep.org/law/Publications_multimedia/index.asp [hereinafter UNEP TRAINING MANUAL].

> injury, with the obligations designated as obligations owing to all states, i.e., as obligations *erga omnes*.[98]

Although the concept encompasses an important procedural consequence, the downside of classifying the protection of the environment as a whole as a common interest is that it attributes a strong legal classification to too broad a subject, which has the negative effect of non-compliance. The principle of resilience has an important role to play in this regard by providing a more detailed interpretation of the concept of the common concern of humankind. This interpretation would show that the object of the common concern of humankind is the preservation of ecosystem functions and the preservation of biodiversity in a space as extensive as possible.

The concept of intergenerational equity focuses on future generations as rightful beneficiaries of environmental protection. It includes the notion of fairness both among the individuals of the present generation and between present and future generations. The concept of intergenerational equity is composed of three elements: conservation of the diversity of natural and cultural resources by maintaining alternative resources within each category; conservation of environmental quality by preventing the exhaustion of higher quality resources; and equitable or nondiscriminatory access to Earth's resources.[99] This last element guides the distribution of access to natural resources both for present and future generations. As for the conservation of diversity and the quality of resources, the aim is to implement equitable access to resources by guaranteeing future generations' capacity of choice among alternative resources, and to resources of the same level of quality as those exploited by present generations.

This concept requires that present generations use the resources sustainably and avoid irreversible environmental damage.[100]

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98. KISS & SHELTON, *supra* note 75, at 15.

99. Edith Brown Weiss, *Implementing Intergenerational Equity*, *in* RESEARCH HANDBOOK ON INTERNATIONAL ENVIRONMENTAL LAW 100, 100 (Malgosia Fitzmaurice et al. eds., 2010).

100. HUNTER ET AL., *supra* note 78, at 491.

In this context, the principle of resilience increases the applicability of the concept of intergenerational equity by restraining the present generation from weakening a non-resilient ecosystem. As mentioned before, a non-resilient ecosystem is so vulnerable to disturbances that, when moving between basins of attraction, the passage to a new basin may be irreversible and the regeneration of the original features of an ecosystem may be impossible.

Furthermore, the principle of resilience contributes to the application of the second component of the concept of intergenerational equity–the conservation of environmental quality–by requiring the preservation of integrity, stability, and beauty of the biotic community.

The precautionary principle prescribes the need for taking anticipatory actions in order to avoid environmental harms, even when the scientific understanding of a specific threat is not yet complete. The principle of resilience also contributes to the implementation of the precautionary principle: first, because it seeks to enhance the resilience of ecosystems in order to prevent their vulnerability and degradation; second, because it proposes the conservation of all ecosystem functions, even those that are not yet fully understood.

The principle of non-regression determines that the creation of norms that contribute to the degradation of the environment is considered a violation of several international instruments whose aim is to protect the environment.[101] The principle of non-regression is based on three theoretical elements. First, it is based on the assumption that environmental law seeks to prevent the degradation of the environment by constantly improving environmental quality. Second, it is based on the premise that the present generation cannot impose its laws on future generations. According to Michel Prieur, if present generations gradually adopt less protective environmental laws, they will prevent future generations from fully exercising their right to a

101. *See* Michel Prieur, *De L'urgente Nécessité de Reconnaître le Principe de "Non Régression" en Droit de L'Environnement*, 1 IUCN ACAD. ENVTL. L. 26 (2011), *available at http*://www.iucnael.org/en/documents/doc_details/663-de-lurgente-necessite-de-reconnaitre-le-principe-de-non-regression-en-droit-de-lenvironnement.html.

healthy life.[102] Third, the principle of non-regression relies on the application of the concept of intangibility of human rights to environmental regulation. Intangibility of human rights is implicit in human rights conventions and stands against the regression of those rights. It is transposed to environmental law because of the effect that the degradation of environmental laws may have on the exercise of human rights.

The principle of non-regression in national law guides the creation of norms by both the legislative and the executive branches and is enforced by adjudicatory authorities, which are responsible for the control of the legitimacy of acts perpetrated by the other powers.

The principle of resilience can assist the application of the principle of non-regression by providing guidelines to assist judges in determining whether a norm represents regression of environmental conservation or not.

Some may argue that the principle of resilience would be redundant and dispensable in guiding judges in deciding whether a norm increases or decreases the level of environmental protection because the principle provides the same criteria that could be provided in court by ecologists' testimonies. However, this kind of criticism constitutes an incomplete interpretation of the principle of resilience by considering solely the ecological aspect of the principle. This argument fails to recognize that the principle of resilience comprehends not only an ecological concept, but also the relation of the ecological concept to the law and to the ethics that govern the relationship between humankind and nature. The principle of resilience commits the ecological concept of resilience to the protection of future generations' interests and to the ethical goal of living in harmony with nature. This principle also introduces the concept of ecological resilience to the legal framework not as a mere judicial finding based on scientific data, but as a full legal principle of environmental law, which, as such, must be used to guide the creation and the interpretation of any environmental norms or any policies or norms that generate environmental consequences.

102. *See id.* at 33, 34.

The principle of non-regression is only truly effective in achieving improvements in environmental quality if it is applied to *all* norms that generate environmental consequences. In other words, the principle of non-regression should be applied not only to environmental, but also to economic policies and norms that affect the environment, and the same applies to the principle of resilience.

The principle of resilience is also strongly influenced by three environmental principles that deal with governance for conservation: the subsidiarity principle, the public participation principle, and the principle of good neighborliness and duty to cooperate. These three principles guarantee the participation of local governments, the affected public, and the international community in the decision-making process related to environmental issues.[103]

The subsidiarity principle reflects a preference for making decisions at the lowest level of government or social organization where the issue can be effectively managed. This principle has a procedural nature: it determines the level of the policy-making hierarchy in which the decision should be made, but it does not guide the kind of decision that should result. The final decision will be taken not only by balancing local interests, but also by balancing national or international priorities.

The public participation principle exists because environmental issues are best handled by the participation of all concerned citizens at the relevant level. However, individuals cannot appropriately participate in decision-making if they do not receive the relevant information on the issue. Therefore, the public has the right of access to information held by public authorities regarding the environment, and the state has the duty to encourage public awareness and participation by making information available. In order to exercise their right, individuals should also have equal access to justice, through the judicial and administrative proceedings provided by the state.

The principle of good neighborliness and duty to cooperate determines that international environmental issues be handled in

103. HUNTER ET AL., *supra* note 78, at 521, 525, 534, 535.

a cooperative spirit by all countries.[104] This principle is binding because it derives from a general principle expressed in Article 1.3 of the United Nations Charter, which sets among the purposes of the United Nations the achievement of international cooperation in solving international problems.[105]

The three above-mentioned principles for environmental governance are very relevant for the achievement of ecosystem resilience especially because they expand the range of stakeholders involved in efforts for conservation. Such principles abolish the idea that environmental conservation is to be promoted only by national governments. Therefore, the application of these principles prevents the situation criticized by Aldo Leopold whereby conservation efforts implemented only by the government are deficient because they do not internalize in the public the ethical value of conservation and because they only reach places where the governmental structure is present.[106]

The principle of resilience is also an essential part of the duty to assess the environmental impact of proposed activities, policies, or programs to integrate environmental issues into development planning. Before implementing activities or policies, the state has the duty to fully identify and consider environmental effects and to give the affected citizens the opportunity to understand the proposed project and to express their opinions about it through public participation in decision making.

As the duty of the state is to fully identify and consider environmental effects, it is very clear that such a duty applies to the identification and consideration of any impact the project may cause to the resilience of the ecosystem. Accordingly, governmental entities must understand the concept of ecological resilience and must be trained to include assessment of impacts on ecosystem resilience in the environmental impact assessment. In order to fully exercise their right to participation in decision-making, individuals and citizen organizations should also seek to understand the meaning of ecosystem resilience.

104. *Stockholm Declaration*, *supra* note 84.
105. U.N. Charter art. 1, para. 3.
106. LEOPOLD, *supra* note 7, at 243-51.

The implementation of the principle of resilience through the use of environmental impact assessment procedures will be considered in greater detail in "Applying the Principle of Resilience."

C. Legal Status of Principles of International Environmental Law

The principles of international environmental law have their origins in a wide variety of sources, which include: environmental treaties, soft law instruments, the United Nations General Assembly Resolutions, arbitral decisions, judicial decisions of the International Court of Justice, expert commentary,[107] application of general principles of international law to environmental issues,[108] and customary international law.[109]

Soft law instruments,[110] the United Nations General Assembly Resolutions, and expert commentary do not bind states. Arbitral and judicial decisions bind only the states under litigation and only if such states accept the jurisdiction of the arbitral commission or of the International Court of Justice. Environmental treaties may create obligations to signatory States. General principles of international law create binding obligations to all states.

According to the United Nations Environment Programme (UNEP), the legal status of international environmental law principles and concepts varies: some are firmly established, others are emerging and gradually gaining acceptance; some have the nature of guidelines or policy directives and do not give rise to specific rights and obligations.[111] The juridical effect of principles and concepts may change from one legal system to another, depending on the context of the case, the activity at issue, the

107. HUNTER ET AL., *supra* note 78, at 464.
108. *Id.* at 469.
109. KISS & SHELTON, *supra* note 75, at 89.
110. UNEP TRAINING MANUAL, *supra* note 97, at 8 ("This term does not have a fixed legal meaning, but it usually refers to any international instrument, other than a treaty, containing principles, norms, standards or other statements of expected behaviour.").
111. *Id.* at 24.

actors, and the geographical region.[112] In other words, environmental principles and concepts may be binding or not binding, depending on the circumstances of the case, on the countries involved, and on the nature of the principle or concept.

Both binding and non-binding principles of international environmental law play primarily a role of anticipation rather than reaction to environmental problems.[113] In other words, the true purpose and capability of international environmental norms is to prevent environmental hazards on a global scale, not to punish States that violate these norms. As a matter of fact, this tendency is noticeable not only in international environmental law, but also in public international law as a whole.

Common obligations of international environmental law can be shared by States when they have an *erga omnes* characteristic, or can be established by multilateral agreements. The target of such obligations is to diffuse potential threats to the world as a whole, rather than to a specifically injured State.[114] There is some controversy among the experts whether each State has an automatic right to react on behalf of the common interest against any breach of common obligations.

Benedetto Conforti argues that States not directly injured by the violation of the international obligation are not automatically entitled to react.[115] Whereas directly injured States have the right to seek measures such as reparation and reprisal.[116] On the other hand, Oscar Schachter argues that every party to a multilateral agreement would have a sufficient legal interest to sustain standing to redress.[117]

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112. *Id.*

113. KISS & SHELTON, *supra* note 75, at 90. Even environmental norms included in treaties are subjected to non-compliance mechanisms that assist parties to meet their obligations rather than punish non-compliers. *See* UNEP TRAINING MANUAL, *supra* note 97, at 11.

114. *See* KISS & SHELTON, *supra* note 75, at 15.

115. *See* BENEDETTO CONFORTI, INTERNATIONAL LAW AND THE ROLE OF DOMESTIC LEGAL SYSTEMS 188-89 (René Provost & Shauna Van Praagh trans., Martinus Nijhoff Publ. 1993).

116. *See id.* (explaining the terms "reprisal" and "reparation" in international law).

117. OSCAR SCHACHTER, INTERNATIONAL LAW IN THEORY AND PRACTICE 209-10 (Martinus Nijhoff Publ. 1991).

The differences in the analyses promoted by both authors are motivated by their different focus: Conforti focuses on countries' reactions to violations of international law, which includes self-help measures; on the other hand, Schachter limits his interpretation to the judicial reaction, stating that uninjured countries would have sufficient legal standing to bring claims on behalf of the common interest.[118]

As noted by Michel Prieur in an interview given to a Brazilian journal, the current punishment for a violation of an international obligation regarding environmental issues hardly goes beyond moral condemnation or the symbolic finding of a violation.[119] This is due to the nonexistence of a court of justice specializing in international environmental crimes.[120]

In sum, although countries not injured directly have no right to pursue unilateral measures to react to a violation of international environmental law, they have standing to bring claims of adjudication. However, as there is not yet an appropriate court where such claims can be filed, violations of international environmental norms remain largely susceptible to mere moral and political condemnation.

V. APPLYING THE PRINCIPLE OF RESILIENCE

The applicability of the principle to a country's legal system requires the prior development of a conceptual framework for decision-making based on the principle of resilience.

Any country seeking to apply the principle of resilience needs, first of all, to recognize it as a moral principle. Therefore, the country must recognize the inherent value of nature and guide its decisions towards the goal of living in harmony with nature.

As noted by Aldo Leopold, the goal to live in harmony with nature is not necessarily achievable, but it is something we

118. *Id.* at 210.

119. Michel Prieur, *O Meio Ambiente Precisa da Globalização*, EXTRA CLASSE, http://www.sinpro-rs.org.br/extraclasse/mai05/entrevista.asp (last visited June 11, 2011).

120. *Id.*

should strive for.[121] Also, it is useful to remember that acceptance of the moral principle of living in harmony with the land mechanism presupposes that compliance with this duty is required even when it is against the agent's moral interest.[122]

Employing the principle of resilience in decision-making requires that it be recognized as a legal principle, after it has been recognized as a moral principle. In order to ensure enforceability of the legal principle, it is important to incorporate it into a code or into a country's framework environmental legislation. A country's framework environmental legislation represents "an integrated, ecosystem-oriented legal regime that permits a holistic view of the ecosystem, the synergies and interactions within it, and the linkages in environmental stresses and administrative institutions,"[123] which is precisely what the implementation of the principle of resilience requires.

After being acknowledged in a statute, the legislature or the resource management institutions should create a procedure for the implementation of the principle of resilience. It is recommended that the government analyze where the principle can be incorporated into existing procedures related to legal protection of the environment. The recommendations addressed in the sections dedicated to Environmental Impact Assessments and Adaptive Management—the incorporation of adaptive management into the circle of risk management—are good examples of how this can be done.

In other circumstances, the fulfillment of the principle of resilience's aims will require the creation of new procedures. The organization of workshops for adaptive management and the creation of development rights to address the loss of real property to the sea in coastal areas (Land use section) are examples of innovations in procedural rules.

Besides incorporating the principle of resilience into procedural rules, the government should set penalties for lack of compliance. As for penalties for noncompliance, it is interesting to note that the concept of ecological resilience reveals another

121. LEOPOLD, *supra* note 7, at 210.
122. TAYLOR, *supra* note 83, at 25-33.
123. UNEP TRAINING MANUAL, *supra* note 97, at 16.

level of environmental degradation: the destruction of ecosystem resilience. When the action perpetrated by a project is responsible for eliminating the resilience of an already vulnerable ecosystem, the damage this project caused to the environment is much graver than the damage produced by the same action in a resilient ecosystem. For example, if a project is responsible for eradicating one single pollinating species, the consequence of this impact will be much graver for an ecosystem that counts on no other species to fulfill the pollination function than in an ecosystem that has many other species providing this service.

In this context, a pertinent question for the legislator would be: should the penalty for whoever destroys the resilience of a certain ecosystem be greater than the penalty applied to whoever perpetrates the same action, but does not produce this result?

In setting the penalties, legislators should seek to employ the penalty as a means to achieve concrete results in improving environmental quality through measures of education for environmental conservation, restoration of an ecosystem's resilience, collection of information for adaptive management, and enhancement of sustainable consumption and production patterns.

These kinds of goals are found in the *Writ of Kalikasan*, in the Philippines. This writ was created to enforce the individual constitutional right to a "balanced and healthful ecology."[124] The remedy can be claimed by any natural or judicial person acting on behalf of persons whose environmental right was or is in danger of being violated.[125] The writ awards no damages to individual petitioners; rather its reliefs include directing the respondent to permanently cease the action or activity that gave cause to the violation of environmental laws, and to restore the environment.[126]

In the State of Amazonas Environmental Court in Manaus, Brazil, Judge Adalberto Carim Antonio has proposed alternative penalties for violators of environmental laws, according to the

124. Rules of Procedure for Environmental Cases, No. 09-6-8-SC, pt. I, r. 1, § 3(a), (S.C., Apr. 29, 2010) (Phil.), *available at* http://sc.judiciary.gov.ph/Rules%20of%20Procedure%20for%20Environmental%20Cases.pdf (2010).

125. *Id.* pt. 3, r. 7, § 1.

126. *Id.*

transgressions.[127] Instead of incarceration or fines, respondents can, among many other innovative penalties, opt to restore the environment and bring additional benefits to the affected community, take classes in environmental education, or act as volunteers in environmental protection organizations.[128]

In order to ensure compliance with the principle, governments should establish who would enforce the principle guidance and its procedural rules. The enforcement can be provided by citizen suit provisions, by environmental courts, or by a specific governmental institution vested with special rights to sue violators, such as the Brazilian *Ministério Público.*[129]

A. Adaptive Governance

Adaptive governance is a method that employs the understanding of how ecological resilience works to effect decision making within resource management institutions, thereby enhancing the influence of social and ecological systems. Adaptive governance seeks to increase the flexibility of the social actors to enhance their capacity to reorganize social systems in response to disturbing events, such as changing environmental conditions.[130] Adaptive governance "conveys multi-objective reality when handling conflicts among diverse stakeholders and, at the same time, adapts this social problem to resolve issues concerning dynamic ecosystems."[131]

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127. GEORGE "ROCK" PRING & CATHERINE "KITTY" PRING, GREENING JUSTICE 85, 86 (2009).

128. *Id.*

129. *Ministério Público* is an institution created by the Brazilian Constitution to defend the legal order, the democratic regime, social interests, and inalienable individual interests. It is vested with rights to investigate and suit whoever violates these interests and values–be it an individual, a private organization, or a governmental organ. In order to ensure *Ministério Público*'s political freedom to control the legality of actions perpetrated by other branches of the government, the Constitution granted *Ministério Público* with functional freedom in relation to the Executive Power, where it is located. Therefore, the Executive Power has no interference on the development of *Ministério Público*'s functions, on its organization, or on the selection of its members. *See* SILVA, *supra* note 93, at 598-99.

130. Walker et al., *supra* note 14.

131. FOLKE ET AL., ADAPTIVE GOVERNANCE OF SOCIAL-ECOLOGICAL SYSTEMS 448-49 (2005).

The adoption of patterns of consumption and production that work in synergy with ecosystem functions and processes is an application of adaptive governance. In this matter, the example of the project "Alcântara: sustainable city,"[132] in Brazil should be mentioned. In this project, the goal of enhancing the economic growth of the city was combined with the concern of producing a commodity that would improve ecosystem quality and the functioning of society.[133] Due to the national potential for producing biofuels, ethanol was the commodity chosen to boost Alcântara's economic growth.[134] However, instead of using the rural area of Alcântara to introduce crops of sugar cane, which are not native and are not adapted to the local ecosystem, the project's proponents decided to produce ethanol from "maripuera," a byproduct of the local production of cassava flour, which contains cyanide.[135] Instead of developing an economic activity that minimally effected the surrounding ecosystem, this project actually improved the environmental quality of the region, because the cyanide had previously been dumped anywhere to seep into the ground.[136]

a. Adaptive Governance in International Law

Adaptive governance is an efficient way of implementing Principles 17 and 13 of the Stockholm Declaration, which deal with governance for enhancing environmental quality. Principle 17 declares that "[a]ppropriate national institutions must be entrusted with the task of planning, managing or controlling the 9 environmental resources of States with the view to enhancing environmental quality."[137] Principle 13 declares that "States should adopt . . . development planning so as to ensure that development is compatible with the need to protect and improve environment for the benefit of their population."[138]

132. INSTITUTO BRASILEIRO DE DESENVOLVIMENTO SUSTENTÁVEL, ALCÂNTARA CIDADE SUSTENTÁVEL (June 16, 2011) (on file with author).
133. *Id.* at 44-45.
134. *Id.*
135. *Id.*
136. *Id.*
137. *Stockholm Declaration*, *supra* note 84, at princ. 17.
138. *Id.* at princ. 13.

There are now discussions about introducing some adaptive governance techniques into institutions on the international level. The need for a flexible institutional framework for sustainable development in order to address new and emerging issues has been recognized by most of the countries attending the Second Preparatory Meeting of the United Nations Convention on Sustainable Development of 2012.[139] Many countries called for: greater participation of stakeholders in the environmental institutional framework; integration of mechanisms at the national, regional, and international levels; and enhanced coordination and cooperation among all international organizations, agencies, and conventions to ensure implementations of commitments and promote synergies.[140] Such intentions show a clear trend toward shaping international environmental governance according to the propositions of adaptive governance.

The trend towards the adoption of adaptive governance at the international level is demonstrated by several countries strengthening the monitoring of policies and programs aimed at implementing multilateral environmental agreements. Such intent is expressed by the countries' statement in favor of the enhancement of the United Nations Commission on Sustainable Development (CSD), which is seen as the only forum in which sustainable development is addressed in an integrated fashion.[141] "CSD is responsible for reviewing and monitoring progress in the implementation of Agenda 21 and the Rio Declaration on Environment and Development; as well as providing policy

139. Jennifer Covert et al., *Summary of the Second Session of the Preparatory Committee for the UN Conference On Sustainable Development: 7-8 March 2011*, 27 EARTH NEGOTIATIONS BULL. 1, 3 (2011), *available at* http://www.iisd.ca/download/pdf/enb2703e.pdf.

140. Co-Chairs' Summary of the Second Preparatory Committee Meeting, Mar. 7-8, 2011, *Rio + 20 United Nations Conference on Sustainable Development*, *available at* http://www.uncsd2012.org/rio20/content/documents/Co-Chairs%20Summary%20of%20PrepCom%202.pdf.

141. *Id.*

guidance to follow up the Johannesburg Plan of Implementation at local, national, regional and international levels."[142]

b. Adaptive Governance in Domestic Law

Adaptive governance is profoundly influenced by a country's approach to decision-making. The relationship between the principle of resilience and the main approaches to decision-making is analyzed below.

1. Cost-Benefit Analysis

The cost-benefit approach requires government agencies to conduct a cost-benefit analysis (CBA) before enacting major regulations. CBA requires a quantitative and qualitative accounting of the effects of a regulation, in which the reasons for action must be explained when the costs exceed the benefits. CBA is based on the premise that the accounting of a regulation's effects can give citizens and officials a full sense of what is at stake when making decisions.[143]

CBA seeks to test the efficiency of government actions. Efficiency is the term employed by economists to designate economic transactions that generate greater societal benefits than costs. Economic efficiency provides us with criteria to evaluate the functioning of government,[144] because regulation and governmental decisions are unlikely to promote social welfare if the costs are high and the benefits are low.[145] Therefore, CBA avoids the diversion of government resources from their most beneficial uses to less beneficial ones.[146]

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142. *Sustainable Development and Indigenous Peoples*, INT'L WORK GRP. FOR INDIGENOUS AFFAIRS, http://www.iwgia.org/environment-and-development/sustainable-development (last visited Nov. 7, 2012).

143. CLIFFORD RECHTSCHAFFEN ET AL., ENVIRONMENTAL JUSTICE: LAW, POLICY & REGULATION 154 (2d ed. 2009).

144. *See* JOSÉ L. CARVALHO ET AL., FUNDAMENTOS DE ECONOMIA: VOL. 1 MACROECONOMIA 108 (José L. Carvalho trans., Cengage Learning Publ. 2008).

145. RECHTSCHAFFEN ET AL., *supra* note 143.

146. DANIEL FARBER ET AL., DISASTER LAW AND POLICY 272 (2d ed. 2006) (quoting Steve P. Calandrillo, *Responsible Regulation: a Sensible Cost-Benefit, Risk versus Risk Approach to Health and Safety Regulation*, 81 B.U. L. REV. 957 (2001)).

Besides evaluating and enhancing the efficiency of government actions, CBA also assists in overcoming cognitive problems that can lead people to misunderstanding the magnitude of the risks, thereby putting things in perspective and preventing the government from being indifferent to dangerous threats or from giving exaggerated attention to small problems that cause great public commotion.[147] Thus, CBA can increase or decrease attention to safety compared with the *status quo*.[148]

The benefits of governmental actions are often intangible and must be translated into monetary values to be considered in the cost-benefit analysis.[149]

Through CBA, life, health, and nature itself lose their ethical value and are subsumed into a monetary amount during the weighting of governmental policies. Worse, as such benefits are felt in the long-term and time affects the value of financial resources, nature, life, and the health of future generations tend to weigh very little to present generations.[150] In this context, prevention of fatalities that would occur in the long-term are just worthwhile when their number is very large or the cost of precautions is very low.[151] Discounting future benefits and foisting threats on future generations underestimates humanity's concern for its progeny, which is a basic moral value of any human culture.

The cost-benefit approach treats individuals solely as consumers,[152] whose interests and rights are determined by their capacity to pay. In this context, nature is just one of many benefits that can be achieved for a certain price. Under this approach, it is impossible to get away from the notion that the relationship between human and nature is marked by domination. The application of the cost-benefit approach instead

147. Robert W. Hahn & Cass R. Sunstein, *A New Executive Order for Improving Federal Regulation? Deeper and Wider Cost-Benefit Analysis* 10-11 (Univ. of Chi. Law & Econ., Olin Working Paper No. 150, 2002).

148. RECHTSCHAFFEN ET AL., *supra* note 143.

149. FARBER ET AL., *supra* note 146, at 270.

150. *Id.*; PLATER ET AL., *supra* note 6, at 572.

151. FARBER ET AL., *supra* note 146, at 271.

152. *Id.* at 277 (quoting Frank Ackerman & Lisa Heinzerling, *Pricing the Priceless: Cost-Benefit Analysis of Environmental Protection*, 150 U. PA. L. REV. 1553 (2002)).

of the management of natural mechanisms makes building harmony between humans and the land mechanism most unlikely.

The CBA employs an expertise-dominated approach, which is akin to the *irrational weigher theory*. Under this theory, individuals rely solely on their visceral and affective reactions to recognize risks when they lack information or when they are presented with any other limit on their ability to engage in an informed assessment.[153] The proposed regulatory approach for this theory is based on shielding law from the "distorting" influence of emotion and public irrationality by delegating regulatory power to politically insulated experts who evaluate costs and benefits in a reasoned fashion.[154]

The expertise dominated approach is criticized for not respecting individuals' factual beliefs and for shielding regulatory law from citizens' visions of the good society,[155] which is an insult to citizens' dignity[156] and obviously against democratic values. Contrary to what the expert dominated approach would suggest, emotion is not a substitute for information, but rather a type of evaluative judgment made by someone who has already had access to information and time to reflect about it. According to the cultural evaluator theory, emotions enable the individual to identify the opinion most appropriate to his or her individual commitments, values, and ideals.[157] The integration of emotions with risk perception equips decision makers to discern issues of justice and ethical values, which cannot be assured by any set of procedures.[158]

The CBA approach seems to tend towards less regulation. Empirical studies have demonstrated that costs are often

153. *Id.* at 256 (quoting Dan M. Kahan, *Two Conceptions of Emotion in Risk Regulation*, 156 U. PA. L. REV. 741 (2008)).

154. *Id.* at 255-61 (quoting Dan M. Kahan, *Two Conceptions of Emotion in Risk Regulation*, 156 U. PA. L. REV. 741 (2008)).

155. *Id.*

156. Douglas A. Kysar, *It Might Have Been: Risk, Precaution, and Opportunity Costs*, 22 J. LAND USE & ENVTL. L. 1, 26-27 (2006).

157. FARBER ET AL., *supra* note 146, at 257 (quoting Dan M. Kahan, *Two Conceptions of Emotion in Risk Regulation*, 156 U. PA. L. REV. 741 (2008)).

158. *Id.* at 257-62 (quoting Dan M. Kahan, *Two Conceptions of Emotion in Risk Regulation*, 156 U. PA. L. REV. 741 (2008)).

substantially overestimated in the CBA conducted prior to decision making; cost estimates often originate from the regulated industries themselves, who have a great interest in defeating regulatory initiatives.[159] Also, CBA usually does not anticipate innovation and gains in efficiency stimulated by regulation. Therefore, the method tends to overestimate the costs and underestimate the benefits of any environmentally protective regulation. This may explain the common perception that U.S. experts and policymakers–who adopt the cost-benefit approach–favor less conservative environmental, health, and safety measures than their European counterparts who adopt the precautionary approach.[160]

In the absence of a regulation forbidding or imposing greater burdens on environmentally harmful activities, governments that seek to stimulate environmental protection usually resort to the creation of economic incentives in order to encourage the adoption of environmentally friendly solutions when there are cheaper alternatives in the market. In this context, the adoption of a cost-benefit approach, the reduction of regulation, and the increasing deployment of market incentives are connected and mutually reinforcing.

In the United States, the tradition of adopting the CBA to evaluate risks and alternative mitigation measures dates back to 1981, during the Reagan Administration.[161] President Clinton's Executive Order 12,866 provided that "in deciding whether and how to regulate, agencies should assess all the costs and benefits of available regulatory alternatives, including the alternative of not regulating" and choose the approach that maximizes the net benefits.[162]

There has been a recent shift towards the pragmatic approach in the cost-benefit American tradition after the enactment of President Obama's Executive Order, *Improving*

159. PLATER ET AL., *supra* note 6, at 574.

160. Kysar, *supra* note 156, at 3-4.

161. Dan Farber, *Obama's Cost-Benefit Executive Order*, LEGAL PLANET (Jan. 24, 2011), http://legalplanet.wordpress.com/2011/01/24/obamas-cost-benefit-executive-order/.

162. Exec. Order No. 12,866, 58 Fed. Reg. 51,735 (Sept. 30, 1993).

Regulation and Regulatory Review.[163] The pragmatic approach is a reorientation of the cost-benefit approach which attempts to introduce the consideration of values that society holds in high regard into the CBA. Therefore, the pragmatic approach recognizes the limits of technical expertise and the role of social values in decision-making considerations. Such an approach focuses on statutory priorities and on justifying why particular policies are preferable to others.[164] President Obama's Executive Order influences the CBAs used by the U.S. federal government by strongly emphasizing public participation in the process and "encourag[ing] consideration of benefits that are difficult to quantify such as 'equity, human dignity, fairness, and distributive impacts'. . . ."[165]

The application of a cost-benefit approach in determining the appropriate response to risks hampers the deployment of adaptive management techniques in governmental agencies because of the difficulty of assessing with a high degree of certainty the costs and benefits of measures to mitigate the risk of a natural event. The risk of a natural event can hardly be estimated from the historical record because of the variability of natural systems. In addition, the harm caused by a natural event is partly caused by human siting decisions as well as deficient risk management systems regarding precaution and response to disasters, which may be difficult to assess.[166]

Besides the difficulty of assessing the risks of a natural event and the benefits that adaptive management would generate in preventing them, the CBA for an adaptive approach is spoiled by the common misinterpretation of the costs of environmental regulation. One of the costs governmental agencies include in the CBA for environmental regulations is the amount of benefits that society will lose by restricting or prohibiting an economic activity.

163. Exec. Order No. 13,563, 76 Fed. Reg. 3,821 (Jan. 18, 2011).

164. RECHTSCHAFFEN ET AL., *supra* note 143, at 161-64 (quoting Sidney A. Shapiro & Christopher H. Scroeder, *Beyond Cost-Benefit Analysis: A Pragmatic Reorientation*, 32 HARV. ENVTL. L. REV. 433 (2008)).

165. Farber, *supra* note 161 (quoting Exec. Order No. 13,563, 76 Fed. Reg. 3821 (Jan. 18, 2011)).

166. FARBER ET AL., *supra* note 146, at 274 (quoting Frank Ackerman & Lisa Heinzerling, *Pricing the Priceless: Cost-Benefit Analysis of Environmental Protection*, 150 U. PA. L. REV. 1553 (2002)).

The benefits of environmentally harmful activities are usually known before their costs to the environment and to society are fully assessed; the assessment of benefits is in the interest of the entrepreneur, who has the greater knowledge about the activity being developed. Corroborating this is the fact that sometimes the downside of an activity has a latency period, during which the negative effects cannot be assessed. Many examples can be given of this phenomenon, such as Polychlorinated Biphenyl (PCB) largely used from 1929 to the 1970s in industrial and commercial applications due to its non-flammability, chemical stability, high boiling point, and electrical insulating properties.[167] Only after fifty years of usage was the substance banned in the United States and other countries due to its devastating health effects.[168]

Because the benefits of a new activity or product tend to be assessed prior to its costs, the CBA of regulatory agencies is most likely to conclude that the activity presents high benefits and uncertain costs. Based on this finding, the agency is likely to decide on regulatory inaction because the regulator will lack safety arguments for imposing a regulatory burden on an activity that presents a mere hypothetical possibility of generating costs that outweigh its benefits to society. An example of this situation was observed in the U.S. Food and Drug Administration's review of nanoparticle-containing sunscreens, when the agency treated situations of deep uncertainty regarding the potential impacts of novel technological processes as unworthy of regulatory attention.[169]

In summary, the adoption of CBA as the sole approach to the decision-making process of weighing alternatives hampers the

167. *Polychlorinated Biphenyls (PCBs): Basic Information*, EPA, http://www.epa.gov/epawaste/hazard/tsd/pcbs/pubs/about.htm (last updated Apr. 3, 2012).

168. *Polychlorinated Biphenyls (PCBs): Laws and Regulations*, EPA, http://www.epa.gov/epawaste/hazard/tsd/pcbs/pubs/laws.htm (last updated Nov. 30, 2012); Heidelore Fiedler, *Polychlorinated Biphenyls (PCBs): Uses and Environmental Releases*, CHEM.UNEP.CH (Oct. 31, 2012) http://www.chem.unep.ch/pops/pops_inc/proceedings/bangkok/fiedler1.html; *Health and Safety Fact Sheet: Polychlorinated Biphenyls – PCBs*, AUSTL. WORKERS HEALTH CTR., http://www.workershealth.com.au/ images/pdf_uploads/023PCBs.pdf (last visited Jan. 10, 2013).

169. Kysar, *supra* note 156, at 17.

creation of protective environmental regulation, the adoption of adaptive management by agencies, and the consideration of ethical values in decision-making—such as the inherent value of nature, and the goals of living in harmony with nature and caring about future generations.

On the other hand, the CBA makes for government efficiency, which is an important value of administration and cannot be forsaken. However, the CBA is not sufficient to address governmental efficiency because it is too focused on short-term outcomes. Its techniques for discounting the future, its limitations on predicting the benefits of protective measures (which include both protective regulation and adoption of adaptive management), and its overestimation of the costs of environmental protection prevent it from being taken as a complete tool to address long-term governmental efficiency.

Ensuring efficiency in the long term for the management of natural resources is the aim of green economy and a requirement for both sustainable development and the principle of resilience. If CBA cannot provide efficiency in the long term, it obligatorily must be coupled with other approaches to decision making.

The need for combining CBA with other decision-making approaches also appeals as a matter of justice. Cost-benefit analysis employs an economic method for solving disputes between economic and environmental interests. Of course such a method is more appropriate to quantify economic interests than any other sort of interest, and clearly the method itself will contribute to the achievement of decisions that tilt towards economic interests.

Due to this trend, the recognition of the principle of resilience as a legal principle and the commitment of procedural rules with the achievement of justice requires CBA to be just one of the phases of decision making, and not the entire process.

The application of the principle of resilience to the decision making process points towards the introduction of a weighing phase, where the administrative organ has to weigh the experts' opinion (represented by the result of the CBA) with input from public participation and with environmental conservation values recognized by statute. In this context, the recognition of environmental conservation values by the law is extremely

important because the courts' power of review over agencies' decisions is usually restricted to reviewing the legality of the act– the court cannot decide on questions of merit, in respect to the Separation of Powers. If the law does not require the agency to consider certain conservation values in its decisions, the courts cannot oblige the agency to do so.

One may argue that weighing ethical values in decision making is not a function of many governmental agencies and, for that reason, the fulfillment of this requirement may endanger the organization and the function of the agencies. For this reason, education and training of government personnel on environmental conservation and its values is very important. Education on conservation for the whole society is also important. It would equip citizens with tools to enforce agency actions through citizen suit provisions or others means of public participation in decision making.

Also, it is interesting to consider the establishment of a separate entity to opine how a proposed project or policy might endanger the interests of future generations and nature itself. This entity could be created based on the Hungarian ombudsman for future generations. The Hungarian ombudsman can address constitutional complaints regarding violations of Hungarians' right to environmental protection and a healthy environment, promote research on topics of interest, and do parliamentary advocacy—for example, by pointing out how legal drafts can impact the interests of future generations.[170]

2. Precautionary Principle

The precautionary principle guides decision makers to take precautionary measures when an activity can cause serious or irreversible harm to human health or the environment, even if cause and effect relationships are not fully established scientifically.[171]

170. *Interview with the Hungarian Ombudsman for Future Generations*, WORLDFUTURE COUNCIL (Oct. 24, 2012), http://www.worldfuturecouncil.org/hungarian_ombudsman.html.

171. Kysar, *supra* note 156, at 4.

The precautionary principle was created from a common deficiency in the application of the preventive principle coupled with the polluter pays principle. According to the preventive principle and the polluter pays principle, when an activity has been scientifically proven to cause harm the proponent must take measures to prevent, mitigate, or compensate for the harm.[172] However, the lack of reliable monitoring data on the long-term cumulative effects of harmful activities on complex ecosystems often leads to uncertainty regarding the scientific assessments of environmental impacts.[173] The lack of scientific certainty of cause and effect relationships was the motive for the creation of the precautionary principle, in order to guide decision makers in the very frequent occasions where they are required to decide how to address potential, uncertain, or even hypothetical threats, which can make the consequences of inaction serious or irreversible.[174]

The precautionary principle acknowledges the complexity of ecosystems and the limits of human understanding of natural mechanisms. That is the reason why the principle adopts an ecosystem approach, rather than fragmenting environmental protection into single-species or single-natural-function approaches.[175] That is also the reason why the relationship between the precautionary principle and science is marked by a culture of humility about the sufficiency and accuracy of existing knowledge when dealing with environmental, health, and safety regulations.[176]

Even though the precautionary principle acknowledges scientific uncertainty when there is not sufficient evidence regarding ecosystem functioning, or on the probabilities of adverse outcomes, nonetheless, the principle attributes an important role to science. Science recognizes and quantifies

172. Minna Pyhälä et al, *The Precautionary Principle*, *in* RESEARCH HANDBOOK ON INTERNATIONAL ENVIRONMENTAL LAW, *supra* note 99, at 203, 205, 212.

173. *Id.*

174. *See* KISS & SHELTON, *supra* note 75, at 95; *see also* Kysar, *supra* note 156, at 14.

175. *See* ROSIE COONEY, THE PRECAUTIONARY PRINCIPLE IN BIODIVERSITY CONSERVATION AND NATURAL RESOURCE MANAGEMENT 30-31 (IUCN Policy & Global Change Series n. 2 2004); *see also* Pyhälä et al., *supra* note 172, at 220.

176. *See* Kysar, *supra* note 156, at 22.

environmental problems, thereby reducing management uncertainties; science provides key evidence to guide decision makers as to which risks are graver and on which management actions should be prioritized; experts also provide decision makers with alternatives for action and assess which alternative is safer under a scientific point of view.[177]

Decision making attendant to the precautionary principle is not made solely based on the information provided by science; the precautionary principle is applied on a case-by-case basis, where scientists inform decision makers, who weigh the scientific knowledge with value judgments of a moral, cultural, economic, and political nature.[178] If decision makers do not choose the alternative that scientists have considered the safest one, they must justify their choice.[179] This rule allows decision makers to diverge from scientists while at the same time providing the public with means to evaluate the legitimacy of their choices.

Along with the scientific knowledge, decision makers are also advised by the Food and Agriculture Organization of the United Nations (FAO)[180] to consider traditional, indigenous, and local resources users' knowledge of how the ecosystem functions. These groups have an intense and long-lasting relationship with the surrounding environment, through which they construct an empirical knowledge that often covers longer periods of observation than scientific studies do.[181] The importance attributed to non-scientific forms of knowledge in the design of public policies acknowledges that science is not absolute.

The precautionary principle recognizes the importance of the well-being of non-human entities, the intrinsic value of ecological

177. Pyhälä et al., *supra* note 172, at 214-18.

178. *Id.* at 221; COONEY, *supra* note 175, at 36.

179. Pyhälä et al., *supra* note 172, at 219.

180. U.N. FOOD & AGRIC. ORG., PRECAUTIONARY APPROACH TO CAPTURE FISHERIES AND SPECIES INTRODUCTIONS 18 (1996), *available at* ftp://ftp.fao.org/docrep/fao/ 003/W3592e/W3592e00.pdf.

181. "[E]cological systems often exhibit frequency behavior on the scale of decades or even centuries. . . . It is hardly conceivable that there would ever be an extensive enough range of data to allow for a comprehensive description using statistical methods." William C. Clark et al., *Lessons for Ecological Policy Design*, *in* FOUNDATIONS OF ECOLOGICAL RESILIENCE, *supra* note 2, at 331, 346-47.

systems and, therefore, the moral obligation of humankind to protect vulnerable or critical natural systems.[182] In this respect, the principle is much aligned to the premises of the *land ethic*.

The precautionary principle is guided by the premise that society must not be paralyzed by the lack of scientific knowledge and, therefore must take action to protect health and the environment[183] even when facing uncertainty. Thus, the precautionary principle guides decision makers to respond to deficiencies of understanding by constantly reevaluating and improving learning and knowledge.[184] Consequently, the precautionary principle requires a high degree of information and monitoring.[185]

The recognition of limited knowledge and the emphasis on taking action and on learning leads to the conclusion that error in environmental management is highly possible. In order to protect the environment from such errors, the precautionary principle recognizes the need to prepare to provide ecological space for recovery from potential policy mistakes. Preparedness against errors can be achieved by leaving a margin of error when establishing harvest limits.[186]

The precautionary principle challenges the current legal, political, social, and economic system on many grounds. First, the principle deals with uncertainty, while traditional legal systems rely on certainty and predictability. Second, the moral obligation to protect the environment contradicts the modern western belief that human interests, such as material growth, always have pre-eminence over non-human interests. Third, as mentioned above, the principle requires leaving a margin of error when establishing harvest limits, which is contrary to the market logic of maximizing revenue by exploiting all available resources. Fourth, the principle requires long-term economic and social considerations to prevent decision makers from not taking into

182. Pyhälä et al., *supra* note 172, at 215.

183. *Id.* at 219.

184. INST. OF THE ENV'T, UNIV. OF OTTAWA, PRACTICING PRECAUTION AND ADAPTIVE MANAGEMENT B-10 (June 2005), *available at* http://www.uottawa.ca/ie/English/Reports/ JBPP_Final_Report.pdf.

185. COONEY, *supra* note 175, at 30.

186. *Id.*

consideration the abundant benefits of preventing irreversible damages that would be felt in the medium and long-term future. Fifth, the principle challenges policy makers to promote an inter-disciplinary consideration of factors that influence decision making when weighing the information available about an uncertain threat.[187]

The precautionary principle is abundantly present in soft and hard law agreements (Rio Declaration, UNFCCC, CBD, Stockholm Convention on POPs, Cartagena Protocol on Biosafety, European Community–Treaty of Rome) and in state practice and judicial opinion. However, it has not been fully applied in rulings of international courts.[188]

When there are concerns regarding unknown but potentially devastating threats to natural systems that are thought to be of fundamental and irreplaceable importance to humanity, the precautionary principle guides decision makers to assess what would be the worst possible outcome and to align their decisions to prevent the occurrence of such event. That guidance is called the *maximin principle*. However, the applicability of the *maximin principle* is limited and it is not recommended for times when the costs of precaution become immoderate or unacceptably large. When an activity can pose serious threats to the environment, but the costs of prohibiting it are too burdensome, the precautionary principle advises governments and private actors to "do the best they can" to mitigate the negative impacts of such activity.[189] This commitment is implied in U.S. pollution control statutes which require the installation of the best available pollution abatement technology.[190]

187. Pyhälä et al., *supra* note 172, at 203.

188. *Id.*

189. Kysar, *supra* note 156, at 24 (quoting Wendy E. Wagner, *The Triumph of Technology-Based Standards*, 2000 U. ILL. L. REV. 83, 92).

190. *See, e.g.*, 33 U.S.C. §1314(b)(2) (2010) (requiring the best available technology by the Clean Water Act, 33 U.S.C. §§1251 (2010), for new sources' discharges of conventional pollutants and for all sources of toxic pollutants and non-conventional pollutants); *see also* 42 U.S.C. §7411 (2010), *construed in* Kennecott Copper Corp. v. Train, 526 F.2d 1149, 1151 n.5 (9th Cir. 1975) (best available technology is also required by the Clean Air Act for new discharge sources installed in National Ambient Air Quality Standards (NAAQS) attainment areas).

The precautionary principle shifts the burden of proof onto proponents and developers. This measure aims to prevent the environment or human populations from bearing the burden of uncertainty. The shift in the burden of proof corrects a defect in traditional legal systems that disallows claims for compensation for accidents and acts of God, which disincentive developers from taking adequate precaution measures.[191]

The precautionary principle provides a few guidelines for decision makers to consider during the weighing process. First, decision making should be transparent and allow public participation.[192] Second, decision makers must consider the proportionality of protective measures in relation to the level of security to be achieved.[193]

Adaptive management is also often referred to as a means to implement the precautionary principle[194] in risk management, although some authors believe that adaptive management and the precautionary principle are incompatible.[195] Adaptive management is a useful tool for the precautionary principle because it stands for taking action for conservation even when there is no complete understanding as to which would be the most appropriate protective measure. Adaptive management, such as the precautionary principle, recognizes the value of learning from experience and of monitoring policy effects, keeping risk regulation to a perceived threat updated over time.[196] Also, other tools of the precautionary principle, such as the shift of the burden of proof, can provide a valuable aid to the adaptive management learning process by incentivizing research and understanding by developers and activity proponents on imperfectly characterized threats.[197]

191. Pyhälä et al., *supra* note 172, at 213.
192. COONEY, *supra* note 175, at 38-39.
193. *Id.* at 36.
194. *Id.* at 31; INST. OF THE ENV'T, UNIV. OF OTTAWA, *supra* note 184; Pyhälä et al., *supra* note 172, at 220.
195. COONEY, *supra* note 175, at 31; Pyhälä et al., *supra* note 172, at 220.
196. Kysar, *supra* note 156, at 34.
197. *Id.* at 28 (citing Amy Sinden, *Cass Sunstein's Cost-Benefit Lite: Economics for Liberals*, 29 COLUM. J. ENVTL. L. 191, 194 (2004)).

Besides the affinity with adaptive management, the precautionary principle shares other premises and values held by the principle of resilience. Therefore, the precautionary principle can make a great contribution to the implementation of the principle of resilience, especially regarding the reconciliation of adaptive management, public participation, legal predictability and legitimacy, and the ethical and ecological values of the principle of resilience.

The precautionary principle reinforces the notion that political communities retain special responsibility to evaluate the effects of their decisions not only on themselves, but also on those not involved in the decision process, such as other societies, future human generations, and nature itself.[198] Thereby, besides being an opportunity to maximize welfare functions, the policy making process becomes a forum for discussions regarding the obligation of the regulating body towards these non-represented groups.[199] Acknowledgement of such a responsibility attributes a collective moral identity to social choices.[200] By this means, the precautionary principle establishes the correlation between policy choices and ethics.

Like the principle of resilience, the precautionary principle acknowledges that humankind's obligation to protect the environment has a moral justification. However, the principle of resilience goes further, acknowledging that society must not only protect the environment, but also adopt ways of life that are in synergy with ecosystem functions, especially regarding patterns of production and consumption.

Besides recognizing these societal moral duties, the principle of resilience also recognizes the individual moral duty to respect nature and to pursue a way of living in harmony with the land mechanism. The precautionary principle promotes the saying "do the best you can" regarding activities that cause environmental impacts but that are, nonetheless, necessary and irreplaceable for society. In the same way, the principle of resilience acknowledges that humans have a moral responsibility to do their best to aid

198. *Id.* at 11.
199. *Id.* at 54.
200. *Id.* at 12.

the land mechanism to maintain its mutually enforcing processes as a recompense for the benefits the environment provides us and for the unavoidable burdens we inflict on the land mechanism.

Also common to both principles is the idea that humans must take action to comply with the moral obligation to protect the environment, even when the scientific knowledge on impacts and their solutions is not yet complete. Therefore, unlike CBA, both the principle of resilience and the precautionary principle point towards regulatory action in the face of uncertainty.

Adaptive management decisions should demonstrate the adoption of the policy alternative that presented the greater synergy with ecosystem functions. If such an alternative is not adopted, policy makers must justify the reason priority was given to the other value. The lack of justification or the lack of sufficient evidence to support the decision may motivate judicial review of the agency's decision.

Some interpretations of the precautionary principle attribute particular importance to the preservation of fundamental ecosystem functions, such as the proposal to employ "safe minimum standards" to Earth's life-support systems facing potentially devastating threats, in order to protect them whatever the cost.[201] This application of the precautionary principle can enforce the ecological goal of the principle of resilience to preserve ecosystem functions and prevent irreversible changes in stability domains.

Because the information available prior to decision making is not complete or conclusive, the precautionary principle places great responsibility and discretion on decision makers to do the weighing process. In order to prevent the process from becoming opaque, thereby losing legitimacy, the precautionary principle requires enhanced means of public participation and accountability of the decision makers within a public administration.[202]

Besides the lack of conclusiveness of any scientific evidence, some authors mention other aspects of management in the face of uncertainty that can impoverish legitimacy. Barbara Cosens

201. *Id.* at 25-26.
202. *See* Pyhälä et al., *supra* note 172, at 214.

observes that adaptive management requires the expansion of agencies' discretion to decide and to change strategies based on the assessment of results.[203] In addition, this approach ascribes to scientists a key role in interpreting the data and in recommending solutions.[204] Because in a democracy legitimacy is achieved by the government of representatives elected by citizens, the concentration of power on non-elected representatives is seen as a reduction of decision-making legitimacy.[205]

Nevertheless, agencies already had substantial responsibility for decision making before the implementation of the precautionary principle and the advent of adaptive management. Since recognition of the need to prevent environmental impacts and the adoption of the preventive principle, agencies were required to prove the potential impact of an activity in order to justify environmental regulation.[206] Besides that, the enlargement of agencies' decision-making power is also due to their expertise in making decisions on complex issues and in solving issues about the interpretation of statutes faster and with a greater level of detail than Congress,[207] which was a reality even before the precautionary principle arose.

Therefore, part of the impoverishment of legitimacy caused by the implementation of the preventive principle is remedied by the precautionary principle, since the influence of scientists in decision making is controlled by political decisions taken by the heads of agencies during the weighing process. On the other hand, the impoverishment of decision making legitimacy due to the transfer of decisions from the legislature to agencies can be addressed by ensuring that there is enough publicity and public participation in the decision-making process. In addition, such problems can be addressed by greater congressional and judicial

203. Barbara Cosens, *Resilience and Administrative Law in Transboundary River Governance*, STOCKHOLM RESILIENCE CTR. (Nov. 17-19, 2010), http://www.stockholmresilience.org/research/researchnews/attheintersectionoflawandresilience.5.4d177c5b12cd2f8876080003697.html.

204. *Id.*

205. *Id.*

206. Pyhälä et al., *supra* note 172, at 205.

207. PLATER ET AL., *supra* note 6, at 215-38.

oversight of agencies and by the employment of mechanisms proposed by economic law literature to prevent agency capture.

Besides legitimacy, the law also makes claims for predictability, which is a very challenging goal when dealing with uncertainty and adaptive management. Theorists on adaptive management usually reject the use of regulation in the face of uncertainty[208] and management approaches that seek to replace the uncertainty of resource issues with the certainty of a process.[209]

It is true that surprises are inevitable and that institutions managing for resilience must be flexible. It is also true that the uncertainty of a management problem cannot be replaced by a procedure. However, it does not mean that flexible institutions cannot have procedure. As pointed out by Cosens, procedural rules provide legitimacy to acts of public administration governed by Administrative Law.[210] Therefore, public administration cannot simply get rid of procedure. By the same token, agencies can act only within the limits of power delegated to them by Congress. The limitation on agencies' power and the agencies' obligation to follow the rules determined by Congress and by the agency itself ensure that the agency will not exceed its limits and, if it does, it will be reprimanded. It is not possible to have congressional, judicial, or citizen control over agencies if it is not perfectly clear which rules and procedures they must submit to. Without the control of one governmental branch over the other, it is not possible to maintain a republican state. A proposal of institutional design cannot ignore such basic legal premises and rules of power distribution in national states; otherwise it risks never being adopted and implemented at all.

The delegation of power to agencies and the establishment of a procedure for adaptive management can be formulated in a manner to attend to both the legal need for predictability and procedural legitimacy, and the need to establish a method to

208. Craig R. Allen et al., *Commentary on Part Three Articles, in* FOUNDATIONS OF ECOLOGICAL RESILIENCE, *supra* note 2, at 301, 305.

209. Lance Gunderson, *Resilience, Flexibility and Adaptive Management – Antidotes for Spurious Certitude?* 3 CONSERVATION ECOLOGY no. 1, art. 7 (1999), *available at* http://www.consecol.org/vol3/iss1/art7/.

210. Cosens, *supra* note 203.

guide the long-term process of adaptive management. Aiming to attend to those two interests, this article proposes a general roadmap for regulation for adaptive management.

The norm enacted by Congress which delegates power to an agency can provide guidelines for the structure of policies and norms that should be created by the agency. For example, the norm can establish that every policy created must define: goals, actions, predicted results, time frames to launch actions in short, medium, and long term, methods of monitoring, the entity competent to do monitoring, deadlines for collection of monitoring data and for release of monitoring results, and penalties for not complying with deadlines and guidelines determined by the delegation statute.

Through the design of an adaptive management model coupled with basic regulation, agencies have a certain freedom to determine the content of policies, while the regulation structures a method. The establishment of a method is essential because it joins demands of legal, political, and scientific levels. From a legal perspective, the pre-determination of a procedure attributes greater legitimacy to the process, ensures legal predictability, and facilitates oversight by the legislature, by the judiciary, and by the public.

From a political perspective, the establishment of a procedure ensures the continuity of the process even if the agency personnel changes along with changes in government. It is widely known that changes in government are a major cause for discontinuity of policy measures and plans. The determination of a procedure can aid in the solution for this aspect by forcing the agency to create long-term planning and goals, which will ensure the continuity of management measures which will have to be considered by the next generation of decision makers.

From a scientific perspective, the establishment of a procedure or method is natural to the beginning of any research project or of any policy analysis. Therefore, such a measure is useful because it conciliates the need for legitimacy and predictability with the scientist's interest in flexibility in determining the content of the policy.

Ecologists usually believe that regulation is not best suited to guide the management of ecosystems with regard to unknown

threats because this kind of management does not provide the flexibility required for dealing with the unexpected.[211] For such cases ecologists suggest the use of adaptive management tools.[212]

Although this work recognizes the value of adaptive management as a way of rendering environmental regulation more flexible, it supports the view that the implementation of an adaptive management process not supported by environmental regulation is inconceivable. The reason for this is quite simple: the management of ecosystems necessarily requires the imposition of restraints on actions perpetrated by private actors, because every ecosystem supports anthropic activities which will be affected by a regulation aimed at enhancing ecosystem resilience. As the actions of private actors can only be constrained by rules of law, adaptive management not supported by regulation would have very limited implementation and efficacy.

The authors who advocate for adaptive management usually prefer market incentives to command-and-control regulations, as if they were independent of each other. However, in order to be successful, any market incentives depend on the scarcity of whatever is tradable. As the market does not naturally attribute value to an ecosystem's functions or services, market incentives always depend on a command-and-control regulation aimed at internalizing environmental costs and attributing scarcity and value to the ecosystem's services. Therefore, adaptive management will always require some basic regulation.

B. Adaptive Management

A change in stability domain can motivate several human reactions: humans can "do nothing and wait to see if the system will return to some acceptable state"; they can "actively manage the system and try to return it to a desirable stability domain"; or they can "admit that the system is irreversibly changed and, hence, that the only strategy is to adapt to the new, altered system."[213] The first reaction—to do nothing—is hardly an option

211. Allen et al., *supra* note 208, at 305.
212. *Id.*
213. Gunderson, *supra* note 209, at 4.

because human activities and human lives depend on the ecosystem, thus the choice of inaction can cause not only economic losses, but also the loss of lives. Therefore, humans need to manage ecosystems sometimes to return to a past condition, and sometimes to adapt to an unavoidable new condition. Due to the complexity of ecosystems, humans often lack a complete understanding about the processes that lead towards changes in stability domain. That is why resource managers usually have to deal with uncertainty.

Literature recognizes adaptive management as the most suitable approach for dealing with ecosystem complexity and the uncertainty generated by unknown threats.[214] This management method is centered on feeding ecological knowledge into management organizations by constantly improving the understanding of ecosystem dynamics through the interpretation of data periodically collected by observation and monitoring.[215]

Adaptive management is a result-based approach to management by agencies; its final goal is to continuously enhance environmental quality. The adaptive management process mainly deals with specifying objectives when addressing a management problem, articulating a policy, and evaluating the performance of the policy.[216] Adaptive management has great potential for dealing with ecosystem resilience because this method relies on the observation and interpretation of essential processes and variables in ecosystem dynamics,[217] constantly using this knowledge to reevaluate and modify the management strategy. During the evaluation process, a critical understanding of the effects of the policy creates an experience platform upon which informed policy designs and meaningful choices can be based in the future.[218]

Adaptive management distinguishes itself from conventional management because it focuses on managing essential ecological processes that sustain the delivery of harvestable resources and

214. *See id.*; Allen et al., *supra* note 208, at 305; C. S. HOLLING ET AL., ADAPTIVE ENVIRONMENTAL ASSESSMENT AND MANAGEMENT (1980).

215. Folke et al., *supra* note 9, at 448.

216. Clark et al., *supra* note 181, at 364.

217. Folke et al., *supra* note 9, at 445.

218. Clark et al., *supra* note 181, at 381.

ecosystem services on multiple temporal and spatial scales,[219] while the conventional approach focuses on the assessment of the maximum sustainable yield of an individual species on a single scale.[220] The protection of groups of species that develop the same function at different scales reinforces the resilience of that function and enables that function to be maintained despite sudden variations within specific scales.[221]

a. Obstacles to the Adoption of Adaptive Management

There are a few characteristics of risk perception that may influence political mobilization towards the adoption of adaptive management measures. It has been noticed that involuntary exposure to risk is regarded by the public as less tolerable than voluntary exposure.[222] This might be explained by the fact that voluntary exposure presupposes that people have both the knowledge about the risk and the freedom to choose to undertake the risk, thus acknowledging people's autonomy, equality, and individual power—ideals most valued by modern society. In the same sense, involuntary exposure to risk is seen as a signal of uncontrollability and uncertainty,[223] which is usually condemned by modern society.

It is probably for this reason that resource managers try to reduce the public perception of uncertainty towards risks of natural disasters. They do so by ignoring most uncertainty and by breaking the problem into trivial questions; thereby achieving a spurious certitude or by replacing the uncertainty of resource issues with the certainty of a process.[224]

Unlike the above mentioned reactions, adaptive management recognizes the uncertainties of risks and confronts them,[225] which

219. *Adaptive Management,* RESILIENCE ALLIANCE, http://www.resalliance.org/index.php/adaptive_management (last visited Oct. 22, 2012).

220. Folke et al., *supra* note 9, at 443.

221. Peterson et al., *supra* note 36, at 182-85.

222. FARBER ET AL., *supra* note 146, at 252 (quoting Clayton P. Gilette & James E. Krier, *Risk, Court and Agencies*, 138 U. PA. L. REV. 1027 (1990)).

223. *Id.*

224. Gunderson, *supra* note 209.

225. *Id.*

may give the public the false impression that adaptive management has greater uncertainty than other management methods. In this context, the environmental principle of information plays an important role in order to inform the public about the uncertainties inherent in any management method, thereby dissipating the false impression. It is expected that the potential reluctance of public opinion to accept this method could be defeated by showing that adaptive management is more suitable for dealing with uncertainty, precisely because it does not hide it.

The perception of risk also poses obstacles to adaptive management because natural disasters get less attention than human-made events.[226] For example, there is less public pressure towards the prevention of natural disasters than towards the prevention of terrorist attacks. When dealing with disasters, people are concerned not only with safety, but also with responsibility and guilt. Natural disasters are not considered to be caused by humans, and they are thought of as nobody's responsibility.[227] Adaptive management will hardly be able to change this perception, unless the increase in information collection enables managers to identify which specific human-made actions caused certain environmental hazards.

Experience shows that the presence of certain circumstances can block the development of adaptive environmental assessment and management, or at least make it not recommendable. This occurs when an ecological system completely lacks resilience, institutions lack flexibility, designing experiments present technical challenges, natural resources present certain characteristics that make experimentation impossible, or design analysis concludes that the risks of failure are socially and legally unacceptable.[228] These circumstances affect a manager's capacity to experiment and learn from experience, which is an essential feature of adaptive management.[229] Also, because adaptive management needs room for experimentation, it goes against

226. FARBER ET AL., *supra* note 146, at 254.

227. *Id.* at 252-53 (quoting Clayton P. Gilette & James E. Krier, *Risk, Court and Agencies*, 138 U. PA. L. REV. 1027 (1990)).

228. Gunderson, *supra* note 209, at 6.

229. Folke et al., *supra* note 9, at 447.

market logic because it proposes the maintenance of a minimum level of untouched and/or economically unused resources in order to preserve the ecosystem's ability to reorganize itself.

There is still reluctance among environmental agencies to implement adaptive management. It is arguably too complex, time consuming, and often expensive—factors very common to processes that involve scientific investigation and democratic debates with insights from public participation.

As administrators pursue short-term efficiency in their management methods, they usually employ first the simplest management alternatives and leave adaptive management to be used as the tool of last resort, when none of the others were effective.[230] The downside to this reality is that adaptive management is employed when ecosystems are already very distressed—at such a time, adaptive management cannot provide substantial aid because it is not appropriate for ecosystems that have no resilience left.

The latency and irreversibility of some risks deny managers the fruits of trial-and-error, because, under these circumstances the effects of an action are only identified years or decades after implementation, when actions cannot be corrected anymore.[231] It is expected that by enhancing the resilience of the ecosystem managers will reduce the probability of irreversible effects, because the ecosystem will have a larger capability to adapt to different circumstances. However, if the ecosystem totally lacks resilience, managers will not be able to rely on adaptive management for dealing with risks with potential latency and irreversibility, because adaptive management entails experimentation.

Certain legal measures can be taken to attenuate or remove the obstacles to the implementation of adaptive management. These measures are explained below.

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230. B.L. Johnson, *The Role of Adaptive Management as an Operational Approach for Resource Management Agencies*, CONSERVATION ECOLOGY (Sept. 7, 1999), *available at* http://www.consecol.org/vol3/iss2/art8/.

231. FARBER ET AL., *supra* note 146, at 252 (quoting Clayton P. Gilette & James E. Krier, *Risk, Court and Agencies*, 138 U. PA. L. REV. 1027 (1990)).

b. EIA and Related Tools

The Environmental Impact Assessment (EIA) related tools can contribute to the transfer of information required by the implementation of adaptive management by predicting the potential impacts of policies, assessing the alternatives, and ensuring public access to information and participation in the decision process.

Tools such as strategic environmental assessments or area wide assessments are of even greater importance in enhancing adaptive management considering that most of the surprises, classified as local and cross-scale,[232] could be predicted and monitored through the integration of information of local and regional scale.

EIA can also help in implementing adaptive management at the project level by requiring, during the license renewal process, the reevaluation of an activity's impacts and of its mitigation measures. Therefore, instead of renewing environmental licenses without further questioning, agencies could evaluate whether the mitigation measures that condition the license were efficient and whether new mitigation measures are needed.

Aiming to prevent the repeated incidence of such situations, several measures tending to simplify the adaptive management process can be employed. First, environmental departments should unify the methodologies employed in the collection of ecosystem data within the several EIA related tools—such as the EIAs itself, the SEAs, and the EMSs—because lack of

232. Gunderson, *supra* note 209, at 2. The concept of "scales" is very important when dealing with resilience, and especially when dealing with adaptive management. That is so because the same event that may cause uncertainty on one scale can be deemed a predictable event on another scale. According to Gunderson, uncertainty is usually caused by three types of surprise: local, cross-scale, and true novelty. "Local surprises are created by broader scale processes for which there is little or no previous local knowledge." This kind of surprise "can be resolved by a broader scale observation, and historical accumulation of knowledge." Cross-scale surprise occurs when a "larger scale fluctuation intersects with slowly changing internal variables to create an alternative stable (local) system state." This is often the source of policy crises. True novelty occurs when "new variables and processes transform the system into a new state. In these surprises, little or no experience exists for either understanding the transformation or structuring management actions." *Id.*

standardization is often a reason why available data cannot be used in modeling and why it has to be recollected by adaptive managers.[233] By these means, the environmental department can focus on managing and analyzing the available data rather than on collecting it. Second, the models developed by managers to aid in the understanding of the ecosystem's function must be kept as simple as possible, and the predictions of the need for new data should be constantly reviewed in order to prevent the collection of irrelevant data.[234]

c. Risk Evaluation, Disaster Preparedness, and Recovery

Disasters are the impacts that hazardous events have on people and property. Such impacts are caused not only by the magnitude of the event, but also by human interaction with nature and by our choices about where and how we live.[235] "No disaster is completely 'natural'" because the degree of impact that a natural event causes to humans is highly determined by "human exposure and vulnerability to risk [which] is a product of cultural patterns influenced heavily by law."[236] Therefore, law has an important role to play in preventing emergencies, especially through the elaboration of emergency plans and land use regulation. The success of disaster law is "judged by [its] results in minimizing disaster costs, as a whole, as well as minimizing disparate impacts on vulnerable communities."[237]

In summary, disaster law is the legal area dedicated to eliminating or reducing the disturbance caused by known and unknown threats. As for unknown threats, there is an area of overlap between adaptive management and disaster law that justifies the application of the principle of resilience in this legal field.

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233. I.B. Marshall et al., *National and Regional Scale Measures of Canada's Ecosystem Health*, *in* ECOLOGICAL INTEGRITY AND THE MANAGEMENT OF ECOSYSTEMS 117, 126 (Stephen Woodley et al. eds., 1993).

234. HOLLING ET AL., *supra* note 214, at 50-51.

235. FARBER ET AL., *supra* note 146, at 3.

236. *Id.* at 9.

237. *Id.* at 4.

There is a clear interconnection between vulnerable ecosystems and natural disasters. The increasing vulnerability of ecosystems noticed in the last decades have been followed by records that cause concern regarding the intensification of impacts caused by natural hazards.[238]

Therefore, enhancing ecosystem resilience is an efficient way to achieve greater levels of safety from natural disasters. This fact has already been recognized by the best literature on disaster management. Farber et al. acknowledges that land use planning that exacerbates disaster risk, failure to maintain green infrastructure, and climate change are among the main causes for the recent increase in disaster occurrence.[239] The 2009 United Nations Global Assessment Report on Disaster Risk Reduction listed, among the strategies for protecting green infrastructure, the need to build ecosystem resilience and promote integrated planning, in which both environmental and disaster risk considerations are factored into land use and development planning.[240] The 2011 version of the United Nations Office for Disaster Risk Reduction (UNISDR) Report mentioned that investing in green cities may be a more cost-effective means of reducing urban flooding than expensive investments to increase storm drainage capacity.[241]

By the same token, disaster management would be enhanced by the insertion of concerns with ecosystem resilience, in the same way that environmental protection would be much enhanced by the introduction of ecosystem resilience into disaster law. Often measures taken for emergency responses are potentially harmful to the environment and could be replaced by

238. *Id.* at 3 ("Every ten years, property damage from natural hazards in the United States doubles or triples in cost."); *see also* 2009 GLOBAL ASSESSMENT REPORT ON DISASTER RISK REDUCTION, *supra* note 91, at 4-5 (noting that from 1990 to 2007, the worldwide mortality risk from floods increased by 13% and the economic risk posed by floods increased by 33%. Half of the most deadly disasters since 1975 occurred between 2003 and 2008).

239. FARBER ET AL., *supra* note 146, at 10.

240. 2009 GLOBAL ASSESSMENT REPORT ON DISASTER RISK REDUCTION, *supra* note 91, at 162-65.

241. U.N. INT'L STRATEGY FOR DISASTER REDUCTION SECRETARIAT, 2011 GLOBAL ASSESSMENT REPORT ON DISASTER RISK REDUCTION 154 (2011), *available at* http://www.preventionweb.net/english/hyogo/gar/2011/en/home/ download.html.

more environmentally friendly alternatives, if decision makers were considering the environmental effects of their actions.

The relationship between flood occurrence, land use patterns, and the construction of levees is an example of a situation where disaster management can choose between a sustainable or unsustainable solution. Both land use regulation and levees are means to control flood risk: the former prevents the formation of ecologically sensitive areas;[242] the latter "exacerbate[s the] risk of flooding downstream and in catastrophic events, when the levees are overtopped."[243] Consequently, the avoidance of floods by land use regulation represents a disaster mitigation measure that is both environmentally friendly and more efficient in preventing natural disasters.

Disaster planners should be aware that concerns about ecosystem resilience and ecosystem services prevent the occurrence of disasters altogether, thus generating benefits not solely to the environment, but also to property safety and, more importantly, to human lives.

However, the 2011 United Nations Global Assessment Report on Disaster Risk Reduction shows that national policy worldwide[244] has been tending otherwise: in 2009-2011 "less progress was made integrating [disaster risk management] into environmental policies than in 2007–2009."[245] This is the result of overlapping responsibilities and legislation which hamper governmental efficiency in addressing environmental and disaster-related problems.

The application of the principle of resilience to disaster management expands the reach of disaster law concerns: besides considering solely the impacts hazardous events cause to humans and property, disaster law is supposed to also consider the

242. FARBER ET AL., *supra* note 146, at 29.

243. *Id.* at 28. Levees contribute to the destruction of coastal wetlands through the reduction of the river's natural flow of freshwater and sediment to wetlands, by funneling water directly to the ocean. The destruction of wetlands increases the vulnerability to floods because wetlands "dissipate storm surge and absorb flood waters." *Id.* at 54-55; 2011 GLOBAL ASSESSMENT REPORT ON DISASTER RISK REDUCTION, *supra* note 241, at 45.

244. 2011 GLOBAL ASSESSMENT REPORT ON DISASTER RISK REDUCTION, *supra* note 241, at 88 (except in middle-income countries).

245. *Id.*

impacts such events cause to ecosystems. The inclusion of environmental concerns in disaster preparedness goals was already acknowledged by 168 nations in 2005, when the Hyogo Framework for Action was adopted.[246] This Framework aims to achieve a "substantial reduction of disaster losses, in lives and in the social, economic, and environmental assets of communities and countries" by 2015.[247]

Governmental and legal responses to disasters rely on the "circle of risk management," which is composed of mitigation, emergency response, compensation, and rebuilding.[248] Mitigation involves prevention and protection against the impacts of major events on lives and property, which might include preventive measures such as investigations regarding the full nature and source of the threat, or disruption of illegal activity, and protective measures aimed at reducing the vulnerability of critical infrastructure or key resources in order to deter, mitigate, or neutralize major disasters. Protection also includes elevated awareness, identification, and promotion of effective sector-specific protection practices. Emergency response involves the activities that address the short-term direct effects of an incident. Compensation and rebuilding are elements of the emergency recovery phase, which also involves long-term care and treatment of affected persons and the development, coordination, and execution of site and service restoration plans.[249]

The principle of resilience will be applied to disaster law if adaptive management concerns and procedure are included in the circle of risk management. Once the vulnerability of ecosystems to disturbances is itself a risk to human health and human activities, the assessment of ecosystem resilience should be

246. *See* World Conference on Disaster Reduction, Kobe, Hyogo, Japan, Jan. 18-22, 2005, *Proceedings of the Conference*, U.N. Doc. A/CONF.206/6 (2005), *available at* http://www.preventionweb.net/english/professional/publications/v.php?id=3800 (adopting the Hyogo Framework for Action).

247. World Conference on Disaster Reduction, Kobe, Hyogo, Japan, Jan. 18-22, 2005, *Hyogo Framework for Action 2005-2015: Building the Resilience of Nations and Communities to Disasters*, ¶ 11, U.N. Doc. A/CONF.206/6 (2007), *available at* http://www.preventionweb.net/english/hyogo/.

248. FARBER ET AL., *supra* note 146, at 3.

249. U.S. DEP'T OF HOMELAND SEC., NATIONAL PREPAREDNESS GUIDELINES 42-43 (2007).

employed in the mitigation process, as a means of investigating the full nature and source of an unknown natural threat. Information on the function of ecosystems, collected by environmental impact assessments and consequent monitoring, can be employed for this purpose, as well as for structuring an adequate and up-to-date emergency preparedness plan. Data produced through the observation of ecosystem reactions to environmental policies can be used during the emergency response phase, in order to avoid allowing decision makers to opt for policy solutions that might weaken ecosystem resilience during rebuilding and recovery.

The circle of risk management can be put to work for the benefit of the principle of resilience even when adaptive management is not yet adopted by environmental agencies. The occurrence of a hazardous event can highlight to the public errors in management that have resulted in greater vulnerability to catastrophes. When a failure in management is noticed, decision makers are more likely to emphasize learning and support a change in polices and methods than when the policy applied seems to be working perfectly.[250] Under those circumstances, the adaptive management procedure has greater chances of being accepted and adopted if it is proposed during the recovery phase of the circle of risk management because there will be greater political will to implement innovative solutions.

The perception of risk influences the political will to adopt adaptive management. However, that is not the sole factor that influences decision making regarding risks. Governments are also subject to procedures and directives guiding which measures and regulations can and cannot be taken to address certain risks. The influence of governmental governance on the adoption of adaptive management will be analyzed in the following section dedicated to adaptive governance.

C. Environmental Impact Assessment

Environmental Impact Assessment (EIA) is a procedure for "evaluating the likely impact of a proposed activity on the

250. Gunderson, *supra* note 209.

environment"[251] prior to the commencement of a project. This procedure is aimed at providing the necessary knowledge to decision makers to prevent environmental harm before it occurs.[252] Although the EIA aids informed decision making by identifying the environmental risks of an activity, it does not determine whether a project should proceed and how it should be regulated; such decisions are assigned to public authorities, who will balance the information provided by the EIA with other national or regional concerns.[253] An EIA is essentially procedural because public authorities' decision is not bound by the findings of the EIA.[254]

The EIA contributes to the implementation of national policies on sustainable development and precautionary action. The EIA procedure provides information on environmental risks to the public and offers the opportunity for public participation in decision-making regarding environmental issues.[255]

Both in the international and in the national sphere, the EIA provides governments with the information needed to evaluate whether the benefits of an activity exceed the activity's negative consequences to the environment. Depending on the result of this balancing process, the activity may be enjoined, restricted, or otherwise regulated in order to oblige the proponent to: change

251. Convention on Environmental Impact Assessment in a Transboundary Context art. 1(vi), Feb. 25, 1991, 1989 U.N.T.S. 309 [hereinafter Espoo Convention].

252. PATRICIA BIRNIE ET AL., INTERNATIONAL LAW AND THE ENVIRONMENT (2d ed. 2002); KISS & SHELTON, *supra* note 75, at 98; PLATER ET AL., *supra* note 6, at 319-52.

253. BIRNIE ET AL., *supra* note 252.

254. PLATER ET AL., *supra* note 6, at 319-52.

255. According to Principle 17 of the UNEP Goals and Principles of Environmental Impact, the public, experts, and interested groups should be allowed appropriate opportunity to comment on the EIA. *See, e.g.*, UNEP Governing Council, *Environmental Impact Assessment*, U.N. Doc. UNEP/GC/Dec./14/25 (June 17, 1987) [hereinafter UNEP EIA]. The requirement of public participation in EIA procedures is also present in legally binding agreements; article 14(1)(a) of the Convention on Biological Diversity, for example, requires appropriate public participation in EIA procedures related to projects that can cause significant impact to biodiversity. Several national laws on EIA have similar provisions. *Convention on Biological Diversity* (June 5, vb1992), 1760 U.N.T.S. 79, 31 I.L.M. 818 (1992), *available at* http://www.cbd.int/convention/text/ [hereinafter CBD].

the initial project, mitigate the expected impacts, or pay for the environmental costs his activity will cause society.

The strongest and most comprehensive elaboration of the states' duty to promote EIA is stated in Rio Declaration Principle 17: "Environmental impact assessment, as a national instrument, shall be undertaken for proposed activities that are likely to have a significant adverse impact on the environment and are subject to a decision of a competent national authority."[256]

However, this was not the only international document that required the elaboration of EIA: it is required under other non-binding instruments[257] and several binding international conventions.[258] The EIA is required by multilateral financial institutions,[259] and the government's duty to elaborate the EIA

256. *Rio Declaration*, *supra* note 89.

257. *See, e.g.*, *id.*; *Stockholm Declaration*, *supra* note 84, at princ. 14-15; UNEP EIA, *supra* note 255; United Nations Conference on Environment and Development, Rio de Janeiro, Braz., June 3-14, 1992, *Agenda 21*, U.N. Doc. A/CONF.151/26/Rev.1 (Vol. 1) (Sep. 28, 1992) [hereinafter *Agenda 21*]; Council Directive 97/11/EC, 1997 O.J. (L 73/5), *available at* http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:1997:073:0005:0015:EN:PDF (amending Directive 85/337/EEC on the assessments of the effects of certain public and private projects on the environment); Espoo Convention, *supra* note 251; Olufemi Elias, *Environmental Impact Assessment*, *in* RESEARCH HANDBOOK ON INTERNATIONAL ENVIRONMENTAL LAW, *supra* note 99, at 227.

258. *See, e.g.*, United Nations Conference on Straddling Fish Stocks on Highly Migratory Fish Stocks Sixth Session, New York, U.S., July 24 – Aug. 4, 1995, *Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 Relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks*, U.N. Doc. A/CONF/164/37 (Sep. 8, 1995); CBD, *supra* note 255; United Nations Conference on Environment and Development, May 9, 1992, *United Nations Framework Convention on Climate Change*, U.N. Doc. A/AC.237/18 (Part II), 31 I.L.M. 849 (1992), 11771 U.N.T.S. 107, S. Treaty Doc No. 102-38 (Mar. 2, 1994); International Convention for the Prevention of Pollution from Ships, 1973, Feb. 17, 1978, *Protocol of 1978 Relating to the International Convention for the Prevention of Pollution from Ships*, 1340 U.N.T.S. 61, 17 I.L.M. 546 (Oct. 2, 1983); United Nations Convention on the Law of the Sea, Dec. 10, 1982, 1833 U.N.T.S. 3, 21 I.L.M. 1261 (1982); KISS & SHELTON, *supra* note 75, at 98-99 (European Union Law).

259. World "Bank-funded projects have . . . been screened for their potential domestic, transboundary, and global environmental impacts" since 1989, when the Bank issued its first Environmental Assessment Directive. *See* BIRNIE ET AL., *supra* note 252, at 131.

has been referenced in international judicial decisions.[260] The EIA procedure is also considered an obligation imposed by the "do no-harm" or "good neighborliness" general principle of International Law to the State that is proposing an activity that can cause transboundary environmental harm.[261]

The duty to promote EIA is so well established in international environmental law that it can be regarded as a general principle of law or even a requirement of customary law.[262]

"The great majority of countries in the world have adopted" the EIA as mandatory regulations or, at least, informal guidelines.[263] Before project initiation, governments usually require a project proponent's elaboration of EIAs as a prerequisite to granting them the necessary permits.[264]

a. EIA Procedure Beneficial Characteristics

Although the principle of resilience is essentially substantive, this article proposes that the principle has a procedural facet in order to facilitate implementation. The application of the principle of resilience to the EIA procedure can comply with this need.

As EIA obliges the consideration of environmental impacts prior to every project that can cause significant environmental harm, it is also important to include concerns regarding ecosystem resilience in activities that incidentally affect and are affected by the environment, but that are not directly focused on environmental management.

The introduction of the principle of resilience in EIA procedure recognizes the state's duty to identify the factors that

260. *See* Gabčíkovo-Nagymaros Project (Hung. v. Slovk.), 1997 I.C.J. 92, ¶ 140 (Sept. 25); Emilio Agustin Maffezini v. Kingdom of Spain, ICSD Case No. ARB/97/7, ¶ 67 (Jan. 25, 2000); Iron Rhine Railway (Belg. v. Neth.), Hague Ct. Rep. 2d (Scott) 59 (Perm. Ct. Arb. 2005).

261. UNEP TRAINING MANUAL, *supra* note 97, at 53; Elias, *supra* note 257, at 228.

262. Elias, *supra* note 257, at 227 (quoting BIRNIE ET AL., *supra* note 252, at 131).

263. UNEP TRAINING MANUAL, *supra* note 97, at 26.

264. *Id.*

put ecosystem resilience at risk and to address such factors in a way that creates greater resilience. Implicit in this duty is the idea, also present in many international agreements, that states should seek to enhance environmental quality—not only to mitigate impacts. Also, a natural and procedural consequence of such a duty is that government officials should receive training in identifying human activities and natural phenomena that may impact ecosystem resilience.

Since everybody has the right to use natural resources in a way that does not impair the perpetuation of ecosystem features, the EIA has an important role in predicting and preventing such impairment. Also, once a proposed activity could harm the environment solely by increasing the vulnerability of the ecosystem to disturbances, it is a logical conclusion that the assessment of ecosystem vulnerability and, therefore, ecosystem resilience should be included in every EIA. Thus, the inclusion of concerns about improving ecosystem resilience in EIA procedures would contribute to the completeness of the EIA and enhance its capacity to predict and prevent all possible impacts.

If the EIA identifies an activity that can impair the continuing exercise of an ecosystem function and the government authorizes this activity, the implementation of the activity can result not only in the collapse of the ecosystem as a whole, but also in the collapse of the economic activity itself, which depends on the regular functioning of the ecosystem. Therefore, the introduction of the evaluation of ecosystem resilience in EIAs is important not only to increase EIA's capacity to prevent environmental harm but also to increase EIA's value to society, by alerting officials and preventing ecological consequences that can result in loss of investments. In order to illustrate the kind of losses entrepreneurs can suffer due to ecological consequences of ill-planned human activity, it is fundamental to mention the case of the blueberry growers. In *Bridges Brothers Ltd. v. Forest Protection Ltd.*, blueberry growers claimed that spraying fenitrothion to control outbreaks of spruce budworm in the Canadian forest caused the death of pollinating bees and, consequently, damaged the blueberry crop.[265] The loss of the crop

265. Bridges Bros. Ltd. v. Forest Prot. Ltd., [1972] 5 N.B.R. 2d 585-91.

over the period of 1970-71 resulted in an assessed loss of $1,331,693.14.[266]

The EIA can also alter a project design in order to increase the adoption of patterns of production in synergy with ecosystem function. This goal can be achieved by using raw materials naturally provided by the ecosystem where the facility is located instead of introducing crops of alien species or importing raw materials from other places (disposal of which will introduce alien substances into the ecosystem, potentially causing disequilibrium in ecosystem function).

The fact that every EIA requires a background study of the ecosystem where the proposed activity will be located and the impacts the activity can cause on species and on ecosystem functions provides environmental agencies a great quantity of information on the environmental status of a region and on the activities developed there. This information is necessary to assess the resilience of an ecosystem and would be too costly to be produced by the government alone. Also, the fact that the generation of such information is mandatory is advantageous to agencies because it makes it a secure source of information, not subject to the lack of funding or other issues that can retard or disable the collection of data by public or private research programs.

The EIA also provides an opportunity for interdisciplinary discussion regarding a project during its elaboration. When decision makers balance the environmental concerns presented in the EIA final report with other interests they can decide whether a project should actually be implemented.

b. EIA Procedure Limitations and How to Address Them

1. Foreseeability of the Harm

The obligation to do an EIA is limited in scope in two ways. First, "a threshold of foreseeability [of harm] . . . must be met

266. *Id.*

before the obligation to do an EIA arises."[267] Under most treaties, "the obligation to do one and to notify other states [endangered by the activity] only arises once it is [previously] known that [the harm] is likely" to occur.[268] This EIA limitation is unfavorable for the implementation of the principle of resilience because most harmful consequences that weaken resilience are unpredictable and are noticed only after they have already occurred.

The need for a threshold of foreseeability of an activity's impacts on ecosystem resilience is particularly difficult to achieve due to the existing uncertainty regarding how ecosystem functions are distributed among the different species and which kind of disturbance would cause the ecosystem to collapse.

There are some possible solutions to this EIA limitation regarding the need for a threshold of foreseeability. One is to rely on the precautionary principle when interpreting references to the likelihood of harm in Principle 17 of the Rio Declaration, in order to lower the threshold of risk required for the EIA obligation to arise.[269] One application of such an approach, adopted by the Antarctic Protocol, is to require for all activities, except in *de minimis* cases, an "initial environmental examination" to determine whether the expected impact is more than minor.[270]

Another solution is to distribute the requirement to assess environmental impacts between the prior impact assessment, regularly the EIA, and the post impact assessment, which is referred to as *post impact monitoring* or just *monitoring*. The prior impact assessment would be responsible for revealing predictable impacts and imposing measures to mitigate them, while the post impact assessment would identify and address unpredictable impacts and inefficiencies of the mitigation measures proposed by the prior assessment.

This approach, which is classified as adaptive, recognizes that prior assessments are not capable of predicting the totality of

267. BIRNIE ET AL., *supra* note 252, at 134.
268. *Id.*
269. *Id.*
270. *Id.*

impacts and providing certainty.[271] Monitoring shifts the EIA procedure's priority from prediction and control to adaptability and responsiveness. Approaches to operating in chaotic and complex environments that evolve and change in parallel with the ecosystem are more likely to be effective in coping with uncertainty.[272] By managing ecosystems for uncertainty, the adaptive approach transforms the EIA procedure into an ongoing investigation rather than a one-time prediction of impacts.[273]

Monitoring provides the opportunity to determine the causes of change and whether such change is a consequence of the project or of another type of action.[274] This procedure also assesses a project's compliance with regulations, agreements, or legislation and provides agencies with the proper information to assess the effects of the project's mitigation policy in order to determine if further action should be taken to prevent environmental harm.[275] The assessment of compliance with legislation coupled with the gathering of information about the progress of a particular project increases the transparency and accountability of proponents' mitigation actions, as the procedure assesses whether mitigation actions are actually reducing impacts.

Monitoring enables managers to identify potential negative trends at an early stage and to better understand the complex relationships between human actions, and environmental and social systems.[276] This understanding enables the construction of scientific knowledge about how to enhance the ecosystem's capability to recover rapidly from disturbances.

The greater transparency and oversight of the results of mitigation actions made possible by monitoring increases the

271. Studies on environmental impact statements demonstrate that most of EIA are often wrong, failing "to accurately forecast the direction and magnitude of the actual harm." PLATER ET AL., *supra* note 6, at 346.

272. DAVID P. LAWRENCE, ENVIRONMENTAL IMPACT ASSESSMENT 440 (2003).

273. *See generally* HOLLING ET AL., *supra* note 214, at 1-21.

274. *See* Keith Storey & Bram Noble, *Increasing the Utility of Follow-up in Canadian Environmental Assessment: A Review of Requirements, Concepts and Experience*, CANADIAN ENVTL. ASSESSMENT AGENCY (2004), *available at* http://www.ceaa.gc.ca/default.asp?lang=En&n=081671C7-1&offset=2&toc=show.

275. *Id.*; BIRNIE ET AL, *supra* note 252, at 424.

276. Storey & Noble, *supra* note 274.

likelihood of proportioning environmental improvements through human activities. Therefore, monitoring provides a tool for expanding the meaning of management beyond the mere mitigation of impacts towards the continuous improvement of environmental quality. The adoption of this broader perspective on management strategies is needed if sustainable development is truly a goal of EIA procedure.[277]

Therefore, the procedural background of the principle of resilience is enhanced by the recognition of the legal obligation to monitor environmental conditions and to employ the monitoring procedure to guide actions aimed at creating positive environmental effects by human activities.

In order to provide the tools for environmental improvement, one important part of the post-impact analysis is auditing the information obtained through monitoring. While monitoring is the observation, measurement, and recording of information about specific aspects of the project,[278] auditing is later in the process when accounts and records are examined and verified in order to show trends and compare the results to the targets, thereby assessing how close the actual situation was to the predicted.[279] "Auditing is effectively an evaluation of the EIA process: investigating whether or not predicted impacts have actually occurred; whether methods used to make these predictions were reliable, whether recommendations were followed; and whether safeguards were effective."[280]

In order to provide an impartial assessment of the environmental quality achieved by a project or by a policy, auditing is supposed to be done by a party not involved in the project or policy.[281]

In the international sphere, the regulation of monitoring is very limited. It is regulated under the Convention on Environmental Impact Assessment in a Transboundary Context (Espoo Convention), which was signed mostly by European

277. *Id.*

278. IAN THOMAS & PAUL MURFITT, ENVIRONMENTAL MANAGEMENT – PROCESSES AND PRACTICES FOR AUSTRALIA 185 (2d ed. 2011).

279. *Id.* at 238.

280. *Id.* at 185.

281. *Id.* at 239.

countries.[282] At Article 7, the Convention recognizes the close relationship between prior EIA and subsequent monitoring but does not mandate the elaboration of monitoring for every likely significant transboundary impact.[283] The concerned parties are supposed to decide, upon request, if a post-project analysis will be carried out and under which conditions.[284]

The monitoring of the implementation effects of plans and programs is required under Article 12 of the Kyiv Protocol and Article 10 of the European Commission 2001 Directive in order "to identify at an early stage unforeseen adverse effects, and to be able to undertake appropriate remedial action."[285]

In summary, European regional law requires monitoring of plans and programs likely to cause significant adverse transboundary impacts, but it does not require monitoring at the project level, except when the concerned countries decide so.[286] At the international level, the obligation to promote monitoring is non-existent.

At the national level, statutes requiring the elaboration of a monitoring plan within the environmental assessment procedure are present in Canada and Brazil. In Brazil, every EIA is required to present a monitoring plan.[287] However, the execution of this plan is much prejudiced because the federal regulation does not provide deadlines and penalties for project proponents who do not provide periodic monitoring reports.[288] Besides that, the elaboration of monitoring reports is not a prerequisite for the

282. The United States signed and Canada signed and ratified the Convention. *See* Espoo Convention, *supra* note 251.

283. *Id.* at art. 7.

284. *Id.*

285. U.N. Econ. Comm'n for Eur., Protocol on Strategic Environmental Assessment to the Convention on Environmental Impact Assessment in a Transboundary Context, art. 12 (May 21, 2003); Council Directive 2001/42, art. 10, 2001 O.J. (L 197) 1 (EC).

286. As for Canada, the only non-European country to ratify the Espoo Convention, it is bound by the Convention, but not by the Protocol, which it did not sign. Therefore, it is not required to monitor plans and programs likely to cause significant transboundary impact.

287. Resolução CONAMA [Res. CONAMA] [RESOLUTION] n. 001/1986, art. 6, IV (Braz.).

288. *Id.*

renewal of an environmental license.[289] In addition to the execution of the monitoring plan, the environmental agencies can require private entities to provide any kind of information regarding the potential or actual environmental impacts of their activities.[290] Therefore, the enforcement of the monitoring plan is left to the discretion of environmental agencies. As in most countries, Brazilian environmental agencies deal with the constant problem of excessive workloads and reduced personnel, which contributes to the lack of enforcement of monitoring provisions.

Additionally, monitoring in Brazil is also exercised by the government during frequent inspections of industrial and commercial facilities by environmental agents to identify environmental impacts not covered or predicted by the project's environmental license.[291] Therefore, the monitoring is usually limited to the assessment of compliance with permits and legislation. If environmental agencies learn of supervening grave risks to the environment or to human health[292] caused by the project, they are able to modify or cancel the environmental license.

The Canadian Environmental Assessment Act assigns to the environmental agencies the obligation to design and ensure the implementation of a follow-up program when a project is required to promote mitigation measures.[293] When a project is not likely to cause significant impact, the agency has discretion to decide whether a follow-up program is appropriate.[294] Follow-up requirements rarely are determined until after project approval is

289. *Id.*

290. Lei No. 10650, de 16 de Abril de 2003, COL. LEIS REP. FED. BRASIL, 146 art. 3 (Braz.).

291. MINISTÉRIO DO MEIO AMBIENTE [MMA], PROGRAMA NACIONAL DE CAPACITAÇÃO DE GESTORES AMBIENTAIS: LICENCIAMENTO AMBIENTAL 67 (2009) (Braz.).

292. Resolução CONAMA [Res. CONAMA] [RESOLUTION] n. 237/1997, art. 19 (Braz.).

293. Canadian Environmental Assessment Act, R.S.C. 1992, c. 37 (Section 38) (Can.).

294. *Id.* Section 38(1).

granted with the result that little attention is paid to specific arrangements for follow-up in the assessment or the EIS.[295]

In the United States, there is no obligation to monitor impacts at the federal level within the EIA procedure. Monitoring is utilized to assess compliance with permits and legislation, especially regarding the presence of contaminants in water and air.[296] Monitoring elaborated under an ecosystem approach is applied to National Parks[297] and to projects of wetland restoration.[298] The policy of wetlands mitigation banking allows developers to compensate for wetlands that will be destroyed through development by ensuring the restoration of wetlands in another location.[299] Monitoring is used to verify that the restoration actually occurred in order to permit the compensation.

EIA effectiveness reviews demonstrate that monitoring is more the exception than the rule. The same can be said about accurate forecasts and the use of confidence limits (as a means of acknowledging uncertainties).[300]

2. Significant Impact on the Environment

The second limitation on the scope of the EIA refers to the fact that the procedure is solely applied to activities that will probably have a significant impact on the environment. Therefore, the procedure is not required for activities whose impact is deemed small or transitory.[301]

Ecosystem resilience can be threatened by activities that generate small individual impacts, but collectively are capable of weakening ecosystem resilience. The process of loss of resilience

295. Storey & Noble, *supra* note 274.

296. Air Pollution Prevention and Control, 42 U.S.C. § 7619 (2006); Safety of Public Water System, 42 U.S.C. § 300g-7 (2006).

297. National Park Service Management, 16 U.S.C. § 5934 (2006).

298. Navigation and Navigable Waters, 33 U.S.C. § 2330a (2006).

299. PLATER ET AL., *supra* note 6, at 610.

300. LAWRENCE, *supra* note 272, at 424; BARRY SADLER, CANADIAN ENVTL. ASSESSMENT AGENCY & INT'L ASS'N FOR IMPACT ASSESSMENT, ENVIRONMENTAL ASSESSMENT IN A CHANGING WORLD: EVALUATION PRACTICE TO IMPROVE PERFORMANCE 103 (June 1996).

301. BIRNIE ET AL., *supra* note 252, at 134.

is cumulative because the inability to replenish coping resources propels a region and its people into a state of emergency.[302] If the environmental evaluation scheme relies only on a project-based EIA, the detection of impoverishment of resilience can be seriously affected. That is why it is important to treat ecosystem resilience as affected both directly and indirectly from activities.

The evaluation of indirect impacts is not exempt from the EIA procedure. Direct impacts on the physical environment, indirect impacts arising from other types of induced activity, the interrelatedness of environmental impacts, and cumulative impacts need to be assessed.[303]

However, due to their nature, indirect impacts are better detected through the use of methods able to link EIA to related projects and activities, such as legislative proposals, policies, programs and plans. According to Lawrence, such a link can be established through the elaboration of strategic environmental assessments (SEAs), the grouping activities over space, the integration of EIA with sectorial and spatial policies, area wide assessments, and EIA systems based on natural boundaries.[304]

This article supports all the actions proposed by Lawrence to link EIA with related activities in order to facilitate the detection of indirect impacts, except the "grouping of activities over space" technique, understood as the method to place together similar activities due to the similarity of their impacts.[305] This technique seeks to easily detect indirect impacts of an activity and to reduce the uncertainty of predictions by excluding the occurrence of different impacts that may interact in unpredictable ways. The compromise to ecosystem resilience requires the repudiation of this idea because this technique increases the intensity of a single kind of impact, whose adverse effects will repeatedly concentrate on the same ecosystem function. If a certain ecosystem function is too frequently and intensely impacted by human activities, this function is likely to collapse, which can cause the entire system to collapse. On the other hand, if the ecosystem suffers impacts of

302. Folke et al., *supra* note 9.
303. CHRISTOPHER WOOD, ENVIRONMENTAL IMPACT ASSESSMENT 89 (1995).
304. LAWRENCE, *supra* note 272, at 48-50.
305. *Id.* at 50.

lower intensity affecting different functions, the ecosystem is more likely to recover from such impacts and be more resilient. Therefore, instead of grouping similar activities in the same places, ecosystem managers should diversify the activities' zoning.

The link of EIA procedure with strategic environmental assessment, sectorial and spatial policies, area wide assessments, and EIA systems based on natural boundaries is an important means of enhancing the capacity for adaptive management, and therefore, for the enhancement of ecosystem resilience, because it provides the opportunity to cross-analyze the information gathered by these mechanisms of data collection.

Strategic environmental assessment is the process by which environmental considerations are required to be fully integrated into the preparation of governmental plans and programs that are potentially harmful to the environment before their final adoption.[306] Because SEA is done prior to the elaboration of the overall policy, it is undertaken much earlier in the decision-making process than EIA, which is done at the project level.[307]

Although the Espoo Convention does not explicitly require the application of SEA procedure, it does require parties to undertake EIA at the project level and to apply EIA principles to policies, plans, and programs.[308] In 2001, the European Commission adopted a Directive on SEA, according to which the SEA is to be undertaken "during the preparation of [a] plan or programme and before its adoption or submission to the legislative procedure."[309]

The EIA system can also link to corporate environmental management systems.[310] An environmental management system (EMS) is a set of processes and practices that enable an organization to reduce its environmental impacts and increase its

306. *Strategic Environmental Assessment*, EPA, http://www.epa.ie/whatwedo/advice/sea/ (last visited Feb. 10, 2013).

307. *Protocol on SEA*, U.N. ECON. COMM'N FOR EUR., http://live.unece.org/env/eia/sea_protocol.html (last visited Feb. 10, 2013).

308. Espoo Convention, *supra* note 251, at art. 2(7).

309. Council Directive 2001/42, 2001 O.J. (L 197) 30, 31 (EC); *see* Elias, *supra* note 257, at 227, 233.

310. LAWRENCE, *supra* note 272, at 49.

operating efficiency.[311] EMS's benefits include increased ability to differentiate the impacts of specific industries and individual producers in a region, and the capacity to measure environmental performance and impacts and to target responses.[312]

The elaboration of EMSs usually occurs due to the free choice of industries encouraged by the reduction of costs and the increase of efficiency and control over environmental impacts. However, governments can stimulate industries to adopt EMS by providing additional benefits, either by leading by example with the development of EMS in agencies and departments, or by requiring EMS in legislation. The strategy of leading by example was adopted by Australia, where the procedure was adopted by the Australian Agency for International Development; by Canada, where the Canadian Ministry of the Environment is encouraging departments to adopt EMS; and by the United States, which requires federal agencies to adopt EMS.[313]

3. Case Study: Spruce Budworm

The case of the management of the spruce budworm in Canada was abundantly analyzed in specialized literature.[314] The analysis promoted by this article focuses on how the principle of resilience and, more specifically, the recommendations addressed in this section would apply to this case.

The spruce budworm is a defoliating insect that attack trees of the boreal forests in North America. The insect is constantly

311. THOMAS & MURFITT, *supra* note 278, at 191; *Environmental Management Systems*, EPA, http://www.epa.gov/EMS/ (last updated Nov. 27, 2012).

312. THOMAS & MURFITT, *supra* note 278, at 191.

313. *Id.* at 203; Exec. Order No. 13,148, 65 Fed. Reg. 24,595 (Apr. 26, 2000).

314. A. D. Pickett, *A Critique on Insect Chemical Control Methods*, 81 CANADIAN ENTOMOLOGIST 67 (1949), *available at* http://pubs.esc-sec.ca/doi/abs/10.4039/Ent8167-3?journalCode=ent; William C. Clark et al., *Lessons for ecological policy design: A case study of ecosystem management*, 7 ECOLOGICAL MODELING 1 (1979), *available at* http://www.sciencedirect.com/science/article/pii/0304380079900085; HOLLING ET AL., *supra* note 214; Asaf Rashid, *Compromising the Environment?: The Spruce Budworm, Aerial Insecticide Spraying, and the Pulp and Paper Industry in New Brunswick* (8 Faculty of Envtl. Studies, York Univ., Outstanding Graduate Student Paper Series No. 3, 2003), *available at* http://yorkspace.library.yorku.ca/xmlui/bitstream/handle/10315/18096/asaf-rashid.pdf?sequence=1.

present in the forest in small numbers, except during periodic outbreaks. As a consequence of these outbreaks, a large portion of the mature forest dies, causing an impact on the forest industry, which is the major economic activity of the forest area.[315] The tree species preferred by the budworm is the same species preferred by the pulp industry: the balsam fir.[316] Therefore, the budworm case represents a situation of direct competition between the insect and human activity.

The budworm outbreak is a natural event that contributes to forest renewal and the maintenance of species diversity. It has been occurring in the region over the last centuries without great disturbance to humans until the 1930s, when the pulp industry found it had to compete with the budworm for fiber.[317]

A historical overview of Canadian forest management shows that since colonization there has been a trend to harvest one species of tree at a time, thereby changing the composition of the forest: from the late 1700s to mid-1800s there was heavy extraction of eastern white pine for ship masts; from the mid-1800s to early 1900s there was heavy extraction of large red spruce; and from colonial times to nowadays, the forest came to present low abundance of eastern hemlock, which was originally very abundant.[318] This factor is relevant because each species presents a different vulnerability to the spruce budworm. The eastern hemlock, for example, only experiences spruce budworm damage in very rare cases.[319] On the other hand, the balsam fir is targeted by the insect.[320] Therefore, it is possible to conclude that the original setting of the forest was more resistant to the insect, because the higher concentration of less vulnerable trees probably created a barrier to the physical dispersion of the insect.

Since the 1920s several authors have recommended the utilization of silvicultural practices to fight the recently frequent

315. HOLLING ET AL., *supra* note 214, at 143.
316. *Id.* at 149.
317. *Id.* at 147.
318. Rashid, *supra* note 314, at 25.
319. *Id.* at 20.
320. *Id.* at 19-21.

budworm outbreaks.[321] However, until 1995 knowledge of the effectiveness of silvicultural control was still deemed "fragmented" and the method was never tried as a means to address the spruce budworm outbreaks.[322] On the other hand, the tactic of spraying insecticides, employed since 1951,[323] was not abandoned even when fenitrothion, the substance used until 1998, was proved to cause human health problems[324] and a great mortality of songbirds[325] and bees.[326]

Thus, it is possible to conclude that, first, when the spraying was first adopted, the knowledge about the technique was not yet complete and the collateral effects of the substance employed by the management plan were not predicted. Therefore, if the managers did not have a complete understanding of silvicultural measures or of spraying, why did they adopt the latter, which carried a greater risk of environmental impacts in case of failure? Governmental protection of the pulp industry may explain such fact.

In fighting the budworm, the forest management plan and the pulp industry were seeking a "definitive" solution which could provide certainty for the economic activity. Besides that, the solution provided the pulp industry the possibility to expand its forestry activities, which could not be provided by silvicultural techniques. That is why managers opted for the most aggressive option, spraying, neglecting silvicultural management, which was deemed an uncertain solution.

The use of spraying became a tradition in forest management for fighting the budworm, and the possibility of not using

321. F.C. Craighead, *Relation between mortality of trees attacked by spruce budworm and previous growth*, 33 J. AGRIC. RES. 541, 547 (1925); Thomas F. McLintock, *Silvicultural Practices for Control of Spruce Budworm*, 45 J. FORESTRY 655, 655-59 (1947); Pickett, *supra* note 314; J.D. Tothill, *Notes on the Outbreaks of Spruce Budworm, Forest Tent Caterpillar and Larch Sawfly in New Brunswick,* 8 PROC. ACADIAN ENTOMOLOGICAL SOC'Y 173, 173-82 (1922).

322. Rashid, *supra* note 314, at 30.

323. HOLLING ET AL., *supra* note 214, at 143.

324. *See* Friesen v. Forest Prot. Ltd. (1978), 22 N.B.R. 2d 146-71 (Can. N.B. Q.B).

325. *See* Rashid, *supra* note 314, at 12.

326. *See* Bridges Bros. v. Forest Prot. Ltd. (1972), 5 N.B.R. 2d 585-91 (Can. N.B. Q.B).

insecticides became non-existent. This is evident in the "Environmental impact assessment of experimental spruce budworm adulticide trials."[327] When discussing the effects of phosphamidon, the insecticide employed by the Program, on forest avifauna, the EIA simply compared the results of this insecticide with those produced by other kind of chemicals, the larvicides.[328] The EIA analysis is exhausted by showing that phosphamidon is the chemical less harmful to birds.[329] However, the EIA does not discuss the alternative of *not* using chemicals at all.

The adopted management plan, which was supposed to provide certainty, inevitably created unpredictable impacts, such as: the spread of outbreaks to areas previously not affected by the budworm because spraying expelled the survivor insects to the neighborhoods; dependence of the forest on the insecticide; and the risk of even greater outbreaks due to the increasing resilience of the budworm. It is possible to infer that this policy created a perverse final result which increased the resilience of the parasite and diminished the resilience of the forest.

The analysis of the budworm case through the perspective of the principle of resilience shows a sequence of management mistakes. First, the environmentally less aggressive option to address a management issue cannot be excluded from the EIA. The EIA provides decision makers with information about the alternatives to a management issue. If the less aggressive option is not assessed, decision makers hardly will be able to adequately weigh that option against the others available.

Second, decision makers must be guided by the principle of resilience to prioritize the environmentally less aggressive option of management. The priority can be set by imposing on the decision makers the obligation to publicly justify why a more aggressive management option is preferred to the less aggressive

327. B.B. McLeod & R.L. Millikin, Forest Pest Mgmt. Inst., Canadian Forestry Serv. Dep't of the Env't, Environmental Impact Assessment of Experimental Spruce Budworm Adulticide Trials: Effects on Forest Avifauna (Dec. 1982), *available at* http://cfs.nrcan.gc.ca/pubwarehouse/pdfs/8774.pdf.

328. *Id.*

329. *Id.*

one. However, if this way of establishing the priority had been adopted in the case of the budworm, decision makers would simply state that the silvicultural technique was not yet sufficiently developed to be adopted. In this case, the imposition of another obligation on the decision makers would be recommended: if a less aggressive management option is not adopted as the main measure to address the problem, the technique should be employed in a limited area in order to test if the reason why this solution was neglected is observed in reality. The employment of monitoring would be essential to implement this recommendation.

Third, the ambition for greater profits from an economic activity that is already under way cannot be pursued to the detriment of the ecosystem where the economic activity is located. Every government and economic actor must internalize the idea that the capacity for growth of a certain activity is limited by the ecosystem's capacity to support the activity. In the budworm case, the pulp industry pushed the forest beyond its capacity to support the forestry activity. That is why the industry rejected the silvicultural techniques, which would have increased the concentration of tree species, important for the health of the forest, but not important for the pulp industry. The industry wanted to keep the high concentrations of balsam fir and Douglas fir, which was the closest they could get to a monoculture for pulp extraction.

Fourth, under the principle of resilience, managers are required to analyze the long-term effects of their decisions, in order to protect the interests of future generations and of nature itself, which can be understood as the preservation of the ecosystem capacity to reorganize and maintain itself. This precept was not followed in the case of the budworm:

> The budworm analysis explicitly focuses on a time horizon determined by the slowest variable in the system, i.e., tree regeneration and growth. It does not consider long-term evolutionary changes that can trigger competitive shifts in tree species composition. Similarly, short-term benefits of a

> management policy might be followed later by unanticipated surprises that, being unanticipated, become crises.[330]

In order to enable decision makers to predict and to weigh the long-term effects of a decision, this article recommends the use of monitoring techniques because long-term effects are hardly assessed by EIA. Therefore, the commitment to the preservation of nature and to future generations' interests requires constant assessment of the results obtained by management policies associated with adaptive management techniques.

D. Land Use and Climate Change Adaptation

Land use and zoning regulations are usually created by local or regional governments. The zoning plan analyzes the existing land uses and determines the community development direction by establishing: different zone district categories, each one with different specifications regarding the range of permitted uses, construction densities, and structural characteristics; an official zone map which maps out the districts on the ground; and a zone enforcement agency which interprets and applies the zone requirements.[331] Through land use and zoning regulations, local governments prohibit certain uses within certain areas,[332] thereby imposing limits on the use of property.

Land can be destined for economic uses (such as commercial, industrial, agricultural, and pastures), residential, recreational, or conservational. Land use greatly influences how resources are managed because it determines or influences: the location of facilities, residences, and natural lands; the size of tracts of developed land; the amount of land conversion; and the distances between facilities and the dependence on means of transport. In other words, land use regulation can influence production and consumption patterns. That is why land use is intimately related to sustainable development.

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330. HOLLING ET AL., *supra* note 214, at 170.

331. PLATER ET AL., *supra* note 6, at 361.

332. Amy L. Edwards, *An Overview of Institutional Controls*, *in* ENVIRONMENTAL ASPECTS OF REAL ESTATE AND COMMERCIAL TRANSACTIONS 345, 353 (James B. Witkin ed., 2004).

By heavily influencing production and consumption patterns, land use regulations greatly influence ecological resilience. Additionally, land use can contribute to the conservation of biodiversity everywhere, in its original habitat. Also, as mentioned previously (Adaptive Management section) ill land use planning can exacerbate the risk of disaster by concentrating populations in risk-prone areas and by failing to keep green infrastructure.[333]

The principle of resilience requires that land use regulations prioritize ecological resilience and safety, even if it limits economic growth in certain circumstances. This application of the principle might appear to undermine the economy; rather, it is only going against the short-term pursuit of profits. In reality, this measure provides a deeper understanding of economy, as it is necessary for keeping the existence of natural resources in the long-term, and for protecting society from disasters to which humankind has given cause through centuries of natural resource mismanagement. By these means, it is expected that the principle of resilience will, in fact, benefit the economy in the long-term, by preserving the resources and the people it depends on.

There are some policy measures, to be explained below, that can use land use as a tool for implementing the principle of resilience by strengthening ecological resilience and disaster preparedness.

a. Transferable Development Rights in Coastal Areas

Recently, zoning regulations concerned with environmental protection in the United States have been adopting the concept of *transferable development rights* (TDRs). TDRs consist in unused development density at one site being transferred and sold to other sites that wish to build beyond standard regulatory limits.[334]

> TDR programs aim to direct development away from environmentally sensitive land to land more suitable for

333. FARBER ET AL., *supra* note 146, at 10, 25.
334. PLATER, ET AL., *supra* note 6, at 366.

> development by creating a market for development rights. Logistically, TDR programs achieve this result by quantifying the development potential of sensitive properties ("sending sites"), and providing that this development potential may be sold to landowners to increase building density in areas suitable for development ("receiving sites").[335]

TDRs create the advantage of avoiding the frequent windfalls and wipeouts from land use regulation that both bar development in some places and allow it in others. "TDRs promote sharing of the benefits generated and burdens imposed by development restrictions. The restrictions make the TDRs more valuable both by reducing harmful spillover effects and by requiring those with property eligible for development to purchase development rights from other landowners. . . ."[336]

In other words, TDRs seek to attenuate the harmful effects of land use regulation. Nonetheless, the concept has been continuously criticized. Some argue that, even though the TDRs provide economic value to the land targeted by the regulation, such value does not compensate the landowner for the loss of personal use of the property and ends up disappointing significant investment-backed expectations.[337]

In American law, regulatory restrictions on the use of land maintain that it may be considered an unlawful taking if the land's economic value is totally wiped out by the regulation.[338] Even the distribution of TDRs has not prevented the filing of takings suits. Litigants seeking to abolish such land use regulations go to courts on the grounds that "although the positive economic value of TDRs mitigates the 'economic impact' of a restriction on land use, such value is relevant only to the question of whether a landowner has received 'just compensation' for 'taken' property."[339] In summary, according to such critics,

335. Good v. United States, 39 Fed. Cl. 81, 107 (1997).

336. Richard J. Lazarus, *Litigating Suitum v. Tahoe Regional Planning Agency in the United States Supreme Court*, 12 J. LAND USE & ENVTL. L. 179, 188 (1997).

337. *Id*. at 190, 193.

338. *Id.* at 193.

339. *Id*. at 200-01.

the distribution of TDRs does not mean that there has been no taking in the first place.

On the other hand, zone enforcement agencies argue that TDRs, instead of eliminating land property rights, are indeed reinforcing them. The zoning rules enhance the property rights of all landowners in the area covered by the zoning plan because those rules seek to preserve the characteristics that make the region attractive for development. In *Suitum v. Tahoe Regional Planning Agency*, a zoning plan was set in place to harmonize the protection of the Lake Tahoe basin and the development of the region.[340] When defending the building restriction on a piece of land especially important to the maintenance of ecosystem functions, the local agency argued that the restricted property would be worth even less if the restriction and the TDR mechanism were not in place, because the environmental quality and the scenic beauty of the region as a whole would be degraded.[341]

Transferable development rights have been maintained by the American courts, which have been considering that, if the land still has any economic value, it follows that it has not suffered a regulatory taking.[342]

Transferable development rights constitute a good mechanism to organize sustainable development by steering development into parcels that are most environmentally suitable and economically profitable, and by sharing the economic benefits and burdens of environmental restrictions more equitably among all landowners within a certain region.

This mechanism might also be applied to another situation that tends to be increasingly common: the loss of land to the sea. A few cases of coastal line change by hurricanes and loss of property to the sea have been brought to American courts. The rule applied is that the owner alone bears the loss of land to the sea. In *Severance v. Patterson*, a hurricane had changed the beach shoreline, submerging the public easement area protected

340. Suitum v. Tahoe Reg'l Planning Agency, 520 U.S. 725 (1997).

341. *Id.* at 732.

342. *See* Lucas v. South Carolina Coastal Council, 505 U.S. 1003 (1992); Penn Cent. Transp. Co. v. City of New York, 438 U.S. 104 (1978).

by the Open Beaches Act—the state regulation that prohibits private property of tidal lands so as to assure public access to Texan beaches.[343] The court decided that landowners of coastal properties must assume the risk of losing their land to the sea and must be conscious of the obligation to maintain the public easement covering the area between the property and the wet beach.[344] In that particular case, the landowner had her property reduced in order to allow public access.[345] The conclusion is that the public trust doctrine is more adaptable to the changing location of the coast than to property rights because the first is dynamic, being determined by the flexible water boundaries, and the second is static, being determined by stable public records.

It is clear that coastal properties need to receive more flexible legal treatment; otherwise it is possible that land owners of entire cities could be totally deprived of their property rights relatively soon. This kind of consequence would generate very disadvantageous results: first, it would threaten legal security, because the assurance of safe property rights is one of the most important functions of modern legal regimes; second, it would also threaten environmental quality, because it is commonly agreed that environmental protection requires strong property rights. The sudden loss of properties in coastal areas may result in disorganized occupation of country side areas with no respect for environmentally protected areas or for zoning restrictions.

Governments should seek to relax property rights in coastal areas through the application of the TDRs regime to coastal properties. Therefore, if the sea covers part of the property, the landowner would be entitled to the right to develop another place. In this case, there would be no claim of takings because it would give to landowners a right they did not previously have. This solution might increase the offer of development rights, which, in turn, would reduce the value of such rights. However, this effect can be corrected by strengthening the zoning regulations in all places (and not only in coastal cities) so the new restrictions

343. *See* Severance v. Patterson, 345 S.W.3d 18 (Tex. Sup. Ct. 2010).
344. *Id.* at 31-33.
345. *Id.* at 22-23.

would function as the creation of a market for development rights.

b. Rise of the Sea and Reallocation of Coastal Ecosystems

In the context of climate change, land use and zoning may be used to ensure that coastal ecosystems will have enough space to restore themselves in the new coastal lines that are going to be defined by the rise in sea level.

Sea level rise will require coastal ecosystems to re-adapt to the new ecosystem features and to change their location to other places with similar ecological conditions. In order to strengthen the resilience of such ecosystems, it would be necessary to carry out in-depth studies regarding the current and previous features of coastal ecosystems in order to maintain records of how they are organized now. These records will be essential to guide human efforts to contribute towards the reconstruction of such ecosystems in other places and to verify that the future coastal ecosystems keep the same functions currently developed by the present coastal ecosystems. Studies should also take into account the ecological features and natural history evidence in order to identify where the new coastal lines are expected to be and where the new coastal ecosystems are more likely to form. Based on that information, governments should restrict the use of land where ecosystems are expected to form, because, if such places are completely watertight or otherwise unavailable to receive fauna and flora, their coastal ecosystems will be fated to extinction. Restrictions in use may be achieved by the distribution of TDRs when possible, or through expropriation, when the restrictions would totally abolish the economic value of the property.

c. Conservation Easements

"[A] conservation easement is a legally binding agreement that restricts the development and future use of the land to

ensure protection of its conservation values."[346] Through a conservation easement, the landowner voluntarily removes from his property right certain elements, generally rights to develop and mine.[347] The conservation easement can be sold or donated to the government or to a non-profit organization, which thereby will acquire a non-possessory interest in the protection of the natural or historic values of the property.[348] If the holder fails to enforce the easement related obligations, they can be enforced by a third party indicated in the easement instrument or by the attorney general.[349] The holder of the easement is responsible for undertaking long-term monitoring of the easement and stewardship of the property.[350]

In the early 1980s, the U.S. Congress enacted tax subsidies for conservation easement donations, which resulted in an increase in the number of such agreements.[351] However, it also contributed to the concentration of conservation easements in more affluent regions, where wealthy donors could take maximum advantage of tax incentives. Conservation easements are currently viewed as a tool for environmental protection, concurring with regulation and public land acquisition.[352] Conservation easements present a lower cost than public land acquisition in the short-term; however, they might be considered more expensive in the long-term due to expenses with monitoring, enforcement, and defense.[353]

Due to climate change, conservation easements might acquire the new use of being an alternative to TDRs for

346. Julie Ann Gustanski, *Protecting the Land: Conservation Easements, Voluntary Actions, and Private Lands*, *in* PROTECTING THE LAND: CONSERVATION EASEMENTS, PAST, PRESENT, AND FUTURE 9 (Julie Ann Gustanski & Roderick H. Squires eds., 2000).

347. *Id.* at 15.

348. BLACK'S LAW DICTIONARY 586 (Bryan A. Garner ed., 9th ed., 2009); Gustanski, *supra* note 346, at 11.

349. Todd D. Mayo, *A Holistic Examination of the Law of Conservation Easements*, *in* PROTECTING THE LAND: CONSERVATION EASEMENTS, PAST, PRESENT, AND FUTURE, *supra* note 346, at 26, 48.

350. *Id.* at 31.

351. JEFF PIDOT, LINCOLN INST. OF LAND POLICY, REINVENTING CONSERVATION EASEMENTS: A CRITICAL EXAMINATION AND IDEAS FOR REFORM 5 (2005).

352. *Id.* at 32.

353. *Id.* at 32-34.

preserving areas that are expected to be the new coastal lines during the rise in sea level. This tool would be efficient both to maintain private properties in areas that will not be lost to the sea and to protect coastal ecosystems' resilience by keeping undeveloped areas that are expected to acquire an essential ecological role in preventing the extinction of coastal ecosystems during the next decades.

d. "Reserva Florestal Legal"

In 1965, the Brazilian federal government enacted the revoked country's Forest Code, which obliged every rural property owner to reserve a parcel of the land, which may range from twenty to eighty percent of the property, for the protection of the original flora.[354] The land protected under this rule is called *reserva florestal legal.*

Reserva legal was created to promote the sustainable use of natural resources; the conservation and regeneration of ecological processes; and the conservation of biodiversity, by preserving the native flora that shelters native fauna.[355]

The localization of *reserva legal* within the rural property is determined by the landowner and must be approved by the environmental agency at the landowner's request. Once the localization is established and the *reserva legal* is registered, it imposes perpetual conservation obligations on the landowner and his successors.

Reserva legal is an administrative limitation imposed on the use of private property.[356] This obligation intends to shape the rural private property in order to ensure that it accomplishes its social function.[357] According to the Brazilian Constitution, all private property must fulfill its social function,[358] and the requirements are established by the Constitution. The constitutional requirements are the following: rational and

354. Lei No. 4771, de 1965, art. 1, § 2, III (Braz.).
355. *Id.*
356. ÉDIS MILARÉ, DIREITO DO AMBIENTE 753 (2009).
357. JOSÉ DOS SANTOS CARVALHO FILHO, MANUAL DE DIREITO ADMINISTRATIVO 754 (22d ed. 2009).
358. CONSTITUIÇÃO FEDERAL [C.F.] [CONSTITUTION] art.5, XXIII (Braz.).

adequate enjoyment of the land; adequate employment of available natural resources and environmental protection; compliance with labor laws; and exploitation in such a way as to ensure the welfare of owners and employers.[359]

If the landowner fails to use the land in such a way as to accomplish its social function, the government can expropriate the property, by compensating the owner.[360] This penalty, however, has not been applied to rural properties for non-compliance with environmental laws. In fact, for several decades, since the establishment of the obligation to create *reserva legal*, there was no concrete penalty for a landowner's failure to register this protected land.[361] This changed in 2008, when the federal government established daily monetary fines for every rural property that failed to register its *reserva legal*.[362]

The regulation caused strong public debates between farmers and environmentalists because the farmers believe that the government is attributing to them an excessive share of the environmental protection burden. In part due to these debates, the Brazilian Congress enacted the New Brazilian Forest Code, which reduced the extension of lands protected by *reserva legal*.[363] Currently, Brazilian law holds the landowner responsible for maintaining the forest in *reserva legal* by planting native trees when necessary according to the legal requirements and the guidance provided by the federal environmental agency.[364] The landowner is allowed to promote sustainable use of the forest preserved as *reserva legal*, as long as his Plan of Use is approved by the environmental agency.[365] The landowner can exploit forest resources and even cut down selected trees, by promoting silvicultural studies and reforestation efforts in order to keep the main characteristics of the flora.[366] Besides the right

359. *Id.* at art. 186.
360. CONSTITUIÇÃO FEDERAL [C.F.] [CONSTITUTION] art.184 (Braz.).
361. MILARÉ, *supra* note 356, at 756.
362. Decreto No. 6514, de 2008, art. 55 (Braz.).
363. Lei No. 12651, de 2012 (Braz.).
364. Lei No. 12651, de 2012, art. 17, *caput*, art. 66, § 2º (Braz.).
365. Decreto No. 5975, de 2006, art. 2 (Braz.); Lei No. 12651, de 2012, art. 17, § 1º (Braz.).
366. Decreto No. 5975, de 2006, art. 11 (Braz.); Lei No. 12651, de 2012, art. 20, 21 (Braz.).

to sustainably use the forest resources, the landowner is also entitled to a total exemption from federal taxes related to the *reserva legal* area.[367]

Reserva legal has some similarities with conservation easements. Both policies promote environmental conservation on private properties, provide tax benefits to the landowners, and impose obligations that are attached to the real property and enforceable on the current landowner and his successors.

Unlike the conservation easement, the establishment of *reserva legal* is mandatory, which prevents having environmental conservation concentrated in wealthier areas. For this reason, this might be a better solution for environmental policies in developing countries. On the other hand, *reserva legal* is less adaptable than conservation easements to the circumstances of the case because there is no voluntary agreement by which the owner can choose the rights of property he is leaving through the conservation easement. Also, as mandatory for all rural properties, *reserva legal* is better able to ensure the conservation of biodiversity everywhere.

e. Restrictions on Farming Methods

Currently agriculture alone is responsible for 85% of water consumption, it covers 35% to 40% of the world's land, and it accounts for 30% of global greenhouse gas emissions.[368] These resources are mostly used to grow food for the world's population, which is an essential economic activity that cannot be impaired. However, in many cases, crops are cultivated in non-sustainable ways, greatly contributing to the rapid depletion of water and soil around the world.[369] Therefore, better management of the use of

367. Decreto No. 9393, de 1996, art. 10, § 1, II, a (Braz.).

368. Jonathan Foley, *A Global Crisis of Land Use and Agriculture*, STOCKHOLM RESILIENCE CTR. (June 1, 2010), *available at* http://www.stockholmresilience.org/5.58f663a12dd939780a80001819.html.

369. *Id.* The Aral Sea shrank 300 kilometers since the 1960s, when the soviets started diverting water from its two tributaries for crop irrigation. The Colorado River, in the United States, does not reach the ocean anymore because of excessive water diversion for agriculture in the desert. Soil problems, such as salinity, erosion, acidification, and tree decline are symptoms of ecosystem breakdown. Oliver Holmgren, *Weeds or Wild Nature*, 61 PERMACULTURE INT'L J. (1997), *available at* http://www.holmgren.com .au/html/Writings/weeds.html.

natural resources by agriculture can generate a meaningful reduction in the consumption of resources and in environmental impacts, while improving ecological services.

New methods of sustainable agriculture have been developed in order to enhance soil nutrient cycling and reduce the need for fertilizers and pesticides.

Recent studies have pointed to permaculture as a very successful sustainable method of cultivating the soil. This method tries to recreate the functional diversity of ecosystems by using stored rainwater to support the growth of multiple groups of species–such as atmospheric nitrogen absorption, soil fixation, and shadow–in order to create indefinitely self-sustained agriculture.[370] That is why the method's name derives from "permanent agriculture." This method reduces aridity, soil impoverishment by erosion, salinity, and acidification.[371] Indeed, crop mixing has been very successful in pushing back the desert and increasing per capita food production in African countries along the Sahara's edge, such as Nigeria, Niger, Senegal, Burkina Faso, and Kenya.[372] Similarly good results were observed in Jordan.[373] In Honduras, sustainable agriculture developed through the employment of traditional knowledge reduced the impacts of hurricanes in the Quezungal region.[374]

Permaculture and other sustainable agriculture initiatives could be encouraged through governmental regulation of land use or incentives such as tax deductions in order to reduce

370. P. A. YEOMANS, WATER FOR EVERY FARM (1973).

371. Holmgren, *supra* note 369.

372. Lim Li Ching, *Sustainable Agriculture Pushing Back the Desert*, INST. OF SCI. IN SOC'Y, http://www.i-sis.org.uk/desertification.php (last visited Oct. 31, 2012).

373. Geoff Lawton, *Greening the Desert*, YOUTUBE.COM (Dec. 13, 2009), http://www.youtube.com/watch?feature=fvwp&v=wTZ0LbvUoOY&NR=1; *Jordan Valley Permaculture Project*, PERMACULTURE RESEARCH INST. OF AUSTL. http://permaculturenews.org/2011/11/11/jordan-valley-permaculture-project-update-post-ipc-happenings (last visited Oct. 31, 2012).

374. U.N. Secretary-General, World Day to Combat Desertification and Drought: Combating Land Degradation for Sustainable Agriculture (June 17, 2008), *available at* http://www.un.org/events/desertification/2008/combating.shtml; J. Hellin et al., *The Quezungual System: an Indigenous Agroforestry System From Western Honduras*, 46 AGROFORESTRY SYS. 229 (1999), *available at* http://www.springerlink.com/content/h32160q2363x1376/fulltext.pdf.

environmental impacts and improve the provision of ecosystems services within agriculture. Adaptive management initiatives could implement these sustainable agriculture techniques in pilot-projects to test which of them are more adequate for certain regions. The success of these initiatives can also work as a showcase to encourage nearby farmers to adopt them.

Local land use or other natural resource management regulations can prohibit crops that are totally inadequate to local ecosystems, such as lettuce and alfalfa–high water demanding crops–in deserts.[375] For example, in the United States, states that apply the prior appropriation doctrine for water usage[376] could push for more sustainable uses of water in agriculture by enacting regulatory provisions that classify as non-beneficial the use of water to irrigate crops that are inappropriate in the local climate.[377]

f. "Global Zoning"

The idea of "global zoning" for agriculture was based on a proposal suggested by Jonathan Foley.[378] When discussing solutions to feed a growing population with limited and already over-exploited natural resources, Foley suggested focusing on existing fields to select places where the production of each crop is more prolific and to verify in which other place around the globe the same kind of climate and soil is found.[379] By comparing such physically similar places, it is possible to verify where land

375. Such practice is seen in the United States, in the Arizona desert. *See* Foley, *supra* note 368.

376. Prior appropriation is the legal regime that governs the right to use water in many western U.S. states. Through this regime, individuals can acquire a vested right to use water by appropriation and can keep this right by applying the water to a beneficial use. In this legal regime, "beneficial use is the basis, measure, and limit of the right." J.B. RUHL ET AL., THE LAW AND POLICY OF ECOSYSTEM SERVICES 119 (2007); *see also* JOSEPH L. SAX ET AL., LEGAL CONTROL OF WATER RESOURCES 124-26 (4th ed. 2006).

377. Idaho Dep't. of Parks v. Idaho Dep't. of Water Admin., 530 P.2d 924, 931 (Idaho Sup. Ct. 1974) (Bakes, J., concurring). "[T]he concept of what is or is not a beneficial use must necessarily change with changing conditions." Water scarcity coupled with extreme weather conditions requires a redefinition on what is "beneficial" to society. *Id.* at 931-32.

378. Foley, *supra* note 368.

379. *Id.*

management is deterring food production. With such data in hand, an international organization such as FAO could create "global zoning" to assess which crops have greater potential in each region. By these means, it would be possible to assess which parties from which parts of the world would benefit most from partnerships among government agencies and/or economic actors for interchange of management experiences. As noticed by Foley, this method presents the risk of encouraging the expansion of monocultures, which is a result that totally goes against the idea of sustainable agriculture.[380] In order to prevent such a risk, the international organization should focus its assessment on the most effective combination of climate, soil, and a certain *mix of crops* (instead of individual crops).

E. Market Mechanisms for Conserving Ecosystem Services

The payment for ecosystem services is a manner of both valuing and preserving the benefits ecosystems generate to humans. It is a tradeoff where the user of the ecosystem service pays the value of the service to the owner of the natural capital that provides the service. The payment for ecosystem services stimulates the owner of the natural capital to preserve the natural mechanism thereby generating an economic activity guided towards preservation and designed to compete with the economic activities that would result in the destruction of the natural capital.

Payment for ecosystem services is mainly based on the traditional market theory and on Hardin's *Tragedy of the Commons*.[381] The market theory relies on the following assumptions: economic actors are rational and selfish, and the demand for resources is determined by the price, not by the finitude of resources.[382] A market for ecosystem services must provide benefits that exceed the costs of trade, that is, informational and transaction costs.[383] Besides that, as investors

380. *Id.*
381. Garrett Hardin, *The Tragedy of the Commons*, 162 SCI. 1243 (1968).
382. RUHL ET AL., *supra* note 376, at 61-63, 101.
383. *Id.* at 73.

tend to go where they can generate more income, payment for ecosystem services should be greater than the profits that would be received by the owner of the natural capital if he were to develop the land.[384]

From an economic perspective, ecosystem services present the following characteristics: they are positive externalities, in the sense that their effects cross the boundaries of the land where the natural capital is located to benefit the economic actors located in the proximate area;[385] it is difficult to exclude a user's access to the services and, by this reason, such services are very susceptible to free riders (term used to designate the person who enjoys an economic benefit without having to pay for it);[386] ecosystem services are not usually traded in the market and, for that reason, their price has to be determined by mechanisms that mimic the market (such as the mechanisms employed in a cost-benefit analysis to measure the benefits of protecting the environment).[387]

Garrett Hardin has shed light on the application of the market theory to environmental protection in the *Tragedy of the Commons*.[388] Hardin's model describes the common evolution of events when private benefits are obtained from finite and

384. *See id.*

385. *Id.* at 59-63.

386. *Id.* at 74-75.

387. *Id.* at 53.

388. Hardin, *supra* note 381. The *Tragedy of the Commons* illustrates the issues that may arise from the private use of jointly owned resources. Hardin gives the example of a common field used by multiple owners to feed their cattle. One owner notes that if he or she increases the number of animals, he or she will be able to yield more profit while maintaining the same costs. In this case, the "costs" are the weight loss of each animal. The additional animals included in the herd will eat the grass that was being eaten solely by the primary animals. Therefore, each additional animal introduced will cause a reduction in the weight of its companions. Thereby, the profit earned by the owner that increased his or her herd is supported by the weight loss of the animals belonging to other owners. The cost of somebody's profit is *externalized* to others. If all owners decide to act in that way, the weight of each animal will be greatly reduced and each owner will end up having less benefit than he or she had in the first place. Therefore, the decision made by one person with an individualistic point of view will worsen everybody's situation. Even if each of the owners could predict the others' action and consequently the bad result, he or she probably would act in the same way because there would not be any guarantee that his or her inaction would be followed by the others. *Id.*

common resources.[389] Unlike the market theory, Hardin's model assumes the finitude of resources.[390] As does the market theory, however, Hardin also believes that economic actors act in a selfish manner.[391] Hardin's conclusion is that environmental protection is obtained only by two means: private property or regulation to internalize externalities.[392] Hardin's theory is only adequate for explaining the results of exploitation of common resources where access cannot be excluded.[393] The main criticism of this theory is that it does not account for social norms as an alternative means for addressing environmental protection.[394]

Following Hardin's lead, payment for ecosystem services does not consider the importance of social norms in addressing environmental protection. On the other hand, the principle of resilience recognizes the importance of social norms, especially moral norms, in protecting the environment. It is due to this distinction that the principle of resilience will establish limits to the application of the payment of ecosystem services as a tool for implementing environmental protection.

The first limitation the principle of resilience creates to the payment for ecosystem services refers to private initiatives for creating a market for ecosystem services, or more simply termed "private payment for ecosystem services." Ruhl et al. exemplify the creation of such a market through private initiative when there are a large number of economic actors both on the service users and on the natural capital owners' sides.[395] In this situation, the common pathway would be: a sufficient number of natural capital owners need to identify each other, agree to threaten to eliminate the natural capital, evaluate the ecosystem service benefits, identify the service users, develop a strategy for

389. *Id.* at 1244.
390. *Id.*
391. *Id.* at 1245.
392. *Id.* at 1245-46.
393. *Id.*
394. Elinor Ostrom et al., *Revisiting the Commons: Local Lessons, Global Challenges*, 284 SCI. 278 (1999).
395. *See* RUHL ET AL., *supra* note 376, at 73.

negotiating with them, and devise a method for allocating any payments received among the group.[396]

Such a pathway towards the payment of ecosystem services raises concern under the principle of resilience because it departs from the idea that whoever owns the natural capital needs to threaten the ecosystem before receiving payment for maintaining it. If highlighting the *threat to the ecosystem* element is not sufficient to show the obviously unethical character of such a pathway, it might be useful to compare this strategy to one used by a criminal who takes someone hostage and promises to kill the hostage if he does not receive the money he requires. The structure of thinking is the same in both situations. One may argue that the first situation is not as grave as the second because it refers to plants, animals, and the biotic community as a whole, while the second refers to people. Of course this is a valid argument and this article does not seek to affirm that people are less or as important as other members of the land mechanism–human life is always above other ethical values. Rather, this comparison is based on the assumption that both human lives and nature have an inherent value and a good of their own,[397] which means that both are entities deserving of moral concern and consideration and, therefore, "all moral agents have a prima facie duty to promote or preserve the entity's good as an end in itself. . . ."[398]

The moral obligation to respect every form of life was recognized by the United Nations General Assembly, that affirmed: "[e]very form of life is unique, warranting respect regardless of its worth to man, and, to accord other organisms such recognition, man must be guided by a moral code of action. . . ."[399]

396. *See id*; *see also* JAMES SALZMAN, A POLICY MAKER'S GUIDE TO DESIGNING PAYMENTS FOR ECOSYSTEM SERVICES 22 (2009), *available at* http://scholarship.law.duke.edu/cgi/viewcontent.cgi?article=2703&context=faculty_scholarship ("If the forest were not threatened by development, PES would seem nonsensical since the consumers would continue to receive the service of water provision with our [sic] without payments.").

397. TAYLOR, *supra* note 83, at 73-75.

398. *Id.* at 75.

399. World Charter for Nature, *supra* note 87, Preamble.

The theory of *private payment for ecosystem services* contains several aspects that evince lack of respect for nature. Besides threatening nature as a requirement for creating markets by private initiative, by attributing a monetary value to the benefits nature brings to humankind, the model for commercialization of ecosystem services unavoidably treats nature as a product. Studies such as the one promoted by Costanza et al., which calculates the total value of Earth's ecosystem services, might be useful for evincing the importance of nature for economic actors.[400] However, this kind of assessment contributes to eroding in people's minds the idea that some things have values that cannot be totally translated into monetary amounts. In other words, treating nature as a product is antithetical to the aim of attributing an inherent value to nature and respecting nature.

Also, *private payment for ecosystem services* attributes no value to ecosystem services that do not benefit humans because they are located far away from human populations.[401] Therefore, the theory shows no consideration for ecological functions that are provided for the sole benefit of wild beings. According to Paul Taylor, this attitude demonstrates no respect for nature, even if it has the potential to benefit nature in many situations:

> People who have an exclusively human-centered view-point in environmental matters may at times perform actions that in fact further the good of wild creatures. But their actions do not express the attitude of respect for nature because they are not done for the sake of the wild creatures themselves. The

400. Robert Costanza et al., *The value of the world's ecosystem services and natural capital*, 387 NATURE 253, 259 (1997), *available at* http://www.esd.ornl.gov/ benefits_conference/nature_paper.pdf.

401. James Salzman & J. B. Ruhl, *"No Net-Loss" – Instrument Choice in Wetlands Protection* 21 (Duke Sci., Tech. & Innovation, Research Paper Series No. 1, Sept. 2005), *available at* http://ssrn.com/abstract=796771 ("Even if a restored wetlands provides the same biophysical level of services as the filled wetland, the services may have little or no value if they are not delivered to a population that needs them."); RUHL ET AL., *supra* note 376, at 79 ("[B]ecause ecological functions are counted as ecosystem services only where and when humans are benefited, the ecosystem service value of any ecosystem function depends not only on the ecological and geographic variability of ecosystems across space and time but also on where people are, when they are there, and their respective levels of demand for different services.").

> underlying aim is to benefit humans, either immediately or in the long run.[402]

Due to the lack of respect for nature noted as the basis of the theory of *private payment for ecosystem services*, this form of payment should be refrained from all together, because the attitude of respect for nature entails being disposed to refrain from certain kinds of action because of their inherent qualities or future consequences.[403] Following Leopold's thinking, aiming for a state of harmony with nature means seeking harmony with the whole land mechanism;[404] one cannot claim to respect nature if one accepts the adoption of legal or economical mechanisms that disregard the moral obligations humans must have towards the land mechanism.

Private payment for ecosystem services generates not only moral issues, but also ecological issues. By being human-centered, payment for ecosystem services results solely in the preservation of ecological functions that are important to humans (not in the protection of ecological functions that are important only to the land mechanism).[405] Also, payment for ecosystem services tends to rely on the minimum parcel of the land mechanism necessary for maintaining the service, therefore focusing on the keystone species that represent the different functional groups and guarantee the basic functioning of the ecosystem.[406] However, the maintenance of keystone species cannot ensure the continuity of the ecosystem.[407] In order to strengthen the resilience of the ecosystem, it is necessary not only to preserve the keystone species, but also the redundant species, because those will be the "insurance capital" which guarantees the continuity of that specific function in case one of the keystone species goes extinct.[408] Therefore, payment for maintaining the

402. TAYLOR, *supra* note 83, at 85.
403. *Id.* at 82.
404. LEOPOLD, *supra* note 7, at 189.
405. *Id.* at 246.
406. Allen et al., *supra* note 16, at 12.
407. Folke et al., *supra* note 5, at 152, 155.
408. *Id.*; Peterson et al., *supra* note 36, at 175.

keystone species can erode ecological redundancy and weaken ecosystem resilience.

Is it possible to create a market for ecosystem services through private initiative that does not incur the ethical wrong of threatening nature? The only situation this work envisions that would be exempt from this wrong doing would be the case where the user offers to pay for the ecosystem services before the owner of the natural capital considers destroying the ecosystem to develop the land. This might seem an unusual situation because, due to the difficulty in excluding access to natural services, the user probably will be already enjoying the service for free before any transaction is made with the owner of the natural capital.[409] Thus, the user hardly would spontaneously offer to pay for something that he already gets for free.

However, a voluntarily offer to pay for ecosystem services may occur under certain circumstances. For example, when the natural capital exists but does not generate the ecosystem service due to mismanagement by the owner. In this case, the potential user might assess the reason why he is not receiving the service and offer to pay for the owner of the natural capital to correct the management problem in order to make the ecosystem services possible. This situation occurred in the municipality of Extrema, in the Brazilian state of Minas Gerais.

In Extrema, the municipality noticed that the water bodies that supplied water for the city presented a decrease in water quality because farmers upstream allowed their cattle to walk in the water bodies, thereby increasing erosion.[410] In order to improve water quality and reduce costs of water treatment in the supply system, the municipality paid the farmers to fence off the water bodies that passed through their properties in order to prevent erosion, both by blocking the access of cattle and by reforesting the margins of headwaters.[411]

409. RUHL ET AL., *supra* note 376, at 80. Service users tend to enjoy the services for free and only notice the effects of missing such services when the natural capital is already gone, when it may be too late to restore the stock of natural capital.

410. Janice Kiss, *As águas vão rolar*, 293 GLOBO RURAL (Mar. 2010), *available at* http://revistagloborural.globo.com/GloboRural/0,6993,EEC1708927-1641-1,00.

411. *Id.*

Another example is when the user notices that the service is fundamental to the continuity of his economic activity and that he will be better off paying the service and ensuring its continuity rather than taking the risk of losing the service in case the owner of the natural capital decides to develop the land.

Except those situations where the user voluntarily offers to pay for the ecosystem service, this article envisions no other means through which the creation of a market for ecosystem services by private initiative would not compel the user to enter into a contract due to an immoral threat by the owner of natural capital.

Although payment for ecosystem services raises several reasons for concern, this tool has a major benefit that justifies its consideration as a valid and useful means of promoting environmental protection: when implemented, payment for ecosystem services inverts the legal and economic trend noticed throughout history to incentivize the development of the land and the destruction of ecosystem services.[412] That is why it is often presented as a useful tool for conservation.

Seeking to promote the benefit generated by the payment for ecosystem services without incurring the wrongdoing of threatening nature, this article accepts the employment of such a preservation tool in the following cases: first, when service users voluntarily propose to pay for the ecosystem service; or second, when the trading program is used as a tool to encourage compliance with regulations that oblige the preservation of the ecosystem on certain parcels of land.

The first model, which can be called the *voluntary payment for ecosystem services*, does not solve the problem of preserving solely ecosystem functions that are useful to humans or of adopting a human-centered perspective that undermines the attitude of respect for nature: these issues can be addressed by applying the *voluntary payment for ecosystem services* in conjunction with the second model–that can be called *regulatory payment for ecosystem services*. The ecosystem-broad regulation of the *regulatory payment for ecosystem services* regulates the preservation of ecological integrity in a determined portion of

412. RUHL ET AL., *supra* note 376, at 102-09.

land, therefore adopting a bio-centered perspective that ensures the preservation of every ecological function, both those that help the ecosystem to maintain itself, and those that are useful to humans.

Therefore, voluntary payment for ecosystem services can be adopted only when there is already in place an ecosystem-broad regulation which, with or without a system of regulatory payment for ecosystem services, provides protection to whole ecosystems in a minimal area to guarantee the maintenance of their resilience. In this context, voluntary payment for ecosystem services acts as *additional* protection to nature, never being used as a single tool to promote environmental protection. The stem of environmental protection and preservation of ecosystem resilience must rely on a regulation that requires the preservation of all ecosystem functions within a minimum extension of preserved land.

Another important feature of relying on regulation as the stem of environmental protection is that every landowner is presumably obliged to conserve nature while in private or voluntary payment for ecosystem services the landowner is presumed to have no such obligation. That is why in markets initiated by regulation, the landowner who does not preserve is obliged to pay somebody else for it in her name, while in private and voluntary markets the landowner who develops the land does not have any obligation while the one who preserves receives a payment for it. The first mindset is much more coherent with the principle of resilience's moral premise that everybody should respect and preserve the land mechanism.

The municipality of Extrema, in Brazil, is an example of both voluntary payment for ecosystem services and regulatory payment for ecosystem services. The municipality voluntarily offered to pay for the preservation of vegetation around the headwaters, which is already required by Brazilian law.[413] Therefore, Extrema is an example of *regulatory payment for ecosystem services for stimulating conservation on-site*. There is also *regulatory payment for ecosystem services for stimulating conservation off-site* when conservation on-site is not recommended, illustrated by wetland banking in the United

413. Lei No. 12651, de 2012, art. 4, I, (Braz.).

States and *servidão florestal* (in English, environmental servitude) in Brazil.

In the United States, filling wetlands requires a prior permit from the Army Corps of Engineers.[414] The Corps' guidelines for giving the Clean Water Act § 404 permits attend to the following order of desirability: the developer should avoid filling wetlands, he should minimize the adverse impacts to wetlands that cannot be avoided, and he should provide compensatory mitigation for unavoidable impacts.[415] In order to be allowed to fill the wetland, the developer must prove that no reasonable alternatives exist to the development of the wetlands.[416] Compensation for the impacts can be implemented on-site or off-site, but off-site mitigation banking is preferred over on-site because of the greater efficiency, scale effects, and environmental protection.[417]

The Brazilian restriction on rural private property known as *reserva legal* (see the Land Use topic) presents some market mechanisms to relax the legal obligation to preserve native forest in every track of rural land. If the property has no native forest, the Brazilian Forest Code allows the landowner to buy a new tract of land to establish the *reserva legal,* or to establish it on third party land, through *servidão florestal* or *Cotas de Reserva Florestal.*[418] The compensation is allowed only if the land is located in the same micro-watershed, has the same size, and same physical characteristics as his land.[419]

Both wetlands mitigation and *servidão florestal* are market instruments employed for promoting the restoration of the whole ecosystem in the most economically feasible place. In both countries, priority is given to the preservation of the ecosystem where it is located because the market instrument is applied only when keeping the ecosystem on-site would impair the economic activity (i.e. the development of wetlands is allowed if the

414. Clean Water Act § 404, 33 U.S.C. § 1344 (2006).

415. Federal Guidance for the Establishment, Use and Operation of Mitigation Banks, 60 Fed. Reg. 58,605, 58,612 (Nov. 28, 1995).

416. Salzman & Ruhl, *supra* note 401, at 3.

417. Federal Guidance for the Establishment, Use and Operation of Mitigation Banks, 60 Fed. Reg. at 58,607.

418. MILARÉ, *supra* note 356, at 759-60.

419. Lei No. 12651, de 2012, art. 48, § 2º (Braz.).

developer proves to have no reasonable alternative, which means that the destruction of the wetland is avoided solely to the extent that it does not impair the economic activity) or would be environmentally disadvantageous and more expensive (i.e. the establishment of *servidão florestal* is only allowed when the developed land has no remaining native vegetation, evincing the priority given to the preservation of an existing forest rather than planting a new forest where it was previously destroyed). Once it is not possible to keep the ecosystem in its original place, wetlands mitigation gives priority to off-site mitigation due to greater efficiency in evaluating compliance, while *reserva legal* gives priority to near-site compensation, in order to ensure the existence of protected land in every micro-watershed and to prevent the creation of "hot spots" of developed land.

The obligation to preserve the whole ecosystem takes away concerns such as the monetization of nature and the utilitarian selection of protected ecosystem services and species, which can be found in *private payment for ecosystem services*. *Regulatory payment for ecosystem services* abolishes the monetization of nature because it promotes a change in perspective: while in the *private payment for ecosystem services* the determination of the price of ecosystem services is focused on the monetization of the benefits ecosystems generate to humans;[420] the determination of the price paid in *regulatory payment for ecosystem services on-site* is focused on how much the regeneration of the ecosystem will cost to whoever assumes the responsibility for it, because whoever pays for the maintenance of the ecosystem (probably the government) is not directly the user of the service.[421] The existence of the regulation prior to the development of a market for ecosystem services demonstrates that the society in question

420. RUHL ET AL., *supra* note 376, at 63 (affirming that natural capital can be economically valued by computing the benefits it provides and comparing it to the profit the owner of the natural capital can receive if he develops the land); James Salzman, *Valuing Ecosystem Services*, 24 ECOLOGY L.Q. 888 (1997) (affirming that the assessment of costs of building physical capital to replace ecosystem services is an effective method of valuing ecosystem services).

421. James Salzman, *Creating Markets For Ecosystem Services: Notes From The Field*, 80 N.Y.U. L. REV. 101, 144 (2005), *available at* http://scholarship.law.duke.edu/cgi/viewcontent.cgi?article=2024&context=faculty_scholarship.

already values conservation; otherwise, it would not create the regulation for conserving the ecosystem.

In this setting, accounting for ecosystem benefits is not as useful, because citizens do not need to be reminded of the importance of conservation by giving monetary values to ecosystem services. In such a legal environment, payment to whoever preserves the natural resources is not a source of profit: rather, it would be better characterized as compensation for the costs that person incurred in preserving resources that will contribute to the greater good.

One may argue that if *regulatory payment for ecosystem services on-site* brings no profit to the owner of the natural capital, payment for ecosystem services will not achieve its intent; that is, to provide an economic incentive substantial enough to discourage the landowner from developing his land. However, it is necessary to remember that the owner of natural resources is obliged by regulation to keep the natural capital.

It is clear that the downside of such a measure, and of any regulation for environmental protection, is to discourage conservation beyond the level determined by the law.

The commitment of the principle of resilience to long-term efficiency in the management of natural resources requires mechanisms that ensure the perpetuity of preserved lands. Market mechanisms, whether associated or not with regulations, must be designed in a way that prevents the easy conversion of currently protected land into developed land when the economic incentive ends.[422] There is lack of certainty regarding the permanence of wetlands protected under the wetland banking system, which is one of the main disadvantages of this market mechanism. In Brazil, this issue was addressed by characterizing *reserva legal* as an obligation *propter rem*: a permanent restriction on the usufruct of the land, which must to be respected by every future owner.[423] However, if the compensation of *reserva legal* is made through the use of *servidão florestal*, there are no guarantees that such vegetation will be protected after the

422. LEOPOLD, *supra* note 7, at 244-45.
423. MILARÉ, *supra* note 356, at 753-54.

ending of the servitude, because the servitude is not required by law to be permanent.[424]

The obligation to preserve the whole ecosystem prevents the utilitarian selection of protected species and ecosystem services because whoever manages the natural resources will be forced by the agencies' guidelines to preserve all species, not only the ones that have economic value.

In conclusion, the payment for ecosystem services is compatible with the principle of resilience so long as it is preceded by a regulation that ensures the preservation of the ecosystem in an area where conservation is well-known to be needed to fulfill ecological requirements for maintaining ecosystem resilience. Voluntary payment for ecosystem services can be used to promote protection in areas where the importance of preservation is secondary, or where the results of preservation are being tested by adaptive management decisions.

VI. CONCLUSION

Sustainable development is essentially a means to implement the *land ethic*. Failure to do so risks reducing the concretization of sustainable development to a mere duplication of old development, the kind of development that gives sole consideration to economic growth, not to environmental preservation.

The acknowledgement of the principle of resilience fills the vacuum existing in the operationalization of the principle of sustainable development regarding situations where environmental protection cannot be conciliated with economic growth. The principle of resilience prevents this vacuum from being filled by the most powerful interest in the conflict–the economic–by providing greater legal protection to the weakest interest in the balance–the environment. The principle of resilience consolidates justice in a situation of natural inequality by prioritizing the preservation of the environment in decision making. Thereby, the principle assists the law to fulfill its most prominent function of applying justice to concrete cases.

424. Lei No. 6938, de 1981, art. 9-A, *caput* (Braz.).

The principle of resilience also obliges decision makers and operators of the law to consider the long-term effects of their acts on nature and on present and future generations. By infusing ecological long-term concerns with patterns of occupation of land, consumption, and production, the legal principle of resilience guarantees that old unsustainable patterns are not replicated during rebuilding after natural disasters and relocating displaced people. The ultimate result is the prevention of disasters and the avoidance of repetition of palliative measures.

The principle of resilience provides an ecological foundation to the economy, which stresses the value of replicating components of ecological resilience in the economy. The principle enhances the enforcement of sustainable yield by acknowledging that economic growth must be restrained when deemed necessary to prevent total exhaustion of natural resources. Therefore, the application of the principle to the economy calls attention not only to restrictions on the exploitation of natural resources but also to the need to close the life-cycle of materials through "reuse and recycle."[425] In a broader sense, the principle acknowledges that humans must live in such a way as not to impair the maintenance of ecological functions that ensure the presence of resources and services which both society and the economy depend upon to continue existing. Since the final result of this effort is the maintenance of subsidies for a balanced society and a stable economy, it affirms that the principle of resilience provides

425. The idea of closing the life-cycle of materials is already present in some countries' experience. In China, the National Development and Reform Commission is seeking to implement the concept of circular economy, whereby "one facility's waste, including energy, water, materials - as well as information - is another facility's input." László Pintér, *International Experience in Establishing Indicators for the Circular Economy and Considerations for China* 1, IISD (May 2006), *available at* http://www.iisd.org/pdf/2006/measure_circular_economy_china.pdf (quoting NDRC, THE CIRCULAR (RECYCLING) ECONOMY IN CHINA (2006)). In the United States, the Resource Conservation and Recovery Act (RCRA) adopts the "cradle to the grave" approach, which tracks hazardous waste from generation to disposal requiring waste generators, transporters, and owners of treatment, storage, and disposal facilities to keep a record on the waste characteristics, origins, and final disposal. Resource Conservation and Recovery Act, 42 U.S.C § 6922(a)(5) (2006); *see also* PLATER ET AL., *supra* note 6, at 743-72.

greater economic efficiency in the long term and a deeper understanding of the economy.

The inclusion of ecological concepts in the functioning of the economy can accelerate the adoption of green economy and make it more resilient because the principle of resilience provides not only an ecological foundation, but also a moral background to the green economy, which is essential to prevent this concept from being sidetracked by traditional economic interests during implementation.

As demonstrated, the use of the principle of resilience will have tangible and practical benefits for society. However, this article does not espouse the principle of resilience only for its utilitarian benefits, but also for its values and for the benefits it will generate to nature itself. Therefore, it is a basic premise of the principle of resilience that its ethical values be enforced even when no utilitarian benefits are expected to arise from it.

The social enforcement of individual and moral obligations generated by the principle of resilience requires education for conservation in order to enable people to internalize the inherent value of nature and the goal to live in harmony with the land mechanism. Education for conservation also provides people with the necessary knowledge to identify how resilience is being harmed and what they can do to prevent despised effects on nature.

Because the principle of resilience addresses moral obligations vested with legal enforcement, it cannot be considered a sectoral principle, applied solely to conducts practiced by environment agencies; rather, it is a cross-cutting principle that must be applied at the highest level of private and public institutions in order to influence decision making in every sector.[426]

426. *See Summary of the Intergovernmental Preparatory Meeting for the Nineteenth Session of the Commission on Sustainable Development*, 5 EARTH NEGOTIATIONS BULL. 293, 6-8 (2011), *available at* http://www.iisd.ca/csd/ipm19/ (last visited Nov. 7, 2012). The cross-cutting applicability of the principle of resilience is in consonance with concerns repeatedly expressed during the discussions about desirable features of policies on sustainable consumption and production held at the Intergovernmental Preparatory Meeting (IPM) for the nineteenth session of the United Nations Commission on Sustainable Development (CSD 19). *Id.*

This article repeatedly demonstrated that the foundations of the principle of resilience are already present in international environmental law and, consequently, that this is already a general principle of international law. Although the principle already exists buried within other principles, we can only enjoy its benefits and apply it to legal procedures when it becomes expressly recognized and systematized at the international level. Thus, the principle can be incorporated in future treaties and influence the interpretation of existing international agreements; it can also be recognized in domestic law, thereby shaping new regulations and influencing the interpretation of domestic law by judges and administrators.

Since the adoption of Agenda 21, nations have come to understand and to apply sustainable development.[427] In twenty years, environmental problems have become worse. The patterns of deterioration show that conservation without resilience is not enough. Accordingly, after the recognition of the principle of resilience in the international legal system, the next step for ensuring implementation of the principle in the international sphere is to infuse Agenda 21 with the principle of resilience.

427. *Agenda 21*, *supra* note 257 ("Humanity stands at a defining moment in history. We are confronted with a perpetuation of disparities between and within nations, a worsening of poverty, hunger, ill health and illiteracy, and the continuing deterioration of the ecosystems on which we depend for our well-being. However, integration of environment and development concerns and greater attention to them will lead to the fulfillment of basic needs, improved living standards for all, better protected and managed ecosystems and a safer, more prosperous future. No nation can achieve this on its own; but together we can - in a global partnership for sustainable development.").