The Principle of Resilience: Concept and Foundation

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Abstract

This article departs from the observation of accentuated degradation of ecosystems worldwide to stress the urgency in changing the patterns of occupation of the land, production, consumption and the ecological and ethical goals of environmental conservation. Aiming to achieve these ends, this article proposes the acknowledgement of the principle of resilience in international environmental law. The principle of resilience is articulated herein based on the concept of ecological resilience; the values of *land ethic*; and the existing principles of international environmental law. Later, the article explains how the principle can be applied to environmental impact assessment. The article concludes that the principle of resilience is aimed at providing moral and ecological foundation for sustainable development and a green economy; to require judges, administrators and operators of law to consider the long-term consequences of their actions on nature and on future generations, thereby achieving better conservation patterns on a case by case basis; to enlighten legislators on how domestic environmental legislation can be improved; to impose an individual and societal moral obligation to respect and improve nature, and to live in harmony with it. Finally, the article proposes a legal framework for implementation of the principle in domestic and international environmental law.

I. Introduction

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.[2] By those means, 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 preserving ecosystems in tight geographical limits, by eradicating species, by polluting the environment, and by changing environmental features humankind has reduced

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[2] 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.

ecosystem resilience[3], which is understood as the capacity of an ecosystem to absorb disturbance and persist. The increased vulnerability of ecosystems causes them to suffer unpredictable changes, and, depending on the intensity of the alteration suffered by an ecosystem, those changes may turn out to be irreversible.

The concept of ecosystem resilience has been giving rise to much discussion because, if ecosystems are currently vulnerable, how are they going to resist disturbances such as climate change and the rise in sea level? Considering that ecosystems will be seriously damaged[4] and that human inaction will only exacerbate such negative impacts, discussions on what should be done to restore ecosystem resilience and to avoid dreadful consequences started to emerge.

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 enhancement of ecosystem resilience requires the conservation of biodiversity[5] and the preservation of ecosystems everywhere[6].
The specialized literature states that the objective of preserving nature everywhere[7] could be enforced by conservation institutions that apply adaptive governance and adaptive management techniques in order to respond more effectively to the changing needs of ecosystems' management.

Adaptive governance enhances an institution's capability to deal flexibly with new situations, thus preparing managers for uncertainty and surprise[8]. Adaptive management is the process of learning from experience by monitoring ecosystem responses to actions taken by institutions that manage ecosystems[9].

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 compromise their activities according to the capacity of the ecosystem to support them. Humankind is used to dominate, not to coexist 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 by understanding nature and by setting the values we want conservation to have[10]. As the Law expresses, systematizes and implements the values of organized societies, it has a role to play in associating the concept of ecological resilience with ethical values for conservation, and applying these values to regulate activities that impact nature, in such a way as to reduce their negative effects on the environment.

The principle of resilience developed here is envisioned as one alternative to current practices, which has proven to be ineffective to fulfill

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[3] 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).

[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 3, at 151, 154–158.

[6] Folke et al., *supra* note 3, at 160; Aldo Leopold, A Sand County Almanac 190–94 (Ballantine Books 1970) (1949).

[7] Folke et al, *supra* note 3, at 160.

[8] Carl Folke et al., *Adaptive Governance of Social-Ecological Systems*, 30 Ann. Rev. Env't & Resources 441, 447 (2005).

[9] Barbara Cosens, *Transboundary River Governance in the Face of Uncertainty*, 30 J. Land Resources & Envtl. L. 229, 238 (2010).

[10] Leopold, *supra* note 6, at 210.

the environmental quality targets set in the last 40 years[11].

The concept of ecosystem resilience may be a new opportunity to achieve sustainability – which has been pursued without great success since 1987, when the Brundtland Commission popularized the term and the definition of "sustainable development"[12].

The "Rio+20 World Environmental Jurists Event" highlighted the importance of environmental law principles, as the mere creation and implementation of well-designed environmental instruments and institutions – that are not guided by legal principles – has proved to be insufficient to change business as usual. In this context, the principle of resilience was mentioned among the set of environmental law principles underlying practices contributing to the enhancement of environmental quality[13]. The discussion on how the law can enforce new values of conservation is expected to continue after Rio+20, influencing domestic law-making and decision-making in public and private institutions alike.

This work 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 article consolidates and contextualizes the legal principle.

This work undertakes a more detailed analysis of how the principle of resilience can be developed, presenting its foundations and suggesting ways of applying it to Environmental Impact Assessment.

II. Ecological Concept of Ecosystem Resilience

Resilience is the capacity of a system to absorb disturbance, to reorganize itself, and persist.[14] 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,"[15] "domain of attraction," or "stability domain."[16]

Ecological systems have more than one stable state or basin of attraction.[17] The group of basins of attraction related to the same ecosystem is called the "stability landscape."[18] 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

[11] "Rio+20 needs to review 40 years of unfulfilled commitments and explore genuine alternatives to current practices" (quoting IUCN President Ashok Khosla). 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.

[12] 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*].

[13] *Lia Demange*, Messages from World Environmental Jurists, GreenLaw, available at *http://greenlaw.blogs.law.pace.edu/2012/06/20/lia-demange-messages-from-world-environmental-jurists/ (last visited Mar. 6, 2013).*

[14] Folke et al., *supra* note 3, at 121.

[15] 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/.

[16] Folke et al., *supra* note 3, at 119, 121.

[17] Walker et al., *supra* note 15; Craig R. Allen et al., *Commentary on Part One Articles*, *in* Foundations of Ecological Resilience, *supra* note 3, at 3, 4.

[18] Walker et al., *supra* note 15.

present a new basin of attraction.[19] 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.[20]

In the case of change in the stability landscape, the resilience of the system can be considered the amount of disturbance the system can absorb before shifting into a different configuration, in other words, shifting to a new stability domain.[21]

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.[22]

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."[23] 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.[24]

Human management of natural elements is traditionally directed towards the maintenance of the ecosystem's stability.[25] This view of human interactions with the natural world focuses on equilibrium states, on "maintaining a degree of constancy by reducing natural variability."[26]

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 (resilience).[27] 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 mold dictated by the fear of departing from a successful formula …"[28] The sudden change that

[19] C. S. Holling, *Resilience and Stability of Ecological Systems*, *in* Foundations of Ecological Resilience, *supra* note 3, at 19, 29, 30.
[20] Walker et al., *supra* note 15.
[21] 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 3, at 423, 425.
[22] C. S. Holling, *The Resilience of Terrestrial Ecosystems*, *in* Foundations of Ecological Resilience, *supra* note 3, at 67, 92.
[23] Walker et al., *supra* note 15.
[24] C. S. Holling, *Engineering Resilience versus Ecological Resilience*, *in* Foundations of Ecological Resilience, *supra* note 3, at 58; Folke et al., *supra* note 3, at 51, 132.
[25] Holling calls this tendency "engineering resilience." Holling, *supra* note 24.
[26] Allen et al., *supra* note 17, at 3.
[27] Holling, *supra* note 24, at 52.
[28] Holling, *supra* note 22, at 105.

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.[29] According to him, the "suppression 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."[30]

Along the same line of reasoning, it is also recognized by Leopold that human control over the health of the land has not been successful.[31] Leopold understands *land* as the community that includes soil, water, plants, and animals,[32] and *health* as the capacity of the land for internal self-renewal;[33] 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.[34] The disappearance of plants and animal species without visible cause despite efforts to protect them, and the irruption of others as pests despite efforts to control them[35] 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 this is called *redundancy*.[36] 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 one species only 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.[37] By presenting fewer possibilities to innovate, the 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.[38]

[29] *Id.* at 83.
[30] Id.
[31] Leopold, *supra* note 6, at 272.
[32] *Id.* at 239.
[33] *Id.* at 258.
[34] *Id.* at 272.
[35] *Id.* at 273.

[36] Allen et al., *supra* note 17, at 14, 15.
[37] Garry Peterson et al., *Ecological Resilience, Biodiversity, and Scale*, *in* Foundations of Ecological Resilience, *supra* note 3, at 167, 187.
[38] Folke et al., *supra* note 3, at 142.

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.[39]

Therefore, Leopold considers "the first principle of conservation" to be the preservation of all the parts of the land mechanism.[40] 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.[41] 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, "small reserves lose their distinctive species if they are surrounded by a hostile landscape."[42]

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.[43] By having this base datum of normality, science may detect what is occurring otherwise which might provide the causes for such change.[44] 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.[45] 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.[46]

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 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."[47]

Referring especially to institutions, Folke, Holling, and Perrings consider the development of effective institutions for biodiversity conservation as a precondition for the creation of incen-

[39] Leopold, *supra* note 6, at 189, 190.
[40] Id.
[41] Folke et al., *supra* note 5, at 160.
[42] *Id.* (quoting R. A. Askins, *Hostile landscape and the decline of migratory songbirds*, 1957 Sci. 267).
[43] Leopold, *supra* note 6, at 274–75.
[44] Id.
[45] Id.
[46] Id.
[47] Folke et al., *supra* note 5, at 160–61.

tives 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.[48]

III. The Land Ethic

Aldo Leopold's *land ethic* opposes theories that consider nature as an object totally submitted to human scrutiny. The idea of nature as an object dates back to Modernity, when, due to the advance of science, humans became able to overcome obstacles to their development posed by nature[49]and they acquired the belief in their superiority over other species and over nature.

According to Christian belief, by altering the land, planting, fertilizing the soil and erecting buildings, humans are complementing God's creation and assuring prosperity[50]. 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[51], whose use by humans is unrestricted.

In the post-war world people became aware that the planet contains limited resources; and that those resources are showing signs of exhaustion. From then on, humans started to consider how vulnerable the planet they depend upon is and, consequently, how vulnerable is the continued existence of the human race[52].

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

Leopold sees ethics as the "tendency of interdependent individuals or groups to evolve modes of co-operation", which ecologists call *symbiosis*[53]. 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"[54]. Land has been just a property to humans; their relationship has been strictly economic, entailing privileges but no obligations[55].

The extension of ethics to natural elements requires a change in the human position: from conqueror of the land-community to plain member and citizen of it[56]. 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 often 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*[57].

Leopold acknowledges that we probably are

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[48] Id.

[49] François Ost, A Natureza às margens da lei 30 (Joana Chaves trans., Instituto Piaget ed. 1995).

[50] *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).

[51] *Id.*, at 10.

[52] *Id.* at 277–387.

[53] Leopold, *supra* note 6, at 238; *see also* Ost, *supra* note 49, 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).

[54] Leopold, *supra* note 6, at 239.

[55] *Id.*

[56] *Id.* at 240.

[57] *Id.*, at 189, 190.

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[58].

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.[59] That is why the land ethic requires some understanding of ecology and of education for conservation, aimed at building ethical support for land economics.[60] The author believes that, if this is set in place, conservation will naturally follow.[61]

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.[62]

Without an ethical relationship with nature, conservationists are obliged to look for economic values to justify efforts to conserve natural elements.[63] 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.

According to Leopold, conservation directed by the market does not cover 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. This can result in their extinction and therefore in increased vulnerability of an ecosystem.[64]

Another problem of conservation as driven by markets is that it does not provide an education for conservation or a sense of right and wrong. 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. The individual who receives a payment to contribute to conservation is driven by self-interest, not by a sense of obligation or by the sense that it is the right thing to do.[65]

Leopold 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' possibilities. 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[66].

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. As mentioned by François Ost, the law operates by systematically considering all relevant points of view, putting them in proportion and comparing them.[67] Most importantly, in an ideal situation, the law is capable of taking into account all pertinent facts and

[58] *Id.* at 210.
[59] Leopold, *supra* note 6, at 210.
[60] Id.
[61] Id.
[62] *Id.* at 262.
[63] Id.
[64] *Id.* at 246.
[65] *Id.* at 244–245.
[66] *Id.* at 251.
[67] Ost, *supra* note 49, at 19–22.

divergent interests, balancing them, and reaching a reasonable and desirably just decision.

The capacity to balance divergent interests in the formulation of policies and decisions by agencies has been enhanced by *public participation in decision making*. Although public participation 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 not binding and are restricted to the procedural obligation of hearing divergent interests. Therefore, the agency usually is 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 substantive public participation in agency decision making is provided, it does not guarantee the defense of interests of those who are not present in the process: nature itself and the future generations. The law can ensure representation of those interests during its weighing and balancing process, if so directed by a legal principle.

Due to the need to enforce consideration of all the interests at stake and the interest of nature itself and of future generations, management for resilience 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.

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.

The foundations of the principle of resilience already exist in International Environmental Law: they lie within binding and non-binding international instruments. However, the principle of resilience 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 in a manner that will stop degradation and strengthen global nature.

Systematizing a new principle to address ecosystem resilience is important because principles of international law designate fundamental legal norms and values that should be pursued by the whole international environmental law system.[68] 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[69]. 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.[70] 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 transboundary environmental disputes. Finally, the principle may assist the integration of international environmental law into other fields of international law.[71]

But what would be the meaning of the principle of resilience?

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[68] *See* Alexandre Kiss & Dinah Shelton, Guide to International Environmental Law 89 (2007).

[69] *See id.*

[70] Id.

[71] David Hunter et al., International Environmental Policy 469, 470 (2007).

The ecological concept of resilience mandates the preservation of biodiversity and the preservation of nature everywhere. Preserving biodiversity for resilience is necessary in order to keep the functions of the ecosystem working with their original quality. Therefore, resilience requires biodiversity to be preserved in its original habitat by a sufficient number of individuals of each species to ensure the execution of the ecosystem function they are responsible for.[72]

The goal of preserving nature everywhere does not mean the maintenance of *some* natural resources everywhere; it means the preservation of the *whole* land mechanism everywhere. The concept of resilience is based on the idea that every land mechanism – 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 very segmentally applied 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 consider 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 must be preserved everywhere, keeping the ecosystem functions alive. If the garden of every house in a city contains individuals of native species, the fauna and flora present in each garden may interconnect with each other and keep the functions which 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.

This work adopts the values promoted in *land ethic* as the guiding values for conservation for resilience. 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. 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.

The principle of resilience recognizes humans as members of the land-community – not conquerors of it – who should get to know the land mechanism as much as possible, in order to respect and love the land.[73] This article interprets the land ethic as requiring humans to *enhance* the land mechanism the maximum they can, and not to merely *prevent and mitigate* the aggressions imposed upon nature that the law mandates individuals to address.

By improving the environment wherever possible, we humans demonstrate that we are conscious of the burden we inflict on the land

[72] 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 6, at 194.

[73] *Id.* at 261.

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. That means that besides the legal obligation to do no harm to the environment, humans have the ethical obligation to improve environmental quality.

The ethical obligation to live in harmony with the environment and to improve environmental resilience can be characterized as an ethical principle because:[74] it is 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 is universally applicable to all moral agents, meaning that the rule cannot defeat itself if everyone attempts to comply with it; it is intended to be applied disinterestedly, meaning that compliance with the principle is required even when it is against the moral agent's interest; it is advocated as a principle for all to adopt, meaning that whoever adopts it approves its adoption by all others; it overrides all non-moral norms or concerns.

One of the major aims of the principle of resilience is to provide guidelines for a governmental policy pursuant of 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, in order to do not prioritize one interest and suffocate the other. Such solutions provide new guidelines for the operation of the law.

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.
- 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 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.

[74] Paul W. Taylor, Respect for Nature 25–33 (Princeton Univ. Press Publ. 1986).

- 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.[75] 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 that "[m]an … bears a solemn responsibility to protect and improve the environment for present and future generations".[76] Therefore, the duty to improve the environment is not solely governmental, but also individual.

The first part of Principle 19[77] of the Stockholm Declaration highlights the role education for conservation has to play in protecting and improving the environment.

The World Charter for Nature, 1982,[78] 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…
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;
11. (e) Areas degraded by human activities shall be rehabilitated for purposes in accord with

[75] 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*].

[76] Id.

[77] *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.").

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

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.[79]

The Rio Declaration on Environment and Development, 1992, recognizes that human beings are entitled to a healthy and productive life in harmony with nature.[80] 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. At Principle 8, the Declaration guides States to reduce and eliminate unsustainable patterns of production and consumption.[81]

The need to build ecosystem resilience not only to reduce the risk of disaster, but also due to its importance in providing sustainable livelihoods, flow of goods and services and reducing vulnerability to climate change is expressed in the United Nations, 2009 Global Assessment Report on Disaster Risk Reduction.[82]

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."[83] 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 fully succeed in inserting in people's minds the idea that ensuring continuity of natural resources is more important than individual comfort and short-term profit. Neither has it yet convinced people that personal ambition has to yield in face of environmental limitations, or else the survival of future generations will be at risk.

By trying to please all concurring 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 not so rarely will 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 on 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 prioritized and under what circumstances? The vacuum left by the concept of sustainable development is repeatedly filled by business interests, whose

[79] Id.

[80] 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*].

[81] Id.

[82] U.N. Int'l Strategy for Disaster Reduction Secretariat, 2009 Global Assessment Report on Disaster Risk Reduction (2009).

[83] *Our Common Future*, *supra* note 12.

answer to the above mentioned question is: 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.[84] The promotion of justice – a primary function of the legal system – can be enhanced by the principle of resilience, which fills the vacuum of 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 profits. Thus, the principle of resilience prioritizes environmental protection, artificially balancing a naturally unbalanced situation. By correcting an ongoing injustice in the management of natural resources and planning for development, the principle of resilience improves the legal system as a whole.

The principle of resilience does not acknowledge rules for prioritizing concurring 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 factual necessity. Human society has to learn how to develop socially and manage natural resources without relying on economic growth.[85] Considering the green economy's goal to generate wealth through sustainable exploitation aiming to eradicate poverty,[86] 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 intergenerational equity focuses on future generations as rightful beneficiaries of environmental protection. It encloses the notion of fairness both among 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 non-discriminatory access to Earth's resources.[87] As for the conservation of diversity and the quality of resources, the aim is to implement equitable access to resources so as to guarantee to future

[84] 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)).

[85] *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 Foundation, Growth Isn't Possible (2010), *available at* http://neweconomics. org/publications/growth-isnt-possible.

[86] 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.

[87] Edith Brown Weiss, *Implementing Intergenerational Equity*, *in* Research Handbook on International Environmental Law 100, 100 (Malgosia Fitzmaurice et al. eds., 2010).

generations the possibility of choice among alternative resources, and access to resources of the same quality as the resources exploited by present generations. Furthermore, the principle of resilience contributes to the conservation of environmental quality by requiring the preservation of integrity, stability, and beauty of the biotic community.

This concept requires that present generations use the resources sustainably and avoid irreversible environmental damage.[88] In this context, the principle of resilience increases the applicability of the concept of intergenerational equity by restraining the present generation from weakening further a non-resilient ecosystem, because the passage of such an ecosystem to a new basin of attraction may be irreversible and the regeneration of the original features of an ecosystem may become impossible.

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; and, 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.[89]

The principle of non-regression is based, first, 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 – if present generations gradually adopt less protective environmental laws, they will prevent future generations from fully exercising their right to a healthy life.[90] Third, it relies on the application of the concept of intangibility of human rights to environmental regulation. 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. These guidelines encompass not only the ecological concept of resilience, but also the connection 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 to the legal framework the concept of ecological resilience not as a mere judicial finding based on scientific data provided by an expert testimony, but as a full legal principle of

[88] Hunter et al., *supra* note 71, at 491.

[89] *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.

[90] *See id*. at 33, 34.

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.

The principle of non-regression is truly effective in achieving improvement of environmental quality if it is applied to *all* norms that generate consequences to the environment. 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 principles that guide 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 levels of government, the affected public and the international community in the decision-making process related to environmental issues.[91]

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. Besides allowing the participation of all concerned citizens, the principle of public participation requires public access to relevant information held by public authorities regarding the environment, and 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 a cooperative spirit by all countries.[92]

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 conservation efforts. Such principles abolish the idea that environmental conservation is to be promoted only by national governments, as criticized by Aldo Leopold.[93]

The principle of resilience is also 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 their environmental effects – which must include any impact the project may cause to the resilience of the ecosystem. That is why 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. Individuals should also understand the meaning of ecosystem resilience to identify how a proposed project can affect it and to verify whether agencies are taking the concept of resilience into consideration.

c) The principle of resilience in Domestic Environmental Law

The applicability of the principle to sectors of 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 accomplishment of the goal to live in harmony with nature.

As noted by Aldo Leopold, the goal to live in harmony with nature is not necessarily achiev-

[91] Hunter et al., *supra* note 71, at 521, 525, 534, 535.
[92] *Stockholm Declaration*, *supra* note 75.
[93] Leopold, *supra* note 6, at 243–51.

able, but it is something we should strive for.[94] Also, it is useful to remember that the acceptance of the goal to live in harmony with the land mechanism as a moral principle presupposes that compliance with this duty is required even when it is against the moral agent interest.[95]

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",[96] 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 of resilience can be incorporated into existing procedures related to legal protection of the environment. The recommendations addressed below, in the section dedicated to Environmental Impact Assessment, 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, such as the organization of workshops for adaptive management.

Besides incorporating the principle of resilience into procedural rules, the government should set penalties for lack of compliance with these rules. As for penalties for noncompliance with the principle of resilience, it is interesting to note that the concept of ecological resilience reveals another 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 pollinizer 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; enhancement of sustainable consumption and production patterns[97].

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[94] *Id.*, at 210.

[95] Taylor, *supra* note 74, at 25–33.

[96] U.N. ENVTL. PROGRAMME, TRAINING MANUAL ON INTERNATIONAL ENVIRONMENTAL LAW 16 (Lal Kurukulasuriya & Nicholas A. Robinson eds., 2006) *available at* http://www.unep.org/law/Publications_multimedia/index.asp [hereinafter UNEP TRAINING MANUAL].

[97] 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". 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.

In order to ensure compliance with the principle, governments should establish who will enforce attainment to the principle guidance and to 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.*[98]

V. Applying the Principle of Resilience Into Environmental Impact Assessment

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.[99] 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.[100] 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,[101] constantly improving the understanding of such dynamics and 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.[102]

Adaptive management distinguishes itself from conventional management because it focuses on managing essential ecological processes that sustain the delivery of harvestable resources and ecosystem services on multiple temporal and spatial scales,[103] while the conventional approach focuses on the assessment of the maxi-

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. *See* 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). In the State of Amazonas Environmental Court in Manaus, in Brazil, alternative penalties have been proposed by Judge Adalberto Carim Antonio to violators of environmental laws, according to the transgressions. Instead of jail or fines, respondents can opt to restore the environment and to bring additional benefits to the affected community, to take classes in environmental education, or to act as volunteers in environmental protection organizations, among many other innovative penalties. *See* George "Rock" Pring & Catherine "Kitty" Pring, Greening Justice 85, 86 (2009).

[98] *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 84, at 598–99.

[99] Craig R. Allen et al., *Commentary on Part Three Articles, in* FOUNDATIONS OF ECOLOGICAL RESILIENCE, *supra* note 3, at 305; C. S. Holling et al., Adaptive Environmental Assessment and Management (1980).

[100] William C. Clark et al., *Lessons for Ecological Policy Design*, *in* FOUNDATIONS OF ECOLOGICAL RESILIENCE, *supra* note 3, at 364.

[101] Folke et al., *supra* note 8, at 445.

[102] Clark et al., *supra* note 100, at 381.

[103] *Adaptive Management*, Resilience Alliance, http://www.resalliance.org/ index.php/adaptive_management (last visited Oct. 22, 2012).

mum sustainable yield of an individual species on a single scale.[104]

Adaptive management requires transfer of information on the conservation status of an ecosystem among involved stakeholders in order to boost the understanding about ecosystem dynamics. The Environmental Impact Assessment (EIA) related tools can contribute to the transfer of such information between entrepreneurs and agencies, for example, by predicting the potential impacts of policies, assessing the alternatives, and ensuring public access to information and participation in the decision process.

Environmental Impact Assessment (EIA) is a procedure for "evaluating the likely impact of a proposed activity on the environment"[105] 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.[106] 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.[107] An EIA is essentially procedural because public authorities' decision is not bound by the findings of the EIA.[108]

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.[109]

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 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."[110]

However, this was not the only international document that required the elaboration of EIA: it is required under other non-binding instruments[111] and several binding international con-

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[104] Folke et al., *supra* note 8, at 443.

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

[106] Patricia Birnie et al., International Law and the Environment 165; Kiss & Shelton, *supra* note 68, at 98; ZYGMUNT J. PLATER ET AL., ENVIRONMENTAL LAW AND POLICY 432–34 (4th ed. 2010), at 319–52.

[107] Birnie et al., *supra* note 106.

[108] Plater et al., *supra* note 106.

[109] 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].

[110] *Rio Declaration*, *supra* note 80.

[111] Stockholm Declaration, *supra* note 75, at principle 14 and 15; UNEP Goals and Principles of Environmental Impact, *supra* note 109; Agenda 21, Sep. 28, 1992, UN Doc.

ventions.[112] The EIA is required by multilateral financial institutions,[113] and the government's duty to elaborate the EIA has been referenced in international judicial decisions.[114] 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.[115]

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.[116]

"The great majority of countries in the world have adopted" the EIA as mandatory regulations or, at least, informal guidelines.[117] Before project initiation, governments usually require a project proponent's elaboration of EIAs as a prerequisite to granting them the necessary permits.[118]

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 issues prior to every project that can cause significant environmental harm, it is an important tool 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 put ecosystem resilience at risk and to address such factors in a way that creates greater resilience. In this duty is the implicit 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.

A/CONF.151/26/Rev.1:volume 1; the European Commission Directive 85/337/EEC as amended by Directive 97/11/EC; and the Espoo Convention on Environmental Impact Assessment in a Transboundary Context. See Olufemi Elias, *Environmental impact assessment in* RESEARCH HANDBOOK ON INTERNATIONAL ENVIRONMENTAL LAW 227 (Malgosia Fitzmaurice et al. eds., 2010)

[112] Such as the U.N. 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) [hereinafter Convention on Straddling Stocks]; the CBD, *supra* note 211; the United Nations Framework Convention on Climate Change, May 9, 1992, 1771 U. N. T. S. 107 [hereinafter UNFCC]; Protocol of 1978 relating to the International Convention for the Prevention of Pollution from Ships, 1973, Feb. 17, 1978, 17 I.L.M. 546 (1978) [hereinafter MARPOL]; United Nations Convention on the Law of the Sea, Dec. 10, 1982, 1833 U.N.T.S. 3 [hereinafter UNCLOS]; the European Union law, see KISS & SHELTON, *supra* note 63, at 98–99.

[113] 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 106, at 131.

[114] *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).

[115] UNEP Training Manual, *supra* note 97, at 53; Elias, *supra* note 111, at 228.

[116] Elias, *supra* note 111, at 227 (quoting PATRICIA BIRNIE ET AL, INTERNATIONAL LAW AND THE ENVIRONMENT 131 (2002)).

[117] UNEP Training Manual, *supra* note 97, at 26.

[118] Id.

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 to keep going. 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 increment 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 possible to mention the case of the blueberry growers, Bridges Brothers Ltd., who 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. The loss of the crop over the period of 1970–71 resulted in an assessed loss of $1,331,693.14.[119]

[119] Bridges Brothers Ltd. v. Forest Protection Ltd. (1972). 5 N.B.R. (2d): 585–591.

The EIA can also stimulate the alteration of the 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 study of 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 an advantage to agencies because it makes this a secure source of information to agencies as it is, 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 and when decision-makers balance the environmental concerns presented in the EIA final report with other interests to decide whether a project should 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 before the obligation arises. Under most treaties, the obligation to do one EIA

and to notify states endangered by the activity arises only once it is previously known that the harm is likely to occur.[120] This EIA limitation is negative for the implementation of the principle of resilience because most harmful consequences of weakened 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 limitation of the scope of EIA obligation. 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. 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.[121]

Another solution is to distribute the requirement to assess environmental impacts between the prior impact assessment, which we regularly understand by 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 assessment is not capable of predicting the totality of impacts and providing certainty.[122] 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.[123] By managing ecosystems for uncertainty, the adaptive approach transforms the EIA procedure into an ongoing investigation rather than a one-time prediction of impacts.[124]

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.[125] This procedure also assesses a project's compliance with regulations, agreements, or legislation and provides agencies with 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.[126] The assessment of compliance with legislation coupled with the gathering of information about the progress of a particular project increase the transparency and accountability of proponents' mitigation actions, as the procedure assesses whether mitigation actions are actually reducing impacts.

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[120] Birnie et al., *supra* note 208, at 171.
[121] *Id*.

[122] 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." See Plater et al., *supra* note 106, at 346.
[123] David P. Lawrence, Environmental Impact Assessment 440 (2003).
[124] See Holling et al., *supra* note 99, at 1–25.
[125] See Keith Storey & Bram Noble, *Increasing the utility of follow-up in Canadian environmental assessment: a review of requirements, concepts and experience*, CANADIAN ENVIRONMENTAL ASSESSMENT AGENCY (2004), http://www.ceaa.gc.ca/default.asp?lang=En&n=081671C7-1&offset=2&toc=show.
[126] *Id.*; Birnie et al, *supra* note 106, at 424.

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.[127] 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 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.[128]

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,[129] auditing is a later stage of 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 comes to meeting the situation initially predicted.[130] "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."[131]

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.[132]

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 countries.[133] 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. The concerned Parties are supposed to decide, upon request, if a post-project analysis will be carried out and under which conditions.

The monitoring of the implementation effects of plans and programs is required under Article 12 of the Kiev 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'.

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 lev-

[127] Storey & Noble, *supra* note 125.
[128] Id.
[129] IAN THOMAS &PAUL MURFITT, ENVIRONMENTAL MANAGEMENT – PROCESSES AND PRACTICES FOR AUSTRALIA 185 (2nd ed., 2011)
[130] *Id.*, at 238.
[131] *Id.*, at 185.
[132] *Id.*, at 239.
[133] United States of America signed and Canada signed and ratified the Convention.

el, except when the concerned countries decide so.[134] 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.[135] Federal regulation does not establish deadlines for project proponents to provide periodic monitoring reports.[136] Besides that, the presentation of monitoring reports is very commonly not taken as a prerequisite for the renewal of an environmental license because, if such renewal is requested within 120 (one hundred and twenty) days before the expiration of the previews license, it is automatically prorogated until a final pronouncement by the environmental agency.[137] 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.[138] 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 work load exercised by 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.[139] 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[140] 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.[141] When a project is not likely to cause significant impact, the agency has discretion to decide whether a follow-up program is appropriate.[142] Follow-up requirements rarely are determined until after project approval is granted with the result that little attention is paid to specific arrangements for follow-up in the assessment or the EIA.[143]

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.[144] Monitoring elaborated under an ecosystem approach is applied to National Parks[145] and to projects of restoration of

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[134] 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.

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

[136] Id.

[137] Resolução CONAMA [Res. CONAMA] [Resolution] n. 237/1997, art. 18, §4 (Braz.)

[138] Lei n. 10650/2003, art. 3 (Braz.).

[139] Ministério do Meio Ambiente [MMA], Programa Nacional de Capacitação de Gestores Ambientais: Licenciamento Ambiental 67, (2009) (Braz.).

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

[141] Canadian Environmental Assessment Act (S.C. 1992, c. 37) (Section 38) (2) (2011) (Can.).

[142] *Id.*, Section 38(1).

[143] Storey & Noble, *supra* note 125.

[144] Air Pollution Prevention and Control, 42 U.S.C.A. § 7619 (2010); Safety of Public Water System, 42 U.S.C.A. § 300g-7 (2010).

[145] National Park Service Management, 16 U.S.C. § 5934

wetlands.[146] 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.[147] The monitoring is used to verify that the restoration actually occurred in order to permit the compensation.

The EIA effectiveness reviews demonstrate that monitoring is more the exception than the rule. The imposition of the obligation to reevaluate an activity's impacts and its mitigation measures during the license renewal process would be an effective way to implement adaptive management at the project level. 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.

2. Significant Impact on the Environment

The second limitation on 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.[148] Ecosystem resilience can be threatened by activities that generate irrelevant impacts if considered separately, but that are capable of weakening ecosystem resilience if considered collectively. The process of loss of resilience is cumulative because the inability to replenish coping resources propels a region and its people to increasing criticality.[149] 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 both as a direct and indirect impact on activities.

The evaluation of indirect impacts is not exempt from the EIA procedure. Direct impacts on the physical environment, as well as indirect impacts arising from other types of induced activity, the interrelatedness of environmental impacts, and cumulative impacts need to be assessed.[150]

However, due to their nature, indirect impacts are better detected through the use of differentiated methods able to link EIA to related projects and activities, such as legislative proposals, policies, programs and plans[151].

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

[146] Navigation and Navigable Waters, 33 U.S.C. § 2330a

[147] Plater et al., *supra* note 106, at 610.

[148] Birnie et al., *supra* note 106, at 171.

[149] Folke et al., *supra* note 9.

[150] Christopher Wood, Environmental Impact Assessment 89 (1995).

[151] 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. See Lawrence, *supra* note 123, at 48–50.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. 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 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.

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. The importance of cross-analyzing such information arises from the fact that most of the surprises, classified as local and cross-scale,[152] could be predicted and monitored through the integration of information at local and regional scale.

Strategic environmental assessment is the process by which environmental considerations are required to be fully integrated into the preparation of governmental plans and programmes potentially harmful to the environment before their final adoption.[153] 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.[154]

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.[155] 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.'[156]

The EIA system can also link to corporate environmental management systems.[157] An Environmental Management System (EMS) is a set of processes and practices that enable an organization to reduce its environmental impacts and increase its operating efficiency.[158] EMS's benefits involve 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.[159]

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, 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;

[152] 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. Lance Gunderson, *Resilience, flexibility and adaptive management – antidotes for spurious certitude?* CONSERVATION ECOLOGY vol. 3, n. 1, art. 7 (Jun.30, 1999), http://www.consecol.org/vol3/iss1/art7/

[153] *Strategic Environmental Assessment*, U.S. EPA (2011), http://www.epa.ie/whatwedo/advice/sea/.

[154] *Protocol on SEA,* U.N. ECONOMIC COMMISSION FOR EUROPE (2011), http://live.unece.org/env/eia/sea_protocol.html.

[155] Espoo Convention, *supra* note 105, art. 2(7).

[156] Council Directive 2001/42, 2001 O.J. (L 197) 30, 31 (EC); See Elias, *supra* note 111, at 227, 233.

[157] Lawrence, *supra* note 123, at 49.

[158] Thomas & Murfitt, *supra* note 129, at 191; *Environmental Management Systems*, EPA, http://www.epa.gov/EMS/ (last updated Nov. 27, 2012).

[159] Thomas & Murfitt, *supra* note 129, at 191.

and by the United States, which will require federal agencies to adopt EMS.[160]

The link of EIA procedure with strategic environmental assessment, area wide assessments, and corporate environmental management systems can be useful to provide adaptive management with additional information, especially if followed by the adoption of certain procedural measures.

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 standardization is often a reason why available data cannot be used in modeling and why it has to be recollected by adaptive managers.[161] 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.[162]

Case Study: Spruce Budworm

The case of the management of the spruce budworm in Canada was abundantly analyzed in the specialized literature.[163] 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 present in the forest in reduced numbers, except during periodic outbreaks as a consequence of these outbreaks, a large portion of the mature forest can die, causing an impact on the forest industry, which is the major economic activity of great part of the area covered by the forest[164] The tree species preferred by the budworm is the same species preferred by the pulp industry: the balsam fir.[165] 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 1930, when the pulp industry found it had to compete with the budworm for fiber.[166]

An historical overview of the management of forests in Canada shows that since colonization there was a trend to harvest a specific species of tree at each time, thereby changing the composition of the forest[167]. This factor is relevant

[160] *Id.*, at 203; Exec. Order No. 13,148, "Greening the Government Through Leadership in Environmental Management" 65 Fed. Reg. 24,595 (Apr. 26, 2000).

[161] 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).

[162] Holling et al., *supra* note 99, at 50–51.

[163] 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*, Vol. 7 Issue 1 Ecological Modeling (1979), *available at* http://www.sciencedirect.com/science/ article/pii/0304380079900085; Holling et al., *supra* note 99; Asaf Rashid, *Compromising the Environment? – The Spruce Budworm, Aerial Insecticide Spraying, and the Pulp and Paper Industry in New Brunswick*, 3 FES OUTSTANDING GRADUATE STUDENT PAPER SERIES (2003), http://www.yorku.ca/fes/research/students/outstanding/docs/AsafRashid.pdf.

[164] Holling et al., *supra* note 99, at 143.

[165] *Id.*, at 149.

[166] *Id.*, at 147.

[167] 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 hem-

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.[168] On the other hand, the balsam fir and the Dougles fir are the favorite targets of the insect[169] 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 1920's several authors have recommended the utilization of silvicultural practices to fight the recently frequent budworm outbreaks.[170] 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.[171] On the other hand, the tactic of spraying insecticides, employed since 1951,[172] was not abandoned even when fenitrothion, the substance used until 1998, was proved to cause human health problems[173] and a great mortality of songbirds[174] and bees.[175]

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 had no complete understanding neither of silvicultural measures nor 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 should provide 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 such a tradition in forest management for fighting the budworm that the possibility of not using insecticides became non-existent. This situation can be seen in the "Environmental impact assessment of experimental spruce budworm adulticide trials". 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. The EIA analysis is exhausted by showing that phosphamidon is the chemical less harmful to birds.[176] 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 creat-

lock, which was originally very abundant. See Rashid, *supra* note 163, at 25.

168 *Id.* at 20.

169 *Id.* at 19–21.

170 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*, vol. 45 n.9 J. Forestry 655, 655–59 (1947); Pickett, *supra* note 163; 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).

171 Rashid, *supra* note 163, at 30.

172 Holling et al., *supra* note 99, at 143.

173 See Friesen v. Forest Prot. Ltd. (1978), 22 N.B.R. (2d) 146–71.

174 See Rashid, *supra* note 163, at 12.

175 See Bridges Brothers Ltd. v. Forest Protection Ltd. (1972). 5 N.B.R. (2d): 585–591.

176 B.B. McLeod & R.L. Millikin, *Environmental impact assessment of experimental spruce budworm adulticide trials: Effects on forest avifauna*, (1982), *available at* http://cfs.nrcan.gc.ca/publications/?id=8774.

ed 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 one. However, it is possible to notice that 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 this 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 that are important for the health of the forest, but that are not interesting 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.[177]

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

[177] Holling et al., *supra* note 314, at 170.

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.

VI. Conclusion

Sustainable development is essentially a means to implement the *land ethic.* Failure in doing so risks reducing the attainment of sustainable development to mere duplication of the old kind of development, the one 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 also enhances the enforcement of sustainable yield by acknowledging that economic growth must be restrained when deemed necessary to prevent total exhaustion of natural resources. 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 provision of resources and services which both society and the economy depend upon to continue existing. As the final result of this effort is the maintenance of subsidies for a balanced society and a stable economy, it is possible to affirm that the principle of resilience provides greater economic efficiency in the long term and a deeper understanding of 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.

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 principle of resilience 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. However, 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.

This article 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 in 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, States have come to understand and to apply sustainable

development[178]. In twenty years, environmental problems became worse. The patterns of deterioration show that conservation without resilience is not enough. That is why this article concludes that, 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.

[178] *Agenda 21*, *supra* note 111.