

**Environmental Territorial Planning: a key instrument to attain Sustainable Development and UN Sendai Framework Goals in the Americas**

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1. **Introduction**

In 2018-2019 three alarms were raised by the UN in regard to the state of the environment of Eco Sphere Earth. The first one refers to the great vulnerability in the face of Climate Change, which includes disaster development. The second one is related to the exponential loss of biodiversity which occurs in all ecosystems of the planet and plunges into the Sixth Great Extinction of Species (the first one resulting from anthropic causes). Lastly, the third one is the threat of reaching a Point of No Return and the start of the extinction of Humanity itself, due to the loss of fertile soils for agriculture and the lack of hydric resources which in turn will cause lack of food (both from land and sea sources) for an increasingly numerous human population, especially in the developing world.

The decarbonization derived from the Convention on Climate Change (UNFCCC) and the Paris Accords of 2015 is not sufficient to avoid the Point of No Return. Much more is necessary. The damage to ecosystems, the pollution and the larger part of the very serious environmental problems which we now face have occurred at a local scale, in other words, at local government level. Thus, the solutions to these problems also should start at a local level. There is no magic formula which will fix things quickly and painlessly. But there is indeed a need to start working on systemic actions.

In face of this situation, the author --as a specialist in Environmental Territorial Planning for local governments—has proposed to use this tool as the means to jumpstart action at the level of local governments in order to avoid the Point of No Return (which will occur between 2030 and 2050) and revert the great environmental problems which we now face and which will only worsen in the coming years.

As things stand, this article tries to explain how Environmental Territorial Planning (ETP) can serve as a strategic tool to avoid the extinction of life on Eco Sphere Earth and save humanity itself.

1. **¿What is Environmental Territorial Planning?**

Environmental Territorial Planning (ETP, or OAT in Spanish) “consists of the inventory, diagnostics and definitions of the natural conditions of the environment in a given geographical space, with the purpose of defining its usage limitations and its aptitude conditions for the development of determined human activities. For practical purposes ETP means to analyze all the set of variables that are derived from a given environment and define from an integral analysis thereof a distribution or division of said geographical space according to the natural aptitudes of said space and according to the limitations it sets upon the development of activities, works or projects” (MINAE, 2006).

ETP differs from conventional Land Use Planning as it does not place humans at the center of the process, instead the key element is its emphasis on Nature and its condition of environmental fragility, which is inversely proportional to its capability to receive an additional environmental load (meaning, human activities).

From a macro point of view, ETP allows to identify fragile ecosystems which require protection or recovery and it also defines zones for agriculture and livestock with recommendations about its sustainable use and also urban development zones for the design of ecological and sustainable cities. ETP is particularly useful to define according to environmental criteria the agricultural border at the level of local governments.

The main instrument to implement ETP is the method of the Environmental Fragility Index (EFI, or IFA in Spanish) developed by the author in the late 90s (see Mende & Astorga, 2006 and Astorga & Milano, 2010) and it was donated to the Department of Environmental Issues and Energy of Costa Rica to be published in the year 2006, as a decree by the Executive Power in order to standardize the procedure of integration of the environmental variable within the land use planning for local governments. Thus, in Costa Rica there is already ample experience in the matter of the application of this methodology and of ETP, which has been already put in action in over 50 (out of 82) local government of the country. In Figure 1, an example is shown of the base map for ETP in the Canton of Limón on the Caribbean Coast of Costa Rica (see Astorga et al, 2019). The use of the EFI method allows to generate as one of its output products, the map of environmental macrozones, of three categories: Very High Environmental Fragility, High Environmental Fragility and Moderate Environmental Fragility. There are no zones of low, o very low environmental fragility. As part of Figure 1, there is also a text box that provides guidance on the human usage types that could be developed on the base of this zoning. The areas in red (which mark Very High Environmental Fragility) should be dedicated primarily to conservation and eco-system recovery. Areas in orange (High Environmental Fragility) should be used for sustainable agriculture and livestock activities and areas in yellow (Moderate Environmental Fragility) for ecologically sustainable urban development.

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| ***Fig. 1.*** *Map of Integrated EFI macrozones of Limón Canton on the Caribbean Coast of Costa Rica (se. Astorga et al., 2019). Three categories are observed: Very High Fragility, High Fragility and Moderate Fragility. The box indicates potential usage of these special units: ecosystem preservation, sustainable agriculture and livestock and sustainable urban development.* |

1. **Basic elements of the Environmental Fragility Index (EFI, or IFA) Methodology**

The EFI (IFA) methodology is a process for the identification of environmental factors by means of geospatial images (at a 1:25,000 scale) and field data. In Table 1 the whole set of 34 environmental factors used for generating EFI (IFA) maps are listed. As can be seen, an important percentage of these factors comes from the detailed interpretation of geospatial images. Many others derive from local information (locally published or through scientific journals) and from field work for the identification of geospatial unities.

The identified environmental factors are rated according to a standard established by the EFI (IFA) methodology and that has been tested in the field for almost 15 years in Costa Rica in over 50 municipalities. Each factor is rated according to the following scale: 1 (Very High Fragility), 2 (High Fragility), 3 (Moderate Fragility), 4 (Baja), 5 (Muy Baja). The rating of each factor automatically defines either an environmental technical limiting factor or to the contrary a technical potentiality. The generation of the maps is realized by means of a GIS (Geographical Information System) that generates maps for each factor and the combination of them generates the maps of the four EFI categories: Geoaptitude EFI (see Astorga & Campos, 2001), EFI Bioaptitud, EFI Edafoaptitude and EFI Anthropoaptitud (see Figure 2).

**Table 1.**

**Key EFI Factors**

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| **Nr.** | **Data** | **Source** |
| **1.** | Delimitation of a geological unit | Field data (1:25.000) |
| **2.** | Name of a geological unit | Field data (1:25.000) |
| **3.** | Rock hardness | Field data (1:25.000) |
| **4.** | Consistency | Field data (1:25.000) |
| **5.** | Lineation factor | Field data (1:25.000) |
| **6.** | Soil layer thickness | Field data (1:25.000) |
| **7.** | Clay content | Field data (1:25.000) |
| **8.** | Porosity / Apparent permeability | Field data (1:25.000) |
| **9.** | Delimitation of a gemorphological unit | Field data (1:25.000) |
| **10.** | Slope | Satellite data process |
| **11.** | Relative relief | Satellite data process |
| **12.** | Drain density (km/km2) | Satellite data process |
| **13.** | Importance of erosion processes | Field data (1:25.000)\* |
| **14.** | Importance of sedimentation processes | Field data (1:25.000)\* |
| **15.** | Drain density of permanent currents | Satellite data process |
| **16.** | Hydrogeological profile index | Field data (1:25.000) |
| **17.** | Infiltration potential | Field data (1:25.000) |
| **18** | Data of groundwater extraction wells | Field data (1:25.000) |
| **19.** | The top three rainy months of the years | Satellite data process |
| **20.** | Slope direction vs. main lineation direction | Field data (1:25.000)\* |
| **21.** | Regional seismicity potential | Satellite data process\*\* |
| **22.** | Local seismicity potential (seismicity index) | Satellite data process\*\* |
| **23.** | Terrain liquefaction potential | Field data (1:25.000) |
| **24.** | Geological fault-caused Surface fracture potential | Field data (1:25.000)\* |
| **25.** | Volcanic threat | Satellite data process\*\* |
| **25.** | Tsunami potential in coastal regions | Satellite data process\*\* |
| **26.** | Flooding potential | Satellite data process\*\* |
| **27.** | Vegetal coverage types | Satellite data process\*\* |
| **28.** | Biological corridor | Satellite data process |
| **29.** | Bodies of wáter and drainage network | Satellite data process\*\* |
| **30** | Soil types | Satellite data process\*\* |
| **31.** | Land use capacity | Satellite data process |
| **32.** | Agriculture and livestock use | Satellite data process |
| **33.** | Urbanistic use | Satellite data process |
| **34.** | Archaeological sites, natural and scientific heritage | Satellite data process\*\* |
| **35.** | Annual maximum temperature projection data | Satellite data process |

*Clave: (\*) with the support of satellite images. (\*\*) with the support of local data*

Figure 3 shows the logic of the data process and the environmental fragility map generation for geospatial units, defined according to geological and geomorphological criteris (see, Mende & Astorga, 2006). This process generates environmental fragility maps that are used as the basis for the automatic generation of environmental territorial planning maps, which are defined by a system of algorithms that allow the generation of the Limiting Factor and Use Potentiality Table for each of the identified environmental fragility units.

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***Fig. 2.*** *Analysis categories considered part of the EFI methodology and their different components. As can be seen all key elements of the physical, biological and human environment are taken into consideration.*

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***Fig. 3.*** *Brief synopsis of the logical flow of the application process of the Environmental Fragility Index for the identification of geospatial units and the development of environmental fragility zoning as base for its transformation into environmental territorial planning. The system can function automatically by a system of algorithms and AI.*

1. **Main EFI products and their application**

Figure 4 shows the logic of the development of the EFI maps. For instance, in the case of geology. The first step consists of the compilation of all information published in journal, magazines, thesis, institutional studies and other information available from local governments and/or other entities. The second step comprises the interpretation of geospatial images with an emphasis on geological interpretation and the preliminary definition of spatial unities. The third step is the acquisition of field data (factors) for each of the identified geospatial units. From this a geological map is built (see Figure 5 and the corresponding geological profiles) and also a Table of values for each of the established environmental factors. The integral processing of the data allows to generate the EFI Geoaptitude map by a lithopetrophysical factor (see Figure 6). This map indicates the geomechanical (support capability) performance condition of the geospatial units within a system of five levels of fragility: from Very High to Very Low. This map results in more powerful communication instrument than explaining the geological map.

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***Fig. 4.*** *Methodological procedure for the generation of EFI maps, for each environmental factor. Previously published data or retrieved from different institutions is compiled and combined with the interpretation of geospatial images and complemented with field-work. Finally, everything is integrated and a thematic map is generation along with its corresponding EFI map (see Figure 5).*

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| C:\Users\Usuario\Desktop\LIMON EMI PARA ACTUALIZAR EL ATLAS 28abil 2017\limon_mapa 6b - perfiles 2.jpg |
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***Fig. 6.*** *Geological map of the canton of Limon in Costa Rica and its corresponding geological profiles. Below that rating of the environmental factors according to the EFI methodology. The resulting EFI map is shown in Figure 7.*

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***Fig. 7.*** *EFI Map of Lithopetrophysical Geoaptitude generated as a product of the geological map of the canton of Limón in Costa Rica (see Figure 6). This map measures the geomechanical behavior of the geological units and allows a better understanding since it only uses types of environmental fragility rating.*

Following the logic discussed above the rest of the set of EFI maps are generated for the different factors. In Table 2 the main maps produced by the application of EFI methodology are listed and their different direct uses.

**Table 2.**

**Main maps generated from the application of the EFI methodology and their direct uses**

| **Nr.** | **Thematic map** | **EFI map** | **Uses** |
| --- | --- | --- | --- |
| **1.** | **Geology** | **Lithopetrophysical Geoaptitude** | Determines geomechanical behavior such as support load |
| **2.** | **Geomorphoplogy** | **External Geodynamic Geoaptitude** | Defines geospatial units of territorial planning. Identifies active erosion-sedimentation processes. |
| **4.** | **Hydrogeology** | **Hydrogeological Geoaptitude** | It establishes the existence of aquifers in the higher subsoil. Determines the hydrogeological vulnerability to pollution. Determines the sites of potential drilling for wells for the extraction of groundwater. Determines the areas for aquifer recharge and discharge. |
| **5.** | **Slope stability** | **Slide Geoaptitude.** | Identifies unstable slope zones susceptible to slides generated by hydrometereological events or seismicity. |
| **6.** | **Natural hazards** | **Integrated Natural Hazard Geoaptitude** | Map that integrates all areas susceptible to natural hazard conditions, for simplicity categories of Very High and High Hazard are used. Determines the degree of vulnerability and defines buildings and infrastructures in conditions of High and Very High risk |
| **7.** | **Local and Regional Seismicity** | **Seismicity Geoaptitude** | Determines the susceptibility of the geographical space to the seismic activity produced by regional or local sources.  Maximum intensities and seismic acceleration. |
| **8.** | **Surface fracture potential caused by active geological faults** | **Neotectonic Geoaptitude** | It categorizes faults as active, potentially active or inactive. It fixes safety zones for the active and potentially active geological faults. |
| **9** | **Liquefaction potential** | **Liquefaction Geoaptitude** | Defines geospatial units with liquefaction potential and restricts soil use. |
| **10** | **Flooding potential** | **Fluvial flooding or mudslide path Geoaptitude** | Defines áreas of High or Very High Risk of flooding and mudslide path or any flow that descends by a fluvial basin. |
| **11** | **Coastal zone Tsunami potential** | **Tsunami Geoaptitude** | Defines the zone with the higher potential effects for Tsunamis based on historical registries for the area. |
| **12** | **Volcanic Hazard Potential** | **Volcanism Geoaptitude** | Defines the sites with the higher potential effects caused by volcanic activity from a localized emission center located within a 30km radius. |
| **13** | **Geoaptitude** | **Integrated Geoaptitude EFI** | Defines the areas of higher Geoaptitude fragility and its technical limiting factors. Also it identifies the sites with a better Geoaptitude in order to locate human activities of potential high impact as long as it does not affect other environmental factors. |
| **14.** | **Protected areas and vegetation coverage. Biological corridors.** | **Bioaptitude** | Delimitation of natural and secondary forest zones. Pasture areas. Agricultural activities. Biological corridors. Water bodies and currents. Definition of the quality of the eco-systems with field analysis. It does not imply a species inventory. |
| **15** | **Present soil types** |  | Based on edafological data and the integration with geological and geomorphological data. Defines the soils with higher agricultural fertility and the ones with lesser potential. It delimits desertification areas. |
| **16.** | **Land Use Load Category** | **Edafoaptitude** | It delimits the zones of forest aptitude and the minimal area that should have forest cover or vegetation eco-systems. It limits the agricultural border, according to land use load |
| **17.** | **Agricultural uses** |  | Determines the types of crops present in the geographical space. |
| **18.** | **Urban uses** |  | Determines the different usage categories according to constructions, including industrial areas, urban areas, commercial areas, etc. It can highlight strategic infrastructure: hospitals, schools, etc. |
| **19.** | **Transit infrastructure and road networks** |  | It delimits and categorizes all the existing road network and their conditions. It identifies strategic infrastructure such as bridges, airports, ports, oleoducts, chemical plants, etc. |
| **20** | **Scientific or cultural interest areas** |  | Archaeological sites. Cultural and scientific heritage sites. Geotopes and Geosites. |
| **21** | **Landscape map** | **Landscape EFI** | It defines landscape units according to topographical criteria and land use thereof. |
| **22** | **Integrated actual use map** | **Anthropoaptitud EFI** | It locates the different existing land uses and rates then environmentally. |
| **23.** | **Integrated EFI Map** |  | Identifies and limits the macrozone of environmental fragility to define guidelines for land use. |
| **24** | **Subclassified EFI Map** |  | Identification of all existing environmental fragility zones in the geographical space. Each zone is accompanied with a technical Table of Limiting Factors and Potentialities, along with the potential use recommendations base on environmental criteria. The environmental conditions are fixed. |
| **25.** | **Actual environmental overuse map** | **Overlay of the actual use map over the EFI Subclassified Map** | It established the balanced environmental use zones. It identifies the over use zones and the reasons that generate said over use. It defines two categories of intermediate use and critical use. It established the corrective measures to apply. In some cases it fixes the guidelines so high impact activity is relocated to a site of lesser environmental fragility. |
| **26** | **Base Environmental Map** | **Combines the EFI Subclassified Map and the Actual Environmental Overuse Map** | It is the base map for the Environmental Territorial Planning of the geographical space. |
| **27** | **Land or soil use zonification Map** | **Environmental Territorial Planning Map** | Defines geospatial units with the use of natural and non-artificial limits. It determines the maximum use for land for human, urban and agricultural activities. It limits the agricultural border. It established the conservation areas and the ecosystem enhancement guidelines. |
| **28** | **Technical and juridical environmental land use restrictions map** |  | Conforms a layer that is overlaid to the zonification map and it established the technical-juridical restriction to the land use for human activities. |
| **29** | **Potential overuse map** | **Overlay of the Environmental Base Map over the Land use zonification map** | Allows to identify the conformity of the environmental territorial planning and it establishes the required corrections when necessary. |
| **30** | **Climate scenarios map** | **Establishment of annual maximum temperatures on the map of environmental fragility and land use proposal** | It allows establishing scenarios of affectation and adaptation to climate change |

*Fuente: Executive Decree Nr. 32967 – MINAE, Astorga & Milano (2010)*

1. **The ETP and local governments**

Local governments play a key role; given that they are the entity that defines the guidelines that determine strategic decisions regarding land use in their jurisdictions. They define which are the urban development areas, the agricultural and livestock activity zones and they can even intervene in the definition of areas for the protection of eco-systems and their recovery. The delimitation of the agricultural border is a field of action of local governments, which should be the first state institution to take action on the topic of environmental protection. Also, local government should manage other topics such as hydric resource management, recovery of ecosystems and degraded basins, preventive risk management, landscape management, cultural use of geotouristic resources and archaeological heritage, among others.

On the other hand, it is relevant to pinpoint the damage notices by the UN for terrestrial ecosystems which has occurred at a local level and has been cumulative. Thus the process to stop this damage and revert it in the short timeframe before the Point of No Return (2030 to 2050 according to UN reports) must be implemented at a local level, where local governments play a leading role.

Local government also play a key role in the implementation of some of the measures, that recently over 11,000 scientists of 153 countries published in an open letter in which they warn that to avoid “incalculable suffering due to climate change” dramatic changes must be made to society. Scientists have a moral obligation to clearly warn humanity of any catastrophic threat and to tell things as they are, as is pointed out in *BioScience Magazine* (BBC News, 10.11.2019).

Within these urgent actions recommended to be implemented at a local level by local governments the following can be highlighted:

* **Polluting agents:** It is necessary to eliminate or limit emissions or production of methane, hydrofluorocarbons and soot. By limiting these contaminants, the short term tendency to warming to be cut by a 50% within few decades.
* **Nature:** the destruction of forests must be stopped, also forest areas, prairies and mangroves must be restored. These measure will raise CO2 trapping from the environment.
* **Food:** a great change in diet is urgent. We all must consume a higher part of plant-based food and reduce food of animal origin such as red meat. It is also imperative to reduce food waste.
* **Economy:** Reduce the dependence on fossil fuels. It is necessary to change the current economic approach that pursues incessant growth and only takes GDP as indicator.
* **Population:** the world populace is growing at a pace of 200,000 births each day. It is recommended to reduce the growth pressure of the world population through ethical measures such as encouraging and guaranteeing the education of girls and young women. Several studies have shown that the higher the education level of women, it usually goes hand in hand with a reduction in the number of children.

These actions must be supported, as possible, from local governments with concrete plans over land use and specific management actions within their jurisdictions. State or national governments may develop general policies but actions required the intervention of everyone and local governments and the communities that comprise them are fundamental as they function as autonomous cells and that can collaborate directly and function synchronically with other cells, other local governments.

1. **Fulfillment of the 2030 Sustainable Development Goals**

At the United Nations Sustainable Development Summit in September 2015, the UN Member States approved the 2030 Agenda for Sustainable Development which includes a set of 17 Sustainable Development Goals (SDGs) to end poverty, fight against inequality and face climate change.

The SDGs, commonly called World Goals, are based upon the Millenium Development Goals (MDGs): eight goals in the fight against poverty that the world set to complete by 2015. The MDGs were adopted in the year 2000 encompass objectives such as the reduction of poverty, world hunger, disease, gender inequality and raising access to potable water and sanitation. Huge progress was made in regard to the MDGs, which shows the value of having a unifying agenda supported by concrete goals and objectives. In spite of this success, poverty has not been eradicated for all.

Within these SDGs there are at least two goals and their guidelines directly relevant to Environmental Territorial Planning:

Goal 11. Make cities and human settlements inclusive, safe, resilient and sustainable

11.1 By 2030, ensure access for all to adequate, safe and affordable housing and basic services and upgrade slums

11.2 By 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons

11.3 By 2030, enhance inclusive and sustainable urbanization and capacity for participatory, integrated and sustainable human settlement planning and management in all countries

11.4 Strengthen efforts to protect and safeguard the world’s cultural and natural heritage

11.5 By 2030, significantly reduce the number of deaths and the number of people affected and substantially decrease the direct economic losses relative to global gross domestic product caused by disasters, including water-related disasters, with a focus on protecting the poor and people in vulnerable situations

11.6 By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management

11.7 By 2030, provide universal access to safe, inclusive and accessible, green and public spaces, in particular for women and children, older persons and persons with disabilities

11.a Support positive economic, social and environmental links between urban, peri-urban and rural areas by strengthening national and regional development planning

11.b By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015–2030, holistic disaster risk management at all levels

11.c Support least developed countries, including through financial and technical assistance, in building sustainable and resilient buildings utilizing local materials

Goal 15. Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss

15.1 By 2020, ensure the conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services, in particular forests, wetlands, mountains and drylands, in line with obligations under international agreements

15.2 By 2020, promote the implementation of sustainable management of all types of forests, halt deforestation, restore degraded forests and substantially increase afforestation and reforestation globally

15.3 By 2030, combat desertification, restore degraded land and soil, including land affected by desertification, drought and floods, and strive to achieve a land degradation-neutral world

15.4 By 2030, ensure the conservation of mountain ecosystems, including their biodiversity, in order to enhance their capacity to provide benefits that are essential for sustainable development

15.5 Take urgent and significant action to reduce the degradation of natural habitats, halt the loss of biodiversity and, by 2020, protect and prevent the extinction of threatened species

15.6 Promote fair and equitable sharing of the benefits arising from the utilization of genetic resources and promote appropriate access to such resources, as internationally agreed

15.7 Take urgent action to end poaching and trafficking of protected species of flora and fauna and address both demand and supply of illegal wildlife products

15.8 By 2020, introduce measures to prevent the introduction and significantly reduce the impact of invasive alien species on land and water ecosystems and control or eradicate the priority species

15.9 By 2020, integrate ecosystem and biodiversity values into national and local planning, development processes, poverty reduction strategies and accounts

15.a Mobilize and significantly increase financial resources from all sources to conserve and sustainably use biodiversity and ecosystems

15.b Mobilize significant resources from all sources and at all levels to finance sustainable forest management and provide adequate incentives to developing countries to advance such management, including for conservation and reforestation

15.c Enhance global support for efforts to combat poaching and trafficking of protected species, including by increasing the capacity of local communities to pursue sustainable livelihood opportunities

It is possible to conclude that to comply with the above quoted goals and the vast majority of its guidelines it becomes imperative to implement Environmental Territorial Planning at a sufficiently detailed scale (1:25,000) so that local governments can perform concrete actions to fulfil these guidelines.

1. **Fulfillment of the Sendai Framework for Disaster Risk Reduction 2015 – 2030**

The Sendai Framework for Disaster Risk Reduction was adopted at the third United Nations World Conference celebrated in Sendai (Japan) between March 14th and March 18th, 2015. It is a successor instrument to the Hyogo Framework for Action 2005-2015: Building the Resilience of Nations and Communities to Disasters.

In order to support the evaluation of global advancement in attaining the goals and targets of the present framework seven global goals have been defined. These goals are measured at a global scale and will be complemented with work destined to prepare the pertinent indicators. The goals and national indicators also will contribute to obtain the result and targets of the Framework:

(a) Substantially reduce global disaster mortality by 2030, aiming to lower average per 100,000 global mortality rate in the decade 2020-2030 compared to the period 2005-2015.   
(b) Substantially reduce the number of affected people globally by 2030, aiming to lower average global figure per 100,000 in the decade 2020 -2030 compared to the period 2005-2015.   
(c) Reduce direct disaster economic loss in relation to global gross domestic product (GDP) by 2030.   
(d) Substantially reduce disaster damage to critical infrastructure and disruption of basic services, among them health and educational facilities, including through developing their resilience by 2030.   
(e) Substantially increase the number of countries with national and local disaster risk reduction strategies by 2020.   
(f) Substantially enhance international cooperation to developing countries through adequate and sustainable support to complement their national actions for implementation of this Framework by 2030.   
(g) Substantially increase the availability of and access to multi-hazard early warning

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***Fig. 8.*** *Spectrum of geological risks or (geo-risks) that exist in Nature and their respective characterization in relation to risk management. It is to be emphasized in the “Prevention” column as in 95% of the cases, preventive action van be realized through land use ruling, in other words, through Environmental Territorial Planning (ETP).*

systems and disaster risk information and assessments to the people by 2030.

The Sendai Framework also defines four priorities:

* Understanding disaster risk
* Strengthening disaster risk governance to manage disaster risk
* Investing in disaster risk reduction for resilience
* Enhancing disaster preparedness for effective response and to “Build Back Better” in recovery, rehabilitation and reconstruction

A proper risk management, especially preventive action, must start with Environmental Territorial Planning. In Figure 8 the list of existing georisks for many countries is presented, especially those that are located within the margin of active plate tectonics.

As can be seen in relation to preventive risk management it is indispensable to perform cartography or the sources of natural hazards (geo-risks) at an appropriate scale (1:25,000 or more detailed) in order to define soil (or land) use rules that allow to define the safe sites in which to develop human activities or at least to define design and conditioning factors that allow for greater security for the infrastructure works to be developed.

In relation to this the EFI methodology defines within its EFI Geoaptitude component all the spectrum of information required to complete a proper preventive risk management (see Figure 9 and 10).

1. **Right to a Healthy Environment**

Advisory Opinion OC-23/17 from November 15th 2017 of the Inter-American Court of Human Rights on the effect of the obligation derived from environmental law in relation to the obligations of respect and guarantee of human rights established in the American Convention of Human Rights.

Within the more relevant aspects developed by the Inter-American Court strictly related to the right to a healthy environment the following can be highlighted:

“The human right to a healthy environment has been understood as a right that has both individual and also collective connotations. In its collective dimension, the right to a healthy environment constitutes a universal value that is owed to both present and future generations. That said, the right to a healthy environment also has an individual dimension insofar as its violation may have a direct and an indirect impact on the individual owing to its connectivity to other rights, such as the rights to health, personal integrity, and life. Environmental degradation may cause irreparable harm to human beings; thus, a healthy environment is a fundamental right for the existence of humankind.” (Article 59)

“The Court considers it important to stress that, as an autonomous right, the right to a healthy environment, unlike other rights, protects the components of the environment, such as forests, rivers and seas, as legal interests in themselves, even in the absence of the certainty or evidence of a risk to individuals. This means that it protects nature and the environment, not only because of the benefits they provide to humanity or the effects that their degradation may have on other human rights, such as health, life or personal integrity, but because of their importance to the other living organisms with which we share the planet that also merit protection in their own right. In this regard, the Court notes a tendency, not only in court judgments, but also in Constitutions, to recognize legal personality and, consequently, rights to nature.” (Article 62)

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|  |  | ***Fig. 9.*** *Synthetic maps of the natural hazard susceptibility for the canton of Limón in Costa Rica. It matches the sum of the maps of landslides (unstable slopes), seismicity, local seismic acceleration, surface fracture potential due to active geological faults, liquefaction, flooding, tsunamis in coastal regions and volcanism. Obtaining this cartography at a 1:25,000 scale or higher detail allows local governments to perform preventive risk management at a local scale which is crucial to be able to save live and perform corrective actions such as education to inhabit with risk, emergency plans, early alert systems and even develop parametric insurance development y resilience insurance against Disasters. The development of this cartography also allows to identify strategic infrastructure which is located in conditions of High to Very High risk.* | | |
| **Landslides** | **Seismicity** |
|  | Imagen que contiene texto, mapa  Descripción generada automáticamente |
| **Seismic acceleration** | **Geological faulting** |
|  |  |
| **Liquefaction** | **Flooding** |
|  |  |
| **Tsunamis** | **Vulcanism** |
|  | | | ***Fig. 10.*** *Example of the products that are generated in matters of Risk Management: a) Map of unstable slopes, b) Map of urbanized areas and c) Map of urbanized areas on unstable slopers in high to very high risk. Area of study: Greater Metropolitan Area of San José, Costa Rica (based upon Astorga et al., 2008)).* |
|  | | |
|  | | |

“The rights especially linked to the environment have been classified into two groups: (i) rights whose enjoyment is particularly vulnerable to environmental degradation, also identified as substantive rights (for example, the rights to life, personal integrity, health or property), and (ii) rights whose exercise supports better environmental policymaking, also identified as procedural rights (such as the rights to freedom of expression and association, to information, to participation in decision-making, and to an effective remedy).” (Article 64)

“Thus, the right to a healthy environment as an autonomous right differs from the environmental content that arises from the protection of other rights, such as the right to life or the right to personal integrity” and “the rights to life, personal integrity, private life, health, water, food, housing, participation in cultural life, property, and the right to not be forcibly displaced.” (Articles 63 and 66)

With the purpose to fulfill the obligation of prevention states “must regulate, supervise and monitor activities within their jurisdiction that could produce significant environmental damage; conduct environmental impact assessments when there is a risk of significant environmental damage; prepare a contingency plan to establish safety measures and procedures to minimize the possibility of major environmental accidents, and mitigate any significant environmental damage that may have occurred” (Articles 141 to 174).

In this manner the application of this Sui Generis Right also favors the realization of a proper Environmental Territorial Planning at a local scale, given that it is the most effective way of guaranteeing a healthy environment.

1. **Rescue and recovery of Ecosphere Earth as a strategic step in uniting Latin America and the Caribbean**

As has been pointed out, Ecosphere Earth is in grave danger. The three red alerts raised by the UN confirm this. Latin America and the Caribbean cannot escape this. The decarbonization of the economy is not enough to avoid the Point of No Return. Avoiding the raising of the oceanic and atmospheric temperature is certainly a positive measure to reduce the negative effects of Climate Change, yet it is not enough. There are other measures to take in relation to the ecosystems of the Ecosphere which are in danger of extinction, partly due to our predating economy based on the false premise that natural resources are infinite (an old idea from the early 19th century).

One of the major problems we have in taking notice that we do face a planet wide crisis is that the negative effects of the three red alerts raised by the UN are diluted over several years or decades. Thus, the everyday problems of the economy, taxation, cost of living, education, health and other are felt more directly and rendered as more important. Not only to common people, but also to the press and the media, the very same authorities of government, both central and local. It may seem that nothing is happening as we feel a gentle breeze blowing in our face, while we tumble down over a cliff to the rock-bottom where we will face our extinction.

While there are global measures to be taken which can mitigate our planetary crisis, such as the Paris Accords of 2015, there are other urgent measures that can be taken now and the more direct and effective way to implement them is in the local scale, through local governments. Thus, the huge importance placed on the fact that local governments and local communities take conscience of the urgency to rank actions and execute them.

Every local government represents a cell of a huge living organism that composes the continental Ecosphere Earth. Just like cell have their own autonomous functions and survival, so local government must function within their territories to revert the damage caused by humankind. It is the only reasonable way, there is no magical solution. It requires a lot of work at a local scale with compromises from local authorities, mayor, educators, businesspeople and producers, academia, independent professionals and the general population.

As we have pointed out the key steps to be taken are:

* Environmental Territorial Planning at a detailed scale (1:25.000)
* Soil use categorization: urban, agriculture and farming, conservation with a clear balance between the three components
* Recovery of degraded territories with strategic and natural reforestation for the betterment of ecosystems
* A quick transition from the productive model of agricultural and livestock activities to a vision of non-polluting and state of the art technology-based regenerative agriculture and livestock
* Environmentally sustainable urban development, non polluting and with incentives for sustainable production that offers opportunities of economic development to human communities to eradicate poverty and mend the social breach.
* Correction and prevention of pollution
* A rapid transition to the use of more sustainable and safe energies such as geothermal
* Strategic planning of development focused in a raise of human and natural resilience

The advantage of taking action with all these measures, as soon as posible, is that it allows every local government to raise its resilience and promote a natural and human development in a more accelerated manner, and also environmentally sustainable at the same time.

The individual action of every local government in the same direction will allow our Ecosphere to heal “cell by cell” and that we can avoid the point of no return. As we can see it is a job for all of us, and we need local authorities clearly conscious and responsible of the urgent tasks ahead.

**National and planetary actions:** the central government authorities must promote strategic actions that facilitate the local governments to take measure as soon as possible. It is necessary that the same government authorities take a more proactive action in the tasks that must be developed to save Ecosphere Earth. Policies must be based on technical criteria, that allow to make strategic decision in very brief timeframes.

In many cases the juridical framework must be updated to adapt to the crisis conditions we face today. The same strategic measures mentioned before, must apply to a national framework that defines a management policy to save Ecosphere Earth.

Ona a global level, strategic action is also needed. One of the most important is to save the oceans and ocean base life. It is vital, because the marine ecosphere is also in grave danger. The Principle of Environmental Sustainability (see, <https://allan-astorga.com>) must be integrated into the economy, because to the contrary, the economic system will become a major global obstacle in the struggle to avoid the Point of No Return.

UN Actions and programs must be bolstered and accelerated, such as the Sustainable Development Goals 2030. Greater investment is necessary in these global programs. Less investment in weapons and war, and a much bigger investment in the planetary Ecosphere.

Latin America and the Caribbean, by means of the work directed from their local government with the purpose of saving their Terrestrial Ecosphere, have the opportunity to signal the right path that could be the basis for a subcontinental union, a federate state, but working together with a common target, which could later evolve into other factors that rise above traditional political and ideological differences.

1. **Forwards, onto artificial intelligence**

The experience acquired in Costa Rica by the author and his collaborators, over the last 20 years has given ample opportunity to test and perfect the methodology and to give a step forward to transform the processing of date and the map generation and soil use guidelines to develop a set of algorithms handled by artificial intelligence (SALVE TERRA program), at least in relation to the greater macro zones of soil use. We consider that this is indispensable in order to guarantee the generation of quick and simultaneous products, in a transparent way.

The author considers that the application of artificial intelligence would eliminate human factors that have contributed to the deterioration of the system, particularly corruption, influence peddling and other elements that distort the system, which is not convenient in any way, and less in conditions of planetary urgency to save the life of the planet.

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