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Application and assessment of the Environmental Vulnerability Index in Greece

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ABSTRACT

The Environmental Vulnerability Index (EVI) was developed by the Pacific Islands Applied Geoscience Commission as a global composite index that quantifies the vulnerability of an area's environment. Greece has been selected as reference area due to its current physical and anthropogenic conditions that may lead to environmental instabilities in the natural, social, and economic infrastructure environment. Hence, in the present approach, using data on Greece, an effort to define the range of information that the EVI may provide for the pertinent country is presented and a discussion on whether the index may be further developed is conveyed. Advantages as well as shortcomings of the Index are also delineated.

1. Introduction

Most of the literature has indicated that ecological resilience refers to an ecosystem's ability to absorb shocks while maintaining almost the same function or – expressed differently – remain within the same state (Carpenter et al., 2001; Folke et al., 2002). On the other hand, vulnerability refers to the propensity of social or ecological systems to suffer harm from external stresses (Kasperson et al., 1995). These terms exhibit usually a vague and confusing character since they have been widely used with different meanings in a variety of disciplines and they are considered to be antonyms (Gallopin, 2006; Pratt et al., 2004a). In other words, when a system loses resilience, it becomes vulnerable (Kasperson and Kasperson, 2001). They also present a dynamic character which is changing from one time scale to another and as such they can be used as valuable indicators of a region's environmental state (Adger and Kelly, 1999; Folke et al., 2002; Leichenko and O'Brien, 2002).

The term vulnerability has been employed by a large number of authors. In the current effort, vulnerability would be treated as a phenomenon in convolution with hazard. Since without a hazard, no system is vulnerable (Gallopin, 2006). Thus, the vulnerability definition followed may be understood as the internal risk factor of a system.

Risk is the potential changes of the exposed system, emanating from the convolution of hazard and vulnerability, and in this context it may be mathematically estimated (Cardona, 2004). Measuring the environmental vulnerability of an ecosystem, a region or a country, is an extremely complex task since the ability of a particular system to cope with potential stresses or the pressure required for an ecological threshold to be crossed cannot be exactly determined in space and time (CCSP, 2009). Such knowledge could enhance the human ability to predict – within a range of certainty – an ecosystem's behavior under specific unsettling events and guide the environmental management options – at any level – towards a sustainable path (Folke et al., 2002).

The Mediterranean region's ecosystems and societies are among the most vulnerable to resources development, climate variability and anomalies. Greater temperature increases than the global average may be mostly expected for the region, with adverse effects on ecosystems and societal well-being. The challenges created by limited resources and climatic vagaries will be further exacerbated by the presence of several resulting stresses and by the area's relatively low adaptive capacity. Improving adaptive capacity and building resilience is essential for reducing the potential impacts and/or related environmental changes on the natural and the anthropogenic environment.

A major challenge then for the research community is to develop appropriate workable methods on how to map multiple ecosystem conditions and hazards, i.e. to determine where they are generated and at what scales, how they change under different pressures,

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what their rates of renewal are and what trade-offs are involved. Currently there are not many tools available to enable decision-makers and natural resources user groups to view, assess and value multiple ecosystem conditions and hazards. In this context, indicators and their synthesis into indices offer a much needed methodological approach (Dale and Beyeler, 2001).

To date, an array of vulnerability indices has been developed such as the Composite Human Vulnerability Index, and the Global Vulnerability Mapping (Kaly et al., 2004). From that array, the Environmental Vulnerability Index (EVI) – developed by South Pacific Geoscience Commission (SOPAC) is applied in the current effort.

The EVI is of particular interest because it focuses on capturing and quantifying the total environmental vulnerability of a country or a region (Luers, 2005). The EVI does not focus on vulnerability to a single hazard (e.g. forest fires or climate change in general), but considers a cross-section of the major factors interacting in complex systems. Furthermore, unlike previously developed vulnerability indices (Pratt et al., 2004a), it is totally focused on impacts on the environment itself and not on human systems.

The EVI has been tested and applied at a global scale and produced the first vulnerability scores for 235 countries in 2004 (Kaly et al., 2004). Since then, it has undergone several revisions. To become a valuable tool that could provide useful information for decision-making and management of the environment at national or international levels the index needs to be updated and debated. In the current approach, some suggestions for further EVI development are being developed while Greece, a typical Mediterranean locale, is used as a reference country for such an application. The results, being representative of the area, may also be used by extension to other similar areas in the world facing pertinent problems.

2. Methodology

The current effort's purpose is principally to evaluate the SOPAC Environmental Vulnerability Index and highlight its weaknesses and opportunities for further development, in order to acquire a more integrated view of a country's environmental vulnerability profile. For such an evaluation, the application of the index on a country exhibiting stresses in both the socio-economic and natural environment is more than required, since such conditions may lead to the identification of the tool's inefficiencies.

The Greek landscape, as also a part of the Mediterranean area, is ecologically fragile and seriously endangered by prevailing social and economic trends (Karavitis and Kerkides, 2002). Hence, Greece was selected as a country fitting the methodological requirements. The EVI evaluation is performed through two distinct phases. In the first phase, the index dynamic behavior through a time scale comparison (applications of 2004 and 2010) is conveyed. For the comparison of the two applications, instead of the indicators' real values, the index scale values were mostly used. This approach may make the comparison more easily presented and indicate issues for the index further development. In the second phase, the index shortcomings, in the environmental vulnerability description are pointed out. Furthermore, some additional and complementary indicators are suggested for integration in the EVI.

2.1. The SOPAC Environmental Vulnerability Index

The EVI uses 50 indicators presented in Table 1 that are classified into different categories (Table 2) reflecting a spherical view of vulnerability (Pratt et al., 2004b).

The first three sub-indices (see Table 2), describe three aspects of vulnerability (Pratt et al., 2004a):

1. *Hazards*: It measures anthropogenic and natural risk (potential risk only).
2. *Resistance*: It gauges the inherent internal characteristics of a country which would tend to make it more/less able to cope with natural and anthropogenic hazards.
3. *Damage*: Describes the ecological integrity or level of degradation of ecosystems.

The indicators, use a scale of vulnerability – that has been determined separately for each indicator (Kaly et al., 2004) – ranging from 1 (least vulnerable) to 7 (most vulnerable). The scale development was based on the ease of use – avoiding many divisions (such as 1–10 scale), – on having a central point and not on sensitivity (Kaly et al., 2001). The final results/scores are produced based on the following equation:

$$\mathrm{EVI} = 100 \times \sum_{l=1}^{n} \frac{\text{Indicator scale value}}{n} \tag{2.1}$$

where n is the total number of indicators used (1, 2,. . ., 50).

The sub-indices score is based on the calculation of the average value of the consisting indicators (Table 2).

The max and min values for EVI score are 700 and 100, respectively. The resulting score (X) is classified into one of the five vulnerability categories (Kaly et al., 2004): (1) resilient $X \leq 215$; (2) at risk $215 < X \leq 265$; (3) vulnerable $265 < X \leq 315$; (4) highly vulnerable $315 < X \leq 365$; (5) extremely vulnerable $X > 365$. The classification has been produced after the first EVI global application (global data and statistics) and describes a country's relative position in relation to worldwide observed values. This means that the above categorization is actually of little use in independent measurements (single country) since the real value of the index is:

1. To compare countries (or regions) at a given time frame and,
2. To compare situations (temporal comparisons) among given countries or regions.

More specific material on EVI mechanics and statistics may be found in Kaly et al. (2001, 2004) and Pratt et al. (2004a,b).

2.2. Area of application

Greece (39.00 N, 22.00 E), is a country in south-eastern Europe that forms its most southern Peninsula. It is bordered to the West, South and East by the Ionian, Mediterranean (which is a crucial environmental, economic and political area), and the Aegean Seas. In the North it is bordered from west to the east by Albania, the Former Yugoslav Republic of Macedonia (FYROM), Bulgaria and Turkey (CIA Factbook, 2009). Greece comprises around 3000 islands, which is about 75% of the total number of islands in the Mediterranean Sea (NCESD, 2009). Greece has an area of 131,957 km^2 with coastlines of 13,676 km and a Mediterranean climate (CIA Factbook, 2009). The country includes mountainous areas with great diversity of ecosystems and species (NCESD, 2009). It has almost 11,300,000 recognized habitats (NSSG, 2008). The country's environmental conditions may be described by increasing coastal areas stress, by expanding differences between touristic areas and the rural hinterlands, serious resources interdependencies, high susceptibility to pollution, and by the sensitivity between the water and soil equilibrium. The soils are extremely vulnerable to erosion and desertification with resulting problems in developing also the water resources (reservoir sedimentation, stream bed stability, etc.). Most of the population is concentrated in the coastal zone, and increasing tourism causes a strong, seasonal services and infrastructure demand. Thus, uneven resources demands in both

Table 1
Indicator list, datasources and scaled values.

	Indicators	Description	Datasource	2004 indicator value	2010 indicator value
1	High winds	Knots of excess wind annually (5 year-average)	NOAA GHCN	4	4
2	Dry periods	mm annual rainfall deficit (5 year-average)	NOAA GHCN	5	5
3	Wet periods	mm annual rainfall excess (5 year-average)	NOAA GHCN	6	6
4	Hot periods	Degrees Celsius of excess heat annually	NOAA GHCN	4	4
5	Cold periods	Degrees Celsius of heat deficit annually	NOAA GHCN	2	2
6	Sea surface temperature	Average annual deviation in sea surface temperature (5 year-average)	University of British Columbia	6	6
7	Volcanoes	Weighted numbers of volcanoes VEI 2+	National Geophysical Data Centre	5	5
8	Earthquakes	Number of earthquakes of ML $\geq$ 6, Depth $\leq$ 15 km	National Geophysical Data Centre	1	1
9	Tsunamis	Number of tsunamis/surges with run-up >2 m above MHWS/length of coastline	National Geophysical Data Centre	2	2
10	Slides	Number of slides/Land Area	International Disaster Database	1	2
11	Land area	Total land area in km^2	CIA Factbook 2009	3	3
12	Country dispersion	Ratio of length of borders (land and maritime)/land area	CIA Factbook 2009	4	4
13	Isolation	Distance to nearest continent	World Atlas	1	1
14	Relief	Altitude range (highest point – lowest point)	CIA Factbook 2009	2	2
15	Lowlands	Percentage of land area $\leq$ 50 m above sea level	Encarta 2004	4	4
16	Borders	Number of land and sea borders shared with other countries	World Atlas	5	5
17	Ecosystem imbalance	Weighted average change in trophic level since fisheries began	University of British Columbia	1	1
18	Environmental openness	Average annual freight density as thousands of USD of freight moved into the country per km^2 of land	CIA Factbook 2005–2009	7	7
19	Migrations	Number of known species that migrate outside the territorial area of a country/land area	International Union for Conservation of Nature (IUCN)	1	2
20	Endemics	Number of known endemic species per million km^2	IUCN	6	6
21	Introductions	Number of introduced species per 1000 km^2	IUCN	2	2
22	Endangered species	Number of endangered and vulnerable species per 1000 km^2 of land area	NCESD	*2*	*7*
23	Extinctions	Number of species known to have become extinct since 1900 per 1000 km^2	IUCN	1	1
24	Vegetation cover	Percentage of natural and regrowth vegetation cover remaining	State of World's Forests, FAO	5	4
25	Loss of cover	Net percentage change in natural vegetation cover (5 years)	State of World's Forests, FAO	1	1
26	Habitat fragmentation	Total length of all roads in a country divided by land area	CIA Factbook 2009	4	5
27	Degradation	Percent of land area that is either severely or very severely degraded	FAO Terrastat	6	6
28	Terrestrial reserves	Percent of terrestrial land area legally set aside as reserves	World Resources Institute	5	5
29	Marine reserves	Percent of continental shelf legally designated as marine protected areas	World Resources Institute	5	5
30	Intensive farming	Annual tonnage of intensively farmed animal products produced over the last five years per km^2 of land area	NSSG	6	2
31	Fertilizers	Average annual intensity of fertilizer use over the total land area over the last 5 years	Eurostat – Agricultural Statistics	5	5
32	Pesticides	Average annual pesticide use over the total land area over the last 5 years	Internet source 1	2	–
33	Biotechnology	Cumulative number of deliberate field trials	Internet source 2	5	5
34	Productivity overfishing	Average ratio of productivity/fisheries catch over the last 5 years	University of British Columbia, NSSG	5	5
35	Fishing efforts	Average number of fishers/km of coastline over the last 5 years	NSSG	1	1
36	Renewable water	Water usage as a percent of available renewable resources	CIA Factbook 2009	2	2
37	SO_2 emissions	Average annual SO_2 Emissions over the last five years	NCESD	6	6
38	Waste production	Average annual net amount of generated and imported municipal wastes per km^2 of land area over the last 5 years	NCESD	2	7
39	Waste treatment	Mean annual percent of waste effectively managed and treated over the last five years	NCESD	7	7
40	Industry	Average annual use of electricity for industry over the last 5 years per km^2	NSSG	3	4
41	Spills	Total number of spills > 1000 l over the last 5 years/million km of coastline	International Tanker Owners Pollution Federation	5	–
42	Mining	Average annual mining productions per km^2 of land area over the last 5 years	Internet source 3	1	7
43	Sanitation	Density of population without access to safe sanitation	Unicef	–	1
44	Vehicles	Number of vehicles per km^2 of land area	NSSG	5	7
45	Population	Total human population density per km^2 of land area	NSSG	4	4
46	Population growth	Annual human population growth rate over the last 5 years	CIA Factbook 2005–2009	3	3
47	Tourists	Average annual number of international tourists per km^2 of land area over the last 5 years	NSSG	4	5
48	Coastal settlements	Density of people living in coastal settlements	CIA Factbook 2009	4	4
49	Environmental agreements	Number of environmental treaties in force in a country	SEDAC/CIESIN	1	1
50	Conflicts	Average number of conflict years per decade within the country over the past 50 years	Greek history	1	1
			EVI scores	353	385
			Data availability (%)	98	96

Internet source 3: NationMaster.com.
Internet source 2: GMO Compass (2008).
Internet source 3: Tzeferis (2010).

Table 2
The EVI sub-indices.

Sub-indices	Indicators used	Sub-indices values		
		2004	2010	Change
Aspects of vulnerability				
Hazards	1–10, 18, 25, 28–44, 46–47, 49	3.77	4.10	0.33
Resistance	11–16, 19–20	3.25	3.38	0.13
Damage	17, 21–24, 26–27, 45, 48, 50	3.00	3.50	0.50
Legend (for indicator type)				
Weather and climate	1–6			
Geology	7–10			
Geography	11–16			
Resources and services	17–44			
Human population	45–50			
Policy relevant sub-indices				
Climate change	1–4, 6, 11–12, 14–15, 24, 36, 45, 48	4.08	4.00	−0.08
Exposure to natural hazard	1–5, 7–10, 45, 48	3.45	3.55	0.10
Biodiversity	6, 11–26, 28–29	3.42	3.74	0.32
Desertification	1–5, 14–15, 24–25, 27, 36	3.73	3.64	−0.09
Water	2–3, 24–25, 27–28, 31–32, 36, 39, 43, 45–46	4.25	4.08	−0.17
Agriculture/fisheries	2–3, 6, 17–19, 21, 24–27, 29–36	3.95	3.89	−0.06
Human health aspect	31–32, 36–37, 39, 43	4.40	4.20	−0.20

space and time greatly increase the cost of making ecosystem services accessible. Drought and flood hazards are common in the area, creating additional water management problems. Wastewater management problems proliferate with the expanding urban population during the summer and effluents are deteriorating the quality of coastal waters.

Greece also has well recognized 'ecological problems' due to frequent forest fires. All in all, the country's ability to respond to environmental challenges is limited and the country could be considered a good test case for the EVI since such a country may well pinpoint the index shortcomings and opportunities for further development.

2.3. Data collection and application

EVI data for the current effort were collected from a variety of sources presented in detail in Table 1. The data sources different than those used by SOPAC in the 2004 application are marked in bold. In addition, the following remarks may be demarcated – indicators 1–6 on climate data remained unchanged (SOPAC data) from the 2004 evaluation, since updated and representative data sets for such an effort could not be located; – indicators 32 on pesticides use, has been omitted since it has to be revised in order to fit the data in a more suitable way. Indicator 41 (2010) on spills, has also been omitted since no valid data could be obtained. In both applications indicator 43 (sanitation) was left out. Such modifications did not affect the final results since the EVI was designed with some flexibility in its application, and can remain operational even with the 80% of the required data (Kaly et al., 1999, 2004).

At the first EVI application in 2004, Greece had a score of 353. In that application of 2004, 49 indicators are applied while this number is reduced to 48 for the application of 2010. This means that in Eq. (2.1), $n = 49$ (2004) and $n = 48$ (2010). The EVI scaled value for every indicator is presented in Table 1 and Fig. 1 while the sub-indices values are presented in Table 2 and Fig. 2.

3. Computation, results and discussion

3.1. Phase one: time scale comparison

The calculation of the EVI was performed as follows: the above stated data were used – the indicators values were computed according to the stated scales in the EVI manual (see Pratt et al., 2004a) – the resulting scores were introduced in Eq. (2.1) and the final EVI score and sub-indices values were produced. The EVI had a total score of 385 for 2010. By comparing the two EVI scores (Table 1), the Total Environmental Vulnerability of Greece has been increased from a *Highly Vulnerable* to an *Extremely Vulnerable* state over the last six years. Such change in categorization may not be interpreted in its absolute meaning per se, but as pointing towards the fact that:

1. The country's natural ecosystems have become more fragile since no mitigation actions for vulnerability reduction have been applied and,
2. The stresses have been increased.

In addition by comparing vulnerability scores, it may be deduced that the possibility for damage suffered due to potential hazards has been increased. The ecosystems have acquired and accumulated more damaging impacts through the years passed and their ability to cope with the potential natural or anthropogenic hazards has also been decreased.

The fact that the calculated differences, in vulnerability, between the two applications are rather small, cannot predetermine their core quality or value. Thus, the crucial part may be that the sub-indices have changed negatively (indicating greater vulnerability) and not the magnitude of the change itself. This enhances that the Greek ecosystems are heading towards an unsustainable and therefore an undesirable state. Furthermore, five of the seven remaining policy relevant sub-indices, present a positive change that leads to more resilient paths. Nonetheless, the sub-indices values are still high and corrective actions are required in order for such values to become lower and remain in that level. The last two sub-indices (Exposure to Natural Hazards and Biodiversity) exhibit a negative change.

In the indicators level 41 of them were finally used: indicators 1–6 were unchanged and indicators 32, 41 and 43 – on both – approaches were removed. The remaining indicators present the following differences: 11 indicators (26.2%) have changed negatively, 2 indicators (4.8%) exhibit a positive change and the rest 29 indicators (69%) were almost unchanged.

Regarding the characterized as almost unchanged indicators, it has to be noted that most of them were actually transformed. Pertinent examples are the Population Density (indicator 45), which

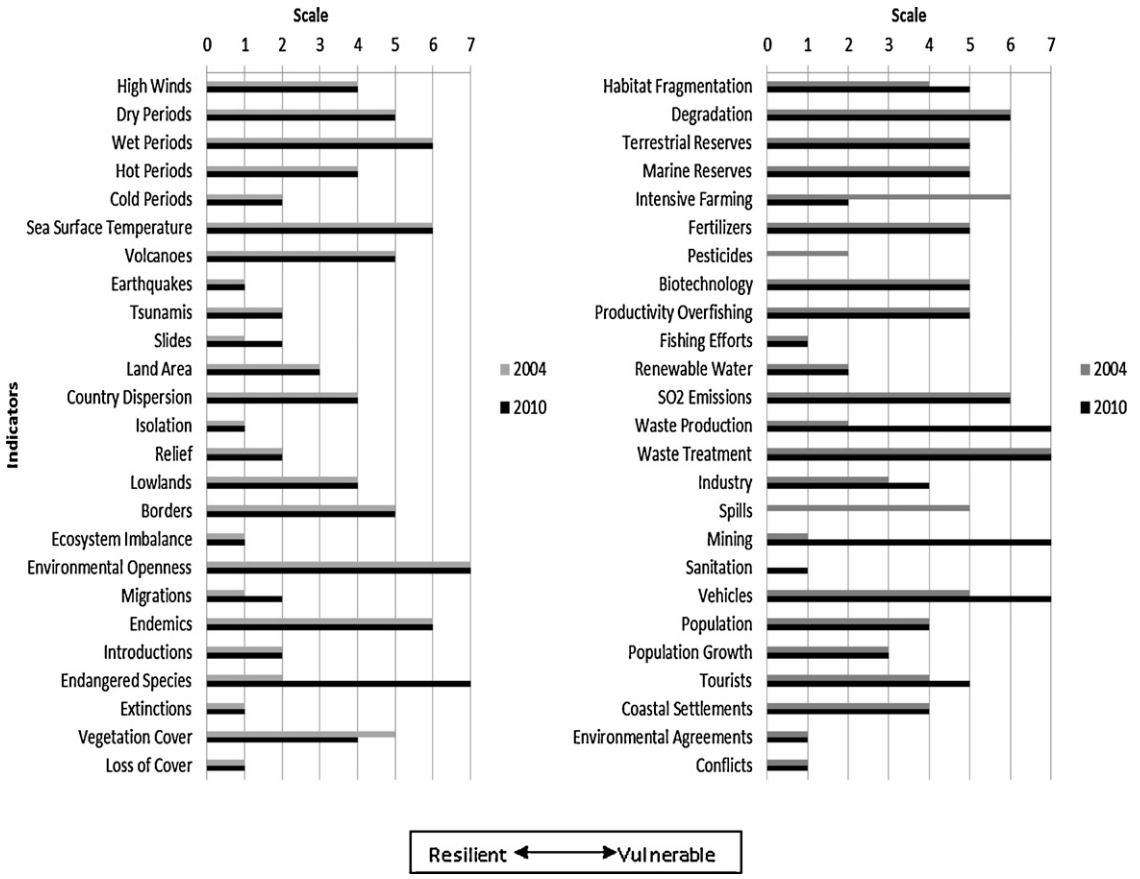

Fig. 1. The EVI indicators in 2004 and 2010.

was about 8165 humans/km^2 (CIA Factbook, 2005) and currently estimated at 8649 humans/km^2 (NSSG, 2008), and the Population Growth (indicator 46) which was almost 0.2% (CIA Factbook, 2001, 2005) and moved to 0.15% (CIA Factbook, 2005, 2009). Such changes may seem significantly low but they do indicate the fact that the EVI scale (1–7) is not sensitive enough to locate them and therefore the total environmental vulnerability may not be estimated appropriately.

Furthermore, regarding the indicators that have been left out, it may be demarcated that those affect the arithmetic value of the index for both the applications, but not the category change, even if such indicators were participating with the lowest value (1). As a result the score categorization is hard to change and therefore to reflect the differences occurring through time.

The use of datasources different to those applied by SOPAC in the 2004 application cannot affect the results since the applied scale cannot trace small fluctuations in raw data. The fact that the EVI has been revised since its first appearance does not affect the whole process since the two application use the same format.

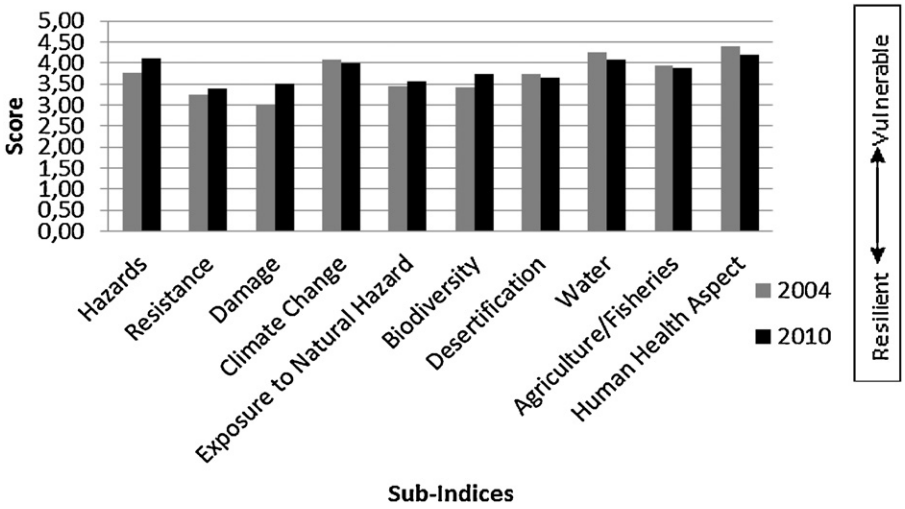

Fig. 2. The EVI sub-indices in 2004 and 2010.

All the above delineate the need for:

- A more sensitive indicator scale. The results may be given in a simplified and more appropriate scale reflecting the attempted quantification of a lot of qualitative data. In this regard, more changes could be traced, with the significant ones scoring higher. However, this procedure might be difficult to be incorporated with dubious results since such quantification is generally treacherous. In this line, another premise may be that the approach could keep the original scale intact, but introduce a "Notes" form where the various popping up crucial elements of an EVI application would be referenced. Thus, moving to a non-ordinal scale approach, with a scale within a scale non-linear representation.
- A more sensitive categorization scale that could trace changes in the overall environmental conditions following the previous premises.
- Emphasis should be given to the vulnerability sub-indices. In their nascent structure, the various indicators possess an unintended built in weight that increases their importance. Furthermore, these describe the vulnerability status in a more appropriate manner compared to the total index score.
- As in many similar cases data availability and reliability are crucial components.

Furthermore, some of the included indicators such as the indicator for Intensive Farming (indicator 30), Pesticides Use (indicator 32), and Productivity Overfishing (indicator 34), need to be revised so as to fit to the available data more efficiently. However, the EVI outcomes, for both the applications, seem to capture only a limited part of the Greek ecosystemic and natural resources conditions and they agree with the fact that the stresses upon the environment, and the corresponding vulnerability has been increased. Hence, the purpose for which EVI has been developed may be fulfilled only to a certain degree.

3.2. Phase two: recommendations for the index further development

The overall presented argumentation affects the EVI scores "internally". Nevertheless, other factors in the country's character (country's special conditions) affect the scores "externally". Such factors are crucial for the state of the environment but they cannot be expressed or described by the current EVI mechanics. Therefore, new elements should be introduced in the EVI structure or the index should be restructured. An initial suggestion would be for the EVI to be consisted of two sections. The first will include the current EVI elements as those have already been designed by SOPAC and will be used for the comparison between countries.

The second section will include country related core sets and will be used (with the first sector as a holistic one) for the temporal comparisons within a country. In that section, each country will have the responsibility to add any attribute that could help with the description of its special conditions that affect the vulnerability of its environment.

For Greece, six factors affecting vulnerability may be presented. Five of them affect the vulnerability state in a negative way (increasing vulnerability) and one affects the vulnerability state in a positive way (decreasing), namely:

I. The great number of unregistered immigrants that live in Greece. They make up nearly one fifth of the labour force (CIA Factbook, 2009). Such a fact increases the size of the Country's active population affecting its density (indicator 45). Some other deriving problems are: luck of social security and pension rights, tax income losses for the state, sanitation (indicator 43), water use, waste production (indicator 38), the unofficial imports of products (indicator 18), different life styles and the creation of social disturbances. Their number would be a useful indicator for the second proposed section not only for Greece but also for other countries facing similar problems. It has to be noted that this indicator will be based on estimations from the relevant authorities, since the actual number cannot be otherwise precisely evaluated.

II. The cumulative effects of the county's high dispersal (great number of islands) and high activities of tourism (national and international). The islands are vulnerable due to their:

- Limited size that affects the amount of the available natural resources such as water, the available surface for both human (agriculture, tourism) and natural (landscapes) activities. In such conditions the competition for space is inevitable and usually harmful for the environment.
- Isolation, that creates unique landscapes to be protected not only from tourism but also from the exposure to other anthropogenic and natural hazards. Exposure and uniqueness are the factors that make the landscapes vulnerable.

Islands can become more vulnerable due to tourism that affects the transportation services, the limited local water and other natural resources, the waste production and the seasonal population density. The EVI indicators 12, 13, 26, 36 and, 47 may not describe such conditions.

III. In this context, some candidate indicators might be the number of islands, their total area and the corresponding tourist density. Other pertinent indicators or combinations can also be tested. Naturally, this attribute cannot be applied in countries with no islands, however it may be modified for countries having similar pristine and vulnerable environments.

IV. The reluctance of the Greek Decision Makers to fully enforce the European Union and National laws as well as the international directives for the environmental integrity. That leaves the Greek environment unprotected towards the uncaring behavior or the economic interests of the citizens, industry, agriculture, and tourism. Thus, the information provided by the indicators 28, 29, and 49 may be treated only as a "symbolic" value. The lack of law enforcement cannot be measured directly. Nevertheless there are signs that indicate it in an indirect manner. Some candidates of those signs/indicators are the encroachment of public forests, the number of forest fires, land desertification, the ability of the country to respond to environmental issues, etc. In such cases, qualitative indicators can be applied according to Table 3.

Table 3
The quality indicator for the country's ability to respond to the occurring environmental issues.

1	2	3	4	5	6	7
The country can fully respond	The country can respond adequately	The country can respond to more than 50% of the issues	The country can respond to 50% of the issues	The country can respond to less than 50% of the issues	The country cannot respond effectively	The country is unable to respond

Adapted from Kaly et al. (1999).

V. The various socio-economic problems leave the citizens disinterested in environmental issues. In the EVI structure there are no indicators that could describe these indirect factors. Some candidate indicators can serve as candidates for this attribute: the percentages of poverty, unemployment, distribution of GDP among population segments and the national debt per capita.
VI. The weakness of the EVI – when applied at national level – is to locate the most vulnerable area of the country. It has to be applied at regional level and such application would be time consuming and costly. Therefore, efforts should be made in introducing elements that would indicate the country's most vulnerable location. Such effors may be facilitated by the following candidate indicators: the greatest population density in the country, the continental and island population densities.
VII. The great biodiversity of the country. Biodiversity plays a significant role in sustaining the resilience of ecosystems and therefore in reducing environmental vulnerability (Chapin et al., 2000; Diaz and Cabido, 2001; Folke et al., 2002; Kinzig et al., 2002; Loreau et al., 2001; Perrings et al., 1995; Peterson et al., 1998). The biodiversity of Greece ranks very high among the European and Mediterranean countries (NCESD, 2009). Greece contains more than 32,000 life species (NCESD, 2009). The great number of species can guarantee that an ecosystem can remain functional (some species to replace others) after a hazardous event. Therefore the number of species can serve as a candidate indicator for that case.

Hence, it may be deduced that the environmental vulnerability of Greece looks different to that the EVI provides. Thus, the following needs may become apparent:

- The need for an EVI revision in order to become more descriptive and fit the observed data more closely and,
- The EVI division in two sections: one standard sector for the comparison of countries and an extra one (country related) for temporal comparisons within a country.
- The need for some extra indicators for the enhancement of the EVI's main body.

It has to be stated that the proposed candidate indicators need to be thoroughly studied in order to be introduced in the EVI structure.

4. Conclusions

The Environmental Vulnerability Index has undergone several revisions since its first application. The analysis of the profile of Greece has highlighted the fact that work has yet to be done for the further development of the index, since it cannot fully describe the environmental vulnerability of a country with diverse and rapidly changing conditions. It can capture only a small part of it and thus, it cannot estimate the ecosystems' fragility appropriately, nonetheless it may still serve as a general index underlining the major areas of concern. It is believed that additional indicators could enhance and focus the ability of the vulnerability description by the index and help to fulfill in a more comprehensive fashion its purpose, not only for Greece but also for other countries facing similar problems. Candidates for such additional indicators must, however, be properly tested. All in all, the EVI can become a valuable tool – once it will be further developed – in the service of decision making and environmental sustainability, where the measurement of the environment's tendency to be affected and its ability to cope with stresses and pressures, both natural and anthropogenic, may play a crucial role.

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