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TOOLS FOR VULNERABILITY'S MEASUREMENT IN ADAPTATIVE MANAGEMENT STRATEGIES TO CLIMATE CHANGE

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Abstract: *Representing one of the contemporary world's problems, the global warming is a complex phenomenon with inevitable, direct and indirect effects upon human health. The vulnerability indicators could become an important tool for an informational system, in order to estimation and quantification of the global warming effects related to the population health. In this paper we pointed out important aspects related to an environmental vulnerability tools to climate change whith the advantages and disadvantages associeted. Furthermore we want to discuss the need for use of appropriate vulnerability indicators for an adaptative management system in Romania and improved development conditions in relation to climate change stressors.*

Key words: *vulnerability, environment, index, indicators*

1. INTRODUCTION

Impacts of climate change pose very serious risks for countries, vital ecosystems, and sectors including agriculture, forestry, health, local economic activities and biodiversity (Bizikova et al., 2009).The fluctuations of temperature in the world - the global warming - meant a growth with 0.6^0C of the world medium temperature in the 20^{th} century. World Health Organization shows that the entropic changes on the climate are the cause of 5 millions of illnesses cases and 150.000 of deaths annually. The heat wave from 2003 caused 35.000 deaths among European citizens, being considered that the entropic effects on the climate of the world represented 50% of the risk of death from that period.

For Romania, the signs of climate changes are also obvious. In the year 2000 the drought affected Romania; 2005 was the year with the more rains since the hydrological monitoring is made in Romania; the flood of Danube river in 2006 represents a sub-regional effect of climate changes; 2007 was one of the driest year from our country, with a rain level much lower than the previous years. The forecasts for next years emphasize a continuous warming with temperatures beyond the usual medium value, with lack of balance in the rain level, favoring the appearance of extreme climatic events (Sirbu et al., 2009).

In Romania are missing the health and IT applications programs, by which the effects of global warming effects upon population health to be studied. The system could identify the hazards, the vulnerable population groups and the bias, developing a monitoring plan of climate change's effects upon population health. The vulnerable population groups include the chronic illnesses (cardiovascular diseases, bronchial asthma and other chronic pulmonary diseases, skin cancers) and the acute illnesses (heatstroke, infectious diseases as acute diarrhea, cholera and even unspecific diseases for the temperate zone as malaria, encephalitis). The vulnerability is higher for the persons with disabilities, with low socio-economic status and for communities with precarious environment and systems of health services. In this context there is need to development a prediction and warning system concerning the global warming effects upon human health, which could monitoring the vulnerability and elaborat the optimal adaptation and prevention strategies at population level, based on environmental, medical and social indicators.

2. MONITORING VULNERABILITY

Vulnerability can provide a valuable indication of how sustainably humans are living within their environmental means through a dual focus. Vulnerability can be defined as the potential for attributes of any system, human or natural, to respond adversely to events (Kaly et al. 2004). In the context of climate change, vulnerability is a function of the character, magnitude and rate of climate variation to which a system is exposed, people's sensitivity and their adaptive capacity. Exposure could include geographical location, especially related to high exposure to risks (Bizikova et al., 2009). A further complication is that vulnerability is dynamic and related both directly and indirectly to a range of environmental, social, economic and political factors. Vulnerability may be assessed to raise awareness of particularly threatened regions or communities, or to develop and implement strategies to reduce risk (Popa et al., 2009). The vulnerability of a country to climate change cannot be measured directly. Vulnerability is highly dependent on context and scale. The methods and frameworks for assessing vulnerability must also address the determinants of adaptive capacity in order to examine the potential responses of a system to climate variability and change. In some quantitative approaches, the indicators used are related to adaptive capacity, such as national economic capacity, human resources, and environmental capacities. Other studies include indicators that can provide information related to the conditions, processes and structures that promote or constrain adaptive capacity (Harley et al., 2008/2009).

3. INDICATORS/INDEXES OF VULNERABILITY

Vulnerability can be monitored by identifying indicators and by creating indices that could both be presented spatially and non-spatially (Bizikova et al., 2009).

An indicator is a single measure of a characteristic defined as any variable which characterises the level of risk, resilience or environmental degradation in a state. An index is a composite measure of several indicators or sub-indices defined as an aggregated average of the scores for indicators which related separately to risk, resilience or degradation. Indicators and indices can be useful when guiding decision-making and prioritizing intervention, as they allow for a comparison of characteristics (Downing & Ziervogel, 2004).

Indices of vulnerability to climate change may include observed data on socio-economic, environmental and other factors as well as model-based estimates of future conditions. Each of these data sources is associated with specific advantages and disadvantages (Bizikova et al., 2009). Indicators for vulnerability and adaptation should be precise, robust, transparent and objective. They should also be simple, clear and easy to understand.

	Romania	Hungary	Bulgaria	Ukraine	Serbia
EVI score	335*	363*	323*	317*	324*
SUB-INDICES:					
Climate Change (EVI-CC)	3,92	4,42	4,08	3,92	3,56
Exposure to natural disasters	3,64	3,27	3,0	3,0	3,10
Desertification	3,70	4,91	4,18	4,27	4,13
Water	4,27	4,42	3,67	4,18	4,89
Human health aspects	4,50	5,40	4,80	5,25	5,50
ASPECTS OF VULNERABILITY					
Hazards	3,70	3,85	3,47	3,50	3,61
Resistance	2,75	3,13	3,00	2,50	2,29
Damage	2,80	3,44	2,70	2,80	3,00

*Highly vulnerable countries (EVI Country Profiles)

Tab. 1.The Environmental Vulnerability Index Profiles for Central and East European Country

One developed indices of vulnerability to climate change is the Environmental Vulnerability Index (EVI) of the South Pacific Applied Geoscience Commission (SOPAC) which assesses environmental vulnerability at the national level (Kaly et al. 2004). The EVI considers 50 normalized indicators that represent the risk of hazards occurring, the inherent resistance to damage and the acquired vulnerability resulting from past damage. The EVI results can categorise countries into 5 vulnerability groups ranging from: Extremely vulnerable (365+), Highly vulnerable (315- 365), Vulnerable (265-315), At risk (215-265) and Resilient (<215). When the EVI was decomposed into sub-indices and categories of risk, a more complex pattern emerged. One of the most usefull subindex is the climate change subindex (EVI-CC) based on 13 of the 50 indicators: five of them represent the magnitude of recent climate change; four of them represent the exposure and sensitivity of ecosystems; two of them essentially represent land area; and two others essentially represent population density (Kaly et al. 1999).

The table 1 shows briefly, the EVI score for some Central and East European Countries. Hungary and Romania was the highest of the five countries indicating that its environment is the most vulnerable. For the sub-index, the highest score (worst conditions) was obtained by Romania for climate change, water and human health aspects.The values of the sub-indices suggests that the different aspects which form vulnerability can operate independently of one another. Decisions about public health measures unrelated to climate change, such as sanitation and water treatment, may have a profound influence on health consequences associated with climate change. This tool allow stakeholders/sectoral experts to choose the most appropriate adaptation action to meet an outcome and a flexible approach that can adjust to new information as it becomes available.

Strengths
- based on a theoretical framework that prompted us to find indicators for all identified aspects of vulnerability - able to prompt local environmental agencies to increase and improve data collection - allows states to undertake self-assessment and policy refinement regarding their own environmental vulnerability - comprehensive in its scope including indicators from a wide range of the most important risks and measures of environmental resilience and integrity
Weaknesses
- does not rely exclusively on published official data, resulting in relatively high cost of obtaining data and omissions - the index is driven by the indicators chosen. That is, a different set of indicators might result in very different vulnerability profiles and rating of countries.

Tab. 2. Strengts and weaknesses of EVI profile

Vulnerability indices (Füssel & Klein, 2006) are applied at many scales from local to global, with different policy objectives: assessment of climate change risks, aiding the allocation of resources across regions, monitoring the progress in reducing vulnerability over time, and identifying suitable entry points for interventions. As for all methods of summarising and modelling data, the EVI is associated with a number of strengths and weaknesses (tab.2) which must be understood for its proper application and use (Kaly, 1999).

The reason for using indices is to provide a rapid and standardised method for characterising vulnerability in an overall sense, and identifying issues that may need to be addressed within each of the three pillars of sustainability.

4. CONCLUSION

Society has to prepare for and adapt to the consequences of some inevitable climate change, in addition to mitigation measures. A prediction and warning method based on IT and knowledge, using informatics means in preventive medicine, is very usefull, because it will reduce the morbidity and mortality associated with global warming. Indicators of vulnerability promise to provide a credible and transparent means by which decisionmakers can identify priority needs and so justify certain types of action. However, given the range of potential evaluation needs, it is unlikely that a single indicator or set of indicators for vulnerability at national or EU level would be universally applicable.

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