VULNERABILITY ASSESSMENT OF RURAL COMMUNITIES TO FLOODS IN THE WESTERN PART OF ROMANIA (BANAT PLAIN)

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ABSTRACT

Climate change scenarios for Romania show an increasing tendency of extreme events phenomena including floods, requiring their integrated spatial assessment at different scales and management. Taking into account political, institutional and economic transformations that Romania have passed over the last two decades, they can be considered major driving forces for socioeconomic reconfiguration and spatial change, with high implications on societal vulnerability and resilience of settlements and environment to global changes. Over the last decade, Romania has recorded serious flood events (in 2005, 2006, 2010) being one of the most affected country at continental level. These floods caused great infrastructural damages and even causalities, partly due to the fact that different sectors of society and infrastructure are little designed to adapt, and partly because of improper management of such events. Moreover, public sector's preparedness to flood hazards is almost missing, most of the protection measures being planned and implemented post-event. In this respect, the assessment of vulnerability to floods at different spatial scales is essential for water management plans, in general, and for implementation of effective measures of risk mitigation and/or adaptation, in particular. The paper aim is to develop an appropriate methodology and tools for assessing the vulnerability of rural communities to floods in the Banat Plain, which is one of the most affected regions in Romania, with the purpose of creating and providing practical scientific services to policy-makers. Both quantitative and qualitative methods will be focused, in order to emphasize and assess various components of human vulnerability to floods. Thus, the research will identify relevant indicators in term of the exposure of the rural communities to floods, of their sensitivity and coping capacity. Participatory research instruments will be also designed, allowing us to integrate the experience and knowledge of the local people in different steps of the vulnerability assessment.

Keywords: Banat Plain, vulnerability assessment, floods, methodology development

INTRODUCTION

The socio-economic, political and institutional changes faced by the Romanian society in the last two decades created a fragile context, which made it extremely difficult to build a solid framework for structural and non-structural measures aimed to mitigate the impact of floods.

Recent hydro-meteorological extreme events (floods occurred in 2005, 2006 and 2010) have highlighted weaknesses in flood management, both at institutional level and in local communities' response, the social factors having a significant role in amplifying the impact of extreme events.

Given that climate scenarios for Romania showed an increasing trend in the frequency of extreme events [1], clearly designed measures are required in order to increase the resilience of human communities to floods, especially through pre-disaster preparedness. So far, the floods occurred in Romania revealed that the public sector's preparedness to flood hazards is almost missing, most of the protection measures being planned and implemented post-event. In this respect, the assessment of vulnerability to floods is essential for water management plans, in general, and for implementation of effective measures of risk mitigation and/or adaptation, in particular.

The paper aim is to develop an appropriate methodology and tools for assessing the vulnerability of rural communities to floods in the Banat Plain, which is one of the most affected regions in Romania with the purpose of creating and providing practical scientific services to policy-makers. Both quantitative and qualitative methods will be employed, in order to emphasize and assess various components of human vulnerability to floods.

The approach proposed in the present research is consistent with the international conceptual and methodological framework of vulnerability assessment. Thus, vulnerability defines both systems' susceptibility to damage induced by environmental change or extreme events and the capacity of the population/communities to recover from or adjust to their effects [2]. In this respect, vulnerability analyses provide the necessary information for evaluating the resilience of a system in front of stresses (i.e. the ability of a system to cope with human and/or environmental-induced changes and keep its functionality or return to a closer form of its own, after the stress impacted it) and, ultimately for decision options to adapt and mitigate risks. The role of decision-makers, stakeholders and institutions is essential in finding the optimal alternatives for adaptation under new contexts and development patterns generated by various types of hazards. Therefore, creating *scientific services*, including transfer mechanisms of scientific information, for decisional structures is important in order to improve governance of hazards and community vulnerability and to facilitate the efficiency of decision-making process at different administrative levels.

Vulnerability derives not only from perturbations or stress factors, but also from the sensitivity of resilient systems and their capacity to cope with hazardous situations [3].

Vulnerability assessment is based on the principle that vulnerability of an area is a function of: a. exposure (the degree to which a system is exposed to significant environmental change or extreme events); b. sensitivity (the degree to which the system is sensitive to or might be affected by these pressures); and c. adaptation capacity (the ability of a system to adjust to environmental change, to mitigate damages and to cope with consequences) [4].

LOCAL CONTEXT OF VULNERABILITY TO FLOODS

The studied region is located in the western part of Romania, being a low plain with altitudes between 75 and 180 m. The climate is under the dominant influence of oceanic

air masses (to which is added the invasion of Mediterranean air), and is characterized by moderate temperatures, heating periods during winter, early springs and relatively high average annual rainfall (600-1400 mm).

In the Banat Plain, the subsidence occupies large areas, influencing the configuration of the hydrographical network. Rivers (Mureş, Bega Veche, Bega, Timiş and Bârzava) have reduced longitudinal gradients (e.g. from 0.1 to 0.3 m / km for Bega and Timiş), and they present a large number of meanders, divagations of river course and braided streams. The plain has many abandoned courses, lakes and swampy areas. Since eighteenth century, people carried out drainage and regulation work, which changed the Banat landscape.

Banat Plain is a densely populated region, which holds more than 250 rural settlements, with an average density of 2.5 settlements / 100 sq km. Due to favorable soil and climatic conditions, land use is predominantly agricultural (cereal crops). Characteristics of the climate regime, topography and configuration of the hydrographical network, together with the human intervention on the landscape (through deforestation in the mountain sector of the catchments and drainage and embankments in the Banat Plain) are among the main factors that create conditions for floods occurrence in the region. Some of them have disastrous effects, such as the historical floods of April-May 2005, which caused damages of 112,000 euro in Timiş County, affecting more than 5,300 households and 92,000 ha of agricultural land [5].

In this context, an integrated assessment of the vulnerability of rural communities to floods in the Banat Plain is a necessary step, useful especially to decision makers in the field of extreme events management.

ASSESSING RURAL VULNERABILITY TO FLOODS: METHODOLOGICAL APPROACH

The methodological approach proposed for the assessment of human vulnerability to floods in the Banat Plain derives from the model of vulnerability used in the field of global environmental change [6], [7], [8]. For the studied rural communities, the vulnerability to floods is defined not only by their potential exposure to such extreme events, but also by their socioeconomic and cultural characteristics, which are influencing the level of potential impact (sensitivity) and their ability to cope with consequences of the floods (adaptative capacity). The comunities' senzitivity and adaptive capacity are internal characteristics of these systems, emphasizing their social or socioeconomic vulnerability [9], [10]. The vulnerability to floods of the studied rural communities is seen as having a multilayered structure, thus multiple causes of vulnerability should be considered (i.e. environmental, social, economical, political and institutional causes).

In terms of the research methods, both quantitative (multi-criteria vulnerability assessment; developing an index of rural vulnerability to floods; and conducting questionnaires) and qualitative methods (field observations; database analysis and development; and participatory research) will by used.

Developing an index of rural vulnerability to floods: Given the conceptual model of vulnerability mentioned above, the authors' proposed assessment of rural vulnerability to floods (*RV*) will integrate data on flood exposure (such as flood severity and

probability), with socioeconomic data on the exposed systems (i.e. the rural communities in the Banat Plain), according to the following formula:

*RV = Exposure * Socioeconomic_vulnerability*Ecological_vulnerability*

Indicators should emphasize different dimensions of vulnerability to floods and different criteria of vulnerability assessment (e.g. human capital, wealth, accesibility and natural capital) – Table 1. Choice of indicators as tools used to point different local issues will take into account the data availability (e.g. most of the indicators will be secondary source indicators, based on 2011 Census), the relevance for the local context and the consistency with the conceptual model of vulnerability [11].

Table 1. Indicators used in the assessment of rural vulnerability to floods in the Banat Plain (socioeconomic and ecological vulnerability)

Dimensions of flood vulnerability	Evaluation criteria	Subcriteria	Indicators
Social	Human capital	Health	Disabled people (%)
			Number of doctors per capita
			Number of hospital beds per capita
		Education	University graduates (%)
			Number of students per teacher
		Age	Elderly (>65 ani, %)
			Children (<10 ani, %)
		Ethnicity	Roma (%)
			Ethnic Hungarians (%)
	Accesibility	Transportation network	Road density (km/sq km)
		Clean water supply	Households with access to the public water supply (%)
	Dwellings	Building materials	Dwellings built of clay and wood (%)
	Cultural capital	Cultural landscapes	Cultural heritage (number of sites)
Economic	Wealth	Income level	Average household income
			Unemployed people (%)
			Dependence on social benefits (%)
	Dependence on agriculture	Structure of household income	Income from agriculture (% in the total average household income)
Ecological	Natural capital	Environmental impact	Number of protected areas
			Areas exposed to contamination due to na-tech hazards (ha)

In the case of the studied rural communities, the people's susceptibility to be damaged by floods and the recovery potential depends on the characteristics of the residential buildings, isolation, access to information, income level, age and economic dependency, health status and health care facilities, education, and even etnicity (which correlates

with social capital, income level or first language) [12]. The potential impact on the environment (ecological vulnerability) should also be considered [13].

Involving local people in the assessment of vulnerability to floods: While multi-criteria vulnerability assessment is designed to be conducted across the studied region, the participatory research will focus on five rural settlements (comprising 15 villages and 12,703 inhabitants), which were most affected by the floods occurred in the spring of 2005 (Foeni, Giulvăz, Peciu Nou, Uivar and Otelec) (Fig. 1).

Fig. 1 Study area position in Romania

A questionnaire was conducted in two of these settlements (Foeni and Otelec) in the summer of 2005, which had as main objective the investigation of people's perceptions on the causes and consequences of the recently occurred floods, on measures taken by the authorities to manage the crisis situation, people’s willingness to volunteer and preparedness in the event of similar hazards [14].

Results showed the need for non-structural measures aimed to mitigate the impact of floods (e.g. educating people in order to react appropriately to emergencies and mandatory insurance of housing). Still, most of the respondents mentioned structural measures, such as strengthening levees, maintenance of hydrotechnical works and of drainage channels, as well as stopping the deforestation in the upper watershed areas. Flood prevention was considered at that time almost exclusively a responsibility incumbent on government and on local authorities.

A significant issue during the 2005 flood recovery was the conflictual relatioship between community members and local authorities. The 2005 questionnaire emphasized the need to improve communication between local people and decision-makers and to make responsibility of the authorities clearer to the public (e.g. by adjusting exaggerated expectation regarding the support provided by the authorities during mitigation and recovery).

The vulnerability assessment for this study implies the application of a further questionnaire to a larger population sample, after eight years from the previous event. The first part of the questionnaire will be focused on topics concerning the public's perception on the local context of vulnerability, considering the following objectives:

- Understanding people'perception on the main types of environmental changes occurred in the Banat Plain and on their intensity;
- Understanting people's perception on changes in frequency and intensity of extreme events;
- Identifying the extreme events perceived as threats by the local people;
- Identifying potential consequences of environmental change and extreme events in relation with households' wealth.

Table 2. Questionnaire topics relevant to rural vulnerability to floods in the Banat Plain

Questionnaire topics	**Variables**
Previous experience to flood events	Personal experience (residence flooded during previous floods, evacuation during previous floods)
	Indirect experience (knowledge about flood exposure based on the narratives of relatives and friends)
Recovery after floods, if experienced	Recovery based mainly on own resources and social networks
	Recovery based on the support of authorities
Awarness	Awarness of exposure to floods in the living area
	Perception of the main floods' causes in the area
	Perception of the floods' consequences during previous events
Worry	Degree of worry regarding the occurrence of flood events
	Degree of worry for specific issues related to floods occurrence (personal safety, safety of the relatives, safety of the household's goods)
Preparedness	Self-assessed level of personal preparedness
	Measures required for community preparedness
	Measures required for institutional preparedness
	Responsibility for implementing preparedness measures
Respondent characteristics	Age, Gender, Education, Employment, Income level, Head of household, Household characteristics: building material of dwellings; number of dependent persons (children and elderly)

The second part of the questionnaire is designed to investigate the perception of vulnerability to floods. Taking into account the results of the previous research, the study's objectives are:

- Identifying efficient communication strategies between decision-makers and local people.
- Revealing information gaps concerning exposure to floods, mitigation measures and preparedness.
- Understand the relationship between the elements of risk perception in the studied region (i.e. previous experience of extreme events, awareness of exposure to floods, degree of worry regarding floods occurrence and the level of preparedness [15]).

Derived from these objectives, there are six main topics of the second part of the questionnaire (Table 2); to ensure comparability, some of questionnaire topics are consistent with recent research carried out on flood vulnerability [16], [17].

FUTURE ACTIVITIES FOR VALIDATION OF THE METHODOLOGICAL APPROACH

The proposed methodological approach will be applied and validated during an extended research activity, projected for 2013-2014. The first stage consist in conducting the projected questionnaire, which will provide valuable information on the local context of vulnerability and will allow us to integrate the knowledge and the experience of local people in the assessment of rural vulnerability to floods. At the same time, the results of the questionnaire will be useful in validation or adjustement of the criteria proposed for the development of an index of rural vulnerability to floods.

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