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A Typology of Rural Areas in Danube Region

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Abstract

The main objective of this paper is aimed at the quantitative analysis of vulnerability to hydro -climate changes in the eleven counties of the Danube region. The vulnerability was seen by three components: exposure, sensitivity and adaptive capacity. Twenty- five indicators were examined. The methods used were factor analysis and cluster analysis. Obtained clusters show spatial differences of vulnerability at the county level. In this context, policy makers should adapt their policies to local conditions. In addition, hydro-climatic changes should be placed in the broader context of sustainable rural development.

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Keywords:

1. Introduction

Danube, important connecting path between different cultures and civilizations has always been considered an economic and commercial opportunity for residents of the territory it crosses. Among the Danube countries, Romania has the largest area of the Danube basin (approximately 30%) and the longest river section (1076 km). Although full of history Danube region has experienced many changes in the last century, this is an area of significant cultural and social heterogeneity and unexploited economic growth potential (MDRT, 2010).

Romanian sector of the Danube Floodplain was dammed almost entirely by making the 1200 km of dikes and 53 agricultural premises, totaling an area of 430,000 ha. Almost complete damming of the Danube Floodplain

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negatively affected both hydrogeomorphic system and local and regional topo-climates (Vişinescu and Bularda, 2008).

Climate scenarios developed for Romania (POAT, 2013) predict, in the most of the Danube region territory, a reduction in mean annual precipitation and an increase in average annual temperatures, phenomena accompanied by an increasing presence of both droughts and floods. The climate change prediction could have a significant negative impact on agricultural production, with important implications for the welfare of farmers, especially subsistence and semi-subsistence ones and for the entire rural economy.

The degree to which weather phenomena affects agricultural systems / rural areas depend upon a variety of factors: species of crops and animals, farmers market orientation - for sale or subsistence, quality of natural resources, quality of human resources (age, education, risk tolerance), etc. In Romania, the vulnerability of the agricultural / rural sector to global climate change has been addressed in numerous studies (ACCRETE, 2014; Sandu, 2013). Those focused mainly on the climate change scenarios implications on crops, highlighting the physical impact on the plants and animals and the economic impact resulting from the loss of yields. Socioeconomic aspects of vulnerability to climate change (with a deep examination of the socio-economic and institutional factors) that show how farmers respond to and cope with climate risks have been explored to a lesser extent.

Danube Region has a diverse range of social economic, political and environmental characteristics. This suggests that different counties of the region have a different degree of vulnerability to climate change. In this context, the development of a methodology for assessing the socio-economic vulnerability, to capture a faithful territorial dimension is an important step that can be completed by creating a typology of rural areas of the Danube region.

2. State of Knowledge

In recent years, the vulnerability concept has gained increased visibility in the scientific community. Vulnerability is conceptualized differently by different disciplines. Its use has its origins in geography, natural hazards research and the food insecurity analysis. There is no single definition of vulnerability - definitions vary by researchers' perception. Thus, in the context of global environmental change, vulnerability is seen as the degree to which a system is susceptible to the effects caused by exposure to various stress forms associated with environmental and social changes as well the system's inability to adapt (Kasperson et al. 2003; Turner et al. 2003).

Blaikie et al. (1994) define vulnerability as the characteristics of a person or a group of people to anticipate, cope with, resist and recover from the effects of natural hazards and states that vulnerability can be seen as a continuum from the capacity to adapt to susceptibility. Vulnerability highlights the degree to which its populations and assets are exposed, as part of a socio-ecological system, to the impact of various risks and points the potential damage developed by a particular phenomenon (Bălteanu et al. 2005).

Brooks (2003) suggests two epistemological approaches to conceptualizing vulnerability. One approach treats vulnerability as "end point" in terms of caused damages to the system by a particular climatic event or risk. The second approach considers vulnerability as the "starting point"; a condition that exists in a system before experiencing an event or climate risk. In conclusion, any assessment of the consequences of climate change should take into account the two approaches (Kelly and Adger, 2000).

Adger (1996) also identifies two components of vulnerability: consequences that an event may have against people (called capacity or social vulnerability), and the risk that can cause such event (called the exposure). Thus, the vulnerability has, in this case, two dimensions: internal and external. The internal dimension refers to the lack of system defense and uncertainty, and its ability to anticipate, cope with, resist, and return to its original state after the impact of an event. External dimension involves system exposure to risks. Bohle (2001) developed a vulnerability conceptual framework called "double structure of vulnerability" that includes exposure and adaptation. In this case, the external perspective refers primarily to the structural dimensions of vulnerability and risk, while the internal dimension focuses on adaptation and actions taken to overcome or at least mitigate the negative effects of economic and environmental change.

Luers et al. (2003) propose a quantifying vulnerability method (considering the system, resulted variable and stress factor) based on its three components: exposure, sensitivity and adaptive capacity. Turner et al. (2003)

recognize that vulnerability is determined not only by exposure to risks (disturbance and stress), but also depends on the sensitivity and resilience of the system experiencing such hazards. These authors develop an integrated conceptual framework of vulnerability built on three major dimensions, namely exposure, sensitivity and adaptive capacity.

3. Material and methods

3.1. The choice of indicators

Vulnerability measurement has proven to be a difficult operation, primarily, due to the fact that often the vulnerability is not a directly observable phenomenon. There are two main approaches in the literature: the indicator approach and vulnerability variable assessment. According to Luers (2003), neither of the methods can fully capture the multiple dimensions of vulnerability.

While indicators based approach can be applied at any scale (household, community, county, region, country and system) its major limitation is the inability to measure the temporal and socially complex dynamics of different systems. In addition, the use of indicators is limited to a certain degree of subjectivity in the variables selection, the data availability at different territorial levels and of difficulty of testing or validation (Luers et al. 2003). However, indicators based approach is a valuable method that can capture the multi-dimensionality of vulnerability in a comprehensible form.

For the analysis fulfilled in this paper it was considered that the study region is the area strongly influenced by the Danube river, composed of eleven riverine counties (NUTS3) (in this paper, due to complex works were at the Iron Gates II, Caras - Severin county was excluded). The Danube region is located in the south of Romania and is made up of seven predominantly rural counties (Tulcea, Calarasi, Giurgiu, Ialomita, Teleorman, Mehedinti and Gorj) and four significant rural counties (Braila, Constanta, Galati and Dolj) (as defined by PHARE, 1998). Addressing issues at the county level marks and maintains the envisaged development type in the coordinates provided by traditional regionalism and administrative operation; counties have institutions capable of implementing specific policies and strategies.

This paper considers that the vulnerability of a system depends on three characteristics: exposure, sensitivity and adaptive capacity (IPCC, 2001).

Exposure is the possible predisposition for connection between a system or a system component and a pressure factor. The concept of exposure is defined as an estimating or measuring process of the exposure intensity, frequency and duration to a disruptive factor.

Sensitivity is the ability of a system to change its attributes and to adapt to a new steady state, different from the previous one. The sensitivity requires the system capacity to acquire a new state, to calibrate its quantitative and qualitative parameters and implicitly its functionality in the new conditions.

Adaptive capacity can be defined as the potential of a system to reduce the consequences of a pressure factor. Unlike resilience, adaptation requires a strong enough response to cause a fundamental change in the system structure (Kasperson et al., 2003). According to Brooks (2003), the adaptive capacity of a system or society prove its power to change its characteristics or behavior to better cope with existing or anticipated external pressures and changes. IPCC (2001) describes adaptive capacity as system, region and community potential or capacity to adapt to the climate change effects or impacts. Adaptive capacity is considered to be a function of wealth, technology, education, information, skills, infrastructure, access to resources etc.

Indicators were chosen by consulting literature and were identified as a theoretical starting point in our approach. In the creation on the database there were constraints generated by data availability. Several indicators proposed in the literature could not be used because they were not available at the county level or their quality was not satisfactory. Thus, a number of twenty – five indicators were selected which aimed a characterization of the Danube region and then a data matrix in SPSS was compiled.

Table 1. Indicators of vulnerability

Determinants of vulnerability	Criterion	Indicator	Data source
EXPOSURE	Extreme climate events	Exposure to flood	Disaster Insurance Pool (2014)
		Aridity Index	Ministry of Agriculture and Rural Development (2011)
	Climate change	Increase in mean annual temperature (2001-2030/1961-1990)	POAT Report - Environment sector and climate change (2013)
		Average yearly precipitation amount (2001-2030/1961-1990)	POAT Report - Environment sector and climate change (2013)
SENSITIVITY	Naturalness	Naturalness index	NIS –TEMPO ONLINE database
		Soil quality (share of IV and V quality classes)	County reports on the environment states (2010-2013)
	Rural population density	Rural population/total area	NIS –TEMPO ONLINE database
	Modernization/	Share of irrigated farmland	NIS –TEMPO ONLINE database
	Intensification	Amount of fertilizer applied per hectare	NIS –TEMPO ONLINE database
		Number of conventional animals per hectare	NIS –TEMPO ONLINE database
		Share of employment in agriculture	NIS –TEMPO ONLINE database
	Subsistence	Share of farms with an area less than 5 ha	NIS – Agricultural Census (2010)
		Crop diversification index	NIS –TEMPO ONLINE database
ADAPTATIV CAPACITY	Social capital	Number of acreditated agricultural organizations	Ministry of Agriculture and Rural Development (2014)
		Share of rural population who vote in local elections	Central Electoral Bureau (2012)
	Human capital	Rural literacy rate	NIS –Population Census (2011)
		Average life expectancy in rural	NIS –TEMPO ONLINE database
	Financial capital	Agricultural nominal wage	NIS –TEMPO ONLINE database
		Average farm size	NIS – Agricultural Census (2010)
		Agricultural hectares / tractor	NIS –TEMPO ONLINE database
	Physical capital	Share of communal and county modernized roads	NIS –TEMPO ONLINE database
		Share of rural municipalities connected to the running water	NIS –TEMPO ONLINE database
		Share of agricultural land equipped with irrigation facilities	NIS –TEMPO ONLINE database
		Share of agricultural land equipped with drainage facilities	NIS –TEMPO ONLINE database
	Social development	Social development index	Regionalization Advisory Council – CONREG (2013)

3.2. Indicators integration and aggregation

After loading the data into an SPSS matrix, indicators standardization was accomplished (mean 0 and dispersion 1). To reduce the large data volume and to capture the common elements of the variables set, the factor analysis was used (principal component analysis). This is a statistical method to reduce the number of variables chosen for describing a domain, by constructing new variables (called factors) in much smaller numbers, and by determining mathematical relationships that specify the relationship between the original variables and factors. Thus, these new variables reproduce, to a large extent, the information contained in the original variables. In this case a number of ten factors were extracted.

Obtained output factors from factor analysis were used as input to the cluster analysis; statistical method in which the elements of a set are grouped in subsets, based on one or more attributes of these elements. Cluster models may vary depending on how you define the distance, the clustering process and the criteria by which decided optimum clustering. Different models application on the same sets may lead to different classifications. The eleven counties of the Danube region were grouped by hierarchical cluster analysis (euclidean distances, the farthest neighbor method) (Figure 1).

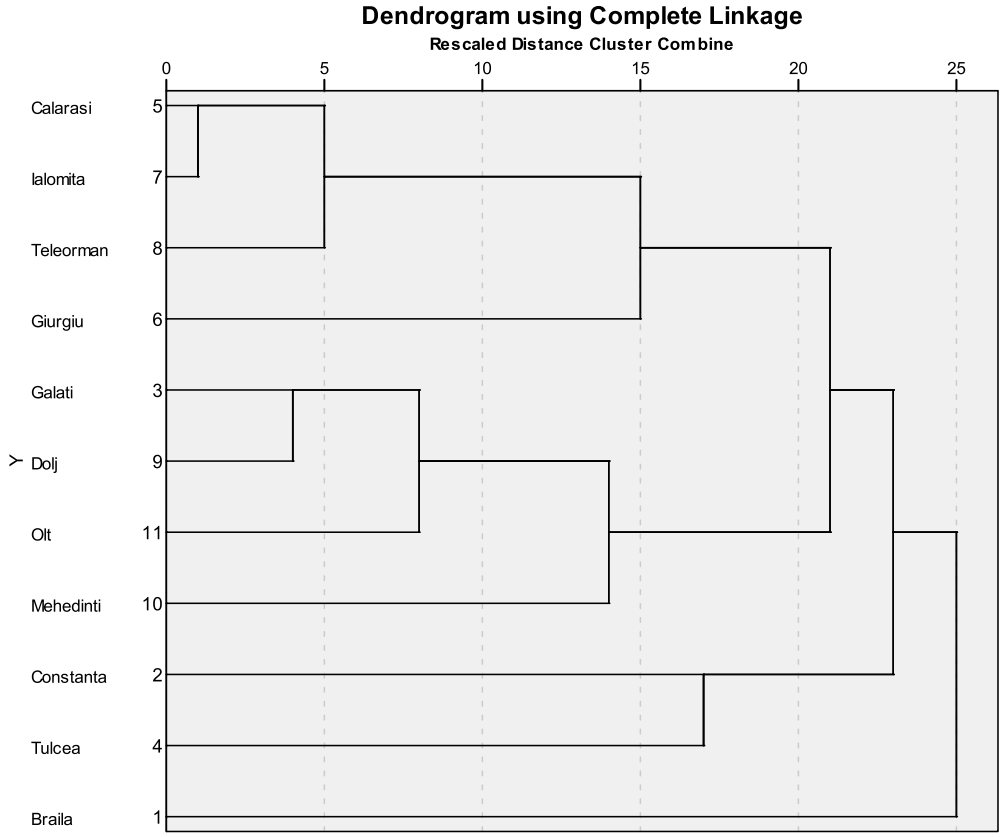

Fig. 1. The similarity degree

Objective of cluster analysis was to classify the eleven counties, starting from a series of known attributes, by ensuring that the elements of each class are as close to each other. Thus, the database units (counties) were grouped into four clusters.

4. Results and Discussions

Cluster analysis led to the identification of four types of counties with relatively homogeneous characteristics (Figure 2).

Cluster 1 that comprises Braila County is characterized by a high degree of exposure to hydro-climatic hazards, particularly floods. Sensitivity is average; prevailing farms fewer than 5 ha, with an average index of crop diversification, which uses to a small extent modern factors of production - chemical fertilizers and irrigation. Intensification expressed in conventional animal per hectare is low to medium. Proportion of land with severe and very severe limitations for agricultural production is average. The anthropization degree is high. Rural population pressure on the territory is low. Social capital is reduced; ability to organize and participate in community life is low. The literacy rate is elevated for rural areas also life expectancy. Financial capital is moderate. Infrastructure in all its three components – roads, agricultural and technical infrastructure is developed enough.

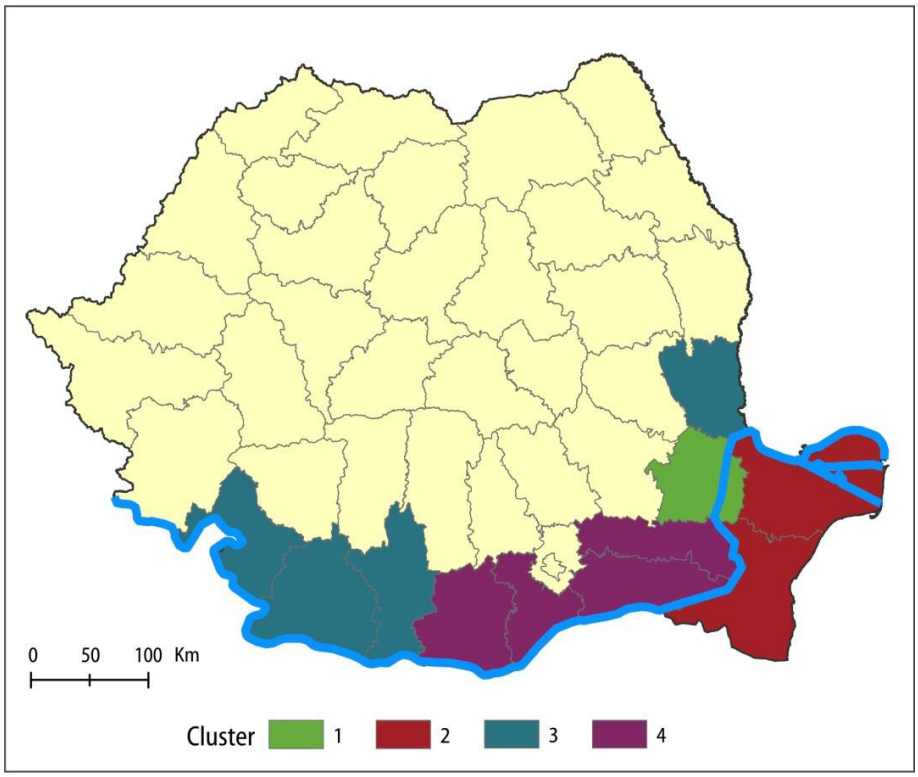

Fig.2. Rural typologies in Danube region

Cluster 2 consists of Constanta and Tulcea counties. It has a medium to high exposure, with aridity tendency and high exposure to flooding in Tulcea County. The high share of subsistence and semi-subsistence farms and reduced crop diversification index causes increased sensitivity. The livestock sector is underdeveloped. In terms of naturalness, Constanta County has a strong human intervention, while in Tulcea natural elements predominate. Rural population density is very low in Tulcea. Human capital is developed; both literacy rates and life expectancy values are higher than the average region. Social capital is reduced. In terms of financial capital both counties have a medium to high position. Agricultural and rural road infrastructure is poorly developed.

Four counties - Galati, Dolj, Olt and Mehedinți - belong to cluster 3. This has a medium to high degree of exposure to hydro-climatic factors; Galați and Dolj counties are characterized by a high degree of exposure to flooding. Regarding the sensitivity component, this cluster is characterized by an average share of subsistence and semi-subsistence households, through high crop diversification, average use of modern factors of production, poor development of the livestock sector and a medium to high dependency of the rural economy by the agriculture. Except Mehedinti County, all three components counties of the cluster have a significant degree of anthropisation. The soils with restrictive conditions for agriculture have a significant share. Ability to organize and participate in community life is weak to medium developed. Financial and human capital occupies a middle position. Infrastructure is weak to medium developed.

Cluster 4 comprises the Calarasi, Giurgiu, Ialomita and Teleorman counties. Exposure to hydro-climatic factors is low to medium. However, Teleorman and Ialomita counties have a high degree of flood exposure. Regarding the sensitivity, this cluster has the following characteristics: high share of farms with less than 5ha (except Giurgiu county); average index of crop diversification; low use of modern production factors; strong dependence to the agricultural sector (share of population employed in agriculture varies between 46% and 56%); high share of quality soils. Adaptive capacity is the lowest of all analyzed clusters. The social development index is very low and puts all four counties among the poorest in Romania; this cluster recorded the lowest level of literacy; infrastructure has the lowest values in the region.

Conclusion

In conclusion, this paper has looked for a quantitative analysis of vulnerability to hydro-climate changes in the eleven counties of the Danube region. The vulnerability was seen by the three components: exposure, sensitivity and adaptive capacity. Twenty - five indicators were examined. The used methods were factor analysis and cluster analysis. Resulting vulnerability matrix presented in Table 2 shows how the three components of vulnerability are distributed on the four clusters.

Table 2. Matrix of vulnerability

Cluster	County	Exposure	Sensitivity	Adaptive capacity
Cluster 1	Brăila	+ + +	+ +	+ + +
Cluster 2	Constanța, Tulcea	+ +	+ +	+ +
Cluster 3	Galați, Dolj, Mehedinți, Olt	+ +	+ + +	+ +
Cluster 4	Călărași, Giurgiu, Ialomița, Teleorman	+ +	+ +	+

This methodology has limitations as well as strengths. Advantages of this approach are given by the indicators transparency framework matrix that allows the analysis of hydro-climatic vulnerability on its determinants. Also, this method allows vulnerability assessment at the sub-national level. However, the transposition of the vulnerability on the map at the county level may lead to a false sense of precision (each county has a significant heterogeneity at the municipalities level). Because of this, vulnerability analysis should be done at the commune level (currently, available data are limited at commune level, which is an insurmountable limitation). The clusters show spatial differences of vulnerability at the county level. In this context, policy makers should adapt policies to local conditions. In addition, hydro-climatic changes should be placed in the broader context of sustainable rural development.

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