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Meta-Analysis ELECTRE III and AHP in Evaluating and Ranking the Urban Resilience

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Abstract:

Recently, climate change has become more visible, with weather extremes and natural disasters causing more economic damage than ever before. Given all the factors that threaten the dynamic ecological balance, it is very important to ask whether there is a possibility to assess the sustainability of some territorial units using technical and scientific criteria. Is there a method to assert that one community or municipality is more resilient than another and to explain all of this? Multi-criteria decision analysis (MCDA) is the most appropriate theory best applied to such complex decisions. MCDA methods are used to assess "if and how resilient my city is". Previous methodological frameworks for urban sustainability have been created and presented in the literature, and most of them use the AHP technique. These methods form a hierarchy of decision-making problems with criteria and alternatives (cities, communities), and the latter are evaluated based on how well they meet the criteria. This paper aims to assess the urban resilience of Durres County, Albania, and its regions and municipalities that share the same urban and geographical characteristics using the AHP and Electre III methods. This city has been studied, analyzed, and evaluated because it has a history of natural disasters and is in a very dangerous area for some indicators. The results of the study concluded that the district, its regions, and communes are at high risk of flooding due to torrential rains accompanied by river floods, erosion of agricultural lands and the coast, as well as other natural risks, and need significant improvements to cope with them. Albania and the region of Durres have been involved over the years in several national and international projects to improve urban sustainability and resilience. However, the assessment and improvement of urban sustainability should always be an ongoing process.

Keywords: urban resilience; AHP; operation research; assessment; criteria; ranking; framework; alternatives.

JEL Classification: Q01; C61; C44; C63.

Introduction

Natural disasters continue to pose, more than before, a serious and increasing threat to urban communities, cities, and municipalities. It is estimated that extreme weather has caused significant damage to approximately four billion people over the last 20 years, claiming over 600,000 lives and causing nearly $1.9 trillion in economic losses (https://www.gfdrr.org/en). The UN defines resilience as "the capacity of a community, group, society, or system to be exposed to risks, hazards, and disasters and to withstand, adapt, and recover in a timely and efficient manner while preserving its essential and fundamental functions and structures, (https://www.unisdr.org/files/7817 UNISDRTerminologyEnglish.pdf).

Institutions, governments, and decision-makers, in general, must frequently collaborate to deal with the aftermath of small- and medium-scale disasters, as well as large-scale events caused by natural or human activity. Local government is the first line of reaction, often with great responsibilities but usually with insufficient capacity to deal with them. They are also at the forefront when it comes to preparing for, dealing with, and managing disasters, setting up and operating early warning systems, and disaster or crisis management structures. This means that for cities that are estimated as high-risk, the strength of the mandate of local responsibilities should be re-evaluated, as well as the need for infrastructural and technological improvements to promote and strengthen urban sustainability. This is why political, academic, and scientific institutions need to recognize, understand, and emphasize the need to strengthen urban resilience and make cities more sustainable, and more secure, (Shaimerdenova *et al.* 2020; Woodruff *et al.* 2021).

Most of the scientific literature related to urban resilience is based on the pioneering work of the theoretical ecologist Crawford Stanley Holling, who was the first to introduce the term resilience in the sense it has today. The term "resilience", in any case, has been used a long time ago; the word comes from the Latin language and refers to the ability of an object or system to withstand a blow or attack and manage to return to the previous state. In the early nineteenth century, the term described the ability of certain types of wood to withstand sudden and heavy loads without breaking, (Holling, 1973; Zeng *et al.* 2022).

The assessment of urban resilience is closely related to the understanding and recognition of disaster risk, which “measures” the level of a city’s exposure and vulnerability to future hazards, especially natural disasters. Disaster risk is a function of hazards, which can be an earthquake, river floods, summer fires, and the exposure and vulnerability of communities to hazards. Factors that are part of vulnerability and exposure are not static; they can be changed and improved, depending on institutional and individual capacities, as well as work and preparation. The preparation of communities will reduce the level of disaster risk and make it easier to cope with the disasters and risks when they occur. The disaster risk parameter is the ratio of the hazard and vulnerability exposure to the resilience and coping capacities (Nohrstedt *et al.* 2021; Anderson & Renaud 2021).

$$Dissaster\ Risk = \frac{Hazard\ x\ Vulnerability\ x\ Exposure}{Resilience\ or\ coping\ capacities}$$

Urban resilience remains a complex and difficult concept to operate. Creating and developing a framework to materialize the concept would be a crucial milestone in understanding which factors and interactions influence urban resilience. The community resilience metrics should be accurate indicators of the community’s actions and capacity to respond to and recover from a disaster event. They should be accurate, reliable, comprehensive, scalable, and affordable. Cutter suggests that communities should implement a resilience measurement tool that meets the following criteria (Cutter 2014; Parker and Simpson 2020):

- They are open and transparent.
- They align with the community’s goals and vision.
- The measurements are simple and well documented.
- They can be replicated, and also address multiple hazards.
- They represent the community’s characteristics and the composition and diversity of its members.
- They are adaptable and scalable to different community sizes, compositions, and changing circumstances.

1. Literature Review

A resilient city requires public administration and other state institutions to focus not only on responding to and coping with the impacts that occur but also on preventing and reducing the risks. Preparing and promoting a culture of resilience can significantly contribute to facing a disaster and decreasing human, economic, and socio-environmental losses. Assessing the community’s resilience is essential for disaster preparedness and recovery. Furthermore, it provides metrics to prioritize, assess, and measure progress and supports decision-making, (Pirlone and Spadaro 2020; Melendez *et al.* 2022).

Urban resilience consists of a combination of several factors, such as social, economic, community awareness, institutional, infrastructure, etc. The intersection of all these factors allows us to present an innovative research study of the territory and to measure its resilience by evaluating the elements that make up the city's resilience based on clearly defined criteria and methodology. The parameters of urban resilience are expressed numerically with simple data that represent their real state. Some parameters may be demographic density, work activities, community preparation, and, above all, the impact of productive activities on the environment (A. Scarelli *et al.* 2018; Koliou *et al.* 2020; Horváth and Dzupka 2019).

Based on criteria and sub-criteria, regions or communities can be evaluated, indexed, and ranked. The most vulnerable sectors are identified and suggestions for future improvement are proposed, taking into consideration the impact caused by previous devastating events. In other words, the process of analyzing and evaluating the system's capacity to face natural, social, and economic challenges would greatly help to identify the problems and propose measures to make the city more resilient and more capable of coping with future disasters (Norese 2016; Zhong *et al.* 2020).

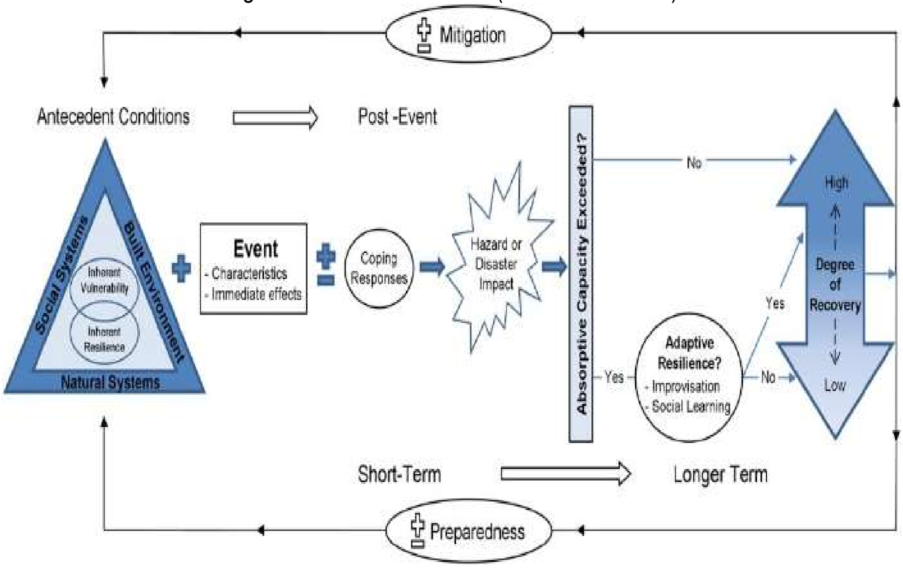
A good level of community and social resilience is also a product of the education activity, which aims at the prevention and minimization of the disaster's effects: "Resilience is something that our society and our people can grow in itself, in our families, and our communities." Resilient communities are well-structured and well-organized societies, capable of facing and minimizing the effects of disasters and recovering quickly by restoring their previous socioeconomic functions and vitality (A. Scarelli *et al.* 2018; Kaletnik and Lutkovska 2020).

Numerous theoretical frameworks on urban resilience include diverse approaches that are involved in functionalizing urban sustainability at diverse geographical scales and risk contexts. Studies on urban resilience are based on the main frameworks provided by the handbooks and literature and by adapting them to the specifics of the objects of their study and on the available data.

In their paper, Sharifi and Yamagata presented a content analysis of 29 resilience assessment frameworks containing the main criteria related to urban system resilience. All of the frameworks were created based on the characteristics of the objects and problems under investigation, with specific environmental issues. Among the most serious issues were river floods, earthquakes, droughts, and summer forest fires (Sharifi and Yamagata 2016).

Cutter's Disaster Resilience of Place model (DROP) is widely regarded as one of the most well-known conceptual frameworks for estimating urban resilience. The model provides a conceptual framework for natural disaster resilience by taking into account global change, hazards, political ecology, and ecosystems. It primarily focuses on community and social resilience, as well as other types of related resilience, and presents a set of variables for measuring resilience. The model defines and analyzes six major aspects of resilience: ecological, social, economic, institutional, infrastructure, and community competence, (Cutter *et al.* 2008; Cutter and Derakhshan 2020), figure 1.

Figure 1. The DROP model (Cutter *et al.* 2008)



Suárez, in his paper, has developed a framework to define urban resilience and to index and measure all the Spanish province capitals. He concluded that most of the Spanish province capitals are far from being resilient and that increased efforts should be made by institutions to improve and strengthen their urban resilience. The paper is based on the "Handbook on Constructing Composite Indicators: Methodology and User Guide," a framework methodology developed by Nardo. The approach was adapted to the objectives of the study, and the resilience criteria were constructed, taking into account the characteristics of the cities (alternatives) (Suárez *et al.* 2016; Nardo *et al.* 2005).

In their work, Scarelli and Benanchi developed an adaptive framework to analyze, access, and rank the urban resilience of 22 Italian cities and communities that are located in the hydrographic basin of the Ombrone River in the Tuscany region, in Siena's province. The available criteria were divided into two sets: the environmental and socio-economic ones. Among the environmental indicators were CO2 emissions as an index of the level of impurity and alteration of the atmosphere, the percentage of the urbanized area, which determines the quantity of risky surface water, the rate of ISO (International Organization for Standardization), EMAS (Environmental Management System) certificated firms, etc. Among the socio-economic indicators, the most important ones were demographic density, the ratio of the enrolled people on the jobseeker's list to the active population, the rate of work accidents, and the ratio of the active population (15–64 years old) to the whole population, etc. (Antonino Scarelli and Benanchi 2014).

Lika, in her paper, has examined Albania's agriculture and food sectors as an excellent model of sustainability and extraordinary adaptability in the face of the great challenge of economic, social, and environmental changes. This has been made possible by policies that have supported their development process. The agro-food sector has also played an important role in environmental conservation and the resilience of a variety of valuable natural habitats in Albanian landscapes (Lika 2021).

Kosova has analyzed and measured the urban resilience of the city of Berat, Albania, and the municipalities threatened by the flooding of the Osum River, using the Scareli & Benachi framework of urban resilience, with some changes related to the available data and the territory specifics. The paper concluded by indexing and ranking municipalities and proposing necessary measures to reduce the risk of river floods and protect the most vulnerable areas, particularly the historic and ancient city of Berat (Kosova *et al.* 2020).

2. Methodology

The urban resilience assessment frameworks contain six main criteria as well as several sub-criteria for each of them, which are used to assess the regions and municipalities of the Durres district (alternatives) (https://www.durres.gov.sal/bashkia/rajonet/674-rajonet-dhe-qytetet). The criteria and sub-criteria have been "weighed" in terms of their importance in the overall assessment of urban resilience, and the alternatives will be "measured", numerically evaluated, and finally ranked, following the criteria. The six criteria are social, economic, institutional, infrastructure, environmental, and community awareness (Moghadas *et al.* 2019).

Social resilience is the capacity of the community to react together as a social group to natural disasters and other extreme challenges. The community can cope with external stresses, disturbances, social, political, and natural disasters and continue with normal life as much as possible. Such communities are capable of absorbing, and adjusting to ecological, economic, and other kinds of social threats (Saja *et al.* 2019; Siokas *et al.* 2021).

Economic resilience is comprised of two components: efficient resource investment to prevent and cope with potential future crises and disasters, and the ability to properly recover, rebuild, and restore pre-crisis conditions. Both of these factors express each other's current state and level of performance. The lack of investment will create obstacles and delays in successfully planning and dealing with the crisis, and as a result, the consequences of a disaster will be greater. On the other hand, effective crisis management with minimal damage and disruption shows serious planning and wise use of investment and resources (Di Caro and Fratesi 2018).

Economic resilience is the preparation and effective use of economic resources to meet the needs of the population during natural disasters. Economic resilience is defined as the economy's ability to withstand a shock and maintain current levels of economic activity or recover to pre-shock levels within a given time frame (Di Pietro *et al.* 2021; Nair and Dileep 2020).

Institutional resilience is about planning, preparing, readiness capabilities, and institutional proficiency to deal with rapid change and stressful situations. It is the ability to cope with crises or disasters and bounce back from them without systemic collapse. Resilient institutions are important to the community and society because they provide stability and help protect the normal continuation of social, political, and economic life and make it easier for actors and organizations to cope with unexpected stressful situations of different origins and nature (Hills 2000; Naderpajouh *et al.* 2020; Farahmand *et al.* 2020).

Infrastructure resilience is defined as the ability of infrastructure and its related systems to positively adapt or respond to extreme stresses and transform in ways that restore, retain, and even improve their essential functions. Resilient infrastructures can withstand and adapt to extreme conditions, returning to their previous normal state while still providing essential services to the population (Heinimann and Hatfield 2017; Cantelmi *et al.* 2021; Najarian and Lim 2020).

Community resilience is related to the degree of connection between individuals and the community, as well as their cooperation in the event of a risk. Community resilience is a measure of a resilient community's ability to respond, cope, and recover from adverse, negative, and extraordinarily difficult situations using available resources that have been prepared ahead of time (Nguyen and Akerkar 2020).

During the powerful and catastrophic earthquake that occurred in the city of Durres in November 2019, the community showed a high willingness to help the injured and the families of the victims. Volunteers, individuals, and various associations were engaged in assisting state institutions in sheltering the injured and distributing materials, food, and assistance. Many non-governmental organizations managed to set up several funds for the homeless families and contributed more than 60 million euros to rebuild the earthquake-damaged homes.

Ecological resilience is the capacity of an ecosystem to return to the point of equilibrium it was before a disaster, which can be caused for natural or anthropic reasons (chemical pollution, technological disaster, etc.). Ecological resilience is the persistence of an ecosystem to remain within the same conditions as determined by the same processes, structures, and identity. Ecological resilience is associated with the ability of the ecosystem to tolerate extreme situations, reorganize, and renew (Arani *et al.* 2021; Glover *et al.* 2021; Koutra *et al.* 2022).

The standard procedure for developing composite indicators is difficult due to the complexity and variety of theoretical foundations, but the majority of the literature generally proposes the following steps.

1. Developing a sound theoretical foundation
2. Identifying and selecting indicators
3. Using multivariate assessments for data reduction and factor retention
4. Weighing and aggregating indicators
5. Visualizing and mapping results
6. Validating results to ensure reliability

2.1. The Mathematical Model and AHP

The Analytic Hierarchy Process (AHP) is a method that is adapted for complex decisions, developed by Saaty, (Saaty 1988). It consists of three parts: the ultimate goal or the main problem to be solved; the possible solutions that are called "alternatives," and the “criteria” which are used to judge the alternatives (Qendraj *et al.* 2021; Qendraj *et al.* 2022). AHP ensures a hierarchical framework for a final decision by evaluating its criteria and alternatives related to the goal. Decision-makers must evaluate the importance of the two criteria via pair-wise comparisons. AHP converts all of these evaluations into numbers, which can be compared according to the scale of comparison (Saaty scale), table 1.

Table 1. Scale for the comparison

1	Equal Importance	Two activities contribute equally to the objective
2	Weak or slight	Intermediate value
3	Moderate importance	Experience and judgment slightly favor one activity over another
4	Moderate plus	Intermediate value
5	Strong importance	Experience and judgment strongly favor one activity over another
6	Strong plus	Intermediate value
7	Very strong or demonstrated importance	An activity is favored very strongly over another; its dominance demonstrated in practice
8	Very, very strong	Intermediate value
9	Extreme importance	The evidence favoring one activity over another is of the highest possible order of affirmation

Source: Saaty 1988

The two most important schools of decision analysis methods are Multi-Criteria Decision Making (MCDM) developed by the American school (Keeney and Raiffa 1979), and Multi-Criteria Decision Analysis/Aid (MCDA) created by the European school (Roy and Vincke 1981), figure 2.

The procedure of criteria evaluation consists of four main steps.

Step1. The identification of evaluation criteria.

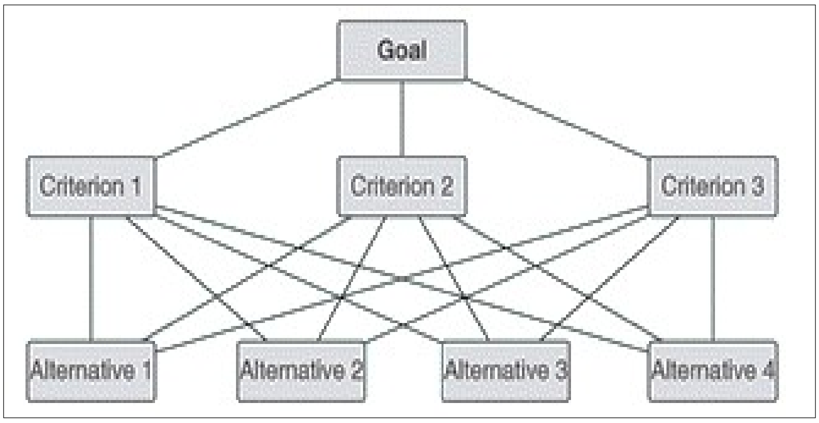
Step 2. The construction of a hierarchy of the evaluation criteria.

Step 3. Calculation of weights of chosen criteria using the AHP method.

Step 4. Calculate values for alternatives and get the final ranking results.

The Analytic Hierarchy Process (AHP) is a very popular MCDA method that is widely used for solving complex problems having several attributes (Xhafaj *et al.* 2021; Wu *et al.* 2021). This method converts unstructured problems into a hierarchical structure of elements, which are the main goal of the selected problem, criteria that are related to the overall goal, sub-criteria as part of the main criteria, and finally, the alternatives as solutions to the problem. A combination of AHP and TOPSIS or other tools like ELECTRE and PROMETHEE has been successfully used in many complex evaluations and ranking framework methodologies.

Figure 2. Criteria and alternatives for resilience evaluation



Source: Scarelli *et al.* 2018

The stepwise procedure to calculate the criteria weights by AHP is as follows:
Step 1: Construct the structural hierarchy.
Step 2: Construct the pair-wise comparison matrix.

2.2. The Decision Matrix

Let assume n attributes, then the pairwise comparison of any attribute i with any attribute j form a square matrix $A_{n\,x\,n}$ where the term $a_{i,j}$ denotes the comparative importance of the attribute i concerning the other attribute j.

In the comparison matrix we have; $a_{i,j} = 1, for\ i = j$, and $a_{i,j} = \frac{1}{a_{j,i}}, i \neq j$.

$$A_{nxn} = \overbrace{\begin{pmatrix} 1 \\ 2 \\ \dots \\ \dots \\ n \end{pmatrix}}^{Attributes} \begin{bmatrix} a_{11} & a_{12} & \dots & a_{1n-1} & a_{1n} \\ a_{21} & a_{22} & \dots & a_{2n-1} & a_{2n} \\ \dots & \dots. & \dots. & \dots\dots & \dots.. \\ \dots. & \dots. & \dots. & \dots\dots & \dots\dots \\ a_{n1} & a_n2 & \dots & a_{nn-1} & a_{nn} \end{bmatrix}$$

Step 3. Construct the normalized decision matrix,

$$c_{i,j} = \frac{a_{i,j}}{\sum_{j=1}^{n} a_{i,j}},\ i = \overline{1,n};\ j = \overline{1,n}. \qquad 2.1$$

Step 4. Construct the weighted normalized matrix,

$$w_i = \sum_{j=1}^{n} \frac{c_{i,j}}{n},\ i = \overline{1,n} \qquad 2.2$$

$$W = \begin{bmatrix} w_1 \\ w_2 \\ \dots \\ \dots \\ w_n \end{bmatrix} \qquad 2.3$$

Step 5. Calculate eigenvectors and Row matrix $E = \frac{N^{th} rootvalue}{\sum N^{th} rootvalue}$ 2.4

$Rowmatrix = \sum_{j=1}^{n} a_{ij} * e_{j1}$ 2.5

Step 6. Calculate the largest Eigenvalue, the Principal Eigenvalue, $\lambda_{max} = \frac{Rowmatrix}{E}$ 2.6

Step 7. Calculate the consistency index $CI = \frac{(\lambda_{max} - n)}{n-1}$ 2.7

Where n is the matrix order.

The consistent ratio $CR = \frac{CI}{RI}$ 2.8

RI is called the random Consistency index.

If the value of the Consistency Ratio is less than 10%, then the decision matrix is consistent and is acceptable. If the Consistency Ratio is greater than 10%, then the process is repeated by revising the subjective pairwise comparisons of the criteria.

The pairwise comparison matrix has been completed by weighing the criteria in terms of their relative importance two by two. The relative importance of each of the two criteria is expressed using index values ranging from 1 to 9. The values are entered into a decision matrix row by row. The main diagonal contains only 1-s. The right upper half of the matrix is not complete until each criterion has been compared two by two to every other one. If the relative importance of A to B is n, then the relative importance of B to A is 1/n. The corresponding fractions will fill the lower-left half of the matrix.

3. Results of the Study

Albania is committed to the implementation of various ecological projects in cooperation with the European Union and the World Bank, for the management of water resources and protection of land from erosion (https://projects.worldbank.org/en/projects-operations/project-detail/P162786).

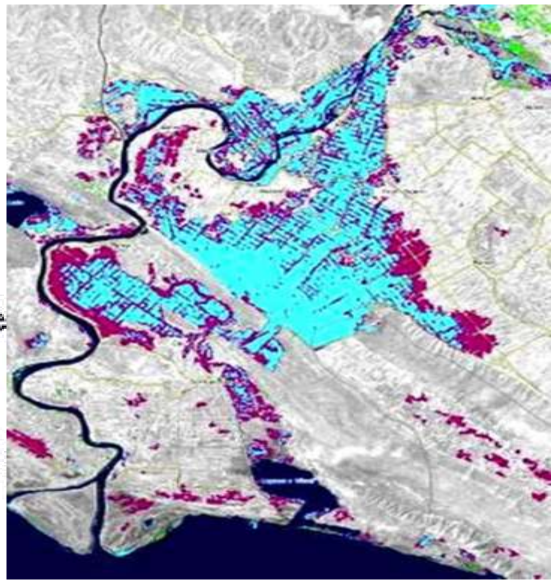
According to the data, Albania is classified as a high-risk or very high-risk country on some natural risk indicators. Albania is considered one of the most threatened countries on the European continent by natural disasters. In the 2021 World Risk Report, Albania is listed among the countries with medium to high risk, together with Greece, Montenegro, North Macedonia, etc. In the global list of 171 countries, Albania is listed as the 61st, indicating that it has a greater potential to be affected by natural disasters. The most devastating natural disasters are earthquakes, river overflows, torrential rains, summer droughts, and forest fires.

Albania is ranked the second country in Europe for its water resources. The river water network of Albania consists of 13 rivers, but in total, there are over 150 rivers of all levels. Most of the rivers continue to cause flooding because of poor infrastructure and prevention measures. Documentary sources on floods in Albania are already abundant, from ancient times until today. From 1852 to the first quarter of the 21st century, there were about 4000 cases of disasters in Albania, while flooding accounted for the largest percentage of disasters at about 38%. The flooded area throughout the country ranges, on average, from 65,000 ha to 110 thousand ha, figure 3-4. It is estimated that floods caused by rain and overflowing rivers have caused about $2.5 billion in economic losses in Albania during the three decades from 1990 to 2021 (https://www.desinventar.net/).

Albania is located in the western part of the Balkan Peninsula, which is considered a high-risk seismic area. Over the last 50 years, Albania has suffered human losses, injuries, and heavy damage in three major earthquakes: in 1967 (Diber district), 1979 (districts of Shkoder and Lezhe), and 2019 (Durres district). The total damage caused by the last earthquake (November 2019) is estimated at almost 1 billion EUR (121 billion ALL), of which around 850 million EUR (around 103 billion ALL) represents the value of destroyed physical assets and around 150 million EUR (18 billion ALL) refers to losses.

Figure 3. The hydrologic map of Albania.

Figure 4. Flooding of the river in Albania.

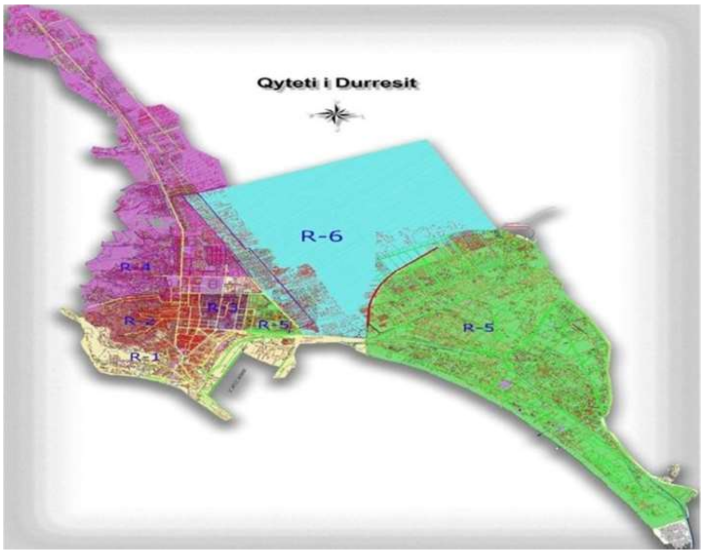


Source: Albanian geological services (http://www.gsa.gov.al/Sherbimet/hartat.html)

The urban resilience assessment scheme of the Durres district is focused on the characteristics and capacities of its regions and municipalities. The population of Durres District is around 250,000 inhabitants, in an area of 433 km^2. The average height is 2- 6 m above the sea. The total borderline is 121.3 km, of which 52.4 km are land borders, 61.8 km are sea borders, and 7.1 km are river borders. The average amount of rain precipitation is 963.4 mm/year or 116 days per year.

The Durrës district is located in a sensitive area of natural hazards. The Adriatic Sea is on the west, two rivers, Erzen and Ishem pass through its territory, and the area has a high level of groundwater. The rainy season is always accompanied by frequent flooding of agricultural lands as well as city and commune roads, causing damage to productive activities, transport, and agriculture, and infrastructure, public and private property. The Durres area is also considered a high-risk seismic area. The situation has been worsened after the '90 with rapid and anarchic construction, contrary to urban planning and building regulations. The district has 9 municipalities, and 6 regions of the Durres city, figure 5.

Figure 5. Map of Durres city, with five regions.



Source: https://www.durres.gov.al/bashkia/rajonet/524-harta-e-rajoneve

A methodological framework has been created based on the literature and similar cases and adapted to the district's characteristics, and the available data. The six main criteria, together with the sub-criteria, constitute a framework with 24 criteria, which are:

Social resilience (percentage of independent people, percentage of people with disabilities, educational attainment, equality, and public recreational facilities).

Economic resilience: (% of homeowners, % of unemployment, % of workers in agriculture, fishing, forestry, the extractive industry, and tourism, and the density of commercial infrastructure in each district).

Institutional resilience (population changes over the previous five-year period, number of building units constructed over the last ten years).

Infrastructure (% of houses with durable construction materials, % of worn-out urban texture, principal arterial kilometers per square kilometers, number of hotels/motels & temporary shelters per 10,000 persons, number of hospital beds per 10,000 persons, fire stations, police stations & emergency operation centers).

Community resilience (civic & social advocacy organizations per 10,000 people, religious centers per 10,000 people, training of administrative staff and institutions, museums and libraries per 10,000 people).

Environmental resilience (length of rivers and coastline in each region, the ratio of building and unbuilding space in each region, the ratio of land changed to urban areas in the area over the last ten years, drainage and erosion control).

Six city regions (named R1-R6) of Durres and nine municipalities are under study, Shijak, Manze, Sukth, Gjepalaj, Ishem, Katundi Ri, Maminas, Rashbull, Xhafzotaj, (named M1-M9). The data are collected from the district website and other Institutions.

The estimation of the alternatives (regions and municipalities) of the Durres district has followed these steps:

1.Create a group of specialists, each in their field, that will analyze and estimate the criteria and sub-criteria. Study and analyze the most implemented frameworks from the literature and create an adapted framework considering the available data and alternative characteristics.

2.The AHP procedure is implemented to measure the weight of each criterion and sub-criteria. The AHP process is based on the pairwise comparison. A consistency ratio (CR) needs to be estimated. If CR does not exceed 10%, the expert's judgment is acceptable.

3.Finally, after step 2, the average weights should be calculated as the final weights of each indicator.

4.Estimate the alternatives, considering each criterion and sub-criterion, compare and rank the alternatives, regions, and municipalities.

The AHP pairwise comparison of six main criteria has produced a 6x6 square matrix and the relative weights of all of the criteria have been calculated. The number of pairwise comparisons is 15, the value of the principal eigenvalue is 6.27, and the consistency ratio CR is 3.5%, which makes the process valuable (< 10%).

Table 2. Decision Matrix of pairwise comparison

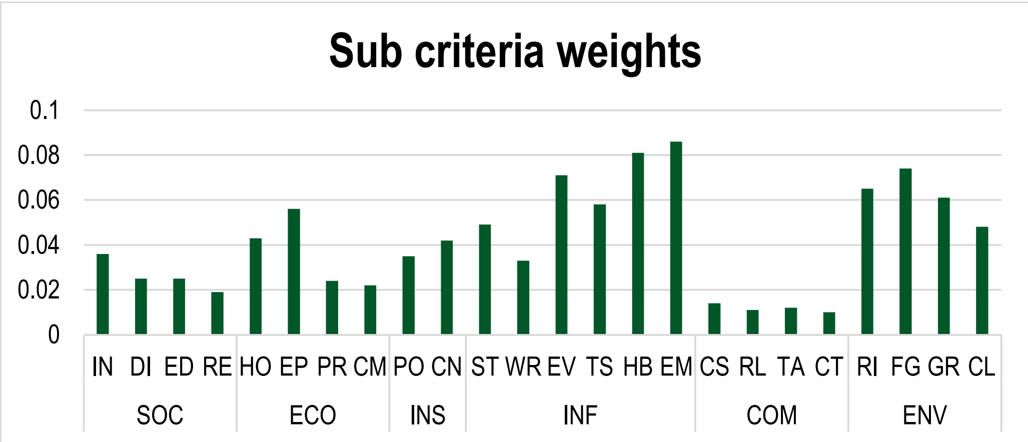
CAT	INF	ENV	ECO	SOC	INS	COM
INF	1	2	3	4	5	5
ENV	.50	1	2	3	4	4
ECO	.33	.50	1	2	2	3
SOC	.25	.33	.50	1	2	3
INS	.20	.25	.50	.5	1	3
COM	.20	.25	.33	.33	.33	1

Table 3. The relative weights of all the criteria

NR	CRIT	PRIORITY	RANK	+	-
1	INF	37.8%	1	8.4%	8.4%
2	ENV	24.8%	2	5.5%	5.5%
3	ECO	14.5%	3	3.0%	3.0%
4	SOC	10.5%	4	3.2%	3.2%
5	INS	7.7%	5	3.0%	3.0%
6	COM	4.7%	6	1.7%	1.7%

Source: https://bpmsg.com/ahp/ahp-calc.php

Figure 6. Criteria and subcriteria relative weights



Source: AHP and Office Excel 2016.

The same AHP procedure is used for the sub-criteria, too, resulting in weighted criteria and sub-criteria, table 2-3. The result showed that the infrastructure factor is the most important among six factors, followed by the environmental factor, economic factor, and institutional and community factors. The same process is implemented for the sub-criteria, producing their weights figure 6.

Table 4. The results and the ranking

Alternatives	Points	Alternatives	Points	Positions
R1	1780	R1	1780	1
R2	1730	M4	1755	2
R3	1725	R4	1750	3
R4	1750	R5	1750	4
R5	1750	M9	1745	5
R6	1625	M6	1739	6
M1	1730	R2	1730	7
M2	1670	M1	1730	8
M3	1644	R3	1725	9
M4	1755	M7	1700	10
M5	1685	M8	1700	11
M6	1739	M5	1685	12
M7	1700	M2	1670	13
M8	1700	M3	1644	14
M9	1745	R6	1625	15

There are several algorithms to get the final results, evaluation, and ranking based on the chosen framework.

The most popular among them are: (i) the PROMETHÈE model (Preference Ranking Organization Method for Enrichment Evaluations) and (ii) the ELECTRE model (ELimination et Choix TRaduisant la REalitè). The last is a powerful method of multi-criteria decision analysis. The Electre III model has been deemed the most appropriate because an alternative ranking is required at the end (Corrente *et al.* 2013).

The method's procedure occurs in three steps: (i) The construction of an outranking relation states for each pair of comparisons (a, b), how much more important a is than b, (ii) through a concordance index, a discordance index, and a credibility index, and (iii) once the results are in, the analysis goes on; the final rank is a new starting point to check, which types of the criteria played a specific role in the acquired position. The ELECTRE III can handle a large number of data points without requiring the analyst to expend excessive effort on pairwise comparisons. For each criterion, 100 points were given to the best alternative. The general point estimation and ranking of alternatives are concluded with ELECTRE III. (See table 5). The best-prepared region is R1, and the worst-prepared region is the M5 region (or Ishem). Each region or municipality should improve its performance by addressing the factors that have contributed to some criticality.

Conclusion

A large number of articles and scientific studies have been published, demonstrating the preoccupation and the seriousness of urban resilience.

ELECTRE III and AHP are implemented to estimate, measure, and rank regions, and municipalities of Durres County. The result showed that the R1 region is the best prepared, compared to other regions and communes, and the worst prepared is the M5 region. However, all the regions and communes that are part of the Durres District are far from being resilient and have to improve their preparedness to face future risks.

These criteria and sub-criteria have been chosen by adapting well-known methodology frameworks with territory characteristics, problems, and available data.

The district of Durres is considered at high risk of flooding, agricultural land, coastal erosion, and high seismic activity, which has caused great damage in the past years

Albania and the district of Durres have been involved in a series of national and international projects to improve urban resilience such as:

- "Southeast Europe Urban Resilience Building Action Network", (https://www.al.undp.org/content/albania/en/home/projects/south-east-europe-urban-resilience-building-action-network.html).
- "Territorial development strategy 2015-2030", (https://cdinstitute.eu/wp-content/uploads/2016/03/Bashkia-Durres-Strategjia-e-Development-Territorial-2015-2030).
- "Establishment of Transnational Civil Protection Adrion Early Warning System to improve the resilience of Adrion territories to natural and man-made risks", (https://transcpearlywarning.adrioninterreg.eu/).
- "Affordable and social housing, housing finance", (https://unece.org/housing/affordablehousing).

Many other many local and national projects have also been implemented to improve the resilience of urban areas considerably. For a more detailed and complete study and better understanding, and estimation of the problems and urban resilience a much larger database is needed from the local and national Institutions.

For more accurate results and valuable conclusions and suggestions, the effective and close cooperation of different specialists is needed, such as geologists, environmental engineers, economists, and operations research mathematicians.

The proposals for improvements to the Durres district, its regions, and municipalities should be expanded to a bigger territorial contest towards problems regarding environmental protection, safety, and strengthening of the territory's resilience. Then, it will be easier to answer the question "My city is getting ready."

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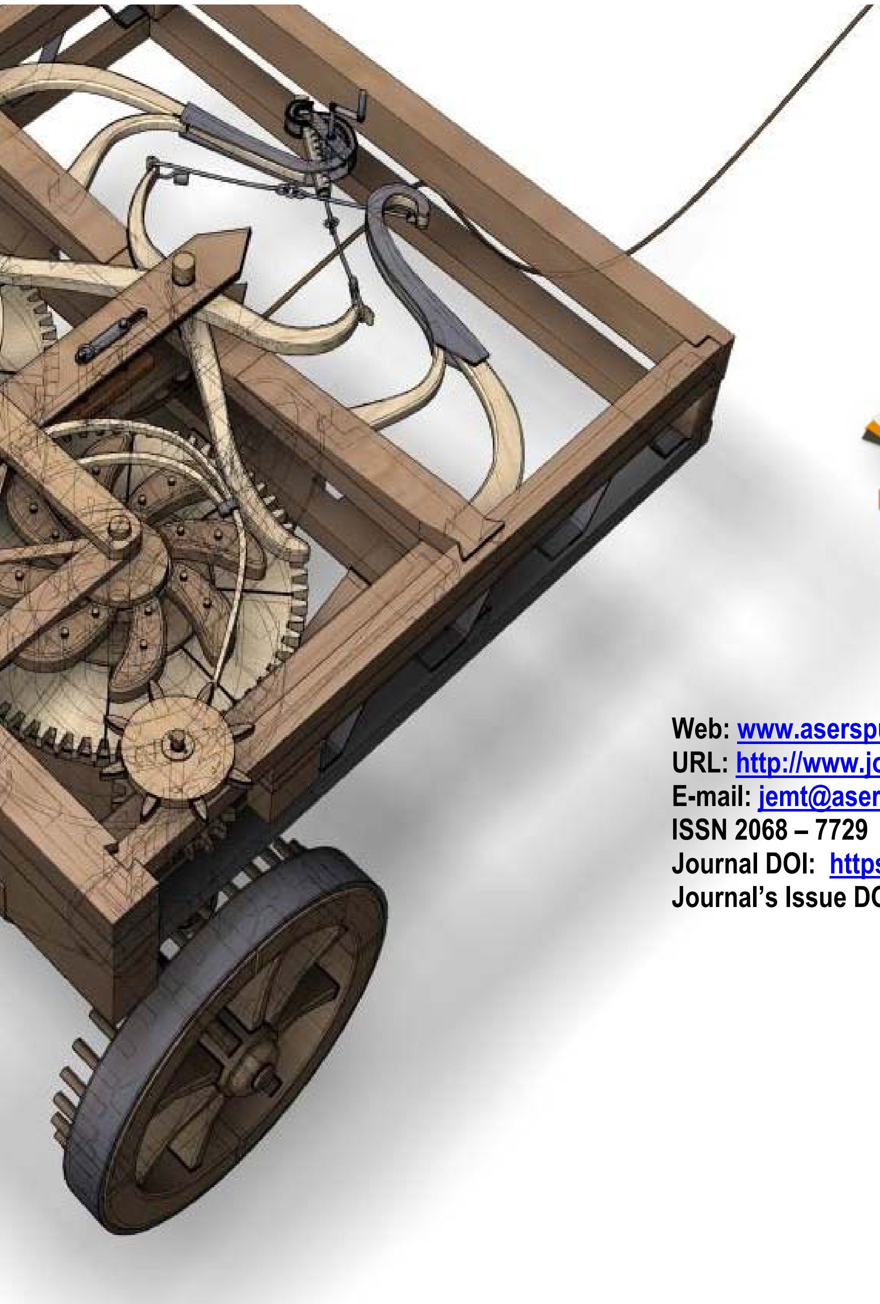

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