Scientific Journal of the Observatory of Mediterranean Basin.
Polis University / Ferrara University /
UNECE Center of excellence / Co-PLAN Institute.

TITLE: **SUPERIMPOSITIONS. Proposals for environmental systems implementation and biodiversity development in the Lezhë region through a multi- disciplinary approach**

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SOURCE: *Scientific journal of the Observatory of Mediterranean Basin, Volume 8, Issue 1 & 2 / 2023, pp. 208-215*

ISSN: *2959-4081*

ISBN: *(print) 978-9928-3470-9-1*
(e) 978-9928-347-10-7

DOI: *10.37199/o41008208*

PUBLISHED BY: *POLIS-Press*

SUPERIMPOSITIONS. Proposals for environmental systems implementation and biodiversity development in the Lezhë region through a multi-disciplinary approach

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Abstract- *Multiple hazards are present over the territory and their impact extends beyond the administrative boundaries, revealing the need for an integrated local - to national –regional approach with the aim of building resilience, as a response to uncertainties. Lezhë district – a region of 479 km2 located in the northwest of Albania – has a large diverse ecosystem (Gencer, 2014), its environmental and landscape features are of considerable importance and constitute intrinsic characteristics of the region itself. Therefore, disaster risks constitute an issue of prime importance. Extremely important phenomena impacting territorial safety are environmental process changes and sudden spatial transformations caused by climate change. Specifically, the region faces risks related to hazards like surface water flooding, due to extreme rainfall, sea level rise, rock falls, forest fires and also seismic-triggered events. The above-mentioned hazards combined with high levels of vulnerability are consequently followed by losses in terms of physical, economic, environmental and also impact on biodiversity. Facing such challenges, it is necessary to build a large-scale strategy to build territorial resilience through strengthening environmental systems. When dealing with complex issues where biotic and abiotic components are involved to propose a design strategy, a multi-disciplinary approach is a prerogative. This contribution is developed under the framework of the two-week workshop at POLIS University and proposes a macro-strategy that faces environmental and territorial issues, followed by specific project actions related to the implementation of blue and green assets with the objective of reducing disaster risk.*

Introduction - Albania is a country characterized by a high number of natural events affecting most of the territory. These events are of a geophysical nature mostly earthquakes and landslides and of a hydrological and meteorological nature like flooding, erosion, and flash floods due to heavy rain. The flooding is also due to discharges from hydro powerplants during the winter. The likelihood and nature of these events varies, but , Albania is affected each year by such events resulting in losses from the economic and physical point of view and often even in human losses. The losses are due to high levels of vulnerability the built systems have in the entire country mainly due to lack of proper planning, the quality of materials used in the construction sector, uncontrolled development especially in the littoral areas and many other factors.

Lezhë district – a region of 479 km2 located in the northwest of Albania – has a large diverse ecosystem (Gencer, 2014), its environmental and landscape features are of considerable importance and constitute intrinsic characteristics of the region itself.

Lezhë is located near one of the main tectonic faults that goes through the Albanian territory making it prone to seismic events. In addition one of the main rivers, the Drini River where the main hydropower plants are built (Fierëz, Koman and Vau i Dejës) goes through this region, increasing, therefore, the likelihood of floods during periods of heavy rain.

Taking into account the characteristic of

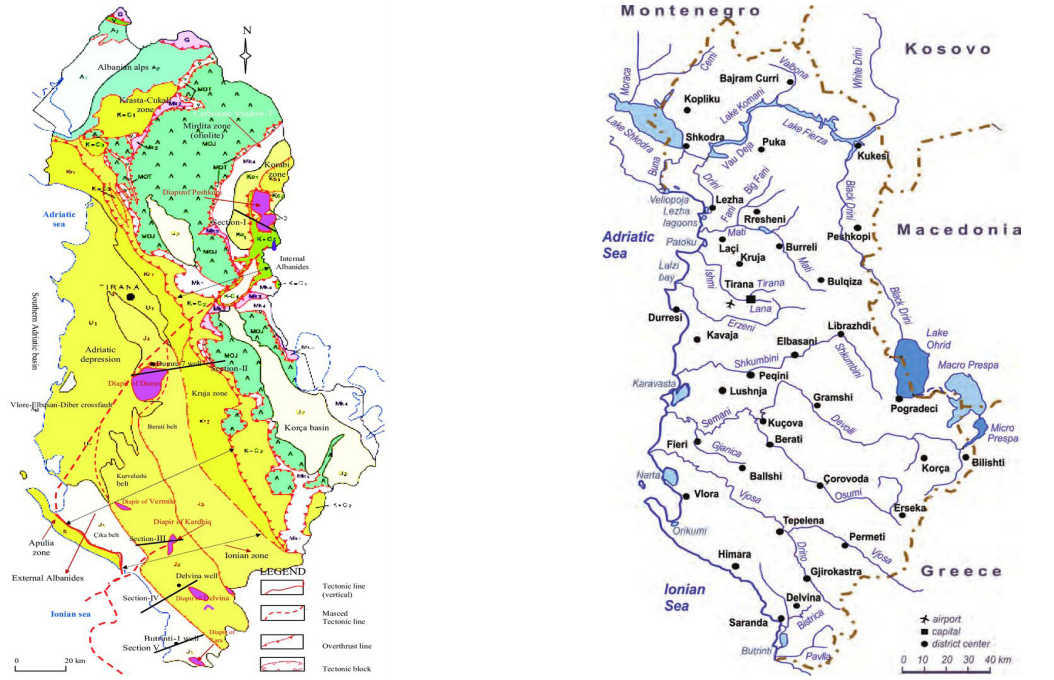

Fig1. a) Hydrographic Map of Albania (source: Miho et al., 2013); b) Schematic Tectonic Map of Albania (source: Prifti et al., 2013)

the region and the numerous hazardous events that can have a significant impact, makes disaster risk and its reduction an issue of prime importance. For decades the approach toward hazardous events has switched from emergency-based to prevention strategies before the event occurs (Sutanta et al., 2010). In the case of complex urban systems, the definition of appropriate strategies requires a multi-disciplinary, multi-scale and holistic approach. The main aim of this contribution is therefore to try and propose strategies for reducing disaster risk in which the aforementioned requirements for disaster risk reduction are met for the case of the Lezhë region. The proposals switch from general strategies to specific project actions in terms of (1) blue systems implementation and (2) green systems implementation. The strategies are proposed based on the information obtained by the site visits in Lezhë, Shëngjin and Kune Vajin, archival research and mainly information provided in the form of maps since the superimposition process itself requires such maps to overlay and give a specific output based on the proposals of Ian McHarg in his work Design with Nature. Detailed information about the process will be given in the following paragraphs.

The work is focused not only on the urban fabric but also on the natural areas part of this region and thus the objectives may be summarized in the following points:

- Analysis of built- environment, actual situation and potential interventions
- Preservation and strengthening of the environmental systems
- Preservation of biodiversity

A complementary work needs to be done in analyzing relevant literature that deals with the relationship between disaster risk reduction and complex urban systems to better understand the international context to try and adapt it to the context of Albania, and specifically Lezhë.

Driven territorial transformations through strategic and design actions can be obtained through the analysis of the actual environment, the generation of risk scenarios to identify possible transformation elements.

Methodology

The proposal of strategies on different scales taking into account different fields of studies required extensive theoretical and practical work. The group consisted of engineers, biologists, an architect and an artistst, and each one presented their ideas on strategic intervention on the territory taking into account their expertise.

The first step was to try and holistically analyse the region, taking into account territorial and physical aspects, combined with social, environmental and biodiversity elements. This was done through an initial brainstorm session taking into account that the main focus was disaster risk reduction. The initial phase consisted of a general overview of the area based on several mapped information, in which specific areas of special importance were defined like dense urban areas, protected natural areas and their connection to the urbanized part of the region, wetlands etc. The various field visits were necessary for understanding and knowing the area

Fig. 2 / Blue and Green System for driven territorial transformations. Source/ the authors

better and also for the identification of the problems or areas which were defined in advance by the studies of the various maps made available.
Considering the characteristics of the area, the problems in terms of territorial and environmental aspects, and the strategic role the region has it was decided that the analysis and proposals should be done following a multi-scale approach. Furthermore, for a pragmatic approach, based on expertise, each member was focused on specific areas and aspects which in the end were compiled in such a way to reflect as clearly as possible the proposed strategies. In terms of outcome and general work, the information is represented mostly in form of maps on different scales using GIS.

Disaster Risk Reduction & Lezhë Region

Disaster is defined by (UNISDR, 2009, p.9) as "A serious disruption of the functioning of a community or a society involving widespread human, material, economic or environmental losses and impact, which exceeds the ability of the affected community or society to cope using its own resources."
Based on this definiton, disaster can be seen as a combination of hazard severity with the possible consequences based on the levels of the vulnerability a built environment has, this combination is followed by losses in terms of physical, economic, environmental and also impact on the biodiversity. One of the most important documents, the SENDAI Framework for Disaster Risk Reduction 2015-2030 states that the multi-hazard management of disaster risk must be done at all levels and within all sectors to prevent new and reducing existing disaster risks through integrated economic, structural, legal and social measures (UNISDR, 2015). Among the four priority areas for action, the document emphasizes the need for investing in disaster risk reduction for resilience and enhancing disaster preparedness for effective response and "Build Back Better". The former focuses on the role investments have in enhancing resilience while the latter points out the need for proper disaster risk management in each phase; preparedness, recovery and rehabilitation to build better and safer urban and non-urban environments.
The strategies proposed in this work are in line with the priorities listed in the SENDAI document due to the combination of large-scale strategies with local scale strategies with the aim of building territorial resilience through strengthening environmental systems. When dealing with complex issues where biotic and abiotic components are involved in order to propose a design strategy, a multi-disciplinary approach is also prerogative.
Lezhë city and the entire region statistically is one of the most affected regions by natural hazards in Albania. Hazards of a hydrological and meteorological nature are very common in the area, followed by seismic events and by additional triggered hazards like rockfall, landslide, or liquefaction especially in the littoral part of the area which is characterized by loose sand and high levels of groundwater. Seismic hazard maps of Albania show that the Lezhë region is characterized by peak

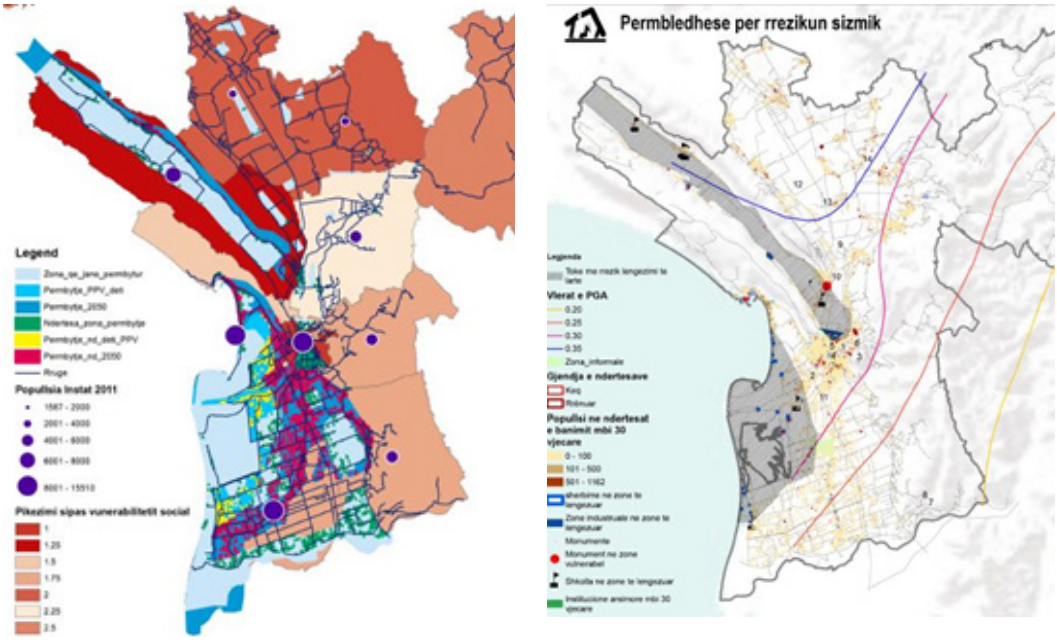

Fig.3/ Example of mapsanalyzedd in the initial phase. Source/ CoPlan

ground accelerations from 0.208- 0.338g with a probability of 10%/ 50 years (Aliaj et al., 2010).Such "secondary" events were noticed in the last earthquake that hit Albania on November 26, 2019, in Durrës. One of the most affected areas by this seismic event was the Lezha region, with buildings destroyed and out of function and signs of liquefaction in specific areas. According to official data by the municipality 76 families, or more than 288 inhabitants had to be evacuated during the seismic event. In addition, due to the presence of hydropowers in Drin River, which goes through this region, during the peak periods of rainfalls, flooding is a frequent and problematic issue of the rural and urban areas.

Historical and more recent events, clearly show that the region is highly affected by natural hazardous events, causing each year lots of economic losses and hindering the development of the region. The reason for this high level of impact is due to the high levels of vulnerability characterizing the area due to uncontrolled development, poor quality of materials used for construction, poor construction techniques etc.

Lezhë Urban System- Seismic Risk

Based on the widely accepted definition (EC, 2011), the risk is considered as a combination of the possible consequences of an event with the probability of its occurrence. The consequences are determined based on the instrict characteristics of the urban systems which give the level of vulnerability and on the level of exposure, which gives the assets exposed to a hazardous event. The probability of occurrence of a hazardous events, known as hazard assessment can be defined taking into consideration detailed analysis of historical past events and actual conditions, and for the case of a seismic event (Kramer, 1996) summarizes two methods Deterministic Seismic Hazard Assessment (DSHA), and Probabilistic Seismic Hazard Assessment (PSHA).

The definition of risk is tightly connected firstly to the aim of the study and secondly to the data availability. The approaches vary from simplified qualitative assessments to the advanced quantitative assessment. Based on the aforementioned requirements, for the case of the city of Lezhë, a semi-quantitative methodology based on indices is seen as the most feasible approach. Such an approach is acceptable in general for risk assessment of urban systems since it provides a holistic approach due to the possibility of a combination of different variables of different nature (physical, social, environmental etc.).

In terms of buildings, the city is characterized by a combination of old buildings typically consisting of reinforced and unreinforced masonry structures (mostly along the area "Beslidhja", "Grumbullimi"), and also prefabricated structures (along street Frang Bardhi) with new reinforced concrete buildings with frame, wall or dual system structural typologies (near the city centre and Shëngjin).

The state of many actual old buildings


Fig.4 / Flooding in the Lezhë region due to intense rainfall. Source/ balkanweb.com


Fig.5/ Typical structural systems in Lezhë city; reinforced concrete (left) and (right) prefabricated buildings. Source / Merita Guri, 2020

is not good due to the age, the action of external factors like humidity or corrosion and human interventions, this is also one of the main reasons for the damages during the November 2019 Earthquake. The situation after this earthquake further aggravated the conditions of existing buildings which were not demolished resulting in higher levels of vulnerability.

Besides the building stock, other elements of the urban systems need to be considered including the infrastructure network, open space and the community. A preliminary study using GoogleMaps and site visit showed that the street network of Lezhë in many areas of the city can't withstand a seismic event during the emergency phase, some of the main reasons include; narrow streets, non-uniform distribution of street categories, lack of appropriate nodes that would improve the accessibility, quick evacuation and connection to important critical infrastructures like the hospitals or fire stations. In some areas due to densification processes, many residential and non-residential buildings are located very close to one another triggering possible domino effects during a potentially seismic event.

Based on preliminary observations, the actual situation of the Lezhë region including the city of Lezhë and Shëngjin needs an improvement in the preparedness level to resist a possible future seismic event. Analyzing risk at a local scale may represent one of the most efficient ways to improve the situation. Even though analyses have been done on greater scales throughout the country, detailed analyses in a local scale are important since the effects of such events are highly felt on this scale
by the community itself.

A good approach would be that of dividing the city into different zones based on several criteria which might include building stock, street network, land-use etc., and for each of these zones, levels of risk are defined in semi-quantitative ways through indicators. The output might be introduced as a fundamental information about actual situation, based on which allocation of funds and future interventions can be made to reduce such risks in the cases when they are present. Due to requirement for high usage of these lands mainly for tourism purposes, results of a detailed risk assessment in this scale can provide a good tool to control such developments in such a way to be safe for the community.

Blue System Implementation

The proposal of strategic action in terms of blue system implementation required a careful analysis of the water as a modifier of the existing system. Therefore a risk scenario was developed to project the condition of extreme territorial transformation. The extreme risk scenario was achieved through the analysis of the flooding caused by surface water and extreme rainfall and a sea level rise of 1.5m since they represent the main problems facing the Lezha district. Such representation on a district scale allows us to understand which areas coexist with a high risk that needs to be addressed to mitigate their impacts.

A reinterpretation of the landscape,

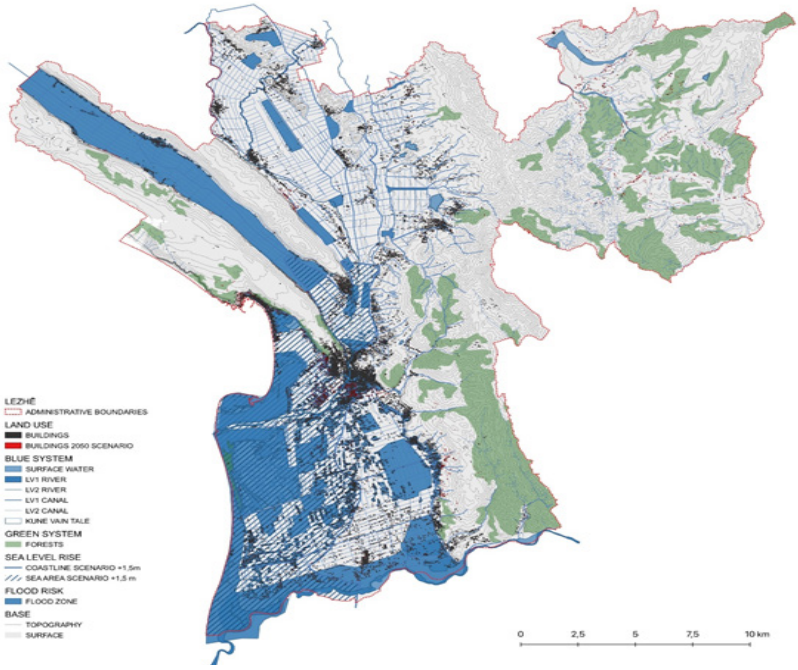

Fig.6 / Water as a modifier. Extreme risk scenario. Source/ the authors

identifying linear infrastructures as elements that can be used to improve territorial resilience performance is the first strategic action (P01). Recognition of infrastructures as preponderant mutant actions on a territorial scale makes it possible to trigger design actions with direct consequences on the landscape. The aim is that of a transition from wetland to agricultural land in a hybrid way rather than rigid measures using for example high embankments. These linear infrastructures are superimposed on the agricultural drainage system consisting of countless canals of different hierarchies. This hybridisation of systems makes it possible to create new water storage tanks and green ecosystems that formed a barrier with native plants resistant to water and salt.

In addition, through improved water resource management it is possible to protect the land from salinization that comes as a result of the advancement of the sea. At the same time (P02) we reach a reduction of pollution caused by cultural eutrophication in the lagoon. By digging a web of water channels from the Drin River to the shores near the delta to dilute the pollutants and by bordering them with cane thickets to boost the purification it will be possible to create new environments for wild animals that are lowering in number because of the reduction of their natural habitat for nesting, rubbing and feeding; this solution will also reduce the presence of typical invasive species, like phytoplankton, mesophytes and crustaceans that are profiting of the actual condition of cultural pollution of the Kune-Vain lagoon, due to the human activities.
Another dangerous phenomenon, not only for Lezha but for the entire Albanian coastal area is erosion. Hundreds of square meters of land are lost every year due to this phenomenon, one of the main reasons for this phenomenon is the disruption of the river regime due to various human interventions like embankments used for irrigation or the collection of coarse-grain and fine-grain soil materials collected from the bed of rivers to be used as construction materials.
Rivers are an important source of aggregate storage along the sea and a disruption of their regime causes; changes in the deposit volume of the materials making the coastal areas prone to erosion and sea advancement, generation of new dangerous wetlands, and impact on protected areas like the Kune Vain Lagoon. To tackle these negative phenomena it is proposed a reorganisation of Drin and Mat River dynamics (P03) through the removal of quarries, this action allows fluvial aggregates to reach the coast and compensate for the erosive action of the sea, thus mitigating sea level rise.

Green System Implementation

The second focus of the proposed strategic action is on the green (forest) system which together with the blue system represent two predominant systems. Forests have a fundamentally protective role against the effects of climate change, such as foods and water scarcity, while also contributing to CO2 reduction in the atmosphere through their sink function.

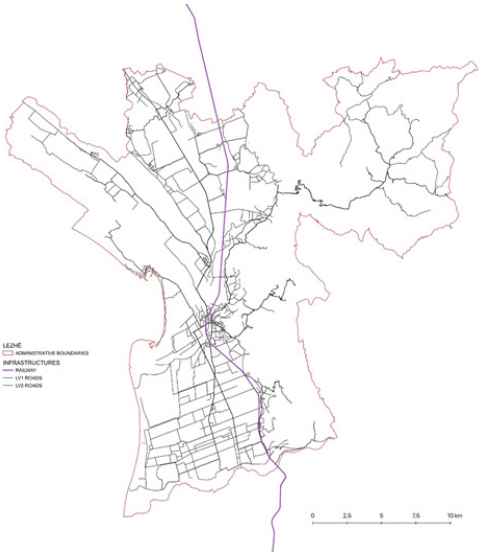

Fig.7/ Infrastructure system in Lezhë district. Source/ the authors

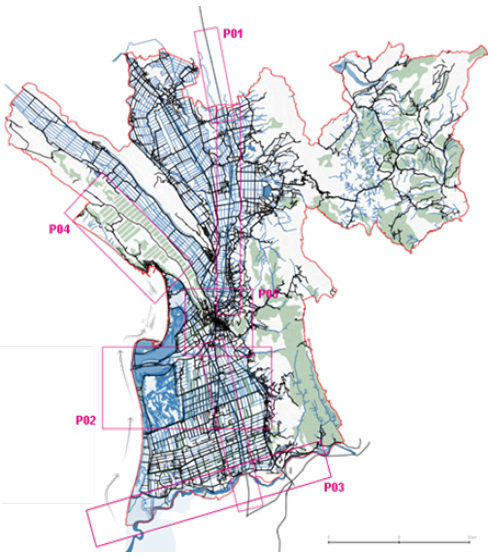

Fig.8/ Lezhë as a superimposed system . Source/ the authors

Yet, forests remain largely unprotected or poorly managed in Albania, still prone to illegal logging and trade, regardless of the respective moratorium approved by the Parliament in 2016.

The first proposal within the green system implementation or the fourth strategic action in general (P04) consists in developing an ecological corridor that connects the wetland and lagoon with high-land, connecting also two natural protected areas of the region: Rana e Hedhun and Kune Vain Lagoon. The need for such eco-corridor is due to fragmented natural landscape and protected areas, biodiversity trapped in case of wildfires, hazardous accidents or floods, the decrease in ecosystem services due to deforestation and finally such corridor would serve as a "fence" to urbanization processes. Biodiversity safe passage, the increase in ecosystem services through forestation and the development of a wind energy park are some of the functions of the ecological corridor in addition to the aforementioned connection functions that it has. The specific proposal for the connection of the areas consists in two proposal areas, Marlekaj Hill (proposal one) and a connection NOD (proposal two) as represented in the sketch below:

The combination of all the proposed strategies gives a new superimposed system that aims to tackle the discussed issues. Lezhë as a new superimposed system together with the proposals is given in the final map below and a summary of the results is discussed in the following conclusion paragraph.**Conclusions**

In conclusion, starting from a broad and integrated vision of issues related to territorial and environmental systems like flooding, earthquakes, biodiversity, this proposal is identified as a pragmatic analysis that seeks to propose specific strategies that will transform the territory to have a positive impact in the resilience levels of the entire district.

Five strategic actions at different scales were proposed in this work, summarized as follows:

a. Landscape as Infrastructure (P01)- where a reinterpretation of the landscape is proposed through the identification of linear infrastructure elements that can improve territorial resilience.

b. Channel Implementations (P02)- where a new system of channels bordered with cane thickets in Drin River towards the shorelines near the delta is proposed. Such intervention can dilute pollutants and can help to create a new environment for wild endangered animals and reduce the presence of typical invasive species.

c. River Management (P03)- where a reorganisation of Mat river dynamics is proposed to enhance the deposit of fluvial aggregates that may tackle coastal erosion problems. The reorganisation consists in reduction and removal of quarries along this river that hinder such aggregate deposits.

d. Ecological Connections (P04)- where an ecological corridor that connects two natural areas in the Lezhë district; "Kune Vain" and "Rana e Hedhun" is proposed, serving also as an area for wind energy.

e. Urban Greenery (P05)- with a focus on the urban fabric, proposing an increase of the green area surface to tackle flood

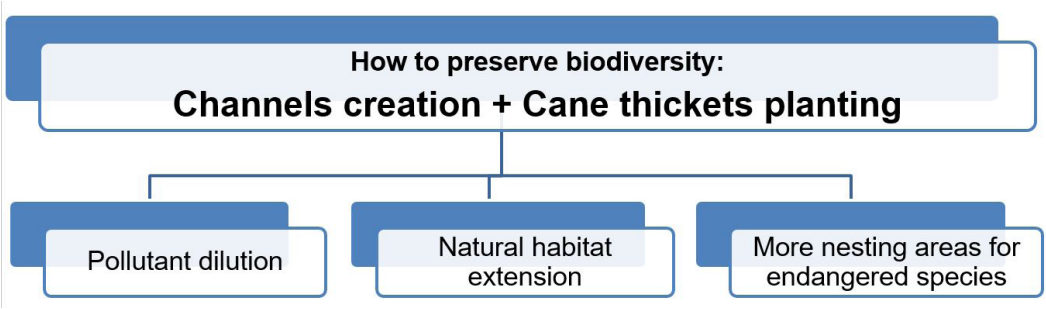

Fig.9/ Proposal for the preservation of biodiversity in Kune Vain Lagoon. Source/ the authors

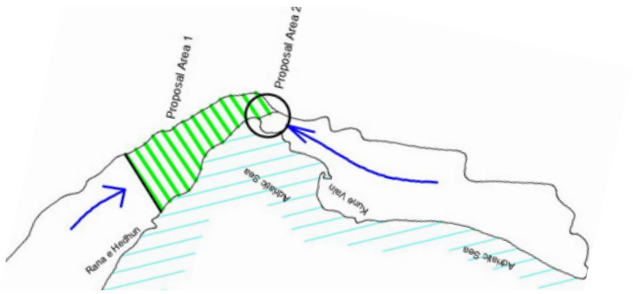

Fig.10/ The proposed ecological corridor. Source/ the authors

issues due to low permeability, increase the quality of air, and increase the spaces for public use.

In addition to the five proposed strategies focusing on green and blue systems, proposals for reducing seismic risk were also introduced. The focus was on developing appropriate methods to assess actual risk and predict future losses from a potentially seismic event by combining all the elements of a complex urban system; the community, the building stock, infrastructure and open space as suggested by (Koren et al., 2018).

The losses can be expressed in terms of physical, economic, social or environmental and can be used by stakeholders to define areas which have higher priorities, allocate funds, reinforce adaptive capacities and develop appropriate strategies for the emergency phase. A good start would be the assessment of risk in the form of indices on a local scale and for areas with high risk more advanced analysis can be further developed.

The strategic directions taken have concrete repercussions on the territory. The new landscape is a hybrid, highly dynamic and expressly resilient landscape. Its adaptive capacity is implemented through the inclusion of new devices that perform well in the face of sudden changes, such as floods, earthquakes and fire. Thanks to the development of specific project themes, smaller scale points were also touched upon with pilot projects of high environmental value. The result is a new territory that accommodates different ecosystems with a high adaptive value.

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