Increasing ecosystem resilience through landscape interventions: the case of flooding in Shkodra

keywords / flooding, ecosystems, co-living, watershed, climate change, resilience, sustainability

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Abstract

With pressure coming from an uncontrolled urbanization process, which in most of the cases has been unplanned and compromising natural potentials, and with little awareness regarding the importance of understanding and respecting the natural features beyond just individual interests, the case of flooding in Shkodra makes for a perfect example, on how an ecosystem can react when reaching a critical point of change, which affects its ability to regenerate. Managing a healthy relationship between urban-rural-and natural is very important, and given the constant flooding challenges that Shkodra faces with every year, learning how to manage and live with water, becomes the key to increasing the resilience of the whole regional ecosystem. Having set the background of the big picture, this paper tries to analyze the case of flooding in Shkodra, by understanding first the natural and artificial processes happening, and then coming in practice with a series of proposals of landscape interventions, aiming to improve ecosystem resilience. The confluence of Buna, Kiri and Drini River, and the surrounding agricultural and urban environment become subject of illustration, previewing how on different emergency scenarios, the whole ecosystem can adapt and sustain itself.

Setting the Context: The challenges of a newly democratic country

Following the fall of the dictatorial regime, during which Albania was one of the most centralized planned economies in Europe, where government practically owned and controlled everything and all forms of territorial development, from the early 1990s the country still inherited a highly centralized, top-down governance with a high degree of control paradigm in urban planning as well (Ruijsink, 2012). A system, which with the fall of the dictatorial structures became disentangled in the very first instant of the Albanian democracy, unable to cope with the high dynamics of transition and population demands (Toto, 2012). Thus, very soon the country went from one extreme (excessive control, even of everyday life aspects of people) to the next extreme (total freedom of movement, development and economy). The "shock therapy", commonly applied in most "eastern bloc" countries (Aliaj et al., 2010), combined with the weak and unexperienced governmental structures in the early democratic years resulted in a complex and sophisticated informal system, which did not only express itself in the urban sector, over 400,000 informal buildings at national scale (Ministria e Zhvillimit Urban, 2014), but also in economic and social development, and many other aspects of life, above all, transformation of landscapes and configurations of the natural habitats (Aliaj, 2008).

On these terms, Albania's urban development after the 1990s has been associated with a very strong link to informality and absence of planning. Thus, the self-organizing role of individuals has been key in structuring development in the main cities, especially in their peripheries.

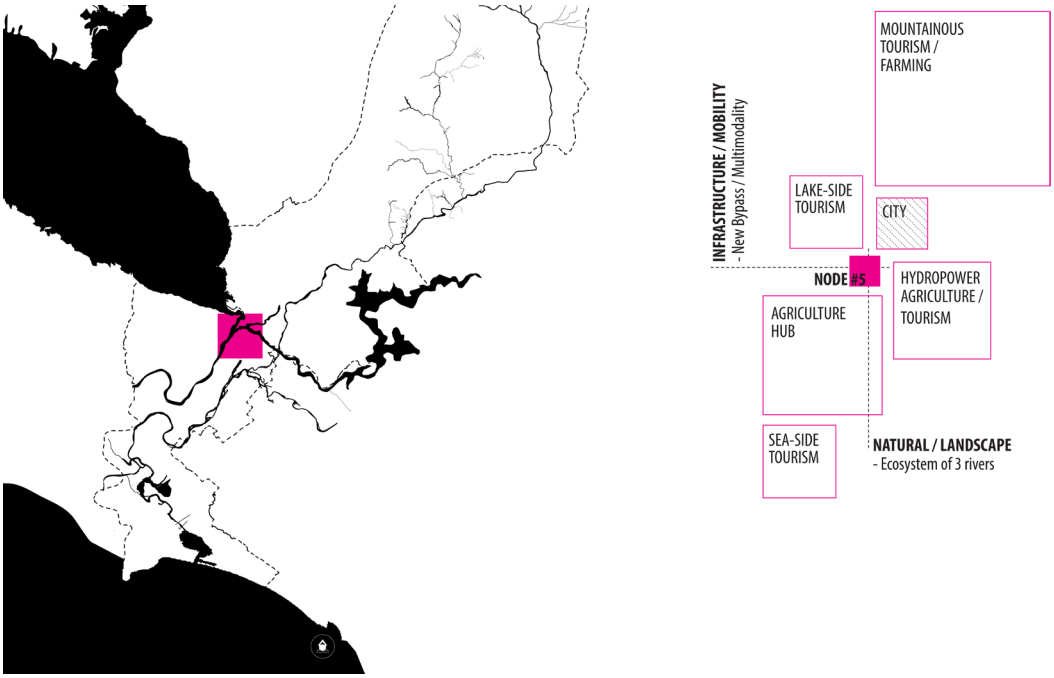


Fig1 / Municipality of Shkodra and the Ecosystem of the Three Rivers (node #5 on the 32nd Cycle of the PhD Workshop) / source: the author

The freedom of movement, inspired many people to move from remote peripheral and isolated areas, towards the main cities, located in the western plain. The informal and rapid urban development, apart from transforming a great deal of agricultural land into urban land, has also had devastating impacts on the natural habitats and environment as well. In terms of environment it can be said that although reforms have been continuous, the situation in the ground remains problematic (Janku et al. 2017). Environment is one of the sectors where 'acquis' has been transposed the most, however, the low level of investment has led to great challenges especially in water and air pollution (Ministria e Mjedisit, 2015). On the meantime, deforestation and coastal erosion are also very problematic. In the case of Shkodra this adds up into a very sensitive environmental issue, which relates to the risk and consequences of flooding. Taking climate change as another greater threat especially for the western plain, where rising sea levels and the intake of land by sea is an eminent threat (UNDP; Ministry of Environment, 2016), the uncontrolled urbanization which has happened in abundance in this specific area is exposed to a series of risks, which need to be addressed properly by the authorities.

Setting the Context: Shkodra, the city that always floods

The municipality of Shkodra is located in the North-Western part of Albania and it is a perfect example, where different ecosystems operate in each other's vicinity. For the scope of the Doctoral Workshop of the 32nd Cycle, between POLIS and Ferrara, this complex formation was divided into fragments. Starting from the Adriatic Sea on its Southern border, which has mainly touristic use and importance on the local economy, the landscape becomes more diverse as it continues in the main land. The Lake of Shkodra, which is in the cross-border area with Montenegro, has great importance as a touristic attraction, as well as values regarding its natural potentials. Whereas near the city of Shkodra, the confluence of three main rivers: Kir, Drin and Buna creates not only a great and rich agricultural habitat and landscape formation, but also poses many challenges regarding the issue of flooding, which is very active throughout the year. Lastly, the North of the municipality is characterized by mountainous and steep landscapes and is home to the so called "Albanian Alps", the National Parks of Theth and Valbona.

On this diverse variation of landscapes, vast plains of agricultural activity and dense urbanized land operate mainly in the central part of the municipality. In a total of 763.77 km2, the natural and water systems constitute 53.2% and 20.44% of the total surface, the urban and the infrastructural systems have a share of 3.28% and 1.06%, and the remaining of 22.02% of the total surface is represented by the agricultural system (POLIS et al., 2016). The urbanized land is mainly concentrated around the city of Shkodra, in the west-central part of the municipality, and the remaining is spread among the rest of the rural territory in

the form of small villages. In close vicinity to the biggest area of agricultural value, the concentration of urban land happens to be also on an area, which is directly affected by the flooding phenomenon. It is this part of the territory in which the Lake of Shkodra is the nearest and where the three rivers confluence. Although damns have been built during the last years, and other forestation measures have been taken, it hasn't been enough to cope with flooding, so Shkodra still gets flooded with devastating consequences. Urbanization of agricultural land and informality have happened on this area also. Building with no regulations near water streams, or close to the areas which get flooded, and the transformation of the drainage system due to this urbanization process, has made land vulnerable to flooding and all the risks that derive from it.

Given that 3 main ecosystems, that of the sea, the lake and the rivers, operate in the vicinity of each other, mixed and overlaid on agricultural and urban land as well, the case of flooding in Shkodra gets more complicated, and in order to unhitch this complexity, it's very important to make a diagnosis of all the sources contributing to the critical panorama. Firstly, Kiri and Gjadër River are constant threats for the plain of Zadrima and the surrounding villages, because of the sediment masses they bring on their flow. Drini River on the other hand has a critical quota of +2.2m on the area of Lezha, contributing to flooding in the area of Blinisht, Bacel and on about 200ha of agricultural land. The more this critical quota raises, the more dangerous the situation becomes. Buna River is also a major source of flooding. Apart from the contribution of the rainfall and melting of snow from the surrounding mountains, it also accumulates water from Kir and Drin Rivers, and it intakes the surplus accumulation of the Lake of Shkodra as well. All this amount of water overcomes the capacity of Buna River for intake-and-flow, leading to further flooding.

Natural phenomena like the combination of rainfall and snow poses also a serious threat. When the raining season starts, there can be periods of 10-15 days of non-stop rainfall, which over-float the surrounding areas, leading to the flooding of both agricultural and urbanized land. Urbanization on the other hand, which in most of the cases is in the vicinity of the water surfaces and flooded areas, has increased the non-permeable surface, increasing the impact area of flooding. The coastal strip is also constantly exposed to flooding due to the strong wind of Shiroka, which is a characteristic natural phenomenon of Shkodra. The wind causes big waves, which wash over the coast and the inhibited villages, allowing salty water to penetrate the inland and overflow the agricultural land as well. Lastly, the drainage system of the agricultural land, is not capable to cope with this amount of water, due to amortization, or urbanization, so as a consequence, the presence of salty water on productive land decreases its quality and productivity.

Water, this crucial source of life

In the history of human settlements, there have been two major reasons, explaining the vicinity of human life to water sources, in the form of villages, towns, or cities:

Commerce: Settlements near water provided easier and faster transportation through water, which was faster than other types of land transportation. Before even the train was invented, these settlements were well-known for their trading activity, which provided them with considerable income, mixed cultures, and generally better living conditions.

Food Security: Apart from agriculture, foraging and hunting, in the earlier times water sources like rivers, lakes and sea provided alternative food resources (water fauna and flora), which were crucial for the development and pace of growth of these settlements. Constant security of potable water, which would also come at a cheaper price, than in the landlocked settlements, which had to build special infrastructure for providing water, was another benefit coming from this vicinity.

Following these two major facts, it's commonly accepted that the forms and patterns of buildings, cities, and regions have always been a direct response to the social, economic, ecological, and climatic conditions of the time (Williams, 2011). Having said that, with climate change being at the forefront of today's challenges, our cities and regions are profoundly changing. New types of infrastructure are emerging, due to the change of structural capacity of the geology and soil, raising water levels, severe draught and flooding, all happening in the same context, where we live and work. With Earth being a water planet, the only water planet as far as we know of, water itself makes for that very particular source, which determines the existence of life. It is rather part of interrelated systems that include the atmosphere, the oceans, and the land, therefore the question on "how to cope and develop with this critical source" becomes very crucial and important, especially when considering that human beings have become one of the most significant forces misusing water.

Fig2 / Aerial Image of the Confluence of the Three Rivers source / Google Earth.

Nowadays traditional threats to water resources, are being exaggerated by global climate change, with severe impacts on our cities and natural lands, where one of the most visible and immediate effects will be the increasing severity of storms, resulting in greater river and coastal flooding (Watson & Adams, 2011). Intense storms will strain the capacity of our inadequate storm-water management infrastructure, and as we have experienced already, the impermeable surfaces of our over-and-ever-expanding cities have already taken away the capacity of the landscape to absorb and permeate this water, resulting to storm-water runoff and major floods.

So we are now confronting urbanization and sprawling, which have taken upon vast natural habitats and landscapes, that previously helped in mitigating flood intensity. On these terms, even the benefits from flooding in most of the cases become threats, due to changed equilibriums in the natural environment, leading to disasters of unwelcomed and unanticipated intensity. And this is the main challenge that Shkodra faces today as well.

Environmental Stressors and Ecosystem Resilience

"Anthropogenic and natural stressors (environmental stresses, flooding, draught and even extreme weather conditions) usually impose disturbances in ecosystems, changing not only their structural elements (species composition and the spatial distribution of biomass), but also functional properties (productivity and nutrient cycling), impoverishing the general ecosystem development" (Freedman, 2015).

Encouraged by climate change, but also by the way we have built (sprawling, intensive land development, urbanization of fertile land, deforestation etc.), natural resources and their functions are being removed from the landscape, leading to increased environmental stresses. On the case of Shkodra, with water being one of the main critical resources, interventions which aim to enhance the balance of water on watershed area, aquifer, floodplain and built infrastructure need to be planned and designed, in order to balance the presence of water in the ecosystem, and also mitigate risks of possible water-related crisis, either drought peaks,

or flooding emergencies. Referring to Freedman's categorizing of two different types of stressors, either "chronical", or "disturbances", flooding in Shkodra would be considered as a "disturbing stressor", meaning that "the exposure of the ecosystem to flooding is intense, but shortly lived".
Freedman also explains that "disturbances are followed by succession, which is a period of community – level – recovery". The speed with which this recovery takes place, also leads to what is consider "ecosystem resilience", which is profoundly related to "the ability of the ecosystem to return to its original condition following a disturbance, or after some other stressor lessens in intensity" (Freedman, 2015). Trying to improve the "ecosystem resilience" in the case of Shkodra, would first ask for a profound change of mentality, or attitude towards a more comprehensive approach in relation to territorial governance and development, with a lot of weight on introducing sustainable practises and environmental sensitive policies, in order to improve the outcome of the symbiosis between men and ecosystems. The change at political level, should afterwards impose physical changes at a territorial scale, in order to lessen the impact of flooding, if not prevent it at all.

Behind the flooding events in Shkodra

During the last 20 years, like any other major city in Albania, Shkodra and its surroundings have gone through a series of major changes, which together with the drawbacks coming from the change in climatic conditions and natural features of each ecosystem (sea, lake, river), increase the vulnerability of the area in regard to the issue of flooding. These changes include:
(i) Urbanization and sprawling on areas, which are prone and exposed to flooding:
These areas are easily exposed to, and are vulnerable to any flooding events. The phenomena of sprawling has mostly happened on rural and farm land in the vicinity of water features, which translates in endangered human population, life stock or agricultural potentials. The presence of salt on agricultural land especially, has had a major impact on features like fertility and productivity.
(ii) Increasing of impervious surfaces, which are unable to cope with storm water management:
With urbanization and sprawling happening almost anywhere in the central and southern parts of the municipality, dispersed implementation of infrastructure has been promoted as well, leading to an increase in the total amount of the impervious surfaces. During flooding events, storm water runoff is high, which causes displace of flood, from its original origin towards anywhere in the neighbouring areas.
(iii) Changes in the agricultural system, either by urbanizing agricultural land, or by transforming some of the major parts of the irrigation system:
With informality, urbanization and sprawling happening on agricultural land as well, changes in the irrigation and drainage systems have followed, due to the highly fragmented landownership structure. This has been translated in impermeable channels, which are not able to cope with water flow, leading in flooded settlements and agricultural land together.
(iv) Deforestation:
Mainly happening due to urbanization and construction, especially in the area of Velipoja, but also on the riparian zones (mostly on the sea – fronts and river – fronts), deforestation has had a major impact on increasing erosion and landslides. During flooding events, the lack of vegetation also makes land unable to cope with slowing the flow of water, leading to the displacement of the flood.

All these conditions have caused a series of flooding events in the course of the years. Below, a chart by Mott MacDonald (edited by the author for the period of 2013-2018), makes an overview of some of the major flooding events in Shkodra since 1851. During the January 2010 event the water load on Buna was nearly 3,600 m3/s, and it was caused mainly by the snowmelt accumulated on the Drini Rier basin (Ministria e Mjedisit et al., 2015). Later, during November and December 2011 Shkodra experienced another major flooding event, the biggest until today, peaking at a total of nearly 900 mm rainfall, almost half of the average annual rainfall for Shkodra. During this event the lake of Shkodra reached a maximum historic level, and the water load in Buna was higher than 4,000 m3/s, amounting at an inundation, which has been recorded as the biggest, in terms of areal extent, depth and duration (Ministria e Mjedisit et al., 2015; MacDonald, M., 2011). In the aftermath of the 2010 flooding event, "the total number of evacuated inhabitants in the area was about 12,145, while the number of affected houses nearly 7,120 (4,540 flooded houses and 2,580 houses surrounded by water); about 32,634 animals were evacuated, and the cultivated land and croplands were highly affected (about 10,280 ha, from which

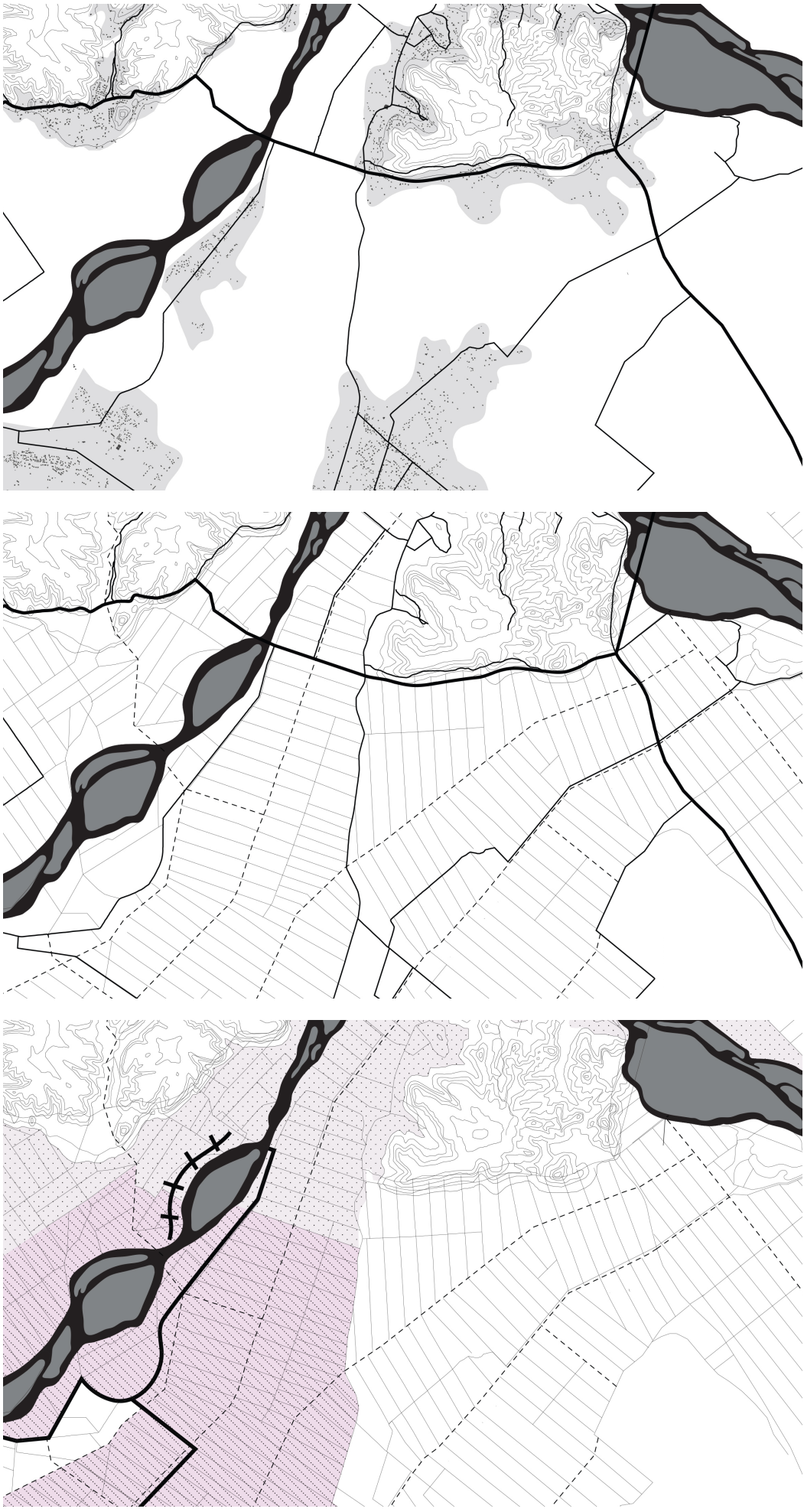
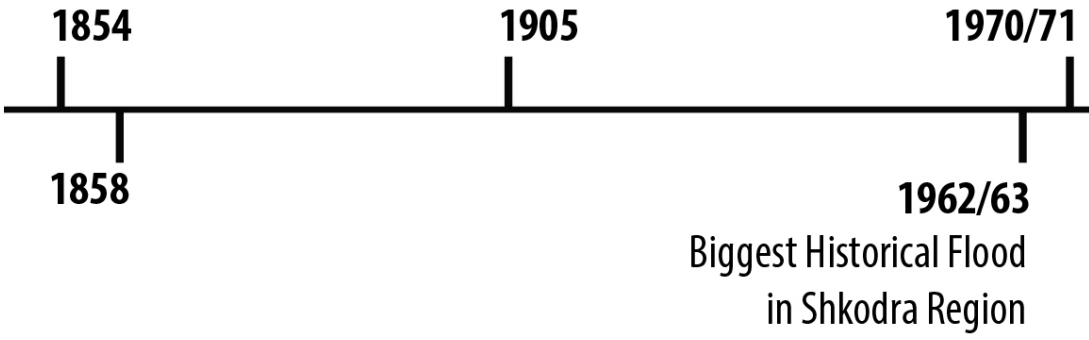


Fig3 / Pattern analysis on the confluence of Buna, Kiri and Drini Rivers: (a) Urban and Natural Flooded Land; (b) Agriculture Land and Flowing Channels; (c) Flooding Events / source: the author



about 4,887 ha of cultivated land), all this leading to an economic damage of nearly 500,350,000 ALL" (Ministria e Mjedisit et al., 2015).

Another major flooding happened in 2018, which was led by very similar factors with the one of 2010. About 4,948 ha of land was flooded, from which 2,635 ha of cultivated land, and a total of 677 houses were surrounded and flooded by water. Between the two major events of 2010 and 2018, a series of other smaller (but not less significant) floods have occurred: (i) three events in 2011 in the area of Nënshkodra and in the villages near Buna River; and (ii) one event in 2014, again in the villages near Buna River.

Hydro – Response: Planning for Flooding

Due to all the natural conditions and man-made changes presented above, one way, or another, Shkodra will always be exposed to flooding. But in order to make flooding bearable, less harming, and why not use it as a positive event where it's possible, authorities should not only introduce a series of changes in terms of policy and territorial governance, but they should as well implement physical interventions, aiming at improving ecosystem resilience, by anticipating flooding. Various resilient design practices can facilitate this anticipation in the stressed ecosystems, and prepare for extreme storms and flooding of inland watersheds and coastal areas, in order to provide resiliency and emergency preparedness for natural disasters (Watson & Adams, 2011). On these terms, the natural features of the all the ecosystems overlaying in Shkodra, should be well weighted, incorporated and integrated in order to make room for water, promote resilience and provide safer human conditions. Referring to Watson and Adams, there are five defining concepts that can guide us towards this mission:

- Design for Resilience

Applying lessons from natural systems as a response to extreme conditions, in order to restore and improve water resources and mitigate threats coming from extreme weather and climate change;

- Protect and Extend Ecosystem Services

The ecosystem services concept identifies and promotes the social, economic and health benefits, which come as an outcome from functioning natural environments, land, vegetation, water and living organisms.

- Create Watershed Plans and Sustainable Storm-Water Systems

Watershed planning is a multidisciplinary approach, which focuses on managing water flow on natural systems, or regions, by incorporating also the practices of aquifer subsurface restoration, and integration of both water and green infrastructure in urban environments. On the other hand, the practice of sustainable storm – water design aims to improve water balances by reducing disturbances, protecting and restoring natural features, and using soil and vegetation for storm – water management.

- Implement Floodplain Management and Flood Resistant Design

Floodplain management focuses on the impacts of flooding, by including land use policies and regulations for developing

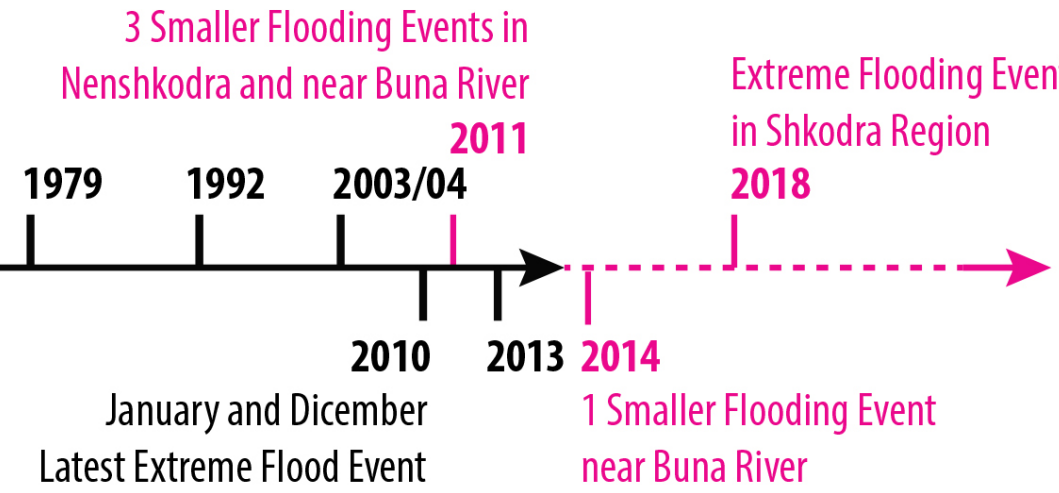


Fig4 / Flooding Events in Shkodra
source / Matt MacDonald (in black) and the author (in magenta)

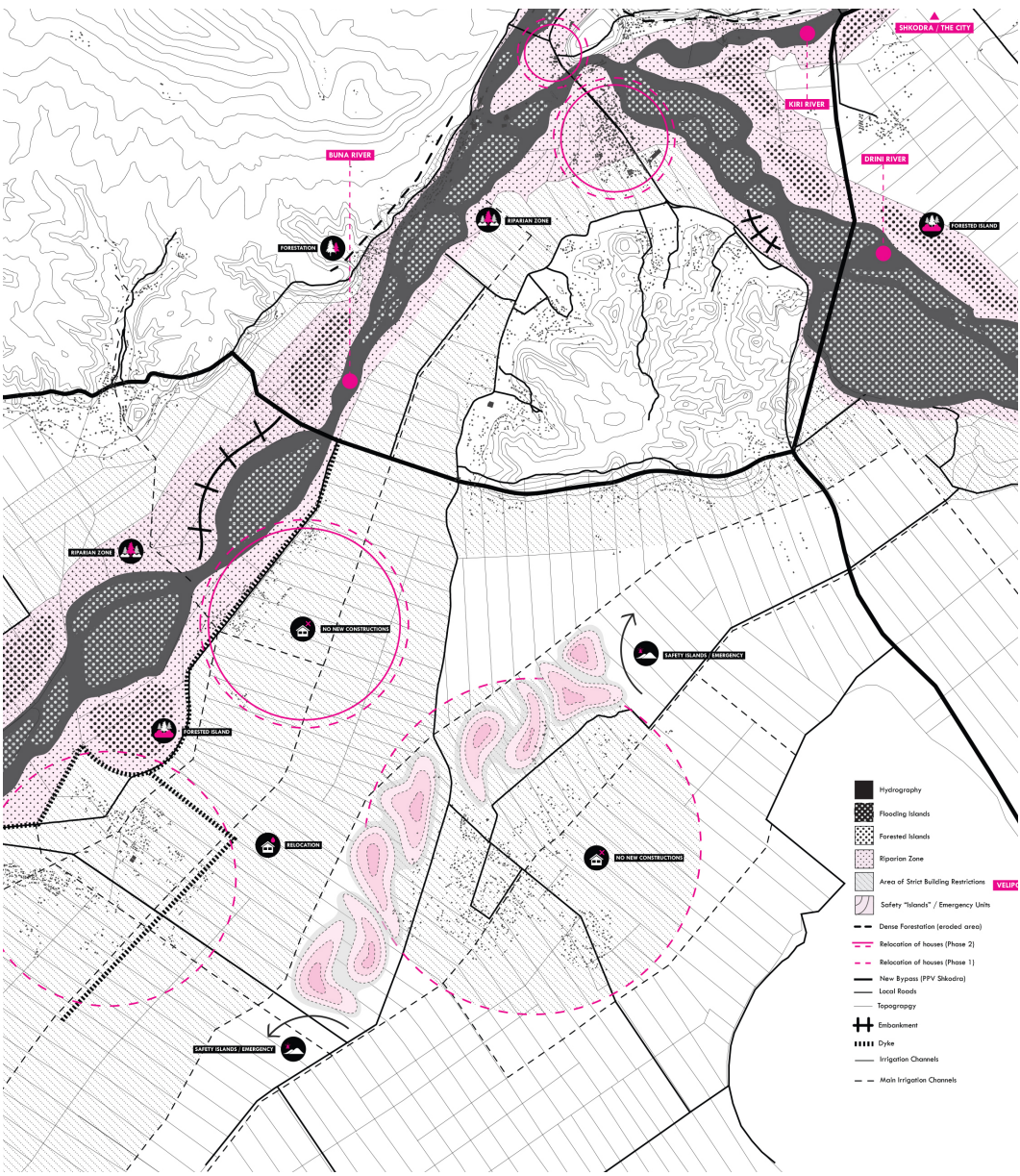


Fig5 / The general strategy of all the interventions introduced within the confluence area
source / the author

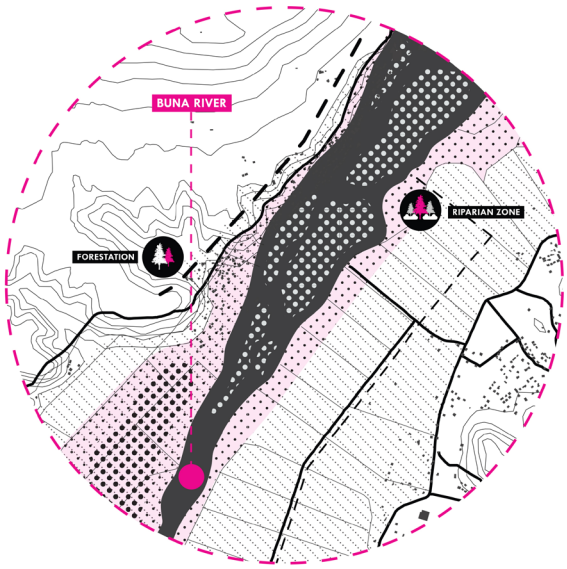


Fig6 / Zoom In #1 within the general strategy of interventions
source / the author

in areas which are prone to flooding, restoration and protection practices for natural resources, floodplains and watersheds, and implementation of flood resistant design, which aims at preventing flood fatalities by relocation, and measures of protection and mitigation.

- Practice the Precautionary Principle

This final fifth concept is more of an ethical principle, suggesting that interventions must be reversible and flexible. The precautionary principle[1] considers that if an action or policy is prone to cause irreversible harm, as long as the opposite cannot be proved, the intervention should not take place at all, or similar less risky interventions should be introduced.

These five concepts have been used to design a series of physical landscape interventions, with the scope of improving ecosystem resilience, in order to address the issue of flooding in Shkodra in a responsible, sustainable and comprehensive way. The confluence of the three Rivers, Buna, Drini and Kiri has been further visualized, in order to explain in details how these interventions would take place and perform during flooding events, by stimulating risk scenarios. The interventions include 3 main topics:

(i) The increase, improvement and control of the intake of inland water, in order to reduce uncontrolled runoff and displacement of flooding;

Landscaping interventions for creating artificial wetlands, riparian belts, floodplains and stream systems can create a net of interrelated components, which allow water intake, balance the amount of water flowing in the inland, and accommodate the surplus in order to prevent over flowing of water in residential and agricultural sites. The benefits of this system consist mainly on moderating downstream flooding by providing storage and slowing water runoff, promoting infiltration, and improving water quality and biodiversity.

(ii) Densification of local vegetation and forestation as an answer to deforestation and storm – water flow management.

The role of vegetation is pivotal in a series of events. Firstly it helps in returning back to the atmosphere, almost half of the annual amount of rainfall. Secondly, by minimizing the energy of rainfall, vegetation reduces soil erosion. Thirdly, vegetation contributes to creating more absorbent soil due to the addition of organic material and presence of healthy microbial communities (Watson & Adams, 2011).

(iii) Protection of human activity (housing and agriculture / farming).

This measure is contextualized on two main directions: (i) law improvements, and (ii) physical interventions.

- Law Improvements: Raising awareness and promoting concepts like "resilience" and "sustainability" should become pivotal in order to have successful planning and implementation of preventive measures. Strict restrictions regarding building permits in areas prone to flooding, and re – allocation of housing or economic activities (especially agriculture and farming), which are in the vicinity of these areas should be enforced. Continuous surveillance and infrastructure maintenance should

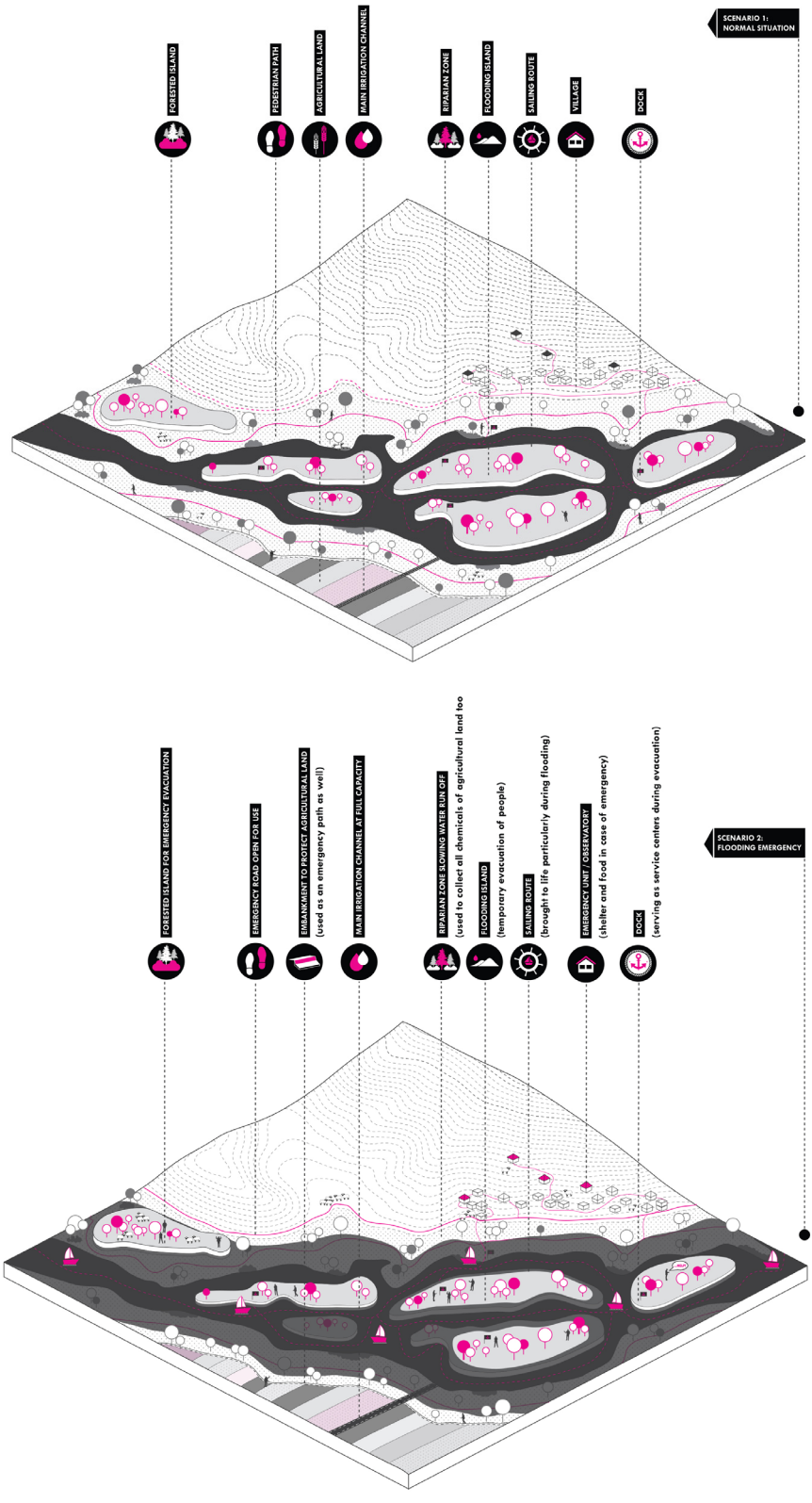


Fig7 / Zoom In #1 within the general strategy of interventions (before and after illustrations) source / the author

always be active, and Emergency Units for evacuating people and livestock during flooding events should be introduced as well.

- Physical Interventions: Introducing wetlands and floodplains can slow the release of water during moderate rainfall. Rainfall capturing techniques can as well help in reducing the amount of storm – water runoff. Artificially created hills in the vicinity of waterfronts, or near villages and agricultural / farming land, can reduce the intake of inland water, and slow runoff volume too. In addition, all the measures introduced on (i) and (ii) are considered as physical interventions as well.

1 / The 'precautionary approach' was defined in 1992 Rio Earth Summit Declaration: "In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.

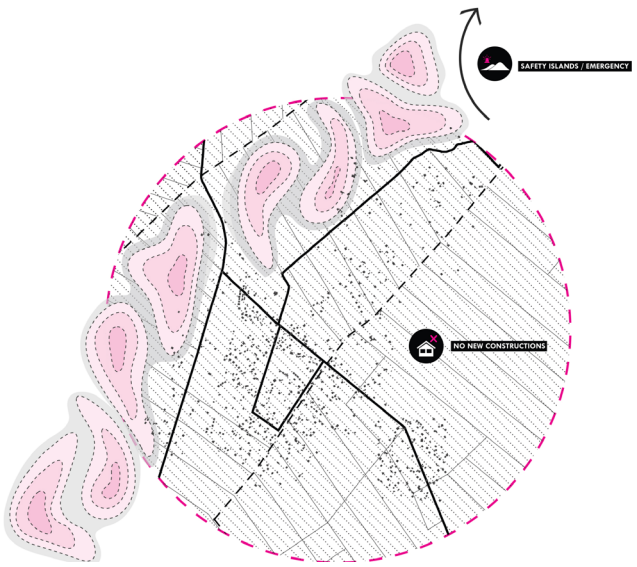


Fig8 / Zoom In #2 within the general strategy of interventions
source / the author

Conclusions

In this paper, the issue of flooding is challenged through a series of interventions with the scope of promoting ecosystem resilience and sustainability, which are able to cope with water and self-regulate during flooding events. Dealing with water, which plays a pivotal role for the life on Earth, means being aware and considering that it is not a solitary source, but it is rather part of more complex and interrelated systems that affect anything and everything. Therefore, nowadays threats to water resources are multiplied by global climate change, which reflect back to our urban and natural lands with severe impacts, among which flooding being one of the most active events. But flooding can only be as dangerous if not understood, anticipated, and prepared for. Preparing for flooding means "understanding the structural elements and functional properties of the ecosystem development, in order to lessen environmental stresses, which disturb the balance of water on a watershed area (Watson. D.; Adams. M., 2011). Then, the designing of proper infrastructure for balancing the presence of water and mitigating possible water-crisis can follow. The interventions proposed within this paper, use the five defining concepts of Watson and Adams, in order to comprehensively address the issue of flooding, coming up with 3 main topics to materialize physical interventions and behavioral properties within the diagnosed ecosystem. By understanding what resilience is, and how to improve ecosystem resilience by opening up to new thinking frontiers and by being able to see beyond the efficiency of short term interventions only, can contribute to deeper and profounder understandings of our existence, the relationships and our impact on the Earthly nature.

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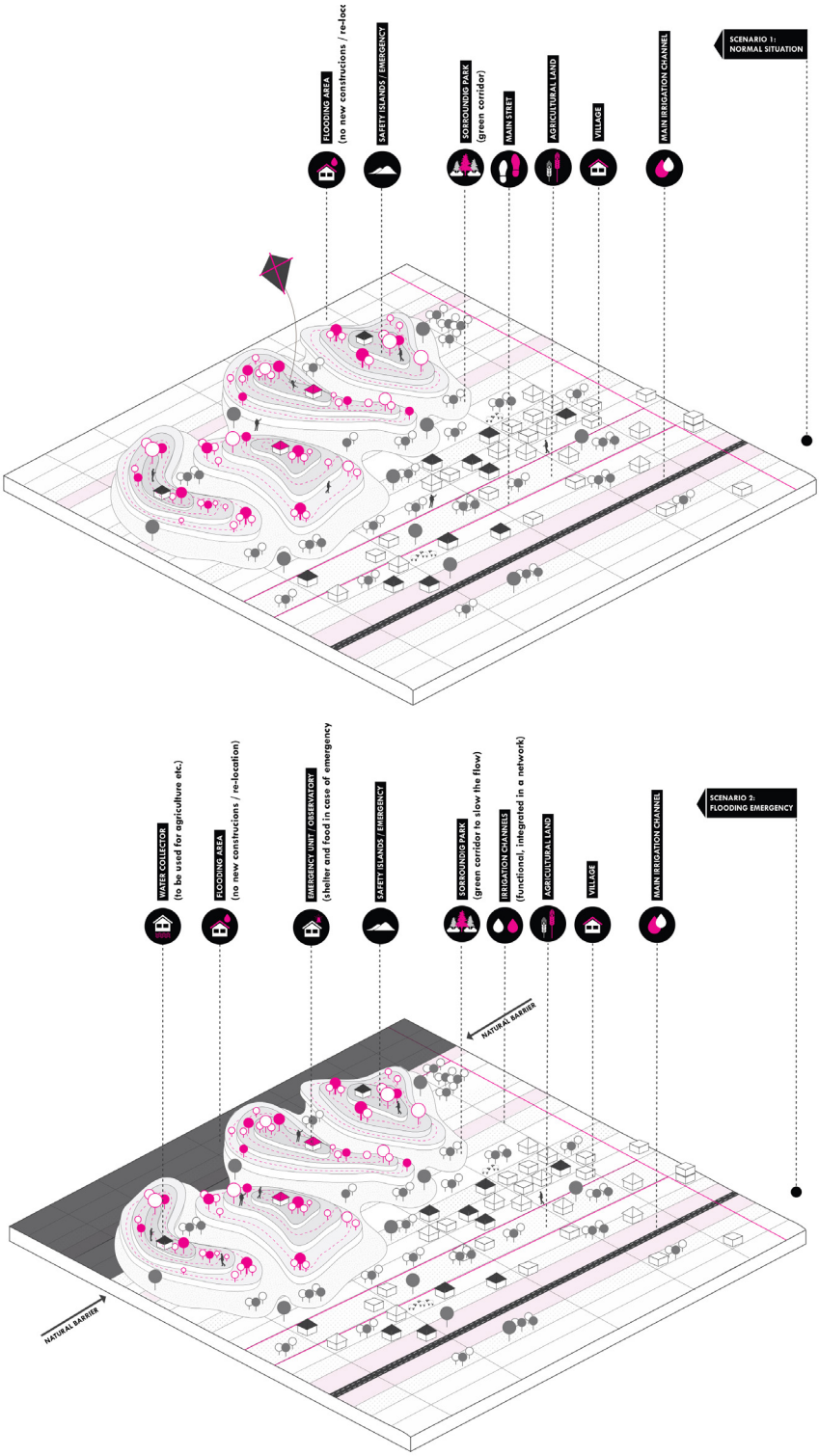

Fig7 / Zoom In #2 within the general strategy of interventions (before and after illustrations) source / the author

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