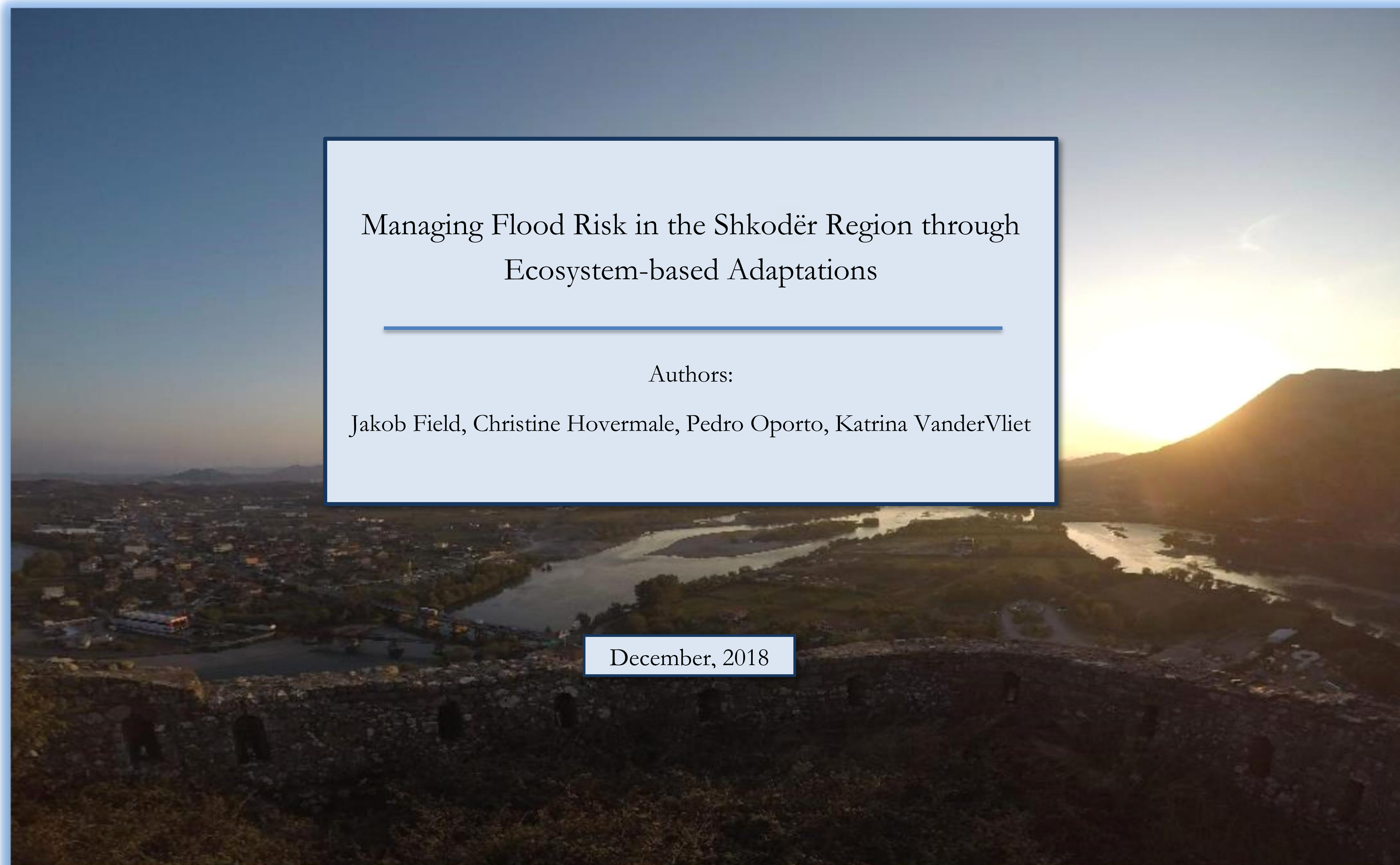

# Managing Flood Risk in the Shkodër Region through Ecosystem-based Adaptations

Authors:

Jakob Field, Christine Hovermale, Pedro Oporto, Katrina VanderVliet

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Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

WPI

# Managing Flood Risk in the Shkodër Region through Ecosystem-based Adaptations

An Interactive Qualifying Project submitted to the Faculty of
WORCESTER POLYTECHNIC INSTITUTE
in partial fulfilment of the requirements for the degree of Bachelor of Science

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# ABSTRACT

The Shkodër region in northern Albania has experienced severe flooding in the past decade, and flood risk is projected to increase due to climate change. Much of the land is farmed, and flooding degrades soil quality, reduces agricultural productivity, and negatively impacts the livelihood of the rural population. We worked with GIZ, the German development agency, to identify and explore the tradeoffs of two ecosystem-based adaptation (EbA) proposals aimed at reducing the impacts of flooding on farmers in the region. This was accomplished through semi-structured interviews with key informants, analysis of remote sensing data, and direct observation. The proposed EbAs could pose many benefits and challenges in the Shkodër region and need to include effective outreach to local stakeholders.

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**Aurora Dibra**: Ecologist
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**Adi Garuci**: Rural Planner
**Rasel Teli**: Urban Planner
**Sead Sadiku**: Hydrologist
**Ismet Ueliuietaj**: Farmer of Shirq
**Valentin Gocaj**: Agronomist of Obot
**M. Lukaj Ernest**: Agronomist of Dajç
**Jonathan McCue**: Sustainable Seas Managing Director

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Our whole group contributed to the final report. Before writing any one of the chapters, we sat down to brainstorm the main sections and content to be included in them. After the brainstorming phase, we divided the writing and research between the four of us to be completed by a set day and time to then go through each other's sections and comment on diction, grammar, and content.
(*) When writing the introduction and executive summary, we each focused on the content we each wrote about in the background, methods, findings and conclusions chapters.

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# EXECUTIVE SUMMARY

## The Shkodër Region and its Farming Practices

Shkodër's agricultural sector is significant to the regional economy and the livelihoods of its residents. Agriculture is the main source of income within the Shkodër region: as of 2017, nearly 60% of Shkodër's residents live in rural areas and 43,246 residents of Shkodër were employed in the agriculture sector (Ibrahimaj, 2017; Filipi, 2014). Approximately 51,000 hectares of agricultural land is distributed between small private family farms ranging from 0.1 to 0.4 hectares where farmers grow wheat, maize, grapes, olives, tomatoes, watermelons, citrus, stone fruit, and alfalfa, which is used to feed livestock (Ibrahimaj, 2017; personal communication, Adi Garuci, October 31 2018; Sustainable Development Department, 2012). Shkodër's arable land is located on 64% of Shkodër's land area that is considered the lowlands surrounding the Buna River (Municipality of Shkodra, 2006).

## Flood Risk to Agriculture

The main city of Shkodra is at the conjunction of Lake Shkodra and the Drin, Kir, and Buna Rivers, all of which drain into the Buna, which flows towards and empties into the Adriatic Sea. The combined flow from the other rivers and the lake into the Buna River can sometimes add up to more water volume than the Buna River can hold, causing it to overflow. As clarified by several key informants, this often occurs with intense amounts of rain in autumn and snowmelt in the end of winter, which increases the volume of water, especially in the Drin River. The expanse of flat, arable land alongside the Buna River is prone to floods, which is why an extensive system of dykes and drainage channels were developed (personal communication, Sead Sadiku, October 29 2018). Although these structures are effective at mitigating flood risk, their lack of proper maintenance combined with limited drainage capacity of the channels means they cannot protect the entirety of the flood-prone land, especially during severe events (GIZ, 2015).

The series of dams on the Drin River can also help reduce the amount of land flooded in severe events by blocking river residues, especially gravel, and hold large amounts of water upstream. Conversely, mismanagement of the dams can increase the risk of flash floods with sudden discharges of spill gates (IFRC, 2011).

Climate change forecasts predict notable changes in the region's climate. Even though precipitation is expected to decrease, it is becoming more concentrated in November and December (Vuković & Vujadinović Mandić, 2018). Additionally, the increased temperatures have caused snow to melt earlier and quicker in the year (Erol & Randhir, 2012). These effects further increase the river flow and flood risk in the fall and end of winter, respectively. Furthermore, Sadiku explained that the rise of sea level, which is expected for the Adriatic Sea, will increase the duration of floods by slowing the speed of water runoff from the land. Erosion also increases the severity of flooding from the Buna River. In some areas, it is changing the shape of the river, making it wider but shallower, increasing the probability of overflow and flooding in surrounding farmland.

The combination of these flood factors has caused catastrophic flood events as recently as 2010 (Figure A) and 2018 covering the west side of Shkodra city and other villages, including Dajç, where the worst flooding occurred, as pointed out by Sadiku. He also described how Shkodër also faces annual floods that largely occur in farming villages such as Bërdicë, Shirq and Obot, which are partially or completely covered every year typically between the months of November to March.

*Figure A - Floods of 2010 (German Aerospace Center, 2010)*

Adi Garuci, a rural planner from the Shkodër municipality, described how flood waters can impact agriculture by wiping away newly planted seeds, matured crops and overall decreasing the soil quality by mixing nutrient-rich topsoil with the less nutrient-dense soils below. He claimed this forces farmers to often replant, delay harvesting cycles, and produce smaller yields.

In June 2015, the German international development agency (GIZ), published the Flood Risk Management Plan for the Shkodër Region, in collaboration with the municipality of Shkodër and other public sectors. GIZ has worked with measures such as spatial planning, preparedness, warning systems, and informational outreach (GIZ, 2015). Ecosystem-based adaptations (EbAs) have the potential to be added to GIZ's flood risk management measures.

*Farmland near Shkodra in November 2018 (Top) and flooded in December 2010 (Bottom)*

# Understanding an Ecosystem-based Adaptation (EbA)

EbAs harness the power of nature to adapt to harmful environmental fluctuations and work to protect the surrounding ecosystems. They can be used to reduce the risk of natural disasters. A fully functioning and healthy ecosystem is more resilient to stressors, such as floods (Munang, 2012). EbAs may reduce the effects of floods and support quicker and more effective recovery from floods, but experts such as Sadiku and Garuci suggest that EbAs cannot help in the case of catastrophic events. EbAs for farmlands include riparian buffer strips, upland afforestation, natural water retention measures, re-naturalizing river systems and living breakwaters. Riparian buffers, for example, utilize vegetation along riverbanks to diminish and delay peak flow while reducing channel erosion, preventing runoff and increasing flow resistance (Todorova, 2017). The most successful riparian buffers are composed of native grasses, forbs, shrubs and trees and are implemented at largescale. Ecologist, Aurora Dibra, further explained that replanting these may be feasible around Shkodër farmland.

## Stakeholders

Promoting EbAs to combat the effects of flooding requires the active participation of policy-makers, scientists, and local community members. These include ministries, agencies, the farming community, ecologists, and other contributors to the design and implementation of an EbA. These three groups of stakeholders each provide their individual perspectives and contributions in creating a successful EbA. We needed to understand their expertise and how they could cooperate together in an EbA's implementation, as well as how they might be impacted by its intervention. This information is critical to consider locations, trade-offs, EbA types and identifying the best implementation strategy for this project.

## Objectives and Methods

The goal of our project was to identify and explore the tradeoffs of two EbA proposals aimed at reducing the impacts of flooding on agriculture in the Shkodër region.

- Understand flood hazard in the Shkodër region based on the hydrology and present infrastructure
- Understand how flooding affects the livelihoods of the local farming community and how they have tried to reduce flood impacts
- Select EbAs at two locations based on flood risk characteristics and key informant feedback

Through the first objective, we learned about the current hard infrastructures such as the levees in Shirq, groynes, and drainage channels through semi-structured interviews with Sadiku and GIZ.

*Our group with Albanian students and agronomist M. Lukaj Ernest from Dajc*

We then conducted semi-structured interviews with farmers and a rural planner from the Shkodër Municipality, Adi Garuci, to learn about the effects floods have on farmers' crops and soil, how they prepare for flooding, and how flooding affects their farming practices and the best types of vegetation for our proposed EbAs. Garuci provided us with GIS maps of the region to better understand the spatial extent and associated damages from flooding. We triangulated the data we gained from our interviews with the data from the GIS and satellite maps to identify possible EbA locations and types for an intervention. To refine these EbA options, we conducted semi-structured interviews with key informants from hydrological, ecological, political, and socio-economic perspectives to acquire feedback and adjust the case studies.

## Impact of Flooding on Agriculture

The three farmers we interviewed all had experience with agricultural losses due to flooding. Ismet Ueliuietaj, a farmer from Shirq, described how his crops are flooded and damaged every year due to the large volume of water that comes and stays on his land from lack of effective drainage. Valentin Gocaj, an agronomist in Oblikë e Madhe with 47 years of experience, also stated the floods spread pollutants across the soil and have caused "psychological damage" to farmers because their crops are less productive or ultimately have been destroyed by the prolonged floods. Due to frequent and anticipated floods, farmers have learned to adapt their practices. As we learned from agronomists and farmers in the studied areas, some farmers are emigrating from the farmlands and the abandoned land is being converted to pastures or natural vegetation. Cultivation patterns are changing due to the recent flooding events (personal communication, M. Lukaj Ernest, November 27 2018; personal communication, Valentin Gocaj, Nov 27 2018). Additionally, according to Ernest and Garuci, increased levels of groundwater are a common issue in the agricultural land of Shkodër. Both flood and rainwater are absorbed by the soil but runs off slowly, as most of the land has no significant slope. Garuci stated that the increased groundwater and flood water washes away the top soil nutrients, spreads pollutants and affects soil oxygenation.

*Waterlogged soil on farmland*

## Potential Benefits of EbAs

According to Garuci, EbA buffers have the potential to reduce pollution from fertilizers within the water runoff by absorbing the extra nitrates from the topsoil. Reforestation of large trees can significantly help absorb excess groundwater from the surrounding soil, thus improving its post-flood recovery (personal communication, Jonathan McCue, November 24 2018). Additionally, to reduce the impact of flooding on agriculture, EbAs can help restore habitats that have been reduced due to factors such as land use conversion to agriculture, deforestation, erosion, and effects related to large volumes of water from flooding. According to ecologists Aurora Dibra and Mirela Isufi, EbAs that include trees also provide extensive habitat for birds and arboreal species. This is important because the food chain in the ecosystem is delicate and habitat is essential for ecosystem survival (personal communication, Mirela Isufi, November 9 2018; personal communication, Aurora Dibra, November 26 2018).

# Potential Challenges and Limitations to EbAs

According to municipality spatial planners Adi Garuci and Rasel Teli, there are issues with clearly defining the intervention areas for an EbA. GIS maps do not necessarily show all the land that could be used for an EbA because they are no longer cultivated. Alternatively, areas that do not have any houses or urban occupation according to the GIS maps may seem adequate for an EbA. However, the maps might not show that there is unregistered illegal construction that is eligible for regularization according to new municipality law. Furthermore, according to Teli, the land ownership system is unregulated, with old and new documents that are still valid but have contrasting information. If it is decided that land will be acquired for an EbA, the implementation can be delayed until its owner(s) are identified and agree to sell it, or the acquisition will be forced without their consent. In the case that EbAs are implemented on private land with farmers' collaboration, there needs to be further assessments to determine who is entitled to the responsibilities and compensations of implementing and maintaining them within each parcel of land. To minimize this issue, Garuci suggests the project should be constrained to the small amount public land that is available. However, this would significantly reduce the size of the EbA and its effectiveness. The land distribution is heterogeneous and poses a challenge for the proposed large scale EbAs. Garuci made clear that an EbA could force farmers to relocate and abandon their agricultural livelihoods and traditions that have been in their families for centuries.

EbAs also face technical limitations in this region, as reforestation efforts require tree saplings that are at least five years old. When combined with the risk of sediment accumulated in the vegetation, this creates logistical and economic challenges during implementation, monitoring and maintenance. When interfacing with current infrastructure, EbAs have to be placed carefully so that tree roots do not interfere and damage present dykes, channels, and roads.

Many key informants showed skepticism towards the success of an EbA during our interviews. For example, ecologists were concerned about the long-term sustainability of EbAs in Shkodër due to the history of deforestation for personal reasons such as cooking and heating. A significant number of our informants also doubted the success of an EbA in reducing flood risk. They wanted a direct solution to stop the floods in the region rather than managing the aftermath. They claimed that the floods in 2010 and 2018 were caused solely by dam mismanagement. Therefore, they expressed that spending the time and money on an EbA would be a waste and that dam mismanagement should be addressed instead. Additionally, other sources argued that no species of vegetation would be able to absorb the flood waters and help reduce flood risk when the flow rates are high due to a dam release.

# CASE STUDY 1: A Riparian Buffer Located Along the Buna River in Obot and Shirq

| | |
|---|---|
| Location | Obot and Shirq |
| Size | Surface Area: 2.1 km$^2$<br>Length: 4 km<br>Width: 100-700 m |
| Type | Riparian Buffer |
| Plant Species | Fraxinus ornus, Carpinus betulus, Populus alba, Populus canadensis, Salix caprea, Salix alba, and Quercus robur |

*Table A – Location and design details of first EbA Case Study*

The first section of the EbA would be placed south-east of Obot i Vjete along the Buna River bend. The second section of the EbA is located in Urela, north of Shirq and southwest of Flusha along the opposite bend of the Buna River. These locations can be seen highlighted in red on the map (Figure B).

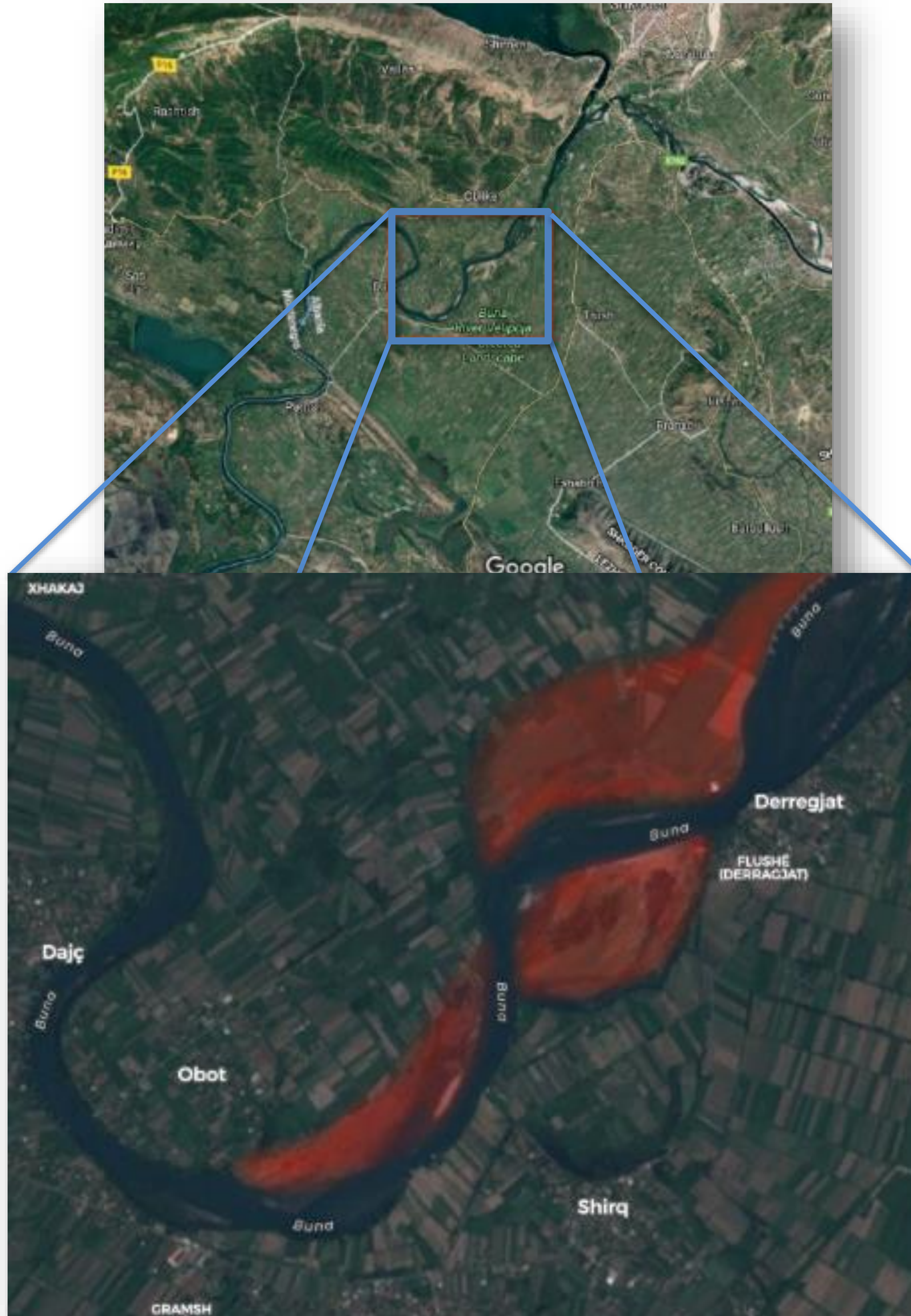



*Figure B- Satellite image with area for first EbA Case study highlighted in red*

In this selected EbA area, there is a mixture of farmland, pastures and some natural vegetation. This area is flooded almost every year and is the first area to experience the floods. Damages to the soil also come from pesticides and pollutants that get carried through the flood waters. The floods created direct damages to livestock, agriculture, and nutrients to the soil. As mentioned previously, farmers in this area have adapted to flooding in several ways but are also abandoning their land.

We were able to identify that these locations are flooded annually, not only in the events of catastrophic floods such as in 2010 and 2018 (Figure C). Garuci explained that the satellite maps, applied with a vegetation index filter, also indicate that floods have severely affected the soil quality for agriculture in this area.

This first EbA case study was chosen based on data acquired through GIS mapping of the Shkodër region. The chosen spot for our EbA is in a less populated area, in order to affect the least amount of people's land.

This EbA was also chosen to work in coherence with the present infrastructure that is already located in this area. Due to the potential threat of high-speed flows, the EbA is placed along with large water breaks, where the current flow is slowed down. To gain an understanding of an approximate width length for this EbA, we used the Sentinel Hub mapping system. The suggested surface area would be 2.1 km2 for the riparian buffer, and would stretch a length of 4 km along the Buna River with a width ranging from 100-700 m. When asked about the idea or concept of an EbA on his land, Ueliuietaj from Shirq replied that it may be helpful to reduce the effects of flooding, however, it would need further discussion between him and other farmers in the area if the proposed EbA requires some of their land. Gocaj from Obot revealed his resistance to EbAs. When asked about them being placed on the farmland in Obot, he said "Possibility is low for EbA".

*Figure C - Satellite images with Normalized Difference Water Index filter (NDWI) acquired from Modified Copernicus Sentinel data [2018]/Sentinel Hub showing the area for the first proposed EbA flooded in 11-16-2016 (Left), 12-18-2017 (Middle), and 02-09-2018*

# CASE STUDY 2: Wetland Reforestation and Restoration Located in Dajç

| | |
|---|---|
| Location | Dajç |
| Size | Surface Area: 5 $km^2$<br>Contour: 10 km |
| Type | Wetland Reforestation |
| Plant Species | Fraxinus ornus, Carpinus betulus, Populus alba, Populus canadensis, Salix caprea, Salix alba, and Quercus robur |

*Table B – Location and design details of second EbA Case Study*

The location of this EbA is southeast of the Belaj and Suka-Dajç villages, alongside the hill range that can be seen in the map (Figure D).


*Figure D - Satellite image with area for second EbA Case study highlighted in red*

Dajç is located southwest of Shkodra. The land is mostly between one to five meters above sea level, with the exact location for the EbA being one meter below sea level. This location was previously a large wetland and rice plantation. However, it is now taken over by a mixture of alfalfa crops and livestock pastures. The main problem is the high level of groundwater in these areas from rainfall and annual floods. Recently, many people have emigrated from this land because most of the population here was elderly and they could no longer farm or plant on their own. As mentioned previously, farmers in this area have also adapted to flooding in several ways.

We were able to identify that these locations are flooded annually, not only in the events of catastrophic floods such as the 2010 and 2018 events (Figure E). Garuci explained that the satellite maps, applied with a vegetation index filter, also indicate that floods have severely affected the soil quality for agriculture in this area.

The GIS maps showed the most populated areas that have been affected by flooding, in addition to the less populated areas, where our EbA could be physically placed. The chosen spot for our EbA is in a less populated area. After visiting this location with hydrologist Sadiku, he described how the small drainage channels from the farmlands and villages converge into one single large channel at this location. However, when the channels become blocked with debris, they begin to back up and overflow onto the land creating a bathtub effect (personal communication, Sead Sadiku, October 29 2018). This causes oversaturation in the land and a potential location for water absorption through an EbA.

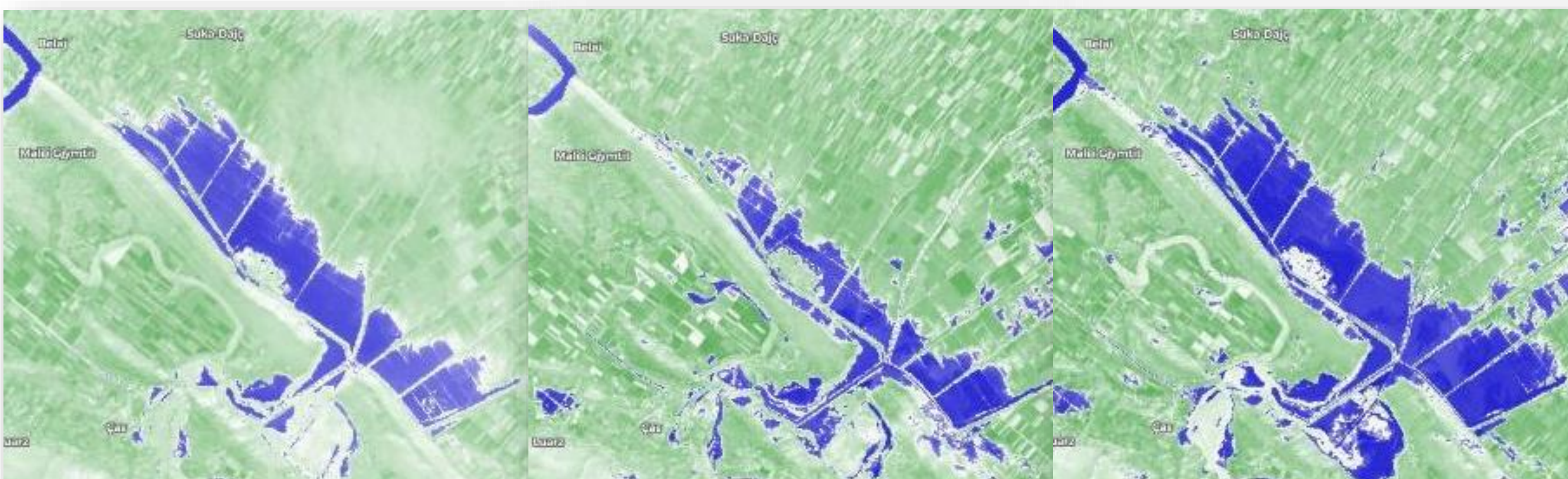


*Figure E - Satellite images with Normalized Difference Water Index filter (NDWI) acquired from Modified Copernicus Sentinel data [2018]/Sentinel Hub showing the area for the second proposed EbA flooded in 11-16-2016 (Left), 01-22-2012 (Middle), and 11-28-2018 (Right), (EO Browser, 2018)*

# Conclusions

There is no real way of knowing whether our EbA propositions will be effective if they are implemented. Additionally, there are other factors of EbAs such as cost, source of funding, and scale that were not fully assessed. We were only able to interview three farmers, which is a small sample size from a large stakeholder group. We also did not interview the dam management company Kesh, and therefore only encountered one perspective of dam mismanagement. There were also limitations in terms of translation and language barriers during interviews, as well as the time constraint of seven weeks to conduct fieldwork. We also had issues with the term “EbA”. Some key informants have experience with measures that, in essence, are EbAs while several stakeholders were completely unfamiliar with the concept. This posed a challenge when communicating our project and acquiring their input. We found that using examples with pictures and maps helped clarify the concept.

When considering an EbA, it is also difficult to determine which areas are more in need of flood risk management and where an EbA would be most effective. Furthermore, EbAs may require private land from farmers or other residents, resulting in possible land buyouts or the necessity to negotiate with people whose land space may be needed for an EbA. Certain farmers could lose their valuable land while there is also a risk of the EbA being entirely ineffective. Finally, as engineering students, not only we are not in the position to make such ethical decisions, many informants also presumed we would be attempting to provide a solution that includes hard infrastructure such as levees and completely stop the flooding. This misled some key informants and we had to explicitly point out that our solution was limited to EbAs.

Overall, our suggestions for GIZ include these two proposed case studies, but also to keep in mind that EbAs pose many benefits and challenges in the Shkodër region and need to be proceeded with caution when considering implementation. Although there are many more in-depth factors to consider, we provided a basis for evaluating the extent to which EbAs can reduce flood effects with respect to the farming community and agriculture within the Shkodër region.

# Introduction

*A narrow dirt road through the Kune Vain Lagoon in Lezhë, Albania connecting the coast to the city*

# INTRODUCTION

The Shkodër region of northern Albania is located at the confluence of the Drin, Buna, and Kir rivers and is bounded by Lake Shkodra to the north and the Adriatic Sea to the west (GIZ, 2015). The region has long been prone to flooding, but climate change impacts, such as more intense precipitation and snowmelt discharge, have led to more frequent and severe floods (Epoka University, 2013, Telegraph, 2010).

Such floods are becoming more frequent in Shkodër. Studies have noted that "repeated lower intensity floods in this region in 2013, 2015 and March 2018 clearly show the increased vulnerability of the area" (Dirking, Klockemann, Kranefeld, & Meincke, 2018, p. 1).

The 2010 flood, "one of the heaviest documented floods of the last 50 years", inundated 15,000 acres and led to the evacuation of 14,500 residents (Dirking et al., 2018, p.1; GIZ, 2015; IFRC, 2011). In March 2018, over 5,000 acres of both urban and rural lands were flooded, multiple villages were cut off for several days, and farmers lost crops and livestock (Davies, 2018).

Flooding in the Shkodër region is caused by environmental and human factors and is expected to worsen due to climate change. Climate change is causing precipitation to be concentrated into the already flood-prone winter months; in addition, it is causing rising temperatures that lead to snow melting earlier in the year and in a higher volume (Vuković & Vujadinović Mandić, 2018; Erol, A., & Randhir, T. 2012).

The resulting high volumes of water increase the flow rate of the Drin River and thus the probability and magnitude of floods. The hydrology of the region also contributes to flooding. There is little elevation difference between Shkodër's farmland and the Adriatic Sea which spans the length of the Buna River that is 44 kilometers long (Municipality of Shkodra, 2006).

When water from the Buna and Drin River overflows from their riverbanks onto the land, water pools on farmland and can remain for up to 30 days or more (Dincer & Kurt, 2012; personal communication, Merita Mansaku-Meksi, October 23 2018; Sead Sadiku, October 29, 2018). Erosion is changing the shape of the river due to the buildup of sediment, which causes the river to become shallower, increasing the probability of overflow and flooding in surrounding farmland (Neslen, 2015). According to many residents of Shkodër, dam mismanagement also contributes to

*Large drainage channel south of Dajc*

flood risk. The timing of dam releases and the amount of water released increases the severity of floods. Drainage channels clogged by debris that lack proper maintenance also increase flood risk in Shkodër (personal communication, Sead Sadiku, October 29 2018).

Our sponsor Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) would like to consider incorporating EbA(s) as a next step to manage flooding in the region. Through vegetation planted along riverbanks, also known as riparian buffers, or converting farmland into permanent grassland to reduce soil erosion, EbAs can make ecosystems more resilient in the face of climate change and reduce the impacts of flooding (Munang, 2012; Daigneault, 2016; Todorova, 2017). EbAs can absorb flood waters through the roots of various plants and vegetation planted along riverbeds and in flood-prone areas, therefore reducing saturation and the time that water sits on the land. The success of any of these EbAs depends on location, land availability, pre-existing infrastructure, and community involvement in planning and implementation (Vignola, 2009).

However, the technical, social, and economic feasibility of EbAs has not yet been researched in the context of Shkodër. The goal of our project was to identify and explore the tradeoffs of two EbA proposals aimed at reducing the impacts of flooding on farmland in the Shkodër region. By engaging with key informants and stakeholders, such as spatial planners, hydrologists, ecologists and farmers, we assessed suitable locations, types of EbAs, appropriate vegetation, trade-offs, limitations, and implementation strategy.

*Flooded drainage channel in Dajc (Provided by Sead Sadiku)*

# Background

*The Shkodër Region and its Agriculture*

*Flood Risks to Agriculture*

*Ecosystem-Based Adaptations*

*Stakeholders*

*Water break structures along the Buna River separating the villages of Dajç and Obot*

# BACKGROUND

## The Shkodër Region and its Agriculture

The Shkodër region is one of the most ancient in the Balkans. Its settlements date back to the Bronze Age starting in 2100 BC, and vary from 0.1 to 0.4 hectares in size with houses typically clustered in the center of the village on the highest elevation available, and farms located closer to the Buna River (Gjyshja & Mara, 2013; personal communication, Adi Garuci, October 31 2018; personal communication, Valentin Gocaj, Nov 27 2018). The region encompasses approximately 19,220 hectares of lowlands, 7,450 hectares of uplands directly east and south of the city of Shkodra, 3,590 hectares of mountains including the Albania Alps to the Northeast, and an extensive drainage system of the Drin, Buna, and Kir Rivers leading to the Adriatic Sea (Municipality of Shkodra, 2006). The city of Shkodra is the fourth most populated city of Albania, with an estimated population of nearly 100,000 (90,743). The majority of the region's population, though, resides in rural and agricultural areas: an additional 125,332 people live in villages in the Shkodër region (Filipi, 2014).

Following the end of the communist regime in the 1990s, residents of the hills and mountains migrated to these rural and agricultural lowlands, which is the green area surrounding the Buna River that

can be seen in Figure 1. They moved to establish small private farms aimed at providing food for their families after the collective farms dissolved with the fall of the communist regime (GIZ, 2015). Additionally, the effectiveness of the dykes and drainage channels established in the Drin and Buna rivers in the 1970's gave a false sense of immunity to flooding, leading farmers to think the land was safe for building and cultivation. Settlement in the low-lying agricultural areas around Shkodër went largely unchecked due to the lack of national and local regulation on construction and the buying and selling of property (UNECE, 2002). The establishment of homes and farms on this land increased exposure to the frequent flooding experienced by the Shkodër region.

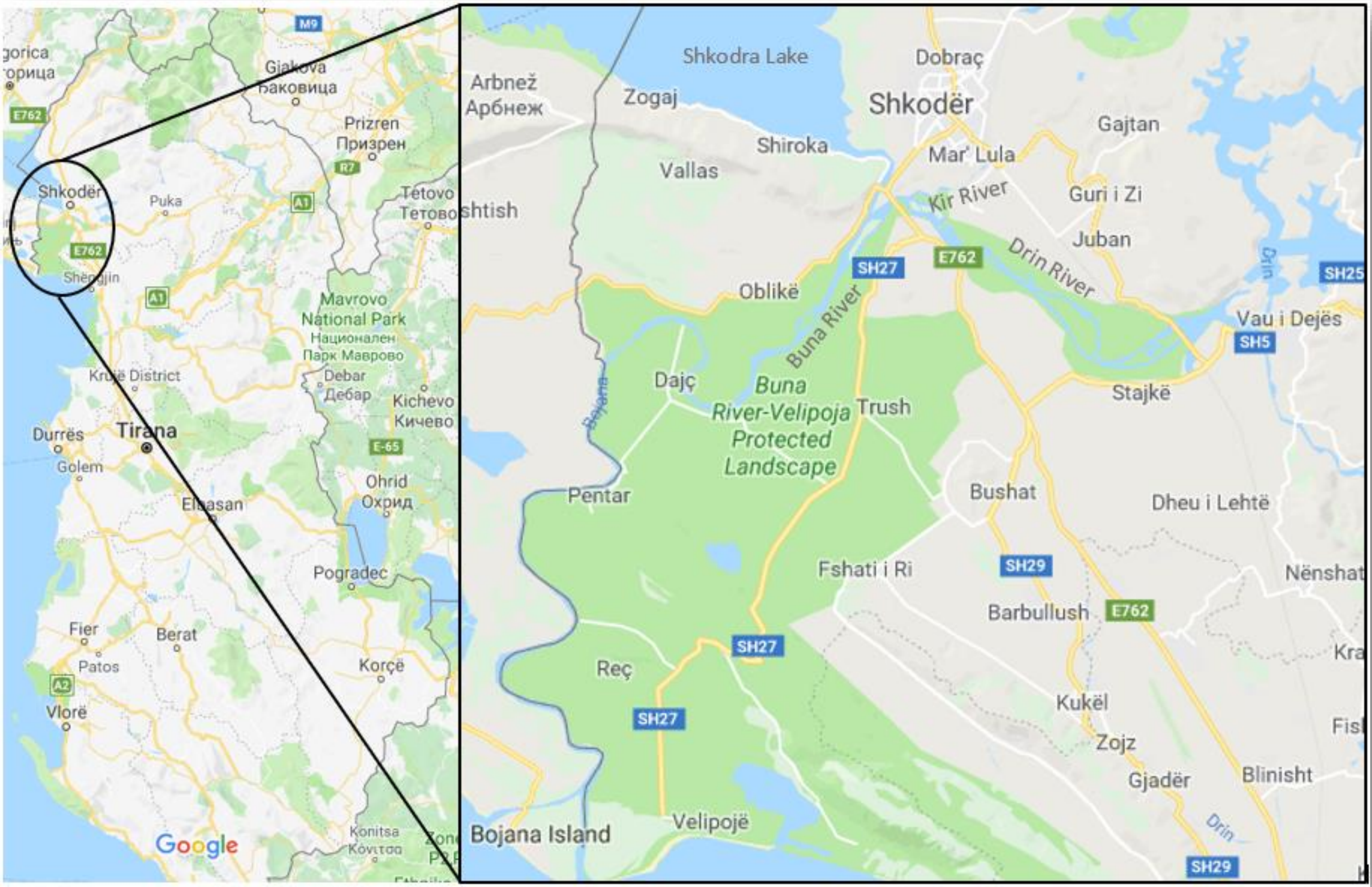



*Figure 1 - Map of the Shkodër region (Google Maps, 2018)*

The 51,000 hectares currently devoted to agriculture in Shkodër comprises approximately 14% of Albania's total arable land (Ibrahimaj, 2017; Metaliu, 2017). The land is distributed between small private family farms of approximately 0.1 to 0.4 hectares each where farmers grow wheat, maize, grapes, olives, tomatoes, watermelons, citrus, stone fruit, and alfalfa, which is used to feed livestock (personal communication, Adi Garuci, October 31 2018; personal communication, Valentin Gocaj, Nov 27 2018; Sustainable Development Department, 2012). As of 2016, there were 376,000 livestock animals in the Shkodër region, consisting of 20% sheep, 18% goats, 15% milk sheep, 11% cattle, and 9% cows (Ibrahimaj, 2017).

Shkodër's agriculture sector is significant to both the regional and national economies. Within the region, 31% of Shkodër's gross value added to Albania's GDP is due to agriculture, forestry, and fishing as of 2016 (INSTAT, 2018). Agriculture is the main source of income within the Shkodër region: as of 2017, nearly 60% (43,246) of Shkodër's residents were employed in the agricultural sector (Ibrahimaj, 2017). In some situations, farmers do not take their products to market and instead utilize their produce as a family food source (Metaliu, 2017). Figure 2 shows the land cover classification and Figure 3 shows the density of houses in the region.

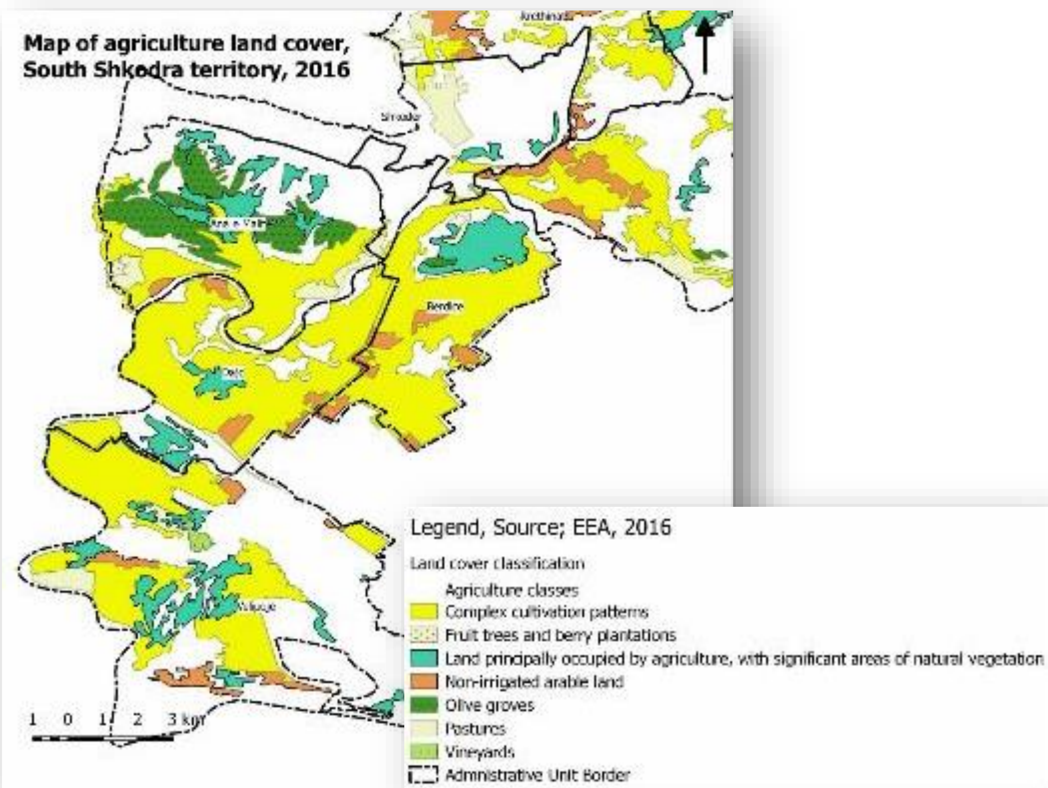



Figure 2 - Map of land cover, South Shkodra territory, 2016 (Garuci, 2018)

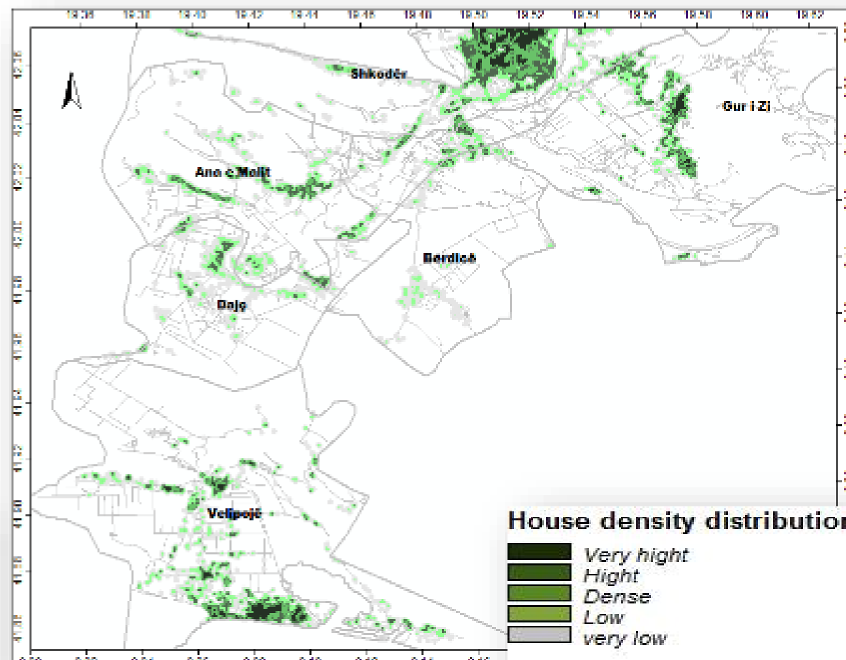



Figure 3 - Map of housing density, South Shkodra territory, 2017 (Garuci, 2018)

The Shkodër region has an extensive hydrological system (Figure 4). The main city of Shkodra is at the conjunction of the Lake Shkodra and the Drin, Kir, and Buna Rivers, all of which drain into the Buna, which flows towards and empties into the Adriatic Sea. The expanse of flat, arable land alongside the Buna River is prone to floods, so in the 1970s the central government introduced an extensive system of dykes and drainage channels throughout Shkodër's low lying farmland (personal communication, Sead Sadiku, October 29 2018).

Additional dykes continue to be built each year to improve drainage flow rate and capacity, along with protecting the villages and traffic infrastructure (personal communication, Sead Sadiku, October 29 2018). The drainage system has three different levels: Category 1, 2, and 3 (Figure 5). The Category 1 channels are 12 meters wide and can discharge a significant amount of water into the Adriatic Sea and help to reduce water flow in the Buna River. Category 2 and 3 channels are five and three meters wide and help to protect the nearby homes and farms from rising groundwater (GIZ, 2015). Local farmers dig additional undocumented drainage channels on their land every year to prepare for possible flooding. They do this to drain the excess water that accumulates on their farmland, however, it is not always efficient (personal communication, Ismet Ueliuietaj, November 9 2018).

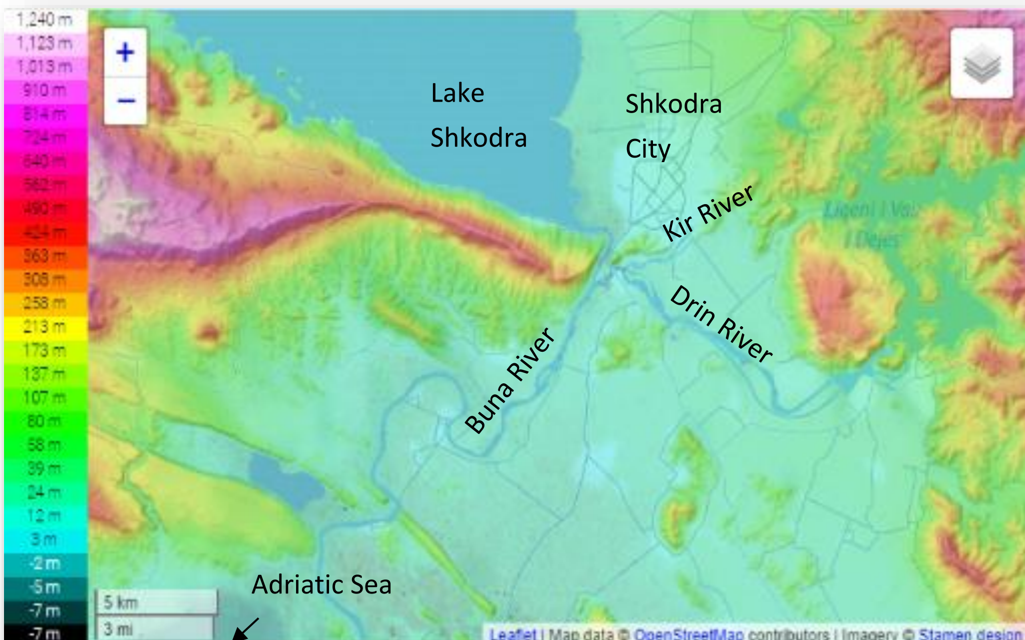



*Figure 4 – Topographical and hydrological map of Shkodër (OpenStreetMap & Stamen Design, n.d.)*

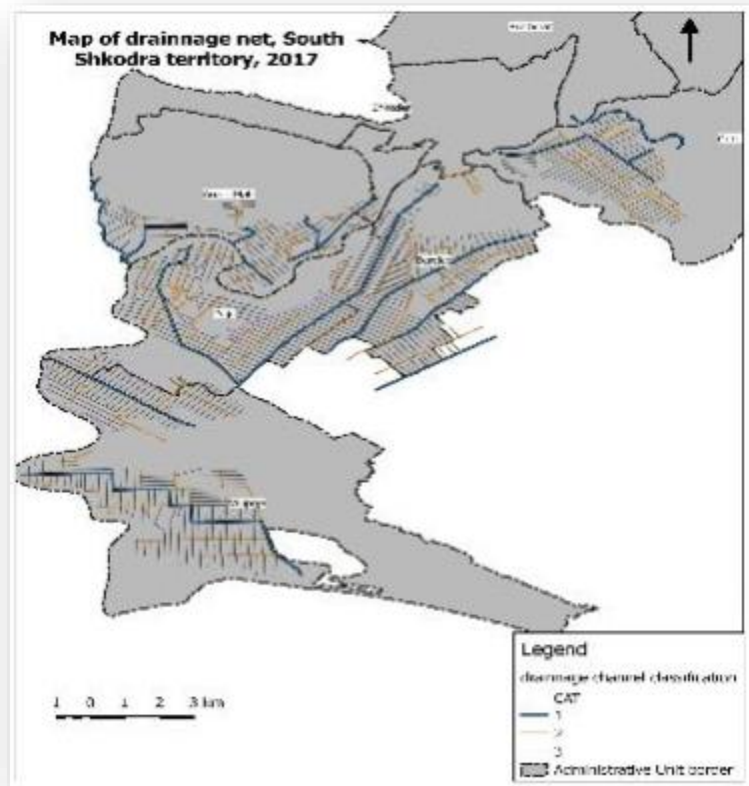



*Figure 5 - Map of drainage net, South Shkodra territory, 2017 (Garuci, 2018)*

# Flood Risks to Agriculture

## Factors that Contribute to Flood Risk

### A. Hydrological System

The agricultural land in the Drin-Buna River basin is relatively flat, with a maximum elevation change of six meters as seen in Figure 2. Due to its low elevation and slope, farmland here is especially vulnerable to water that builds up from the lake and rivers. The combined flow from the Drin and Kir Rivers, and Lake Shkodra into the Buna River is more water volume than the Buna River can hold, causing it to overflow (personal communication, Merita Mansaku-Meksi, October 23 2018).

The Buna River and drainage channels flow away from the city of Shkodra to the Adriatic Sea but neither have drastic slopes, with an approximate average of 0.3 meters in variation per kilometer. These small changes in elevation cause the water to flow slowly through the channels and Buna towards the sea (personal communication, Sead Sadiku, October 29 2018). As a result, the volume of water flooding into the farmland from the river overflow and precipitation is often higher than the drainage capacity of the existing channels. This causes a “bathtub effect”, where the flood water accumulates on top of farmland for extensive periods of times, up to 30 days in some locations. However, this “bathtub effect” also causes water to back into the Shkodra Lake, causing floods on the west side of Shkodra city and even into Montenegro (Dincer & Kurt, 2012; personal communication, Merita Mansaku-Meksi, October 23 2018)

*Farmland near Shkodra in November 2018 (Top) and flooded in December 2010 (Bottom)*

## B. Climate Change

Climate change increases the probability and magnitude of floods in the Shkodër region due to a combination of sea level rise, earlier and concentrated snowmelt events, and variations in rainfall seasonality. Current average rainfall varies between 2000-3000 mm per year (Epoka University, 2013). There are two climate scenarios that we have looked at called Representative Concentration Pathways (RCP). The first, less extreme scenario is RCP4.5, where greenhouse gas (GHG) emissions peak near 2040 then decline. The second, more extreme scenario is the RCP8.5 or "business-as-usual" scenario, where GHG concentration continues to increase by 2100 (Vuković & Vujadinović Mandić, 2018). Average annual precipitation has already decreased up to 20% in the region compared to the base period of 1961-1980. While the RCP4.5 scenario predicts no significant change, the RCP8.5 scenario expects annual precipitation to decrease by another 20% in the years 2046-2065 (Vuković et al., 2018). However, seasonal precipitation is changing, with higher levels in December, January, and February followed by drought periods in June, July, and August throughout the Western Balkans and the Shkodër region, as can be seen in Figure 6 (Vuković et al., 2018). The concentration in precipitation at the end of winter and the beginning of spring increases the flow rate of the Drin River and the probability and magnitude of floods in the same periods.

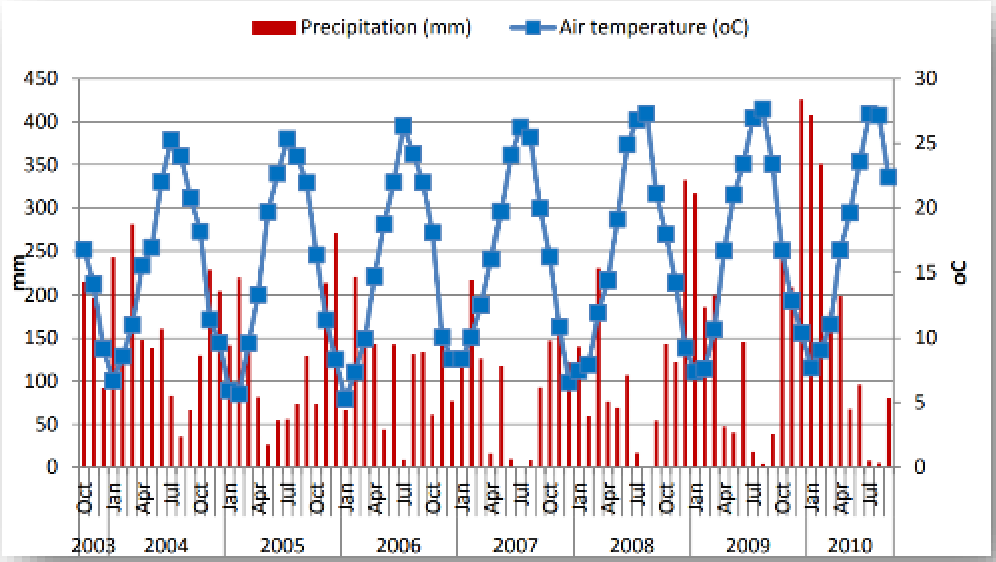
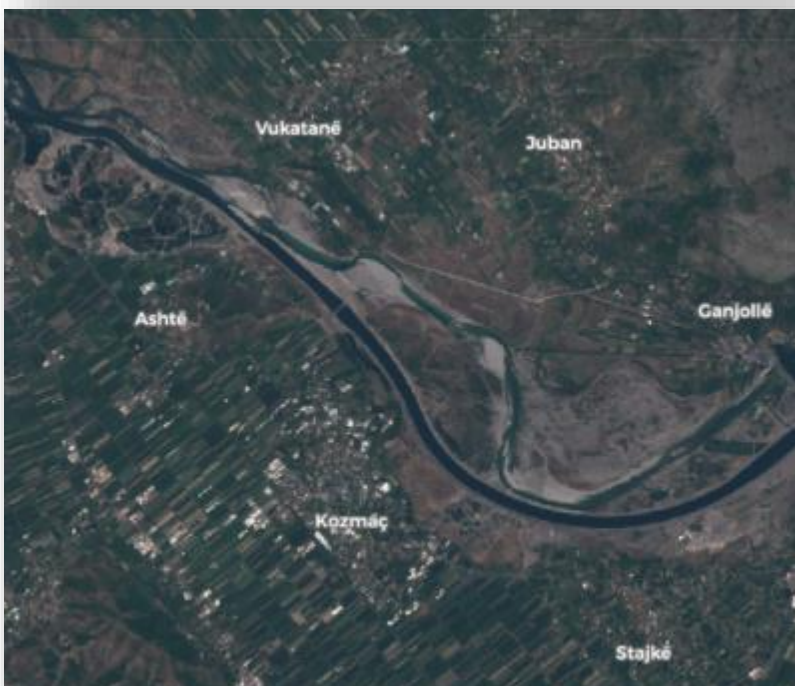



*Figure 6 - Monthly average rainfall and air temperature for the stations of Ulcinj, Bushat, Dajç and Velipoje in the period 2003-2010 showing the increase in peak rainfall for the fall and winter months (MedPartnership, 2015)*

The annual average temperature increased 1.0 to 1.5 °C from 1961 to 2015, and is expected to increase by 1.6 to 2.1 °C from the years 2046 to 2065 (Vuković, A. et al., 2018). These increased temperatures have caused snow to melt earlier in the year, therefore causing the Drin River to receive snowmelt from the Albanian Alps earlier in the spring and winter in higher volumes (Erol, A., & Randhir, T. 2012; personal communication, Merita Mansaku-Meski, October 23 2018). This increases the flow rate of the Drin River and thus the probability and magnitude of floods in the spring after the snow melts.

Changes in sea level also add to flood risk: sea level is projected to rise between 0.2 to 0.85 meters in the Adriatic coast of Albania by 2100. The sea will cover part of the flat agricultural territory in Shkodër and increase the backwater and bathtub effects during floods due to Shkodër's drainage channel connection to the Adriatic Sea (Dincer & Kurt, 2012). In addition to increasing flood risk, forecasts for 2040-2050 suggest that the direct impact of climate change will decrease the yields of alfalfa, grapes and olives (some of the main crops in this region) by 3% to 21% (Sustainable Development Department, 2012). Increased temperatures also shorten the reproductive cycle of many pests, therefore increasing the number of pests and diseases that can weaken crops (Demiraj Bruci, Finda, Islami, & Kamberi, 2009). These combined effects are expected to adversely affect the agricultural sector around Shkodër.


## C. Erosion

Erosion increases the severity of flooding from the Buna River. In some areas, erosion is changing the shape of the river, making it wider but shallower, increasing the probability of overflow and flooding in surrounding farmland. Erosion is a natural effect that can be worsened by anthropogenic interventions such as dredging and deforestation. For example, in 2015, severe floods in southern Albania were attributed to river erosion caused by deforestation of the river margins where the river meets the land (Neslen, 2015). The extent of erosion can be seen in Shkodër both in the Buna river (Figure 7) and Drin river (Figure 8) represented by the grey area covered in gravel sedimentation.

In addition to exacerbating the effects of floods, erosion along the Buna River deteriorates the integrity of the soil layer at river margins by washing both the nutrient-rich topsoil and its base away (GIZ, 2015). Since each farm is only about 0.1 to 0.4 hectares, the loss of arable land is significant to individual farmers (personal communication, Adi Garuci, October 31 2018; personal communication, Valentin Gocaj, Nov 27 2018).

*Figure 7 (Top) - Satellite image from 07-21-2018 showing erosion (in grey) along the Buna river south of the city of Shkodra acquired through Modified Copernicus Sentinel data [2018]/Sentinel Hub (EO-Browser, 2018)*

*Figure 8 (Bottom) - Satellite image from 07-21-2018 showing erosion (in grey) along the Drin river east of the city of Shkodra acquired through Modified Copernicus Sentinel data [2018]/Sentinel Hub (EO-Browser, 2018)*

## D. Hydropower Plants and Dam Management

The construction of major hydropower plants and dams in Shkodër since the 1970s has also contributed to flood risk in the area. The three major hydropower plants in the Drin River are the Fierza (1978), Komani (1985), and Vau I Dejes (1971) dams with their respective power plants (Kesh, 2017). The Fierza dam, is located closest to the source of the Drin River and the Kosovo border. From there, the Drin flows to the Vau I Dejes dam where the river basin begins to empty to the sea. Shkodra is located slightly northwest of the Vau I Dejes dam. These three hydropower plants produce 95% of Albania's power, and excess energy provided by these dams is sold to neighboring countries (Sustainable Development Department, 2012).

The series of dams can help reduce the area flooded in severe events as they block river residues, especially gravel, and hold large amounts of water upstream. Conversely, mismanagement of the dams can increase flood risk. After analyzing heavy floods in 2010, experts concluded that dam operators of Vau I Dejes delayed opening the spill gates until the reservoirs were full and structural damage was imminent. This required operators to release a peak of approximately 3,500 cubic meters per second, more than seven times above the normal release of 500 cubic meters per second (IFRC, 2011).

*Drainage channels converging south of Dajc*

## E. Dykes and Drainage Channels

In the past, the network of dykes and drainage channels led farmers to think the land was safe for building and cultivation, but this same system of dykes and channels now contributes to flood risk. Farmers are expected to keep the drains clean and unobstructed, which has not proven to be a reliable maintenance strategy.

The control of water flow provided by the present dykes in Shkodër protects buildings in villages, such as Dajç and Shirq, during small scale yearly floods. On the contrary, every year, the village of Obot and the agricultural land in Urela, within Shirq, gets flooded from the overflow of the Buna River because these dykes limit the water run-off to other areas. In severe flood events, such as in 2010 and

2018, most dykes were overflowing with water into the normally protected areas and roads (personal communication, Sead Sadiku, October 29 2018).

Additionally, the farmland south of Dajç gets flooded frequently whenever the drainage channels are unable to drain the water fast enough. The small channels in this area converge into a single larger channel, which can provide a drainage capacity towards the Adriatic Sea of around 100 m3/s. When compared to the Buna River's overflow of up to 3500 m3/s at peak dam discharges, the current drainage capacity is far from sufficient. Studies have been done on increasing the performance of the channel network, but have concluded that it would require extensive land acquisition and a larger investment than the Shkodra municipality can afford (personal communication, Sead Sadiku, October 29 2018). The drainage channels were unsuccessful at reducing flood risk in severe events such as the floods of 2010 and 2018, and also in frequent events because of blockage from debris and lack of proper maintenance (personal communication, Sead Sadiku, October 29 2018). Although the local municipality also invested in cleaning the channels, farmers are expected to keep the drains clean and unobstructed in their land, which has proven not to be a reliable maintenance strategy (GIZ, 2015).

*Gravel pile from dredging by the Buna River*

## Recent Floods

The combination of these flood factors have caused catastrophic flood events as recently as 2010 and 2018, with flood waters covering the west side of Shkodra city and other villages, including Dajç, where the worst flooding occurred (personal communication, Sead Sadiku, October 29 2018). In the 2010 flood (Figure 9), approximately 14,500 people were evacuated from 4,800 houses that were either flooded or isolated. Additionally, the flood severely impacted agriculture land and livestock around the Buna River where 12,000 acres of cultivated land were flooded (GIZ, 2015) and 16,500 animals were evacuated (IFRC, 2011). The more recent flood of March 2018 resulted in approximately $3.5 million in damages from about 6,000 households in agricultural land (personal communication, Adi Garuci, October 31 2018).

Shkodër also faces annual floods that largely occur in farming villages such as Bërdicë, Shirq, and Obot, which are partially or completely covered every year, typically between the months of November to March (personal communication, Sead Sadiku, October 29 2018). These more frequent and severe floods (Figure 10) create an opportunity for flood risk management tools such as ecosystem-based adaptations.

*Figure 9 - Floods of 2010 (German Aerospace Center, 2010)*

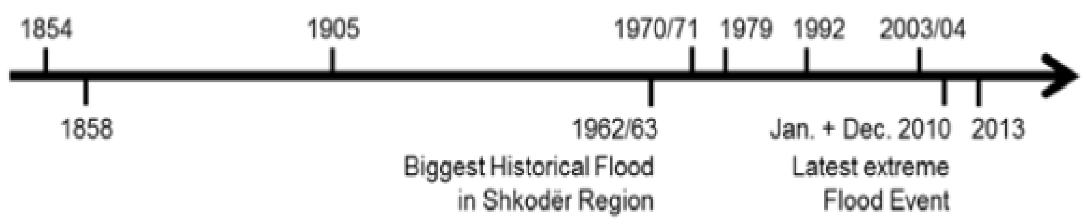



*Figure 10 - Timeline of Floods in Shkodër Region up to 2013 (GIZ, 2015)*

## Impact of Flooding on Agriculture

Floods affect the planting and harvesting cycle in numerous ways. Flood waters can wipe away newly planted seeds, which forces farmers to replant and delays harvesting. In addition, floods can destroy matured crops right before the harvest (Sustainable Development Department, 2012).

Flooding also decreases soil quality by mixing nutrient rich topsoil with the less nutrient-dense soils below it, hurting the soil quality post-flood (personal communication, Adi Garuci, October 31 2018). Saturated soil is soft since all of the pores within the soil contain water, causing weaker aggregates, which are structures within soil that provide pores that retain air and water. These structures fall apart from the impact of the water, allowing soil particles to be washed away by flood waters (Magdoff & van Es, 2012; National Soil Survey Center & USDA, 1996). When soils are waterlogged, oxygen is quickly depleted from the soil leading to multiple chemical reactions called redox that sequentially reduce other nutrients in the soil (De-Campos, Mamedov, & Huang, 2009). All of these factors influence crop yields.

*Waterlogged soil on farmland*

## Current Flood Risk Management Plan

In June 2015, the German international development agency, GIZ, published the Flood Risk Management Plan for the Shkodër Region, in collaboration with the municipality of Shkodër and other public sectors. GIZ is following the guidelines of the EU Flood Directive, with the goal to reduce the negative consequences of flooding on human health, the environment, cultural heritage, and economic activity (GIZ, 2015).

The plan considers both structural and nonstructural measures. Structural measures include the construction of flood defenses (i.e. dams and dykes), raising foundations of houses in floodplains, and the development of water permeable asphalt. Non-structural measures include the distribution and education of flood risk management materials, the implementation of flood warning systems, and the optimization of resource use, such as food, fuel and water (GIZ, 2015).

Since the plan was developed, GIZ has worked with measures such as spatial planning, preparedness, warning systems, and informational outreach (GIZ, 2015). As part of the Climate Change Adaptation and Transboundary Flood Risk Management project and adopting the EU Flood Directive, the Preliminary Flood Risk Assessment was concluded by GIZ in November 2018. GIZ is now pursuing Flood Hazard and Risk modeling (GIZ, 2018). Ecosystem-based adaptations (EbAs) have the potential to be added to GIZ’s flood risk management measures.

# Ecosystem-based Adaptations

## Understanding an Ecosystem-based Adaptation

EbAs harness the power of nature to adapt to harmful environmental fluctuations and work to protect the surrounding ecosystems. They can be used to reduce the risk of natural disasters. A fully functioning and healthy ecosystem is more resilient to stressors, such as floods (Munang, 2012). EbAs may reduce the effects of some floods, help mitigate flood risk and support quicker and more effective recovery from floods, but experts suggest that EbAs cannot help in the case of catastrophic events (personal communication, Sead Sadiku, October 29 2018).

| Rural EbAs | Description |
| --- | --- |
| Riparian Buffer | Plant vegetation along riverbanks to reduce peak flow, erosion, and sediment (Daigneault, 2016). |
| Upland Afforestation | Replanting and preserving forests to decrease soil moisture through transpiration. The roots of the trees also mitigate erosion of the shoreline (Daigneault, 2016). |
| Natural Water Retention Measures | Crop rotation along contours, or alternating a row of a specific crop with a row of grass, reducing soil erosion. (NRCS & USDA, n.d.)<br><br>Conversion of farmland into permanent grassland to reduce soil erosion. (Todorova, 2017) |
| Re-Naturalizing River Systems | Giving flood water a place to go along the river bank, such as backwaters and restoring floodplains (Geneletti, 2016). |
| Living Breakwaters | A system of living organisms that help slow the flow of water in a given area |

*Table 1 - Summary of rural EbAs*

## Rural EbA Examples and Case Studies

EbAs for farmlands include riparian buffer strips, upland afforestation, natural water retention measures, re-naturalizing river systems and living breakwaters (Table 1). Riparian buffers utilize vegetation along riverbanks to diminish and delay peak flow while reducing channel erosion, preventing runoff and increasing flow resistance as seen in Figure 11 (Todorova, 2017). There are multiple co-benefits to riparian buffers such as preventing pollutants from entering the rivers, providing habitat and persevering nutrient input into rivers and surrounding land. The most successful riparian buffers are composed of native grasses, forbs, shrubs and trees, and are implemented at wide scale. Re-planting these may be feasible around Shkodër farmlands (personal communication, Aurora Dibra, November 26 2018).

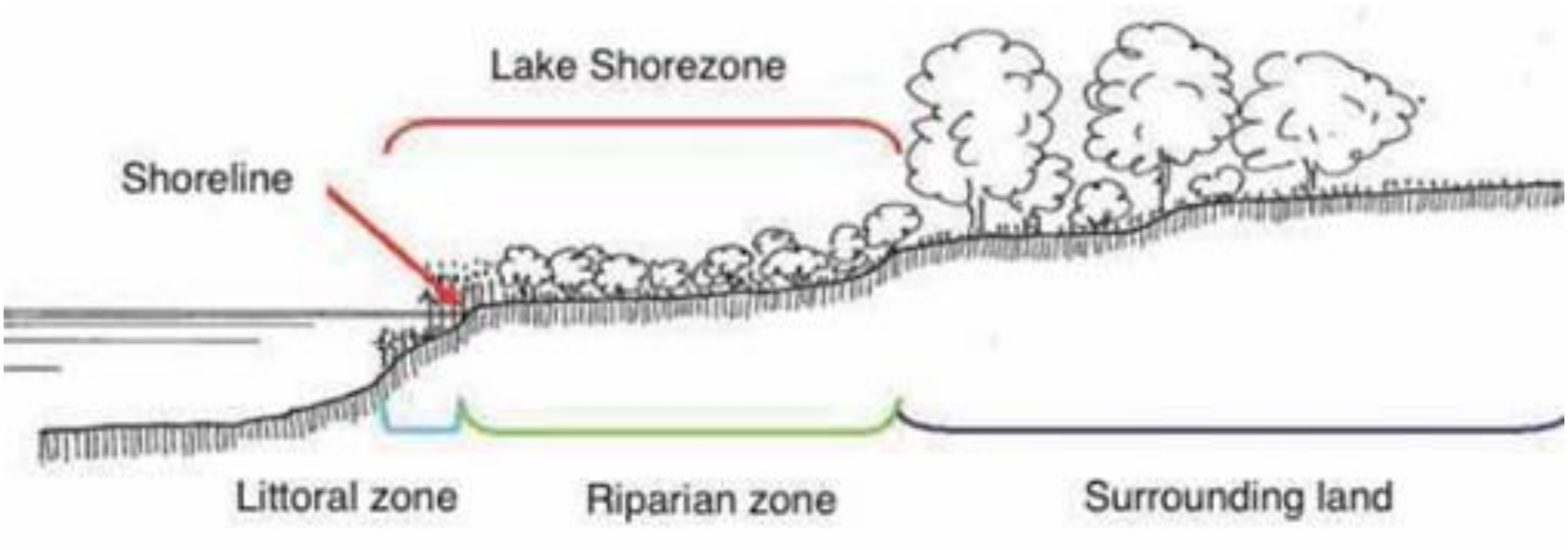



*Figure 11 Riparian Buffer Zone (GIZ & Zennaro, 2015, p.71)*

Upland afforestation reduces flash flooding, delays peak flows, decreases erosion, and reduces sediment loads through flow resistance and infiltration by replanting and preserving upland forests (Daigneault, 2016).

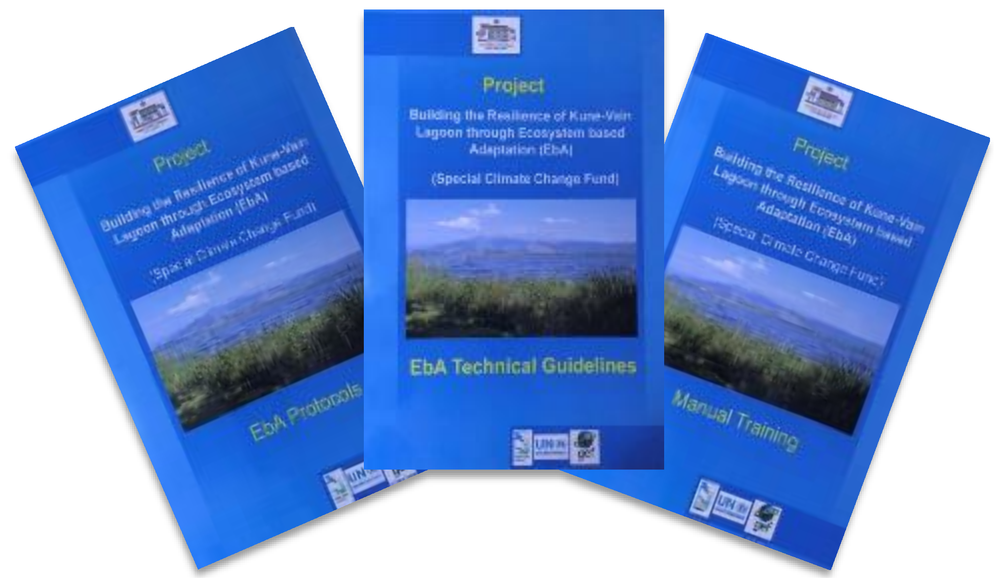
These methods share similar flood-reduction benefits. Plants absorb water through their roots and then emit water vapor through pores in their leaves, known as transpiration. Through this, upland forests are able to moderate soil moisture levels and dry the soil at depth. Vegetation roots also create stable structures for soil mantle and reduce erosion in the case of flooding (Daigneault, 2016).

Studies suggest that planting riparian buffers in agricultural areas affected by flooding is one of the most cost-effective EbA plans, to decrease flood risk but also to filter sediments and pollutants from the water. For example, a study conducted in Pennsylvania on 16 streams outlined that forested riparian buffer streams limited 200-800 times fewer pollutants (nitrogen) than non-forested streams (Chesapeake Bay Foundation, n.d.). However, upland afforestation provided the largest benefits overall. These two approaches provide benefits that are likely to increase as the climate changes (Daigneault, 2016).

In a similar study in Bulgaria, farmers reduced and stored runoff water by retaining it in catchments. EbAs, such as natural water retention measures, and conversion of arable land into permanent grassland helped to regulate surface runoff, enhance ecosystem resilience to climate change, improve biodiversity, and create carbon stocks all through implementation (Todorova, 2017).

A study along the Bear Creek watershed in Iowa suggested that multi-species riparian buffers increase soil stability and quality over time. Soil stability was measured in topsoil to calculate several indices such as mean weight diameter. Over approximately 20 years, soil structure was strengthened in order to reduce erosion, with improved soil quality over a longer period of time (Long, 2015).

EbAs are currently being considered more as an option to address extreme weather and climate change in Albania. The United Nations Environment Program (UNEP) is currently implementing the first EbA in Albania in the Kune-Vain Lagoon System. Jonathan McCue and the UNEP have developed EbA technical guidelines, protocols, and manual training suggestions to explain the steps and considerations involved in the implementation of an EbA specifically in Albania. However, they are still in the early stages of this project and do not know how successful or sustainable the EbA in the lagoon will be.




*Kune-Vain Lagoon EbA project books provided by John McCue*

## Co-benefits and Setbacks to EbA Implementation within a Rural Setting

EbAs can offer multiple co-benefits for mitigating flood risk, protecting livestock and crops, and alleviating poverty, such as

- **Climate change adaptation and mitigation**
- **Socio-economic development**
- **Environment protection and biodiversity conservation**
- **Contribution to sustainable economic development (Daigneault, 2016)**
- **Improvement of soil quality and nutrient preservation**
- **Limitation of pollutants entering from river runoffs (Garuci, 2018).**

There are, however, many limitations of EbAs. For example, reforestation and riparian buffers require a large amount of land use which can be costly and completely disruptive to the lives and livelihoods of stakeholders, particularly community members and local farmers. EbAs must also consider land ownership issues. Placing an EbA on private land is complicated in areas where it is not clear who owns the land. Gaining owners' approvals to place an EbA on their land can also be difficult. Placing an EbA on public land requires government approval. Once an EbA is in place, there needs to be a system of maintenance which may require personnel and ongoing funding for upkeep (Teli, 2018).

# Stakeholders

## Stakeholders' Role in Successful EbA Implementation

Promoting EbAs to combat the effects of flooding requires the active participation of policy-makers, scientists, and local community members. The three groups of stakeholders each provide their individual perspectives and contributions into creating a successful EbA. Simultaneously, they must cooperate in order to consider trade-offs and identify the best possibilities for EbAs concerning their type, location, impact, and process of implementation. The interaction between these stakeholders is depicted below in Figure 12.

## Policy Makers

There are many organizations and agencies that would hold a stake in the process of identifying, implementing, and maintaining EbAs. Outlined below are a few of the ministries, agencies, and municipalities that would be involved in EbA interventions.

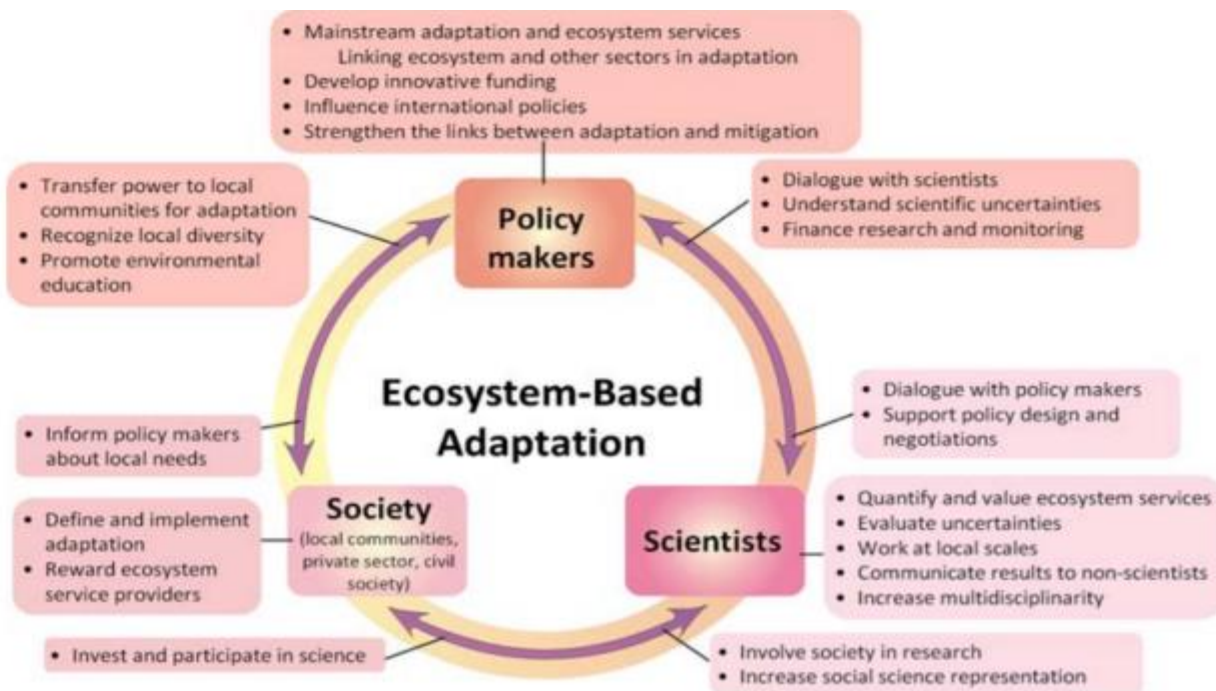



*Figure 12 - Key roles stakeholders play related to ecosystem-based adaptation*

### A. Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ)

Our sponsor GIZ has a unique position within the group of stakeholders. GIZ is focusing on the possibility of an EbA being integrated into the Shkodër region to mitigate flood risk. From an implementation standpoint, GIZ provides support to the municipality and other local actors, but does not as an organization implement EbAs. Coordination and management of implementation strategies are elements that GIZ would be involved with, along with providing knowledge and expertise.

### B. Central Government

Percentages of funds allocated to flood risk management come from the central government of Albania. The central government would collaborate with the municipal government in providing funds and developing implementation strategies.

### C. Municipal Government of Shkodër

The local government is involved in formulating policies and implementation strategies regarding EbAs. Within the municipality, there are offices such as spatial planning and finance that would be more heavily included in the implementation process.

### D. Communes

Small local government communes that regulate areas susceptible to floods such as the Dajç Commune cooperate with the municipal and central governments when addressing implementation and policies. Communes also govern locally and connect community members with rules and plans for implementation of an EbA.

### E. Ministry of Environment

Environmental regulation, sustainability, and protection of biodiversity are all concerns of the Ministry of Environment. Regarding an EbA, the ministry would be in charge of ensuring its cooperation with regulation and ecosystem.

### F. Ministry of Agriculture & Rural Development

EbAs catered towards reducing flood effects on agriculture would be regulated with involvement of the Ministry of Agriculture and Rural Development. They also have regulations in place concerning development, consumer protection and other subcategories of agriculture.

### G. National Territorial Planning Agency (NTPA)

The NTPA is involved with the land use planning aspect of an EbA. There are policies in place for use of the land, and also possible maintenance of it. Due to the large scale of some EbAs, the NTPA could be especially important in acquiring and planning land use for a specific parcel of land in flood prone areas in the Shkodër region.

## Society

### A. Farming Community

Many farmer livelihoods and their land are severely impacted by frequent and catastrophic flooding. Specifically, agriculture and crops can be damaged by the floods, which in turn inhibits productive agriculture and ability for farmers to make a living. EbAs also may be placed or have a direct effect on agricultural land, therefore the consent and perspective of farmers is crucial to consider.

### B. Other Residents in Flood Prone Areas

Many people in the Shkodër region live in rural areas that are affected by flooding. Although many households are protected by hard infrastructures, excessive rainfall and floods are impactful in ways such as making transportation more difficult or contaminating drinking water. The installation of EbAs would theoretically help these residents, but similar to the farming community, their consent and perspective is necessary to be evaluated

## Scientists

### A. Ecologists and Environmentalists

The design and planning of an EbA involves many environmental considerations such as interaction with the current ecosystem. EbAs offer certain ecological benefits that help the surrounding areas. Ecologists and environmentalists are adept in identifying benefits and communicating them with respect to floods, biodiversity, and agriculture.

### B. Hydrologists

Understanding hydrology and impacts on floods on the topography of the region are necessary in developing a functional EbA. Hydrologists provide valuable information on how hydrological systems and flooding affect land use, and they can provide technical expertise on the effectiveness and feasibility of an EbA.

# Methods

*Objective 1 - Understand flood hazard in the Shkodër region based on the hydrology and present infrastructure*

*Objective 2 - Understand how flooding affects the livelihoods of the local farming community and how they have tried do reduce flood impacts*

*Objective 3 - Select EbAs at two locations based on flood risk characteristics and key informant feedback*

*Interview with farmer Ismet Ueliuietaj*

*from Shiq*

# METHODS

The goal of our project was to identify and explore the tradeoffs of two EbA proposals aimed at reducing the impacts of flooding on agriculture in the Shkodër region. We gained an understanding of how the hydrology and present infrastructure in the Shkodër region contribute to flood risks. We learned about the impacts of flooding on the farming community by conducting semi-structured interviews with a rural planner and farmers in the Shkodër region. Subsequently, we developed two EbA proposals. We based their location on GIS maps and satellite data, and considered the location of hard infrastructure such as dykes and levees. We determined the kind of EbA based on our background research to address the ways floods were impacting agriculture. We then received feedback from scientists, government officials, and farmers for these EbAs. Outlined below are our objectives with their corresponding methods and how we worked to achieve our overall goal.

# Objective 1 - Understand flood hazard in the Shkodër region based on the hydrology and present infrastructure

This objective allowed us to better understand why flooding occurs in the region. This knowledge helped us later when we selected EbAs for the region, since we were better able to choose EbAs that would work with Shkodër's hydrology and present infrastructure.

## Key Informant Interview with GIZ

We interviewed Merita Mansaku-Meksi, GIZ Deputy Team Leader for the Climate Change Adaptation in Transboundary Flood Risk Management, Western Balkans project, and Fationa Sinojmeri, the Junior Technical Advisor for the project. This purpose of this interview was to better understand the following:

- Why floods occur in Shkodër and the neighboring countries involved in the Drin and Buna River Basins,
- The capacities of the Buna, Drin, and Kir Rivers, and Lake Shkodra.
- How the hydropower plants have affected flood risk.
- The current steps GIZ is taking to address flood risk.

GIZ has been working to assess flood risk in the Drin River Basin the past few years by working on the preliminary flood risk assessment for their Climate Change Adaptation in the Western Balkans project (Bodenbender, 2017).

## Key Informant Interview and Observational Walk with Hydrologist

In the interview with Sead Sadiku, hydrologist and specialist in the Drin and Buna River basins, we sought to learn more about the relationship between flood risk, hydrology, and present infrastructure in and around the Buna and Drin Rivers. Our questions focused on how close houses and farms are to the river, and how quickly the water rises in each area during the rainy season as he showed us specific areas along the Buna River.


*Sead Sadiku (Hydrologist)- Darragjat*

# Objective 2 - Understand how flooding affects the livelihoods of the local farming community and how they have tried do reduce flood impacts

Through interviews, we sought to understand how floods have affected local farmers and to consider what types of EbA would be appropriate, acceptable, and reduce the effects of flooding on agricultural land.

## Semi-structured Interview with a Shkodra Municipality Rural Planner

We interviewed rural planner, Adi Garuci from the Shkodra Municipality to understand how rural land is used specifically for agricultural practices. He provided us with maps of the region and detailed information to better understand the spatial extent and associated damages from flooding.

*Lukaj Ernest (Agronomist) -Dajç*

*Ismet Ueliuietaj (Farmer)-Shirq*

*Valentin Gocaj (Agronomist)-Oblike*

## Interview and On-site Agricultural Observation with Flood-affected Farmers

We interviewed farmers from flood-prone villages to understand the effects floods have on their crops and soil, how they prepare for flooding, and how flooding affects their farming practices. The farmers included Ismet Ueliuietaj from Shirq, agronomist Valentin Gocaj from Oblike, and agronomist M. Lukaj Ernest from the Dajç Administrative Unit. These interviews, translated by Albanian students, allowed the farmers to explain their experiences with flooding, what they believe is causing the flooding, what they feel needs to be done in order to help prevent their land from being flooded out again, or to at least lessen the harmful effects that the floods have on their land. Farmers were selected through snowball sampling. Adi Garuci provided contact information of farmers from the selected possible EbA locations. On-site interviews with these farmers located in the areas that had been affected by flooding also allowed us to understand more specifically how the land is being used and which crops are being planted.

## Observation of Workshop with Key Informants on International Collaboration for Transboundary Flood Risk Assessment and Management

We attended the "Preliminary Flood Risk Assessment in the Drin/Drim - Buna/Bojana River Basin 2nd Workshop of the Technical Working Group Shkodra, 7-8 November 2018" in Shkodër, Albania, considering the international collaboration between Kosovo, Macedonia, Montenegro, and Albania affected by flooding from the Drin and Buna River Basins. We attended to learn about the current measures that are being taken regionally to reduce flood risk and how the flood risk is being assessed.

*"Preliminary Flood Risk Assessment in the Drin/Drim - Buna/Bojana River Basin 2nd Workshop of the Technical Working Group Shkodra, 7-8 November 2018" in Shkodër, Albania*

# Objective 3 - Select EbAs at two locations based on flood risk characteristics and key informant feedback

We identified two EbA options and specific locations with the goal of effectively reducing the effects of flooding in the Shkodër region. We evaluated the EbA selections with a combination of hydrological, ecological, political and socio-economic perspectives, focused on the feasibility and effectiveness of such propositions on reducing the risks of floods to agriculture.

*Mirela Isufi (Ecologist)- Dajç*

## Semi-structured interviews with key informants to devise EbA solutions

We returned to the field to ask key informants such as the rural planner, hydrologist, ecology professor, and farmers for their suggestions for EbA options. Below is a list of these informants and how their perspective would contribute to the selection of EbAs:

- **Rural Planner for the Shkodra Municipality (Adi Garuci) -** EbAs with respect to governmental planning feasibility
- **Hydrologist (Sead Sadiku) -** EbAs with respect to combating excess water from floods
- **Ecology Professor of the University of Shkodra (Aurora Dibra) -** EbAs with respect to preserving biodiversity affected by floods
- **Farmers (M. Lukaj Ernest, Ismet Ueliuietaj, and Valentin Gocaj) -** EbAs with respect to strengthening agriculture, reducing impact of floods, and possible

## Field assessment with EbA specialist at the Kune-Vain Lagoon Project

The Kune Vain Lagoon Project is located in Lezhë, Albania just south of Shkodër. The goal of the project is to build the resilience of the lagoon with use of EbAs. We attended this project with key informant Jonathan McCue, Managing Director at Sustainable Seas Ltd, who was contracted by the United Nations for knowledge concerning EbAs in coastal margins. The purpose was to learn about other EbA projects in Albania regarding what types of vegetation to use, who is involved in implementation, and how the EbA mitigate flood risk in order to help devise EbA options specifically for the Shkodër region.

## Creation of maps representing EbA scenarios

We used previously acquired GIS maps in order to evaluate EbA locations with respect to current land use, land cover, agriculture, extent of past flooding, and other variables. We then generated our own maps displaying the proposed EbA locations. We downloaded satellite images from the Sentinel-Hub and highlighted the EbA areas and shape using Adobe Photoshop. The purpose of these maps was to clearly communicate our propositions to gain key informant feedback and specific information for the select locations later on.

## Feedback interviews with hydrologist, urban and rural planner, an ecology professor and farmers

To gain key informant feedback on EbA options as possible flood risk management measures, we presented digital or hard copy maps of different locations, with each proposed EbA solution drawn out in a highlighted area. We also included a digital or printed table with descriptions of numerous EbAs. The purpose of these materials was to both explain the concept of an EbA, but also show specific types of EbAs, where they could be placed, and how they can help manage the flood risk to agricultural land that is flooded annually. For each key informant, we explained the maps and EbAs and then asked them for their feedback, concerns, and recommendations on the EbAs, locations, and implementation strategy. Each key informant addressed a different topic when they provided feedback, as seen on the right.

- **Hydrologist (Sead Sadiku) -** How each EbA solution would be affected by the volume and flow rate of the river, along with how effective they would be in combating the issue they would address.
- **Urban (Rasel Teli) and Rural (Adi Garuci) Municipality Planners -** The perspective of the municipal government on implementing, maintaining and funding each EbA, along with identifying the most appropriate and opportunistic times to implement them.
- **Ecology Professor of the University of Shkodra (Aurora Dibra) -** The state of previous and current ecosystems of the proposed location, the impact each EbA could potentially have in such ecosystems and agriculture, along with assessing the long-term effects and survivability of each EbA from an ecological perspective.
- **Farmers (M. Lukaj Ernest, Ismet Ueliuietaj, and Valentin Gocaj) -** The positive and negative effects of each EbA on agriculture and its flood-affected community, along with how they perceived these tradeoffs and what are other possible considerations and restrictions they identified.

## Data analysis and triangulation of maps, interview transcripts and write-ups, photo documentation, and case studies to evaluate EbA solutions

The main purpose of this method was to evaluate our EbA proposals across several criteria, as a project deliverable, in addition to validating and enriching our background and contextual knowledge behind the design of EbAs. The outputs of this method were two case studies, where we proposed specific EbAs and determined their locations, along with suggested vegetation and implementation strategies. Furthermore, we assessed some of the political, socioeconomic and technical limitations to the success of the EbA measures. The data points from the background and previous methods that we used in this process are as followed:

**Data Input**

- GIS maps of land cover and building density
- Satellite maps of river basins, flood events, and vegetation indexes
- GIZ Flood Preliminary Flood Risk Assessment maps and fact sheets
- Regulatory plan for the Shkodra Municipality
- Hydrologist interview write-up
- Urban planner interview write-up
- Rural planner interview write-up
- Ecology Professor interview transcript
- Farming community interview transcript
- Consultation of EbA implementation in the Kune-Vain Lagoon
- Photo documentation of hydrological walk and farmland observation

| Risk assessment/ significance of risks to farming related to hazard addressed | Sociopolitical challenges and opportunities | Effect of adaptation to the flood hazard | Co-benefits to managing flood risk |
|---|---|---|---|
| Extension and duration of flooding in the housing and agriculture area | Land use and ownership | Projected climate change effects on flood hazard without adaptation | Other hazards affected by the adaptation |
| Critical damage to the housing area and the community | Stakeholders that would be involved | Long-term effectiveness of adaptation | Environmental co-benefits |
| Number of farmers and other people affected | Local community acceptance factors | Best case effect on hazard and likelihood | Socio Economic co-benefit |
| Economical damage to crops and livestock | Possible funding opportunities | Worst case effect on hazard and likelihood | |
| Socioeconomic status of affected population and recovery capability | Related projects and possible collaborations | | |
| Damage to soil and arable land | | | |
| Water contamination related to flooding | | | |
| Frequency and trends of floods | | | |

*Table 2 – Evaluation Criteria for EbAs*

**Evaluation Criteria**

These criteria were a starting point for us to develop principles for defining the location and design of the EbAs. We based these criteria for evaluating flood risk management measures on the EU Flood Directive (EU and Council, 2007) and on GIZ's work on the Preliminary Flood Risk Assessment for the Drin/Drim - Buna/Bojana River Basin. Additionally, we identified specific criteria for EbAs that we evaluated with use of our key informants' expertise and our background research on EbA case studies.

# Findings

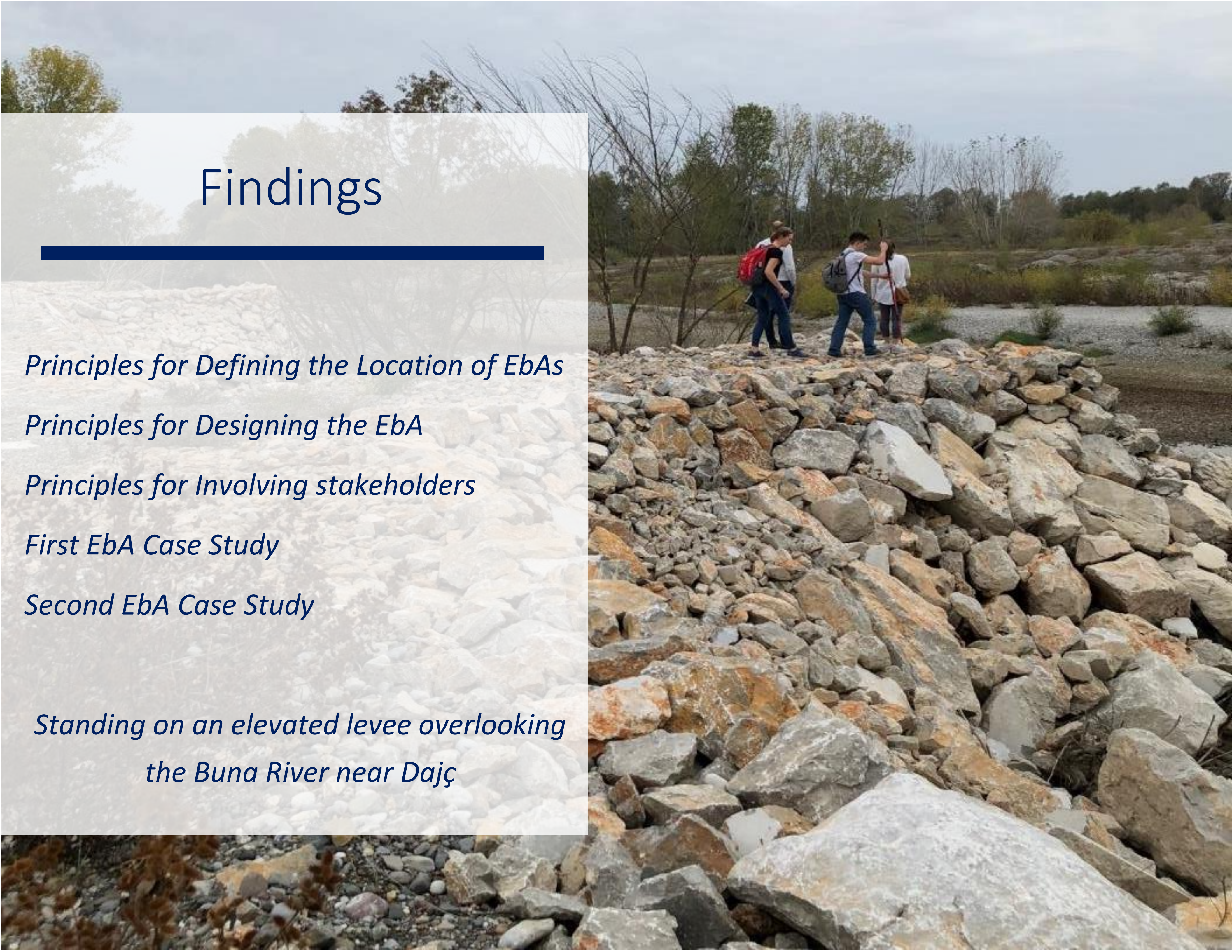
*Principles for Defining the Location of EbAs*

*Principles for Designing the EbA*

*Principles for Involving stakeholders*

*First EbA Case Study*

*Second EbA Case Study*



*Standing on an elevated levee overlooking the Buna River near Dajç*

# FINDINGS

In this chapter we first discuss the principles we used for choosing an EbA. These include the principles for defining the location of the EbA, designing the EbA, and involving stakeholders. In all three principles, we assess the benefits and challenges surrounding each EbA specifically in Shkodër. We then discuss in detail how such trade-offs are likely to influence the type, location and implementation of the EbA and its acceptability to various stakeholders. We utilized all three principles to explain our choices and reasoning behind developing the two EbA case studies proposed below.

## Principles for Defining the Location of EbAs

### Identifying Areas Prone to Seasonal Floods

The Shkodër region suffers from both yearly floods and catastrophic flooding, as shown by our key informant interviews and background research. GIZ is continuously developing flood hazard and risk maps which clarify the extent of the hazard in different locations in Shkodër (personal communication, Merita Mansaku-Meksi, October 23 2018). We also utilized updated satellite images to view more recent flooding events. Images from the Sentinel 2 satellite, starting in 2015, are publicly available for the Shkodër region from the Modified Copernicus Sentinel data [2018]/Sentinel Hub. Lastly, to expand on the local perspective of flood hazard in specific locations, we consulted hydrologist from the local government, Sead Sadiku, as well as affected farmers.

## Minimizing the Negative Impact on the Agriculture Community

The agriculture of the Shkodër region, as we learned from municipality rural planner Adi Garuci, is critical for the livelihoods of the local population. Although the main purpose of EbAs is to reduce flood risk, Garuci and the local farmers defend that they must be implemented with minimal impact to the local communities. When it comes to defining the possible locations for an EbA, it is important for the EbA implementer to consider the current occupation, ownership, and use of the land.

Garuci provided GIS maps of land cover (Figure 3) and of building distribution (Figure 4) which contain information about the distribution of agricultural land, pastures, vegetation, and urban buildings. Although these maps are updated, Garuci explained that they lack detailed information on what locals cultivate in each of the small parcels of land and where there might be illegal and still unregistered buildings.

These land use and occupation issues constrain the ability to clearly define the intervention area for EbAs in this region. The GIS maps may not show all available land due to farmers no longer cultivating certain areas of farmland anymore. Alternatively, areas that may seem adequate for an EbA because they do not have any houses or urban occupation according to the GIS maps, might have unregistered illegal constructions that are eligible for regularization according to new municipality law (personal communication, Rasel Teli, October 30, 2018). In order to get accurate and new information, one can also utilize satellite images from Modified Copernicus Sentinel data [2018]/Sentinel Hub in combination with field assessments.

One of the main negative consequences that EbAs can cause in Shkodër is forcing the relocation of farmers from their houses and land. This becomes problematic when EbAs require private land to be obtained from local residents and farmers. As mentioned previously and according to Garuci, most farmers in Shkodër have small parcels of land, which according to Ernest, families divide even further between family members. On top of that, many of these farming families that have been in the region for decades do not bring their crop and livestock produce to market. Instead, they focus on self-sustainability within their families and villages (personal communication, Adi Garuci, October 31, 2018). This characteristic makes these farmers vulnerable to interventions, such as EbAs, that can overtake their land. Even if the EbAs does not affect their houses, losing agricultural land can still be enough of an impact to force them to relocate to other land or even abandon their agricultural livelihood as a whole (personal communication, Adi Garuci, October 31, 2018). Although many locals are leaving their lands because of flooding, others prefer to stay and accept the limitations of adapting to the risk. Furthermore, the majority of the population leaving is young, while the elderly stay in Shkodër (personal communication, Valentin Gocaj, Nov 27, 2018). According to Garuci, “this EbA can’t force them to just move out of the land and find a new career somewhere else, they will be unemployed”.

Due to the potential negative social impact of EbAs located on private land, urban planner Rasel Teli and rural planner Adi Garuci suggest that the plans should constrain the EbAs to public land instead. However, Teli, Sadiku, and Garuci claimed that the public land is very limited in the region. Furthermore, Garuci explained that the municipality either does not possess or is not willing to share updated maps of the public land in the study area. Overall, limiting the scale of an EbA to public land would also limit its scale, which is a tradeoff to be considered when identifying potential EbA locations.

## Identifying Areas Where EbAs Can Compliment Hard Infrastructure

The presence of large trees and similar vegetation is known to potentially damage channels and dykes with its roots, according to Sadiku. He described that appropriate reforestation practices do not allow any trees to be planted within five meters of dykes or channels. EbA specialist for the UN John McCue explained that, although hard flood risk management infrastructure limits the extent of EbAs that involve reforestation, both strategies are effective at reducing flood risk when combined.

As described in our background, the purpose of the considered EbAs is related to preserving the ecosystem in order to improve its resilience to floods. Sadiku claimed that they can be a valuable addition to hard infrastructure that focuses on controlling the flow of flood water, such as dykes and channels. He concluded that there are opportunities and challenges with placing EbAs near hard infrastructure, and this is an important consideration for identifying potential locations for them.

# Principles for Designing EbAs

## Understanding Flood Risk Characteristics

The three farmers that we interviewed experienced extensive losses due to flooding. Their expertise on local characteristics of flood risk was critical to support the design of the EbAs that can address these issues. Ismet Ueliuietaj, a farmer from Shirq, described how his crops are flooded and damaged every year. He explained that the water washes away his plants and seeds, forcing him to invest in replanting after the floods are over. He further claimed that these floods occur due to the large volume of water that comes from dam discharges and stays on his land for up to a month due to the lack of effective drainage. The discussion on how the drainage system can be ineffective at reducing flood risk in the background section supports Ueliuietaj's claim.

In addition to crop damage, flood-prone areas are susceptible to increased runoff carrying sediment and waste such as synthetic fertilizers, which can pollute the water and soil. Ueliuietaj noted that farmers "use chemical things but are not really effective because the ground is getting poorer and poorer every day". According to Garuci, when flood or rainwater flows over agriculture topsoil, it washes away these fertilizers and causes severe water contamination with increased nitrates, including drinking water in wells. Valentin Gocaj, an agronomist in Oblikë e Madhe and Obot with 47 years of experience, stated that the spread of pollutants across the soil prolongs the damages to arable land.

*Figure 13 – Satellite images with Normalized Difference Vegetation Index filter (NDVI) showing the effects of flooding in the vegetation in the study area in 04-20-2018, after the severe floods of the previous month (Sentinel-Hub, 2018)*

According to Ernest and Garuci, farmland that is prone to long term pooling effects takes longer to recover due to decreased concentration of important nutrients in the topsoil and increased levels of groundwater. Sadiku explained that often both flood and rain water infiltrate the soil at faster rates than it runs off, as most of the land has no significant slope. Garuci claimed that the increased groundwater further contributes to the lack of soil oxygenation. He concludes that this makes the soil less adequate for agriculture after floods and allows for other vegetation to grow instead (Magdoff & van Es, 2012; National Soil Survey Center & USDA, 1996; De-Campos, Mamedov, & Huang, 2009). Satellite images acquired from Modified Copernicus Sentinel data [2018]/Sentinel Hub that highlight different vegetation through the Normalized Difference Vegetation Index (NDVI) (Figure 13) indicate the impact of the flooding on the soil. Soon after flooding, one can see a lighter green shade where the water covered the land for the longest amount of time. Through the next months, the same areas transition to a dark green shade on the same maps. According to Garuci, this shows the soil in this area after floods is not ideal for crop growth but rather other natural vegetation. He explained that the floods wash away the nutrients in the topsoil and increases the concentration of groundwater. This prevents vegetation to grow in the first few weeks, hence the light green color. Later on, the modified soil characteristics still inhibit agricultural practices but promote natural dense vegetation to take over these areas, visible by the dark green (personal communication, Adi Garuci, October 31 2018). The soil returns to its normal characteristics within months but this issue ultimately interrupts and delays agricultural cycles, decreasing annual crop yields (personal communication, Adi Garuci, October 31 2018; personal communication, Valentin Gocaj, Nov 27 2018; personal communication, M. Lukaj Ernest, November 27 2018; personal communication, Ismet Ueliuietaj, November 9 2018). Ismet also claimed that the quality of the soil in his land is also decreasing over the last years, showing that there are negative long-term effects of yearly flooding to the soil quality beyond annual cycles.

Despite evidence concerning the negative impacts of floods, there are also reasons to believe that flooding has several positive impacts on the Shkodër region. According to Garuci, excessive flooding can bring nutrients and minerals from the northern mountains down to arable land in the region. Gocaj however also suggested that the major hydropower plants along the Drin River may filter out these minerals from reaching and replenishing arable land. Additionally, flooding distributes nutrients to water sources and wetland areas to support healthy biodiversity and can aid in supporting fish and other aquatic organisms (Donald, 2017).

## Identifying EbAs that Minimize Flood Impacts on Agriculture

The process for designing EbAs for Shkodër was focused on identifying options that catered to the possible locations and addressed the previously described flood risk characteristics. We combined our knowledge from literature research with key informant expertise and suggestions on EbAs. According to Garuci, EbAs have the potential to reduce fertilizer pollution runoff through vegetation absorption of the extra nitrates from the top soil. This is supported by studies that have noted how riparian buffers filter sediment and waste. Furthermore, McCue believes that EbAs involving reforestation that use large rooted trees can significantly help absorb excess groundwater from the surrounding soil, thus assisting in its recovery after a flood.

*Flood of December 2010 (NATO, 2010)*

## Selecting the Vegetation for the EbAs

Ecologist Aurora Dibra mentioned specific types of vegetation that are better at absorption of water than others. Some of her suggestions to strengthen soil in flood conditions were the Fraxinus ornus (Manna Ash) and Quercus robur (English Oak). We analyzed what the specific vegetation for an EbA would be in the design process after deciding the type of EbAs to propose.

*Truck transporting gravel taken from the Buna RIver*

## Anticipating Challenges for Implementing and Sustaining the EbAs

The land ownership system is poorly regulated in Shkodër and the local municipality only has organized data on one of the two different document systems that are still valid (personal communication, Rasel Teli, October 30, 2018). The lack of clear land ownership is expected to be especially problematic when implementing EbAs. Currently, when locals contest ownership of a segment of land, it can take more than an year for the government to officially recognize the owner because multiple people usually claim rightful ownership based on different documents or stories of how their families have been farming there for decades or even centuries (personal communication, Rasel Teli, October 30, 2018; personal communication, Adi Garuci, October 31, 2018; personal communication, Ismet Ueliuietaj, November 9, 2018). Until the municipality effectively addresses this issue, it presents a challenge for implementing EbAs on land that is not confirmed to be public. If the EbA implementer decides to acquire land, the implementation process can be delayed until the land owner(s) are identified and agree to sell it. According to our sources, it is also possible that the local or central government can force the land acquisition without the owner's consent.

According to adequate reforestation practices and in order to have the EbA sustain through floods during its implementation and growth period, the trees need to be planted as saplings that are at least five years of age. Additionally, to promote biodiversity and sustainability, a combination of two to three species of large trees is strongly recommended (personal communication, Aurora Dibra, November 26 2018). The necessary acquisition and transport of the saplings of different species to the proposed locations will inevitably pose logistical challenges, which will also add to the implementation cost of the project.

Waste and other water-carried pollutants are also likely to affect the EbAs (personal communication, Aurora Dibra, November 26 2018). To promote the sustainability of the EbAs, adequate monitoring and maintenance will be necessary, which can be costly and challenging, especially if the EbAs are implemented on private land and farmers are expected to collaborate. As seen with the maintenance of drainage channels in the past, depending on the local community with such tasks was not an effective strategy (GIZ, 2015). Additionally, the land ownership irregularity in Shkodër creates difficulties with defining who is responsible for maintaining the EbAs (personal communication, Rasel Teli, October 30, 2018).

# Principles for Involving Stakeholders

## Soliciting the Views of Stakeholders

If our EbA proposals are eventually implemented, it is important for the future implementer, such as the Shkodra Municipality, to involve local stakeholders to provide their individual perspectives and contributions to create a successful EbA. As we discussed in the background chapter, these policy makers, farmers, and scientists must cooperate in order to consider trade-offs and identify the best possibilities for EbAs. Ueliuietaj, Gocaj, and Garuci emphasized that farmers have not been involved or consulted with in past flood risk management measures. The farmers' perspectives can be utilized by EbA implementers for suggestions and key insights on the successes and limitations of EbAs specific to the region.

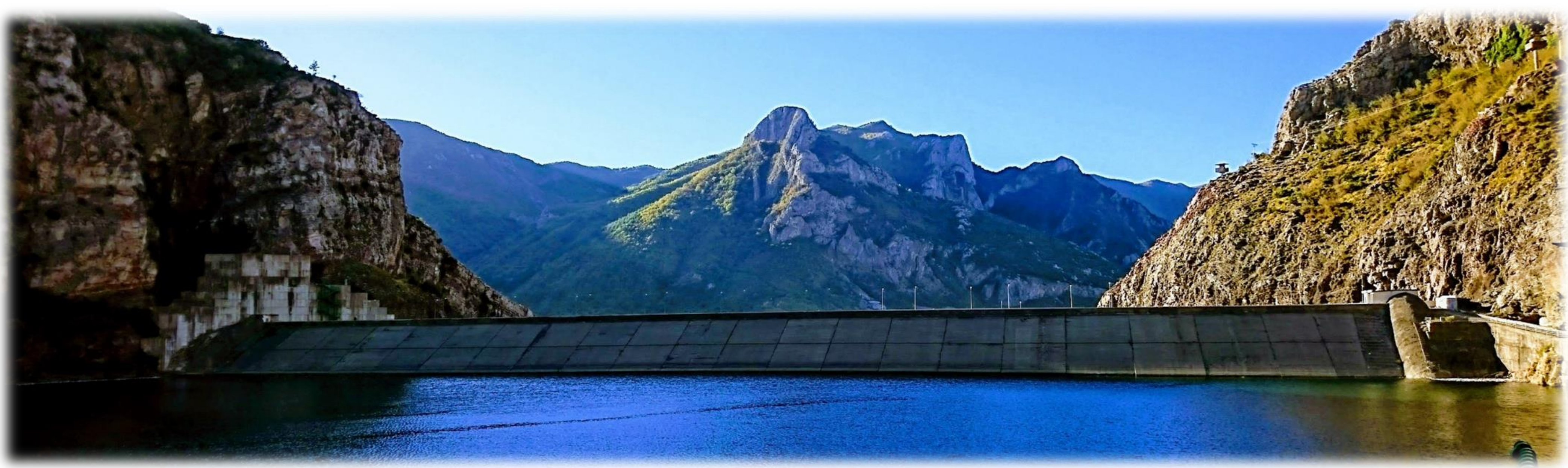
## Considering Stakeholders' Perceptions towards EbAs

When we interviewed stakeholders from the various stakeholder groups, we received feedback on why they thought an EbA would or would not work in the Shkodër region. Their feedback helped us to refine our EbA selections and allowed us to gauge their reaction before an EbA is implemented.

While we received negative opinions towards EbAs in Shkodër, some stakeholders did like the idea of an EbA because of its potential benefits. Ecologists Isufi and Dibra believed an EbA could be beneficial due to the positive impacts it would have on the ecosystems. They supported the idea of an EbA because it would, in theory, provide habitats for native bird species and other flora and fauna and would start to restore the vegetation lost from deforestation, and prevent erosion. In relation to wetland reforestation, Isufi commented on the potential benefits to the ecosystem: “Maybe we will have the regeneration of species. It's like a chain, we stop flooding and then the chain goes towards regeneration”. In comparison to other structural measures, EbAs in this region have the potential to restore previous vegetation that was damaged by human intervention, and thus restore natural habitats, filter sediment, improve water quality and control erosion.

## Skepticism towards the Success of EbAs due to Alleged Dam Mismanagement

One common concern we encountered was alleged dam mismanagement. Most stakeholders we interviewed claimed that dam mismanagement has created more severe flooding in the region. According to a key informant, hydropower reservoirs should ideally be half full by the end of winter in February/March to accommodate for anticipated seasonal snowmelt and rainfall. Additionally, in February of 2018 water levels of the dam were above the appropriate safe limit to maximize the energy output for the turbines in order to produce higher revenues. This same informant also explained that to manage the volume of water effectively, the water should have been periodically released through the spill gates throughout the winter. This led to an emergency situation in March of 2018. When the dams became full from the snowmelt, the spill gates had to be fully released with little to no flood warning. These informants do not believe that developing an EbA will solve the flood risk issues within their region. In two of our interviews, the informants stated that spending time and money on an EbA would be a waste unless the dams were better managed to prevent extreme floods like the 2010 and 2018 events. One of our key informants stated that the dam managers "haven't controlled the come and go of the water from the mountains and the rivers have gone out of their beds, so this is the reason why the villages are flooded and has caused a lot of damage and broken houses". One key informant noted that "they don't get flooded by the rain or by the river; it's just the water that comes from (the) hydropower that gets put down". These claims about dam management provide one example of the pushback and resistance that a future EbA implementer will encounter in Shkodër.



## Farmers Have Adapted Their Practices to Reduce Flood Risk without the Intervention of an EbA

Due to frequent and anticipated floods, farmers have learned to adapt their practices to address the flood risk. They converted arable fields to pastures or natural vegetation and altered their cultivation patterns due to the recent flooding events (personal communication, Ernest, November 27, 2018; personal communication, Valentin Gocaj, November 27 2018). According to Gocaj, many farmers have changed their crop cycles by planting in the middle of the spring and harvesting by the end of November because they anticipate seasonal flooding in the fall and in the end of winter. This adaptation, however, only allows for one crop cycle per year. (personal communication, Valentin Gocaj, November 27 2018; personal communication, Ismet Ueliuietaj, November 9 2018). Overall, however, the bravery and adaptability of some locals to floods pose a challenge to justifying the need for EbAs in the study area.

## Clearly Communicating with Stakeholders

We developed two forms of media that could help communicate key information about EbAs: a brochure and a short video. The brochure describes our EbA case studies, the definition of an EbA, and their benefits and limitations (Appendix C). The short video also mentions the potential benefits and limitations of EbAs (Appendix D). These forms of media allow the viewer to achieve a general understanding of the concept in a short amount of time.

Another method for communicating with stakeholders is through workshops which we saw in the Kune-Vain Lagoon System EbA project. The UNEP ran a series of three workshops for local municipality, community organizations, and NGOs. Two of these workshops covered the theory and reasoning behind an EbA, while the third workshop involved a field day where these community members saw where the EbA would go and how the vegetation would be planted. This series allowed local stakeholders to gain a better understanding of EbAs.

## First EbA Case Study

### A Riparian Buffer Located Along the Buna River in Obot and Shirq

| Location | Obot and Shirq |
|---|---|
| Size | Surface Area: 2.1 km$^2$<br>Length: 4 km<br>Width: 100-700 m |
| Type | Riparian Buffer |
| Plant Species | Fraxinus ornus, Carpinus betulus, Populus alba, Populus canadensis, Salix caprea, Salix alba, and Quercus robur |

*Table 3 – Location and design details of first EbA Case Study*

The first section of the EbA will be placed south-east of Obot i Vjete along the Buna River bend. The second section of the EbA is located in Urela, north of Shirq and southwest of Flusha along the opposite bend of the Buna River. These locations can be seen highlighted in red on the maps (Figure 14) and some of its details are in Table 3.

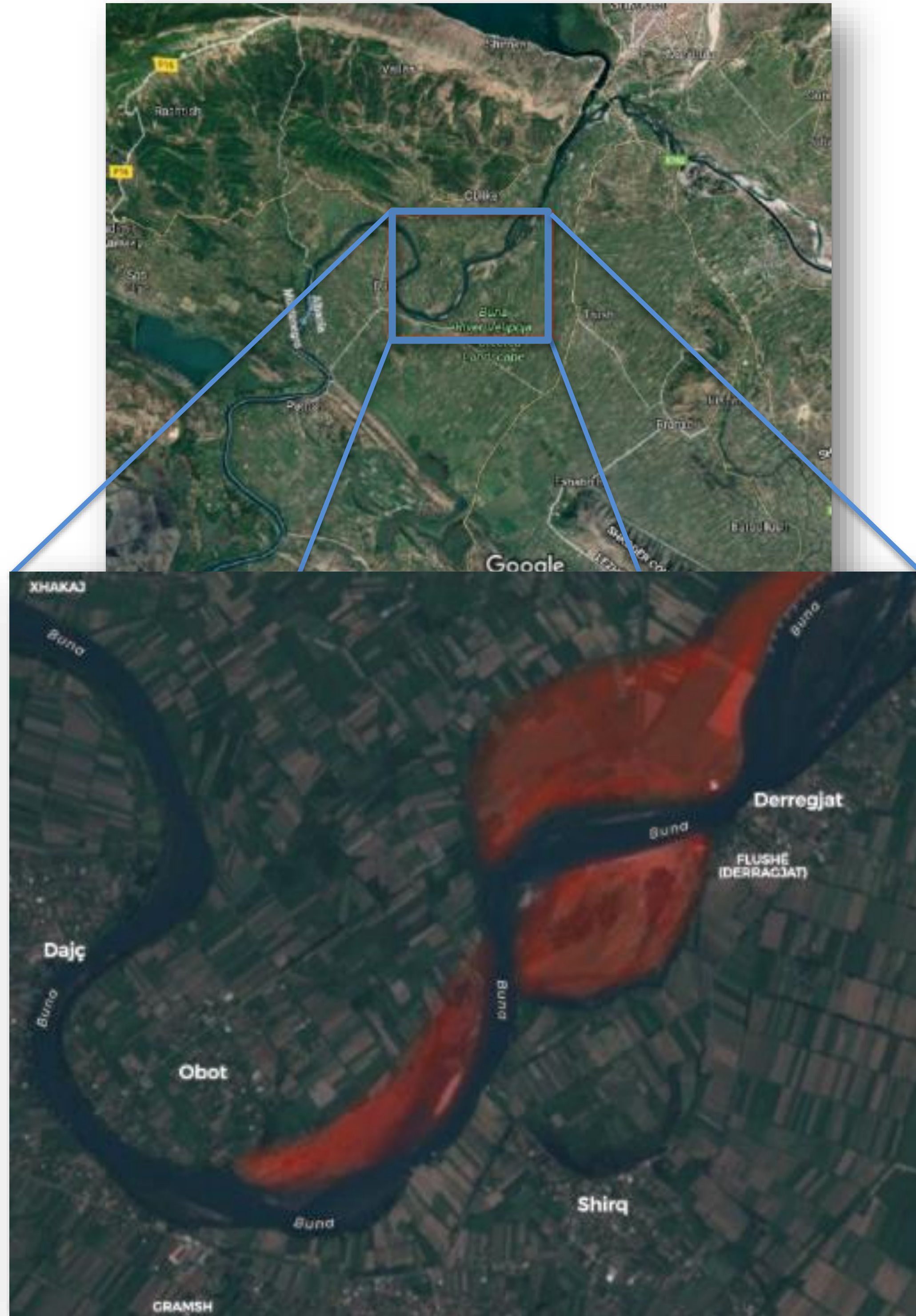


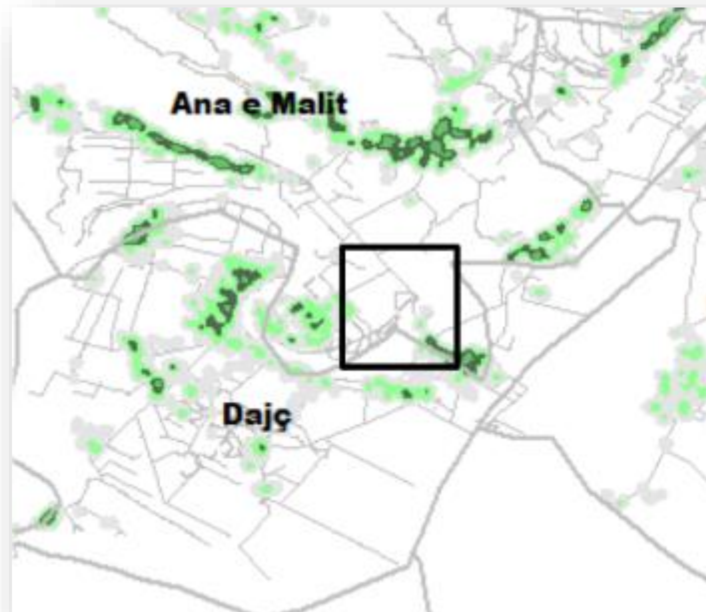

*Figure 14- Satellite image with area for first EbA Case study highlighted in red*

## Principles for Defining the Location of EbAs

We were able to identify the areas that are frequently flooded through the use of online satellite mapping systems known as the Sentinel Hub (EO Browser, 2018). The data from the maps show these locations are flooded annually, not only in the events of catastrophic floods such as the floods of 2010 and 2018 (Figure 15). When it comes to those catastrophic events, these locations are also where the floods start first due to water overflow from the rivers (personal communication, Sead Sadiku, October 29 2018; GIZ, 2015). This first EbA case study was also chosen based on data acquired through GIS mapping of the Shkodër region. Garuci provided GIS maps for our studies which show housing density within these regions. These maps show where the most populated areas are located and were overlaid with maps showing how far and how frequent flood waters have reached in past years. The location is in a less populated area, in order to affect the least amount of people's land (Figure 16).

*Figure 15 (Top) - Satellite images with Normalized Difference Water Index filter (NDWI) acquired from Modified Copernicus Sentinel data [2018]/Sentinel Hub showing the area for the first proposed EbA flooded in 11-16-2016 (Left), 12-18-2017 (Middle), and 02-09-2018*

*Figure 16 (Bottom) - Housing Density Map Outlining Housing Density: Location of First EbA Case Study (Garuci, 2018)*



We chose the setting for the EbA, which is located in Obot, after analyzing the maps above. Obot is about 3.5 meters above sea level according to agronomist Valentine Gocaj from Obot. Before the fall of the communist regime, much of this land was off limits due to the risks of flooding. The houses of the villages were located higher up in the hills to avoid the flood risks. When the regime fell, families from the Oblike mountain side moved to Obot to farm on arable land in the floodplain that is prone to frequent flooding. Migrants from the mountainous northern village of Oblike were not completely aware of the potential for the yearly floods (personal communication, Valentin Gocaj, Nov 27 2018).

We have located this EbA in a mixture of farmland, pastures and some natural vegetation. Alfalfa is one of the main crops in the region. This area is also known for its vegetable greenhouses and decorative plants. Additionally, land parcels are divided between three or four plots of cultivation for different family members (personal communication, Valentin Gocaj, Nov 27 2018).

The lower section of this EbA is located in the village of Shirq. Local farmer, Ismet Ueliuietaj, claimed that his farm in Shirq is flooded out yearly, not only during less frequent, severe floods. He discussed how his land is losing more and more nutrients each year: “she's getting poor, the ground all her essence or all her goodness, because of the floods, she becomes poorer every single year because of them, because of the water, of course, it loses her nutritional values”. This was displayed through his crops that started to develop diseases and early deaths that are overtook his farm. Ueliuietaj is not the only farmer in the area to experience this type of nutrient loss and crop death after the floods. He stated that he knew of other farmers who had left their land and moved on to different locations because it was no longer economically viable to farm.

Additionally, this EbA was also chosen to work in conjunction with infrastructure to reduce flood damage located in this area. We selected the location on the inner side of the river’s bends because EbAs cannot be placed at the outer bend of a river with a high flow rate. Extreme flow rates with fast rushing water, especially in the event of dam releases, would sweep away and uproot the trees and shrubbery of the riparian buffer. Due to this potential threat of high-speed flows, the EbA is placed along with large water breaks, which is a form of hard infrastructure known as groynes, created to slow down the high-speed flow rates of the water in the river (personal communication, Sead Sadiku, October 29 2018).

## Principles for Designing the EbA

The village of Obot is flooded almost every year and “it is the first area to accept the floods” (personal communication, Valentin Gocaj, Nov 27 2018). Damages to the soil also come from the pesticides and pollutants that are carried in the flood waters. Gocaj shared that “2.8 tons of detergents (pesticides) entered the Buna river during the 2010-2011 floods and the area was like a lake” (personal communication, Valentin Gocaj, Nov 27 2018). The flood water pooled on the land for about 30 days, and when it drained, the farmland was “burned from the chemicals and land appeared white” (personal communication, Valentin Gocaj, Nov 27 2018).

The floods also caused losses of livestock, crops, and soil nutrients. Due to the loss in nutrients, and such little amount of arable land, the farms shrank in size and were no longer economically sustainable. Grains can no longer be planted on the farms because it cannot sustain through the floods. This limits the variety of crops that can be planted on the farmlands and creates a damaging impact on the farm’s revenues. Greenhouses take the biggest damages during the floods because of their heavy costs. However, Gocaj explained that the most difficult damages to deal with are the physiological ones. “Most farmers became discouraged after having their crops destroyed from the floods year after year” (personal communication, Valentin Gocaj, Nov 27 2018).

“Burned Earth”

- Valentin Gocaj describing the aftermath of pollutants impacting farmland in Obot

The different vegetation indicators, as explained previously, (Figure 17) indicate that flooding has severely affected the soil composition for agriculture and has led to waterlogged soils (personal communication, Adi Garuci, October 31 2018).

As seen in the figures, waterlogged soil poses a threat to agriculture in these regions and the development of crop growth over time. The chosen riparian buffer EbA works to reduce the amount of saturation in these waterlogged soils and disperses the excess water absorption through their roots and transpiration out through their leaves. The buffer also helps to preserve nutrients that are in the waterlogged soil by trapping and filtering out sediments and minerals in runoff from the river.

Another reason we chose a riparian buffer for our EbA proposal was because of the man-made erosion problem known as dredging, that has especially affected the Buna River in Obot and Shirq. Sadiku showed multiple concerns with the erosion problem along the shores, specifically in this region. He made it clear how illegal and natural erosion are also causing flooding in these locations. He confirmed the city of Obot is flooded every year and in the events of extreme floods, the village becomes isolated and cut off from the rest of civilization, strengthening our reasons for placing the EbA in Obot. Riparian buffers work to reduce these types of erosion along the river bed with their roots, also making it an ideal choice for this location.


*Figure 17 - Satellite images with Normalized Difference Vegetation Index filter (NDVI) acquired from Modified Copernicus Sentinel data [2018]/Sentinel Hub showing the area for the first proposed EbA having different vegetation from the rest of the farmland (EO Browser, 2018)*

Ecologist from the University of Natural Sciences located in Shkodra, Aurora Dibra, noted that the best types of species to use for a riparian buffer are those native to the region. We also took into account such factors as the cost, growth rate, hardiness to flooding, and water absorption capabilities. We identified the following tree as good candidates for the riparian strip. Latin names for these species are Fraxinus ornus, Carpinus betulus, Populus alba, Populus canadensis, Salix caprea, Salix alba, and Quercus robur.

To gain an understanding of approximate surface area of the riparian buffer area we used the Sentinel Hub mapping system to measure the size of the buffer labeled on the map in red. The suggested surface area of the buffer is 2.1 km2, would ideally stretch a length of 4 km and have a width ranging from 100-700 m. The shape of the land highlighted area in red on the map in Figure 14 is covered entirely by the vegetation of the riparian buffer. This highlighted proximity mostly occupies land affected by erosion and waterlogged soils. This erosion is caused by a combination of dredging and water flow overtime. Additionally, the shape of the EbA is to work in coherence with the existing levee located in Shirq. The area covered is of large enough scale to be effective as an EbA, but not too large so that it does not intrude on a significant number of private landowners.

## Anticipating Challenges

Our decision to locate the EbA along the Buna River near Obot recognizes that much of the land is private, which may pose issues in land acquisition. Public land is located only at the edges of the Buna River in narrow segments. Furthermore, a riparian buffer is only effective at wide scale as mentioned before (personal communication, Aurora Dibra, November 26 2018). If the proposed adaptation is limited to only the existing public land, it will also limit its effectiveness at reducing erosion and water absorption.

Another challenge to consider is the trash that is often carried down the river by the water, which could accumulate in the riparian buffer (personal communication, Aurora Dibra, November 26 2018; personal communication, Mirela Isufi, November 9 2018) causing more damaging pollution on the area. As mentioned previously, this creates the need for monitoring and maintenance focused on cleaning.

Additionally, the presence of dykes and smaller channels is significant in this location (personal communication, Sead Sadiku, October 29 2018; GIZ, 2015). The network of drainage channels can be seen in Figure 5. EbAs such as a riparian buffer could potentially damage these infrastructures if they are placed too close and stretch farther than expected with their growing roots. The roots of EbAs can damage levees by breaking through and creating small passageways for the water to flow according to hydrologist Sadiku.

*Drainage channel in Dajc littered with trash*

## Principles for Involving Stakeholders

Farmers have found ways of adapting to the annual floods. "Flood problem is an old problem" according to Gocaj. Ueliuietaj from Shirq stated that many farmers try to cope with the floods by digging their own man-made drainage channels in their farms to shorten the length of time that water pools on their land after a flood. Farmers in this area will try to dig the channel beforehand if they know a flood is coming but Ueliuietaj stated that many dig the channels after the flood has already hit due to the lack of warning systems far enough in advance of the approaching flood.

Many farmers have also adapted to the floods with their choice in crops, as mentioned previously. Here 75% of the farmland that is frequently flooded is now planted with alfalfa, which is more resilient to flooding. "Alfalfa helps the earth recover faster" (personal communication, Valentin Gocaj, Nov 27 2018). The farmers in this location plant alfalfa once every five years with two or three harvests per year. As a cover crop, when it is not harvested, it would provide a useful complement to the proposed riparian buffer strip. Along with crop choice, farmers in Obot and Shirq have also dealt with the effects of flooding by letting land lie fallow for an entire crop cycle. In the past, farmers were able to plant two crop cycles per year, however, due to the impact of more frequent floods, farmers began to change their practices. If a flood is predicted for that year, farmers will not plant in the winter crop cycle, and will instead only plant in the summer. This crop cycle usually begins on the first day of spring and the crops are harvested at the end of November. This damages the agricultural economy and the source of income for the farmers. Although there is little farmers can do to protect their crops in the events of flooding, Gocaj confirmed that many farmers are able to save their cattle and other livestock by moving them to higher ground when they know a flood is coming and if they are prepared for the event. In the Oblikë area, farmers have made long-term investments in elevated houses for livestock, as well as greenhouses and other storage (personal communication, Valentin Gocaj, Nov 27 2018). Alternatively, according to Gocaj, many farmers are leaving their farmland and moving elsewhere due to the damages the floods are having on their farmland. This land is either abandoned or rented out.

Our choice of location and the type of EbA would involve some form of cooperation with farmers whose land would be overtaken by the riparian buffer. Many farms in the area are small plots so land acquisition would be time consuming and would require a level of coordination that is not present. Ueliuietaj stated he thinks that the concept of an EbA is a good idea but he's “not really sure that the farmers can give their land to this project. This can get to some kind of discussion between them and they can discuss and then decide if they, the farmers want to give their land for this”.

Lastly, when asked about the idea or concept of an EbA on his land, Gocaj from Obot revealed his resistance to EbAs when asked about them being placed on the farmland in Obot. “Why management? Why not a solution?” He stated, expressing that he believed EbAs were not good enough. More needed to be done in stopping the floods other than a riparian buffer. “Possibility is low for EbA” (personal communication, Valentin Gocaj, Nov 27 2018).  He explained how he believed management starts with an information system. It is important for farmers to understand the time of year the rains come, when and where the floods will hit and to create an emergency plan.

# Second EbA Case Study

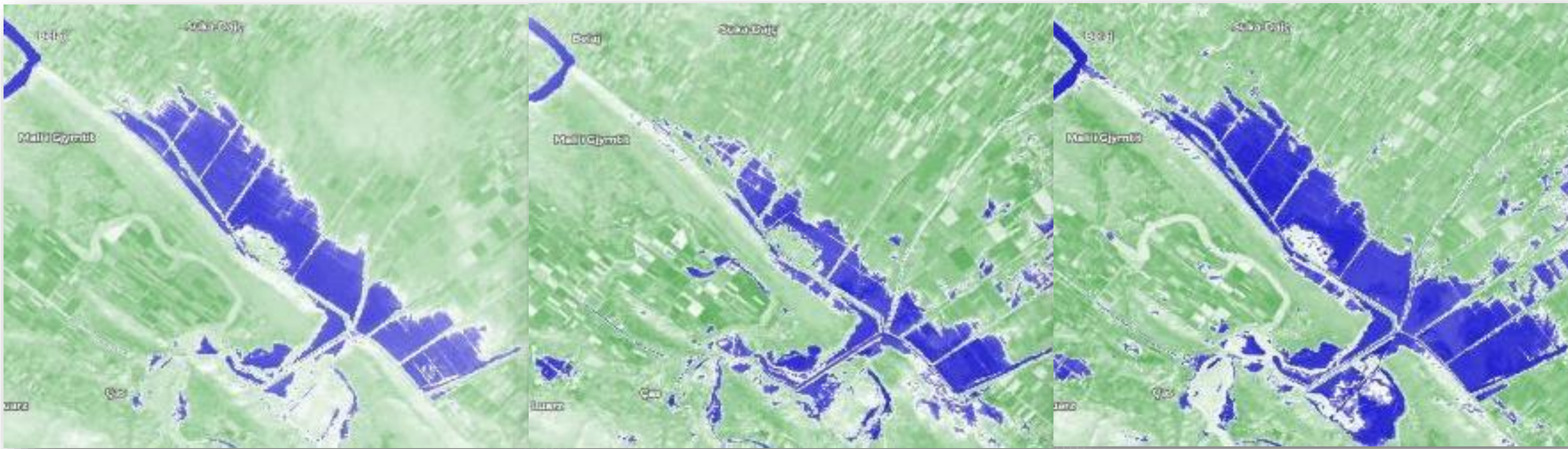
## Wetland Reforestation and Restoration Located in Dajç

| | |
|---|---|
| Location | Dajç |
| Size | Surface Area: 5 km$^2$<br>Contour: 10 km |
| Type | Wetland Reforestation |
| Plant Species | Fraxinus ornus, Carpinus betulus, Populus alba, Populus canadensis, Salix caprea, Salix alba, and Quercus robur |

*Table 4 – Location and design details of second EbA Case Study*

The location of this EbA is southeast of the Belaj and Suka-Dajç villages, alongside the hill range that can be seen in highlighted in red in the maps (Figure 18) and some of its details are in Table 4.


*Figure 18- Satellite image with area for second EbA Case study highlighted in red*

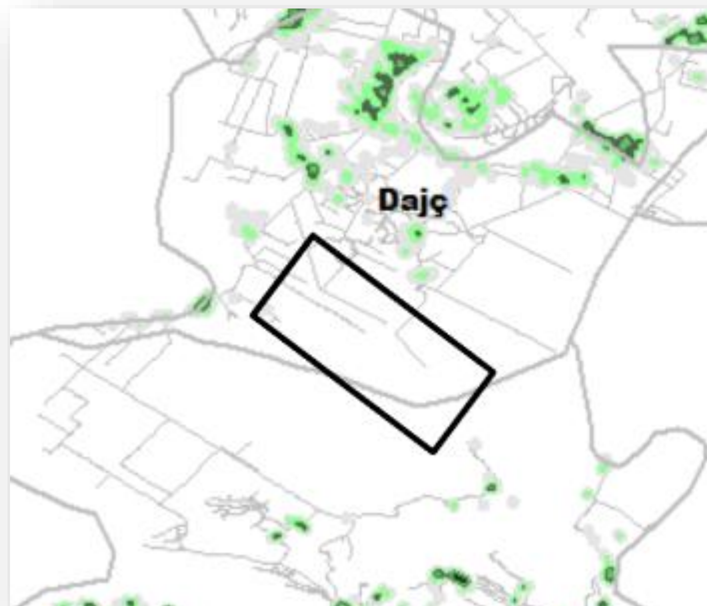


## Principles for Defining the Location of EbAs

This location is vulnerable to frequent annual flooding. The Sentinel-Hub indicates this location is flooded annually, not only in the events of the catastrophic floods of 2010 and 2018 (Figure 19). During catastrophic floods, this location is flooded first due to the overflow of water from the drainage channels that converge here. When the channels receive more water than they can handle, they begin to backup and fill this location with excess water (personal communication, Sead Sadiku, October 29 2018; GIZ, 2015). We used GIS maps to choose the location for the EbA. These maps showed the most populated areas that have been affected by flooding, in addition to the less populated areas where our EbA could be constructed. The chosen spot for this EbA is in a less populated area in order to reduce the amount of people's land that is overtaken by the EbA (personal communication, M. Lukaj Ernest, November 27 2018; personal communication, Adi Garuci, October 31 2018).

*Figure 19 (Top) - Satellite images with Normalized Difference Water Index filter (NDWI) acquired from Modified Copernicus Sentinel data [2018]/Sentinel Hub showing the area for the second proposed EbA flooded in 11-16-2016 (Left), 01-22-2012 (Middle), and 11-28-2018 (Right), (EO Browser, 2018)*

*Figure 20 (Bottom) - Housing Density Map Outlining Housing Density: Location of Second EbA Case Study (Garuci, 2018)*



Garuci also confirmed in an interview that this location is mainly used as wetlands. There are few farms and pastures located directly where we have suggested an EbA (personal communication, M. Lukaj Ernest, November 27 2018). The housing areas located away from the EbA and are positioned higher in the hills. The location of the EbA can be seen boxed on the housing density map in black (Figure 20).

After analyzing the maps above, we chose the location for the EbA which is located in Dajç. Dajç is located approximately 15 km west of Shkodra with 11 villages, some 9,000 residents and a surface area of 2,683 hectares according to agronomist M. Lukaj Ernest from the Dajç Administrative Unit. The exact location for the proposed EbA is one meter below sea level. This EbA area was previously a large wetland and rice plantation but now much of it is devoted to arable crops such as alfalfa and pasturage (personal communication, M. Lukaj Ernest, November 27 2018). Crops such as apples, oranges, figs, and corn are also grown in Dajç. One hundred and ten hectares are dedicated to cultivating decorative plants. However, recently, many people have migrated away from this land because most of the residents were elderly and could no longer farm or plant on their own.

*Figure 21- EbA Case Study 2 On-site Location*

After visiting this EbA location with hydrologist Sadiku (Figure 21), he described how the many small drainage channels from the farmlands and villages converge with one single large channel at this location. These drainage channels can be seen converging on the drainage channel map (Figure 22) with the EbA location boxed in red. However, when the channels become blocked with debris, they begin to back up and overflow onto the land creating a bathtub effect as described in the background chapter (personal communication, Sead Sadiku, October 29 2018). This causes oversaturation in the land and waterlogged soil, making this a place that would benefit from water absorption and strengthens our reasons for choosing a wetland reforestation EbA.

Wetland reforestation EbAs work to absorb large amounts of water in highly saturated land areas in order to improve soil quality and preserve nutrients. Placing an EbA in this location would mitigate the risks for long term saturation of the land when the drainage channel overflow in this location and would lessen the extent the waters reach during extreme flooding events. It would also work to improve agriculture land and create more viable land for planting crops.

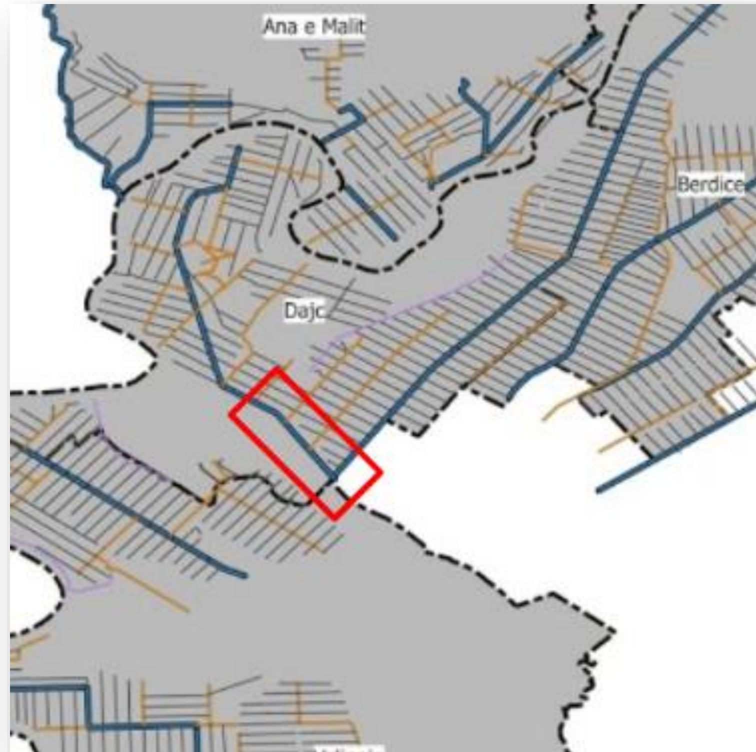



*Figure 22- Map of drainage net, South Shkodra territory, 2017 (Garuci, 2018)*

## Principles for Designing the EbA

Like in Obot, floods have hurt the agricultural economy. Farmers in the area are uncertain about what to plant in the land. Ernest explained how the discharges from the floods cause agricultural chemicals to disperse and pollute the land: “Flood pressures are very damaging on the land because it is under the level of the sea” (personal communication, M. Lukaj Ernest, November 27 2018). Waterlogged soils are the biggest problem: “If water flows, it is not as damaging to soil. If the water stays still, it’s more damaging” (personal communication, M. Lukaj Ernest, November 27 2018). Waterlogged soils occur from the main problem which is the high level of groundwater that Ernest explained. Twenty-five thousand hectares of the fields in Dajç are flooded every year. In 2010, the area was flooded three times in one year. “This area had one meter of water for 40 days” (personal communication, M. Lukaj Ernest, November 27 2018). The different vegetation indices acquired from Modified Copernicus Sentinel data [2018]/Sentinel Hub (Figure 23) indicate that flooding has severely waterlogged the soil for agriculture after the floods (personal communication, Adi Garuci, October 31 2018).

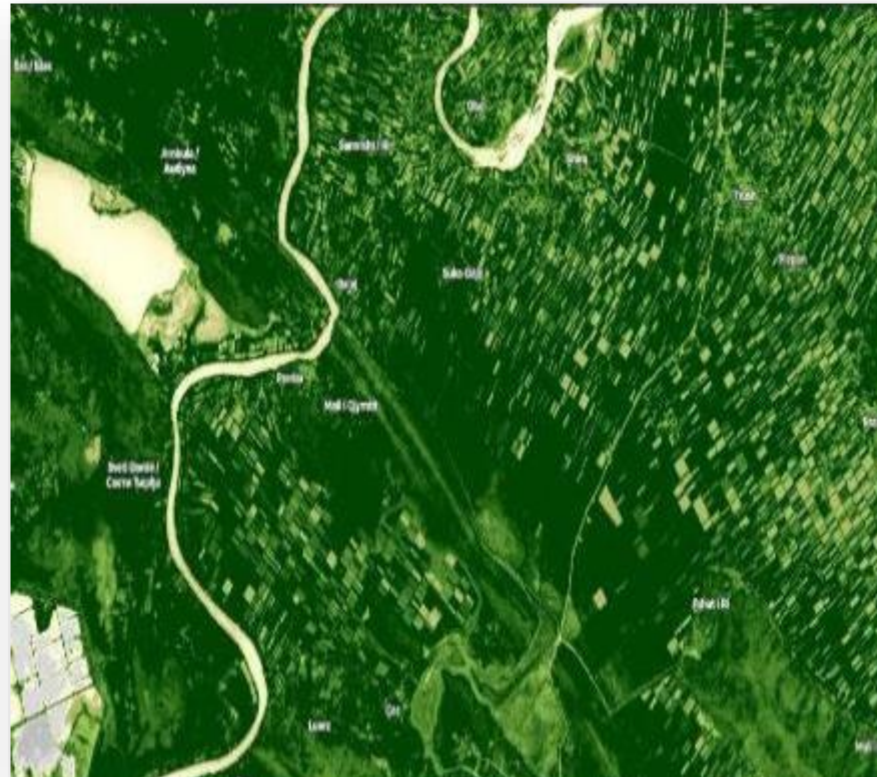


*Figure 23 - Satellite images with Normalized Difference Vegetation Index filter (NDVI) acquired from Modified Copernicus Sentinel data [2018]/Sentinel Hub showing the area for the second proposed EbA having different vegetation from the rest of the farmland (EO Browser, 2018)*

Much like the first EbA case study, types of vegetation were discussed with ecologist Aurora Dibra in an interview. She confirmed that the species Fraxinus ornus, Carpinus betulus, Populus alba, Populus canadensis, Salix caprea, Salix alba, and Quercus robur absorb large amounts of water and would also work well in a wetland location.

To gain an understanding of approximate surface area of the reforestation area we used the Sentinel Hub mapping system. The surface area is suggested to be 5 km2 with 10 km of contour. The shape of the land highlighted in red on the map in Figure 18 is covered entirely by the vegetation for wetland reforestation. This highlighted proximity mostly occupies land affected by waterlogged soils. The waterlogged soils reach the full lengths of the outlined shape on the map due to water overflow from the drainage channels. The area covered is of a large enough scale to be effective as an EbA, but not so large that it intrudes on a significant number of private landowners.

## Anticipating Challenges

Lastly, in the location for the second EbA, the present infrastructure is mostly larger drainage channels and a single road that goes to Velipojë (personal communication, Sead Sadiku, October 29 2018; GIZ, 2015). The network of drainage channels, including its three different levels, is seen in Figure 22. This means the wetland reforestation has to be implemented around these structures with enough distance between them to prevent damage from the roots of vegetation. Additionally, waste can be transported through the drainage channels and overflow into the wetland forest where it would accumulate (personal communication, Mirela Isufi, November 9 2018; personal communication, Aurora Dibra, November 26 2018). As mentioned previously, this means they need continuous monitoring and maintenance focused on cleaning.

*Fisherman in Kune-Vain Lagoon*

## Principles for Involving Stakeholders

Farmers in Dajç have tried to adapt to more frequent flooding in similar ways to farmers in Obot. They too only cultivate one cycle per year, in those and other flood-prone areas. Others are leaving the land, getting jobs outside of these farming regions, and either renting or simply not using their land (personal communication, M. Lukaj Ernest, November 27 2018). Ernest stated how farmers are moving to higher grounds in the events of flooding, or leaving agricultural land affected by yearly floods.

Unlike the first EbA location in Obot, the land here is comprised of larger parcels of either arable land or pasture. On the other hand, as Ernest said, many families divide their land to be taken care of by different members of the family and this might not be represented by the visible land divisions. This creates difficulties within land acquisition strategies and EbA implementation on farmland because it would require a level of coordination between farmers and additional members who own the land to concur (personal communication, Adi Garuci, October 31 2018).

*Key informants discussing implementation of EbA in Kune-Vain Lagoon through drawings in the sand*

# CONCLUSIONS

## Limitations

We have performed background research and interviewed many experts in areas where we considered implementing an EbA. We have also located and designed our EbAs based on principles outlined in the findings in order to propose functional EbAs. However, we have no real way of knowing if the proposed EbAs would be effective in reducing the effects of flooding on agricultural lands in practice. During the course of our work, we discovered more and more details about EbAs that we did not have the time or expertise to investigate, such as vegetation spacing, land availability, detailed size and scale of the chosen EbA, expected cost, and sources of funding.

Another constraint was that we had limited perspectives from certain stakeholder groups. We only interviewed three farmers, which is a small sample size from a large stakeholder group. Farmers were also difficult to connect with and schedule interview times with, which was problematic as they are the stakeholders most affected by EbAs. In addition, we only interviewed residents living in Shkodër and not anyone from the dam management company, Kesh. Therefore, we did not receive Kesh's view on how dam management affects flood risk. This could have created a bias in our view of how dam management affects flooding in our findings.

Even though we had student translators from the University of Shkodra, we are unsure if some of our ideas or our interviewees' ideas got lost or misinterpreted in translation. This would negatively affect the quality of the interview.

The use of the term "EbA" also caused some issues, since most of the people we interviewed had not heard this term before. However, they had often heard of the concept, so we were better able to receive feedback and information concerning EbAs after providing specific EbA examples. In addition, we only had approximately seven weeks to conduct our project in the field. Our project has many complexities to consider and it is difficult to gain all perspectives within a short time frame.

Perspectives concerning our project were acquired entirely through academic research and expert key informant opinion. We relied on these with help of principles and criteria in order to locate, design, and justify our EbAs. There is a risk that if implemented, our EbA propositions may be ineffective.

## Ethics

An EbA, if it works, cannot mitigate the effects of flooding throughout the entire Shkodër region. This led to an ethical dilemma of how to choose who should be protected and who should be left out when we were considering the location of our proposed EbAs.

More likely than not, an EbA will require farmers' land. Farmland can either be purchased, overtaken by the government through eminent domain, or farmers can comply with placing an EbA on their land. The process of acquiring land for an EbA may bring utilitarianism, or the sacrifice of a few farms for the benefit of the greater good, into discussion. The implementation of an EbA would cause a smaller group to no longer be able to farm on their land for the benefit of the larger farming community in the area. In addition, after these farmers lose their valuable land, they must be compensated sufficiently. If an adequate amount of land cannot be obtained for the EbA, there is a chance that it will be unsuccessful or limited in its overall benefits. If this was the case, then farmers will have given up their land for something that was ultimately ineffective in mitigating flood risk and preserving agricultural land.

Another ethical concern emerged when we introduced ourselves as engineering students to residents of the area and our key informants including the three farmers. This gave the impression that we would utilize our engineering knowledge towards creating a hard infrastructure solution to flooding in the region. People were initially misled because they believed as engineering students, we would be more inclined to present hard infrastructure solutions such as levees. We had to explain that we were specifically exploring the possibilities of only EbAs and no other interventions.

*Our group with Albanian students and agronomist M. Lukaj Ernest from Dajc*

# Concluding Remarks

Working on this project made us realize the complexity of the issues behind flood risk, from dam management to climate change to hydrology, and the amount of research and number of stakeholders required to address these issues. After every key informant interview, we learned something new to consider when researching the possibility of an EbA. For example, our interviews with rural planner Adi Garuci enlightened us on the impacts of flooding on soil quality and crops, and additionally the economy of the region. This led us to interview farmers to learn more about their farming practices and the impacts flooding has had on their livelihoods.

In many of our classes at WPI, we focus on finding a defined solution. This is a common theme throughout our various majors concerning engineering, computer science, and mathematics. When we began this project, we started with the mindset that an EbA could help to stop flooding - in other words, a defined solution to a “straightforward” problem. However, as we learned more about EbAs, flood risk in Shkodër, and the involved stakeholders through background research and interviews, we realized the complexity and uncertainty of this issue. We learned that certain data is more valid in specific circumstances, and it is important to balance different perspectives and opinions in order to approach the issue holistically and not rely on one perspective too heavily. It was also challenging to balance the technicalities of EbAs with the social and political contexts that emerge along with EbA consideration. Social contexts tended to be more complex, and in order to narrow down the scope of our project due to time constraint we focused much on the technical aspects of EbAs. Additionally, as engineering students, the technical aspect of the project was more inside our comfort zone. Social and political perspectives were also incorporated but to a lesser degree.

Sometimes the best course of action cannot be achieved immediately or with only one measure. In this case, EbAs would only be a small contribution to addressing flood risk in the entirety of the Shkodër region. Throughout the project we had to critically evaluate how an EbA would be effective, keeping in mind the uncertainties behind EbA success when actually implemented. Our work and insights can help provide GIZ with a more well-rounded judgment on EbAs, but more work would have to be facilitated by GIZ in order for an EbA to be considered for implementation.


*Christine, Jakob, Pedro, and Katrina*

Through this project, we are adding value by shining a light on a new approach for flood risk management. Even though it may not be the perfect solution on its own, EbAs can be considered as an additional flood risk management solution specifically focused on adapting to climate change. This project highlighted the potential benefits and tradeoffs that come with EbAs so that interested parties can make the best decisions regarding whether or not they want to pursue an EbA. The approach of an EbAs implementation not only needs to address the technical planning and design of an EbA, but also be focused in terms of increasing awareness and taking into account the residents directly affected. Our project not only envisages awareness, but also the importance of considering a holistic approach regarding EbAs. In our findings, we provide principles for how we gathered perspectives from social contexts while utilizing technical information from background research and key informants in order to successfully choose an EbA. Although there are many more in-depth factors to consider, we provided a basis for evaluating the extent to which EbAs can reduce flood effects with respect to the farming community and agriculture within the Shkodër region.

*Our group with sponsors from GIZ*

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# APPENDIX A - INTERVIEW QUESTIONS

GIZ

- What is currently being done to help address flood risk in Shkoder?
- How is the Climate Change in the Western Balkans working to reduce flood risk?
- How does hydrology affect flood risk here?
- How has climate change affected flood risk?
- What infrastructure is affected by flooding?
- In what ways do the hydropower plants increase or decrease flooding?

Hydrologist

- How does hydrology affect flood risk here?
- What infrastructure has been built to address flooding? How effective is it?
- How quickly and how much does the water rise during flood season?
- Where are the illegal structures located?
- Are people moving away from this area because of the flood risk?

Urban Planner

- What are the steps it would take in order to implement an EbA?
- Does the government give back any money or compensation to the community after floods have happened?
- What are the steps a citizen affected by the flood would have to go through in order to get compensation for their losses?
- How are the dams regulated and who decides when it's necessary to release the spill waters?
- What measures have already been taken by the municipality to reduce flooding?
- Is there any urgency from the government or the community to create flood risk management measures?
- How much funding does the municipality have to put towards flood risk management?
- How do you think the community would react to the implementation of an EbA? Would there be any discrepancies?
- Why have people moved towards the flooded regions?
- Did the citizens know they were building illegally when they built on these flood-prone lands?

- Were there or are there currently any regulation already put into place to stop the community from building on these flood-prone lands?
- Is there any punishment for building illegally on these flood-prone lands?
- Who would provide funding for the EbAs?
- Who would be responsible for maintenance and upkeep of the EbAs after implementation?
- Would there be an opportunity for employment through these EbAs?

Rural Planner

- How is the land used in different regions?
- How much land is designated towards agriculture?
- Is there any information or recorded data on the crop loss or loss in value of each household/farm after major flooding?
- What kind of mapping has already been done in regards to recording recent flooding or historical floods?
- What steps would need to be taken in order to implement an EbA into a rural area?
- Are there any specific areas that get flooded out first in the event of a radical flood?
- Are there any areas that get flooded out frequently, if not, every year?
- What effect does climate change and the seasons have on flooding?
- How has dam management affected flooding in the regions?
- How had drainage channels management affected flooding?

Local Farmers

- What crops do you grow on your farm?
- How long have you been here living and how long farming?
- Did you build this house? Has it been in your family line?
- How often do you get flooded?
- How do floods affect your crops? What percentage do you lose?
- How do you prepare for floods?
- How do you try and protect your crops from floods?
- How long does it take for you and your farm to recover after a flood?
- Do you know anyone who has moved away and for what reasons?
- Do you think there could be anything done to prevent the flooding?
- How close are you to the water?
- What areas on the map are affected by flooding?
- How do you use this land on the map for crops? Where do you grow certain crops?

Ecologists

- Have you worked with EbAs before?
- What do you know about the concept of EbAs?
- What can you tell us about the ecosystems around the Drin and Buna rivers?
- How have the ecosystems been affected by flooding?
- How do ecosystems relate to the agriculture in the area?
- Do you have any vegetation recommendations for an EbA in Shkoder?
- What species are best for water absorption?

# APPENDIX B - TRANSMEDIA PLAN

EbA Brochure

- Pre-production
    - Gather technical information about EbAs
    - Gather benefits and limitations from multiple perspectives
    - EbA scenarios including location and design
- Production
    - Take information from pre-production and format in brochure on Canva
- Post-production
    - Print brochures at local print shop in Tirana for distribution at final presentation

Video: A New Approach to Flood Risk Management

- Pre-production
    - Gather recorded media from Go-Pro and Zoom Mic
- Production
    - Use media to form an EbA awareness video displaying limitations and benefits with key informant interviews using Adobe Premiere
- Post-production
    - Export video file and provide for GIZ

Time-Lapse Maps

- Pre-production
    - Identifying areas and indices to use on Sentinel Hub
    - Finding ideal time periods/lengths to show
- Production
    - Using data from Sentinel Hub to compile time-lapse maps showing extent of floods, NDVI index, and others.
- Post-production
    - Utilize time-lapse maps in order to show flood progression and impact visually
    - Provide GIZ with information on how to produce these visuals

# APPENDIX C - EBA BROCHURE

Proposed Ecosystem-based Adaptations:
https://drive.google.com/file/d/1QtUCUSgqw3dAZEdWjYzRsARhDgquGDlb/view?usp=sharing

# APPENDIX D - EBA VIDEO

A New Approach to Flood Risk Management: https://youtu.be/sedlVau741o