Rock Armor along Karavasta Lagoon Channel and Channel Mouths

Co-Creating Nature-Based Solutions for Hazards in Divjaka

Andrei Bornstein, Cristobal Rincon Rogers, Luke Rudolph, Nora Smith

12/14/2022

Introduction

Albania is the country most vulnerable to climate change in Europe. Divjaka, a rural coastal region in Albania, is especially at risk because of the community's reliance on land and bodies of water for livelihoods. Farming, fishing, and nature-related tourism are all major livelihoods in the area. The Shkumbini River and Karavasta Lagoon are both located in the national park, but are not directly connected to each other. Plants, animals, and people rely on the river and lagoon to support the ecosystem and livelihoods of locals. For this proposal, we chose to look at the Karavasta Lagoon as a potential area for intervention.

Overview of the Karavasta Lagoon

The Karavasta Lagoon in Divjaka serves an essential role in the region. In addition to supporting fishing and ecotourism, the area is protected under the Ramsar Convention as a critical habitat for fish and water birds. Furthermore, its status as a national park, the highest ranking amongst protected areas, further emphasizes its importance to Divjaka's biodiversity. However, the stability of the lagoon system and the biodiversity around it has been put at risk by erosion-related blockage of the channels that link the Karavasta Lagoon, the Godulla Lagoon, and the Adriatic Sea.

Methodology

To prepare this sketch, our group conducted several activities to utilize participatory planning properly. These activities include field visits, key informant interviews, and stakeholder meetings. Additionally, we researched the environmental impact of rock armor through a textbook on the practical usage of rocks for environmental projects and read previous project proposals to understand the sketch format.

Design

The design process for this proposal involved numerous stakeholder groups, with the largest inputs coming from a regional Fishery Management Organization (FMO), the Regional Agency of Protected Areas (RAPA), and the Japanese International Cooperation Agency (JICA). Other contributions came from the Protection and Preservation of Natural Environment in Albania (PPNEA) and the Institute for Nature Conservation in Albania (INCA). FMO, RAPA, and JICA described the hazards they observed concerning the park. FMO, RAPA, INCA, and PPNEA all contributed information related to the negative effects these hazards have on the ecosystem and livelihoods. They made suggestions on improvements and interventions using a nature-based approach. Finally, JICA provided information on potential interventions, as well as what work they have done in the national park.

The identified hazards to the lagoon system caused by the channel blockage include:

1. Decrease in lagoon depth (FMO, RAPA, JICA)
2. Decrease in lagoon oxygen levels (FMO)
    a. Reduces fish population capacities
3. Increase in lagoon salinity (FMO, JICA, PPNEA, INCA)
    a. Decrease in water level raises the ratio of salt to water within the lagoon

From these hazards, negative effects to the ecosystem follow. Some of these effects include:

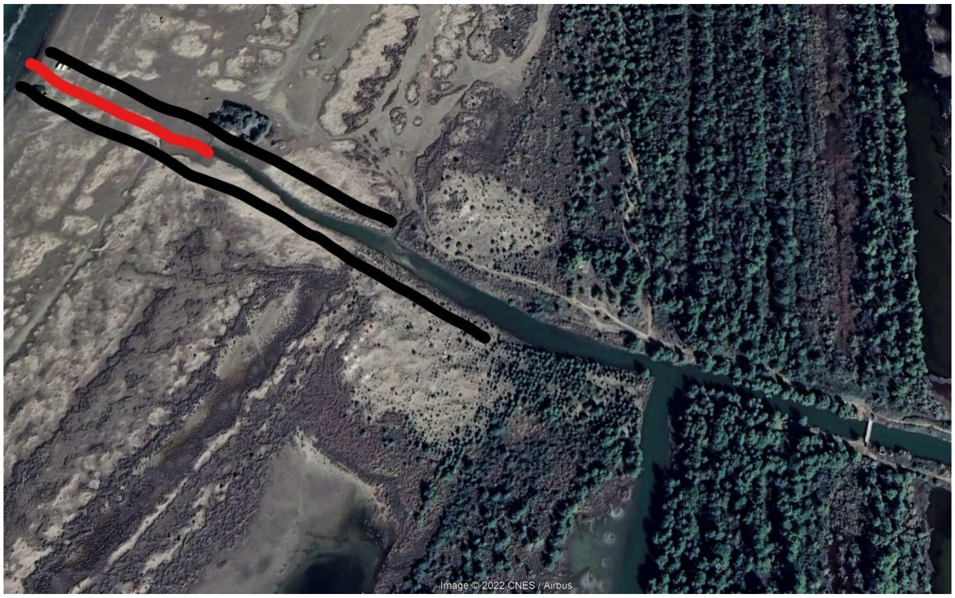
- Decreased fish populations (FMO, JICA)
    - 70% decrease in fish populations over 30 years
- Decreased bird populations (PPNEA, INCA)

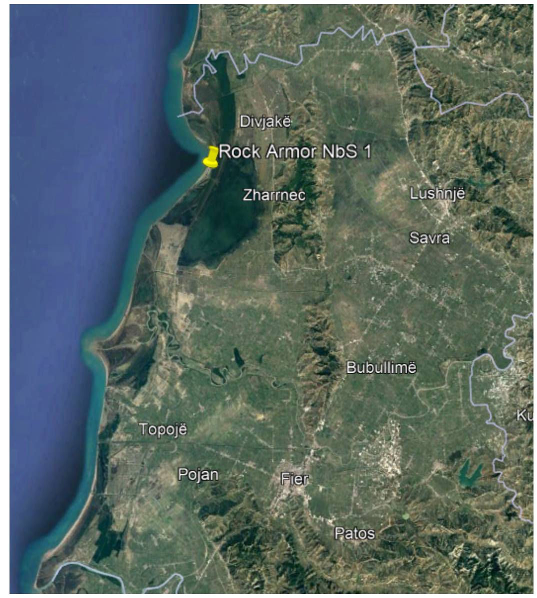
These effects are detrimental to livelihoods related to the lagoon:

- Fishermen are not able to bring in enough money (FMO, JICA)
- Tourism will decrease without birds (RAPA, PPNEA, INCA)
- Park service jobs rely on the health of the lagoon (RAPA)

Potential Implementation

The areas suitable for possible interventions are pictured below:





(Google Earth, 2022)

Map 1 highlights the Northern channel on the Adriatic side, with a pin placed in the same area on Map 2. This area sits between the Karavasta Lagoon and the Adriatic Sea near the northern end of Divjaka. From here, the channel has been blocked by erosion brought from the Shkumbini River, as well as coastal erosion caused by a combination of work from the Shkumbini River and the Semani River. Implementation of rock armor in this area would include removal of sand while simultaneously reinforcing the area with rocks. This adds a layer of complexity to the project, but might prevent the channel from needing more deepening in the future.

Large rocks would be placed in this area from the beginning of the sandy soil to the coastline, which is around 0.41 miles on each side (represented in black). Channel widening and lengthening would need to occur along 0.3 miles of that stretch (represented in red). The materials used in these areas could be secondary materials, such as solid structures left over from construction or demolition projects within the city. Additionally, these materials could be further supported by timber stakes sources from fallen trees within the boundaries of the park (RAPA).

Rocks near the mouth of the sea would need to be placed in a specific formation to deal with coastal forces. This formation can be calculated using existing equations designed to maximize strength based on rock type, rock shape, and other factors. Moving inland, rocks can instead be dumped, as the priority will be preventing the movement of sand instead of both preventing soil movement and resisting ocean flows.

While not a solution akin to ecosystem-based adaptation, rock armor is less disruptive to the environment than concrete projects for a few reasons. Firstly, there are no costs or emissions associated with the production of rock. Secondly, the potential use of recycled materials allows for a reduction of waste production for the region. Finally, natural rock reinforcements can be supplemented with regional plants like mediterranean pine trees, used by JICA in a coastal erosion prevention project, in order to continue to preserve biodiversity and avoid habitat destruction.

The amount of time needed for this kind of implementation is largely dependent on the accessibility of materials. JICA estimated a potential length of 2 to 3 months, based on previous channel clearing projects, RAPA and the municipality recommended that implementation take place during a dry season; specifically, between the months of April and May.

FMO said that members of their organization would be willing to work to implement a rock armor solution. RAPA also expressed interest in providing manpower towards this project. JICA has previously done work in clearing out the Northern channel, and was the primary informant on the need to both clear and reinforce the channel walls. Their projects within the park have been supported by local officials, RAPA, and community representatives for various economic sectors. Additionally, the municipality of Divjaka shared support of the idea, and would be involved in implementation of this intervention as well.

Potential Positive Impacts

The positive impacts of this project could be measured both on the population and on the ecosystem:

- 129 species of bird have been identified to live within the park (iNaturalist)
    - As bird populations increase, ecotourism activities such as birdwatching could increase (PPNEA)
    - The park shelters around 1% of the population 6 species of birds, making it an essential site to their preservation (JICA)
    - 25 species of fish, mammal, and bird are identified as endangered, and rely on the park as either a breeding area or a wintering shelter zone (JICA)
- Increase of fish populations from the 70% decrease recorded over past 30 years (FMO)

    - This increase is likely to impact at least the 30 fishermen working with FMO, as well as other fishermen in the area (unknown number)
    - The predicted timeline for measurable effects on populations is 3 months (FMO) to around 5 years (JICA)
- Coastal lagoons serve as a carbon sinks, so continued existence of the lagoon is very likely to keep emission levels lower (PPNEA)
    - The exact value cannot be predicted, since there have been few empirical studies on the topic

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Riparian Forest Buffer along the Shkumbini River

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Introduction

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Overview of the Shkumbini River

The Shkumbini River flows westward through many municipalities, opening up into the Adriatic Sea north of the Karavasta Lagoon. This river runs along the border of Divjaka and the southernmost part of Fier County. Previously, the river entered the sea around 5.4 kilometers from the Northern Channel of the lagoon. However, from 1986 to 2000, the mouth of the river moved around 4.5 kilometers further north (Troendle, 2002). The reasons for this are still only theorized, but it is known that the movement of the mouth cut off several kilometers of river, causing the river to increase in speed. This in turn has caused the worsening of several identified hazards.

Methodology for Preparing NbS

The design process for this proposal involved numerous stakeholder groups, with the largest inputs coming from the Regional agency of Protected areas (RAPA), the Japanese International Cooperation Agency (JICA), the municipal government, and a shepherd who farms along the Shkumbini river. Additional inputs came from the Protection and Preservation of Natural Environment in Albania (PPNEA) and the Institute for Nature Conservation in Albania (INCA). RAPA, JICA, and the shepherd shared with us the hazards they observed to be facing in the Shkumbini river. RAPA, JICA, PPNEA, INCA, the shepard, and the municipal government all contributed information related to the negative effects these hazards were having on the ecosystem and to the livelihoods of the community as well as some suggestions for improvement and intervention using nature based approaches.

Problems Identified and Associated Effects

The identified **hazards** to the river system are as follows:

1. Accelerated **erosion of the riverbanks** (Aleksander Llapi (municipal government), Albert Lika)
2. Strengthening of riparian forces that result in increased **coastal erosion** (INCA)
3. A study conducted in 1997 estimated that there would be a **50% reduction in soil erosion** when there was a buffer of actively growing vegetation (including trees and grasses) about 60 to 70 meters wide (Broadmeadow, 2004)
4. There was a study done in 2008 on the Albufera des Grau Lagoon which had a similar structure to the Karavasta Lagoon. This lagoon had only one channel that connected it to the sea, but it was sometimes disconnected in the summer months when the water level would go down and there was not enough water to reach from the lagoon to the sea. They noticed that during these months, the **salinity of the lagoon** went up especially when the channel was not functional (Obrador, 2008)

From these hazards, **multiple negative effects** can be identified. Some of these effects include:

- **Physical loss** of farmland to **erosion** (Albert Lika)
- Increased **sediment loads** in the river (Aleksander Llapi (municipal government))
- Increased **flooding of adjacent farmlands** (Albert Lika, Aleksander Llapi)
- Increased **flooding of coastal areas** (INCA)
- **Deposition of sediments** on coastal land 100 meters south of the Shkumbini River to the northern channel of the Karavasta Lagoon (JICA)
- **High salinity, or seawater**, environments can cause "excess ion intrusion as well as osmotic water loss" which can be problematic for fish that are used to a less saline environment where they do not lose water to osmosis. (Deane, 2008)

These **effects are detrimental to livelihoods** in the region:

- Floods bring industrial pollutants from the river into farmland (Albert Lika)
- Coastal erosion contributes to issues surrounding the lagoon channel blockage
    - Fishing is affected due to the eroded sediments from the coast blocking the channel, deteriorating the quality of water (FMO)
        - Fishermen can no longer rely on fish as their main source of income
        - Caught only 1 kilogram of fish in a month (FMO)
    - Bird life is negatively affected by the lack of their food source, fish (INCA)
        - The Dalmatian Pelicans did not breed properly this year which they believe is linked to the poor water quality and depleted fish population (PPNEA)
        - Divjaka attracts most of its tourists from bird watching, but if the bird species decline, then tourist may be less inclined to come (RAPA)
    - Tourists destroy the dunes that help to prevent coastal erosion (RAPA)

- Gradual riparian encroachment into farmland could reduce land used for growing crops and grazing animals (Albert Lika)

Potential Implementation

The potential areas for interventions are pictures below:

Figure 1: This map highlights the first proposed area for a riparian forest buffer, zone A.

Figure 2: This map highlights the second proposed areas for a riparian forest buffer, zone B.

Figure 3: This is a map that shows the location of zone A (left blue circle) and zone B (right blue circle).

We propose to plant pinus pinea (stone pine) species saplings. These trees are in the Divjake-Karavasta National Park, so they are native to the area (Park Management Plan). In addition, they are helpful in preventing the erosion of sandy and loose soil. (De Angelis, 2018) The trees are usually 10-20 meters apart (Kubisch, 2017). Therefore, to create a closer distribution, we recommend planting trees about 10 meters apart. In addition, we will use six rows of trees using triangular spacing, as seen in figure 1. Trees in each row will maintain a 10-meter distance from other trees. Therefore, we will have a 60-meter wide buffer.

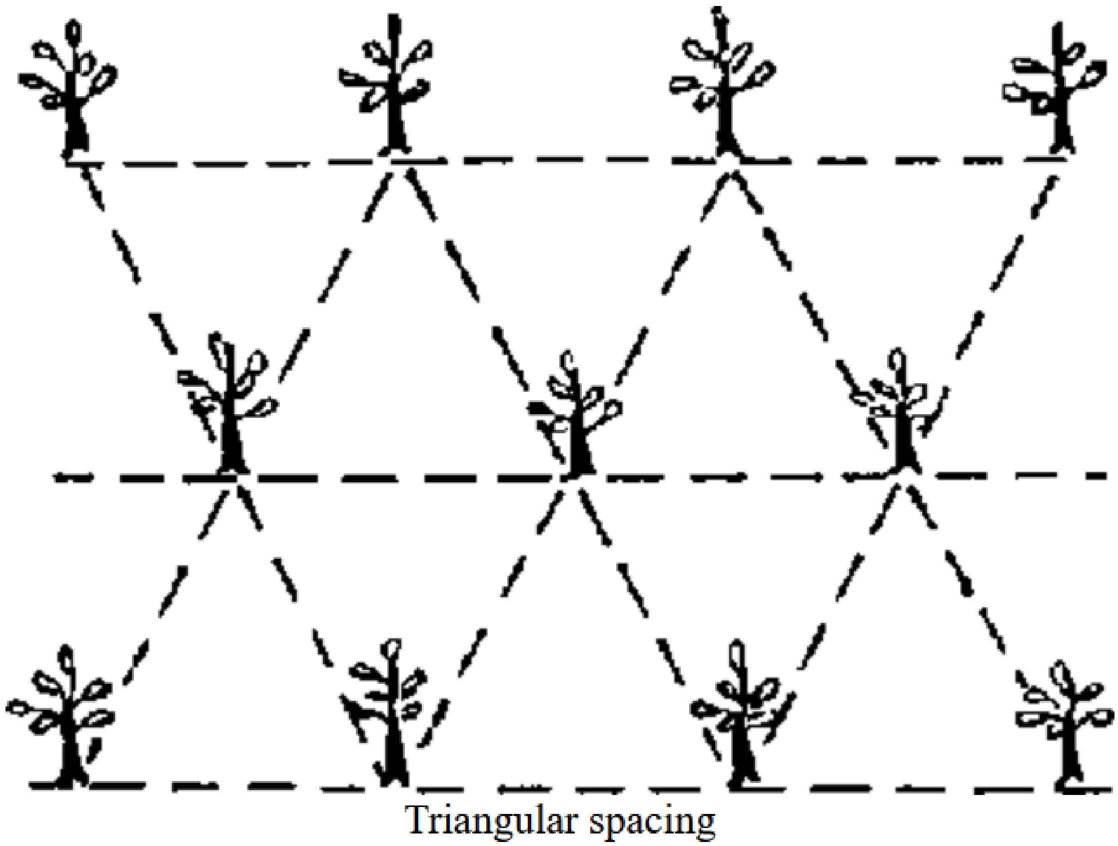


Figure 1: This image shows an example of triangular distribution of tree saplings (ILO & UNDP, 1993, p. 190).

The first proposed site, zone A, is about 600 meters long. Therefore, 424 stone pine saplings would be planted along this stretch. The number of tree saplings required for a six-row riparian buffer using 10-meter equilateral triangular spacing is dictated using the equation $\frac{7}{10}x + 4$, where x is the length of the segment in meters. The best time to plant the trees would be in the winter months from December to February. Most planting will be done on the weekends, so about 30 to 40 saplings per weekend will take about 3 months.

The plants will need to be properly hydrated in case of a large drought during the dry summer months. The saplings should be hydrated when there are signs of dry wood and wilting leaves. They should receive 2 liters of water per day that is sprinkled around the base of the tree.

After in-person interviews with high school students in Divjaka, we learned they would be willing to plant these trees as they have done tree plantings in the past. Therefore, it could be beneficial if an NGO or youth council group, in cooperations with RAPA, would work with the high school students in Divjaka to help organize the reforestation of this zone. The students could only plant on the weekends, so this is why it would take about 2-3 months to plant. They would also have to bring water tanks or pumps from the river in order to irrigate the saplings.

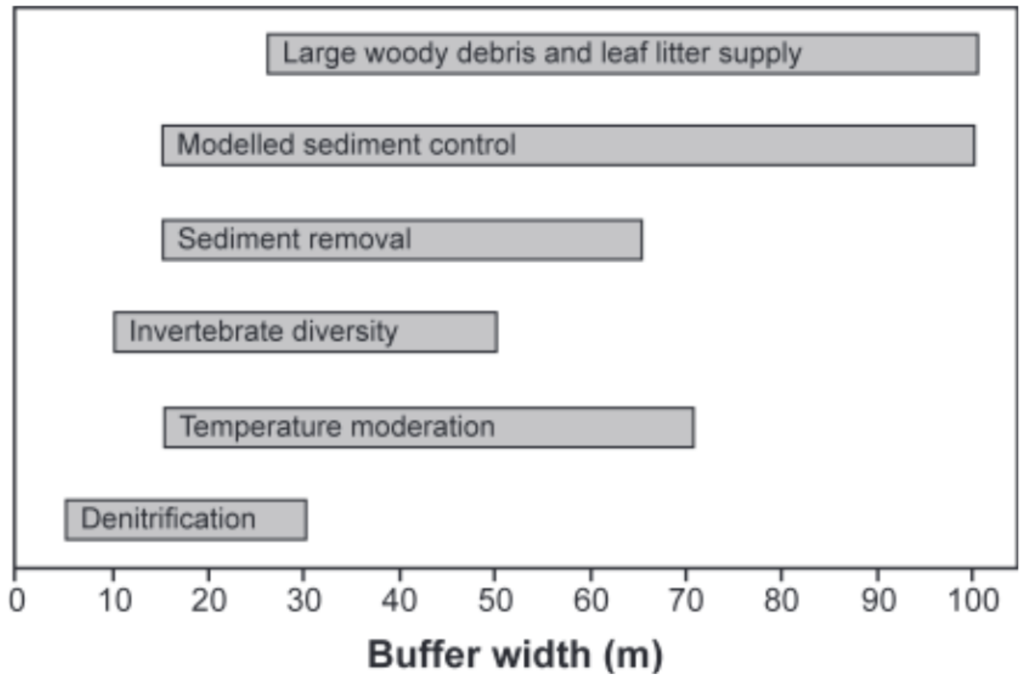
Potential Positive Impacts

The net positives of this project can be measured both on the population and on the ecosystem:

- The tree roots of the riparian forest buffer should strengthen the soil and reduce the amount of material that is eroded by the river (ConservationTools, n.d.)
- This should cause less deposition filling up the channel and hopeful the channel should stay cleared once it has been opened (RAPA)
- Salinity levels in the lagoon should go down and dissolved oxygen levels should increase (JICA)
- Fish populations should return and so will the birds (PPNEA)
- When fish could return to a normal level, then fishermen could support themselves with their fish yield as their main source of income (FMO)

Similar Projects

- A study in the UK concluded that an estimated 50% attenuation in the flowing sediments of a river in southern Scotland resulted from the placement of a 60-70 meter wide buffer. If performed on less erodible soils than mineral soils, it would likely not need to be as wide to achieve an effective result. (Broadmeadow & Tisbet 2004)
- A study on a stream in central Iowa concluded that if the entire 11 kilometer stream had riparian forest buffers in place, the soil loss of the bank could be reduced by 72% (Zaimes, Schultz & Isenhart 2004)



Ranges of riparian forest buffer widths to achieve improvements (Broadmeadow & Nisbet 2004)

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