Banjeer

Let the River Flows

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Team Introduction

We are four Indonesian students studying abroad in South Korea. The stark difference between a developed country like South Korea and a developing country such as Indonesia motivates us to contribute to our country's development. We strived to realize it by utilizing our knowledge in technology.

Therefore, we want to realize our goal by joining the Imagine Cup hosted by Microsoft. We fancy turning our product into reality with the help and guidance of the experts.

Members:

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Problem Statement

The flood in Jakarta has been a recurring problem since the 17th century. At that time, most of the area of Jakarta was still in the form of swamps and wild forests, so it was often flooded from the water of several rivers, especially the Ciliwung River, which overflowed during heavy rains[1]

The Jakarta flood in 1621 was the first flood in the era of VOC rule in the archipelago, precisely during the leadership of Governor-General Jan Pieterszoon Coen. At that time, many houses were made of wood to wash away when the flood-hit Jakarta quickly. The flood in Jakarta is still happening annually, and climate change makes the matter even worse every year.

Why Flooding?

To address the problem, we need to know precisely why floods happen in Jakarta to address the issue. Some of the ground is as follows:

The geographical location of Jakarta
Most of Jakarta's area is considered as a lowland area. In fact, the average Jakarta's surface height is merely 7 meters above sea level. Furthermore, 40% of the city's area is below the sea surface level.

High rainfall intensity
Jakarta also suffers from high rainfall intensity during the rainy season. The situation worsens due to the climate change that brings the intensity up every year, furthermore, due to the fact that Jakarta is a lowland area. High rainfall intensity in a higher region nearby (Katulampa dam, for example) will also cause a severe flood in Jakarta.

Poor drainage system
As a developing country, Indonesia still implements the open drainage system. Therefore, the waterways are exposed to the public and vulnerable to careless actions of the people.

Poor Public Awareness Towards the Environment
From research data from the Ministry of Health, it is known that only 20 percent[2] of the total population of Indonesia cares about hygiene and health. Therefore, poor public awareness is one of the main causes of the annual flood.

Current Government Approach

The provincial government is trying its best to countermeasure the annual flood. In fact, they spend **1 trillion rupiahs (70 million USD)[3]** each year to reduce the effect of the annual flood. Some of the actions are naturalization of rivers, dredge and building reservoirs, rivers, ponds, and vertical drainage[4] Both three approaches require an extensive amount of capital and labor due to the fact that they have to visit and identify the condition of the river manually. However, these costly and time-consuming approaches fail to address the problem entirely.

Solution

We came up with a solution to aid the flood countermeasure in the capital city of Indonesia. **Banjeer** came up with the resolution of using Computer Vision to monitor the condition of rivers from satellite images. We aim to help various stakeholders, including the government, enterprise owners, and the citizens, in the mitigation, preparation, and response to Jakarta's annual flood.

Automating the river condition will help the government reduce the capital, time, and human resources spent on the annual flood countermeasure. The web is also equipped with features to foster Jakarta's citizen awareness of its environment. In the short term, we seek to aid the flood mitigation, preparation, and response better. In the long term, however, we expect to stop Jakarta's annual flood entirely.

We also hope that we can further improve our product so it can help the response to the flood globally, especially in the developing nations. We realize that floods are a major problem globally, especially for developing nations like Indonesia.

Features and Mockup

Underlying Tech

Machine Learning

We took geospatial data from Maxar open data of select sudden onset major natural disasters as our training dataset for our machine learning model. The images that we took are GeoTIFF images of multiple floods disasters and we process those images and separate them into 1024 x 1024 RGB images to simulate the way that we will process the data for our web.

We manually annotate them as a multi-channel mask for the target dataset, with rough guidelines as follows:

Good (Green)
1. A bluish color to the river indicates very little mud and sediment.
2. No trash or human waste is visible.
3. The riverbanks are populated by trees and are clear of any unnecessary buildings.

Mediocre (Yellow)
1. A slightly off-color to the river indicates trapped mud and sediment.
2. Some trash or human waste is visible.

Critical (Red)
1. A brownish color to the river indicates very high mud and sediment present.
2. Many trash or human waste is visible.
3. Unnecessary buildings densely populate the riverbanks.

The model that we are using is a U-Net with a pre-trained ResNet-50 backbone that serves as the encoder. It will output a 512 x 512 colored mask of the predicted river and its quality. We train our model

in the cloud using an Nvidia T4 GPU for 2 hours with the backbone frozen (untrainable) and another 2 hours with the backbone unfrozen (trainable). We also apply some basic transformations to the training data to increase its robustness. In the end, we save the state of both the model and optimizer so that we can continue to further improve the accuracy and robustness with transfer learning as we get more and more data and expand to other regions.
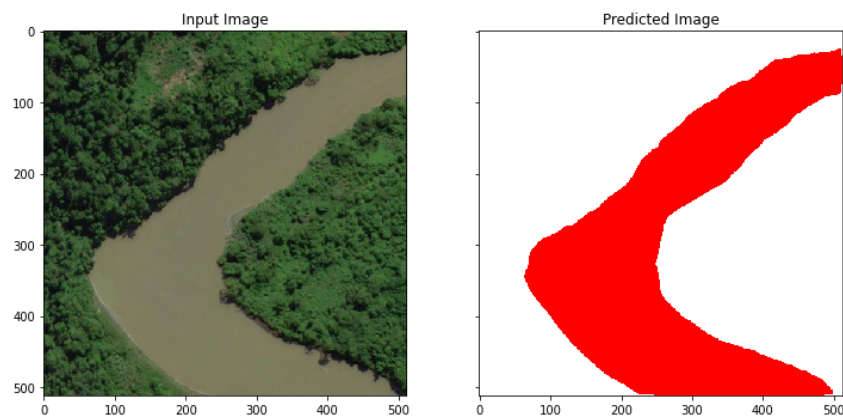
Using our exported trained model, we will preprocess data from satellite images of a chosen area, as we haven't integrated a MLops system for our web, and layer the predicted mask on top of the original image so that we can display it to our website.

Web

Our main product is our website, where we host both our features and information. We build our website using React JS and Django as back-end.

Map Overlay

The main feature of our product is a map overlay that indicates the condition of the rivers in the selected locations. We divide the condition into three main categories:

- Good (Green)
- Mediocre (Yellow)
- Critical (Red)

We use satellite imaging and feed it into our machine learning model to predict the quality of the river, and we use the prediction to layer over the satellite imagery. We made it as intuitive and straightforward as possible so that no one will have a problem in using the product and understanding the analysis.

My nearest River

We provide a feature to search for the nearest river from the user's location and provide an analysis of the said river. **Banjeer** then will give recommendations to improve the conditions and prevent floods in that area. This feature aims to increase their sense of belonging and raise people's awareness of the conditions of their nearby rivers. By serving the river condition to the surrounding inhabitant, we hope that they also start to take actions to prevent floods in their area such as not throwing their trash into the river, and making a community service to clean their environment.

Demo and Source code

Our demo video can be accessed here and our source code here

Stakeholders

We divided our stakeholders into three main targets that are the government, the citizen, and the enterprise owner

The Government

We aim to help the city government that seeks help in determining the condition of the river in their city easier, cheaper, and less time-consuming. Then, they can use the information from our product to take any action for the river that is in a critical state.

Characteristics

The stakeholder has a large amount of capital. Therefore, capital is not a problem for them if the product is meaningful enough to solve their problem. However, a lot of bureaucracy is needed to approach the stakeholder. Therefore, a specific marketing strategy is needed for the government.

Frustrations

The media constantly criticize the government's countermeasures every year. Until now, no governor has successfully tackled the flood problem in Jakarta. A breakthrough in the annual flood countermeasure will make their persona arise in front of the general public.

The Citizen

We aim to foster the awareness of the citizen regarding the salience of maintaining a clean environment by informing the condition of the nearest river to their home and the risk of flood. Therefore, we will provide our service **for free** to the general public. We also make our web as simple as possible to accommodate various users from different backgrounds and conditions.

Characteristics

The stakeholder has poor awareness of their environment. This is due to the economic condition as well as the Indonesian flawed education system. Moreover, they are reluctant to spend their money on products that are not beneficial to them directly. As a consequence, it is arduous to generate revenue from Indonesian citizens regarding an environmental product.

Frustrations

The annual flood affects their lives annually. The effects includes[5]:

Health problems
When large amounts of dirty water stagnate, health problems cannot be avoided. Various outbreaks of health problems are more easily spread and attack anyone, especially the elderly and children.

Economic Loss
The occurrence of damage to the house and the goods in it turned out to cause economic losses. In some areas, which are strategic locations, it can even slow down the economic cycle.

The Difficulty of Clean Water
When a flood comes, the amount of clean water will automatically decrease even though clean water is needed in a situation like this.

The Enterprise Owner

We aim to help the enterprise owner to forecast and prepare for the upcoming flood. This is essential for them since a lot of business owners rely on the condition of the annual flood. For instance, an

automotive-related business requires to predict how much spare parts to supply after the flood. Furthermore, the business customers are also impacted by the flood hence affecting their sales.

Characteristics

Similar to the government, enterprise owners tend to have a lot of capital. However, the main aim for this stakeholder is profit maximization instead of the commonwealth of the general public. Therefore, we have to package our product as a tool to aid them in generating more profit.

Frustrations

Predicting the right amount of goods to be stored is a challenging and capital-intensive problem. Furthermore, the annual flood makes the problem even worse. Therefore, finding the right tool to assist them during the annual flood period will be really beneficial for them.

Marketing Strategy

We have several marketing strategies to increase the awareness and consideration as follows:

Collaboration with Government
As the initial step to launch to the market, we will collaborate with the government to help them in the countermeasure of the annual flood.

Collaboration with Environmental NGO
The environmental NGO is where many Indonesian that are already conscious of the environment gather. Furthermore, they already have their own channel that connects environmental-conscious citizens. Therefore, through their channel, we hope that we can approach the general public faster.

Social Media
We will also promote our platform using social media ads to attract the general public and enterprise owners.
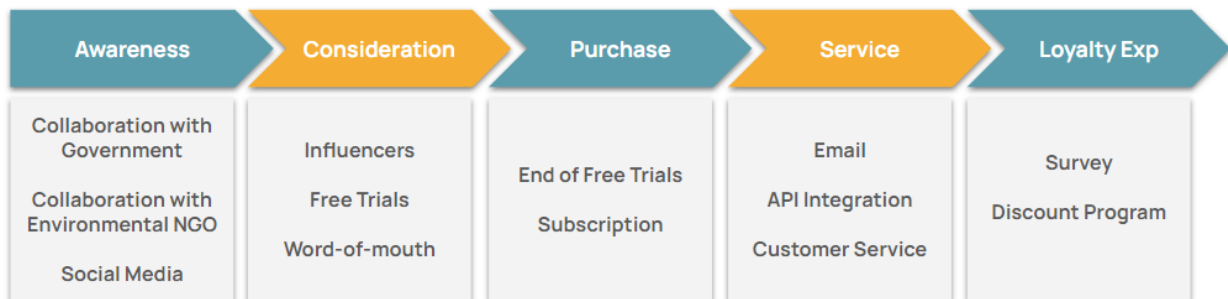
Influencers
We will promote our product to the general public through environmental influencers. The strategy is working really well lately in the Indonesian market.

Free Trials
We will provide a week free trial for enterprise owners to experience the features of our product and decide to use our product.

After we successfully raise the awareness and consideration towards our product, we will continue to stay relevant to the market in the following method:

Awareness	Consideration	Purchase	Service	Loyalty Exp
Collaboration with Government Collaboration with Environmental NGO Social Media	Influencers Free Trials Word-of-mouth	End of Free Trials Subscription	Email API Integration Customer Service	Survey Discount Program

Pricing Model

We provide 3 tier pricing model for our services based on the need of the individual or institution, which are:

Banjeer Lite
This is the free tier of our service that targets regular citizens. Users will have access to bi-weekly updated data of the river conditions and *My Nearest River*. This tier aims to increase people's awareness of the condition of their nearby river and encourage them to take care of their closest river.

Banjeer Pro
This is a subscription-based tier of our service that targets business enterprises. Users will have access to real-time data of river conditions and *My Nearest River*. We also provide Banjeer's map API to the enterprises for their own or commercial uses. This tier aims to help businesses that deal with and are affected by floods make their decision and build their products.

Banjeer Gov
This is a one-time payment of our service that targets government agencies as partners. As with the previous tier, the agencies will have access to real-time data of river conditions and *My Nearest River.* On top of that, we also provide Banjeer's map API as well as our machine learning model, and we will also partner with said agencies to improve and solve problems regarding issues of floods and river conditions in general.

	Banjeer Pro (Government)	Banjeer Pro (Enterprise)	Banjeer Lite (Citizen)
Pricing Model	One time payment	Subscription-based	Free to use
Data Frequency	Real-time	Real-time	Non real-time
API	✓	✓	✗

Limitation and Future Plans

We don't have access to good satellite data of floods to train our model for specific areas, such as in densely populated areas. We plan to collaborate with satellite imaging companies so that we can gain access to better and more images to increase the quality and accuracy of our prediction.

We also haven't implemented the real-time prediction, as we haven't implemented a robust MLops system for our website and we haven't got a way to obtain real-time satellite images. We plan to collaborate with satellite imaging companies to provide real-time imaging of the covered region. In the near future, we plan to integrate the MLops feature to deal with real-time prediction and use Bing Maps API to simplify the way the user experiences our website.

Lastly, we aim to improve our service and prediction by consulting with a hydrologist to provide better annotation and provide better suggestions to improve river conditions around the globe. We also plan to make our service more publicly available by partnering with more government agencies and companies, as well as advertising to regular citizens.