Mangrove script:
In 2013, when Typhoon Yolanda hit the Philippines, thousands of lives were lost, and entire towns were swept away. But in one coastal barangay, something different happened. The waves came, the wind roared yet the damage was minimal. What stood between the storm and the village? Not a wall. Not technology. But a forest of mangroves. Mangroves don't look like much. They're tangled, muddy, and easy to overlook. But they are nature's frontliners breaking storm surges, anchoring the shoreline, and sheltering fish, crabs, and birds. One hectare of mangroves can store more carbon than a hectare of rainforest. **Barangay Parina**, surrounded by a 9-hectare mangrove forest, was protected from the storm surge during Typhoon Yolanda, keeping homes largely intact. **They don't just protect the environment, they protect us**. General Santos City is a coastal area, which is why Mangroves play a huge role in mitigating climate change and acting as a buffer against storm surges, high waves, and flooding. A PNAS study (2025) measured real-world waves within coastal wetlands and found that forested wetlands (including mangroves) can attenuate extreme storm waves by ~35% over three wavelengths, providing significant flood protection when it's most needed, they also have very dense roots which bind the soil together, thus preventing erosion.

An AI-based system that helps detect signs of diseases or stress in mangrove trees based on leaf images. The system uses machine learning or **CNN (Convolutional Neural Network)** to analyze uploaded photos based on the classification for example; a **Healthy** leaf indicates that the tree is in good condition by showing a green color and tells that it is free from major deformities. **Stressed** leaves specify early signs of decline, telling from the slight curling or browning of the edges, which may be caused by nutrition imbalance, salinity, or temporary environmental factors (Mahmoud et.al., 2021). **Diseased** has significant discolorations (yellow, brown or black spots) which indicate clear fungal infection, pest damage, or rot.

Why **CNN?** CNNs are ideal for analyzing leaf images because they automatically detect key features like edges, textures, and disease spots through convolutional layers, eliminating the need for manual feature extraction. Their ability to recognize patterns regardless of position (translation invariance) makes them robust for varied leaf orientations. CNNs also efficiently process multi-channel data (RGB, infrared) and can leverage pretrained models for tasks like disease detection or species identification, even with limited datasets.

1st layer: Detects edges of the leaf.

2nd layer: Detects shapes like spots or vein patterns.

3rd layer: Learns higher-level features like patterns caused by disease.

It is used during field inspections, reforestation checkups, post disaster assessments, or anytime there is a suspicion of tree damage. This can also be used for scheduled mangrove monitoring activities organized by local governments.

This project will be used in mangrove rich coastal areas of GenSan, especially Buayan and Tambler. The AI model can be embedded in a mobile app or web-based system and can be used in the field to assess the health of mangrove leaves on site. It is especially useful in rural barangays where manual monitoring is common and technological support is scarce.

The primary users of this system are the local government unit (LGU) environmental officers, mainly the City Environment Natural Resources Office (CENRO), barangay staff, and environmental volunteers who are responsible for monitoring and maintaining mangrove forests. The system is designed for people with little to no technical background, assisting them with mangrove inspection and documentation. Residents who live near the area will also benefit from it by allowing healthier mangroves to have better coastal protection, more fish, and better livelihoods. When the problems are detected earlier, the community is safer.

The user takes a photo of the mangrove leaf, uploads it to the dashboard or mobile app. The AI system that is trained using a labeled dataset of the leaves then analyzes the leaf according to its current health classification (Healthy, Stressed/At risk, and Diseased/Unhealthy) and returns a diagnosis with a confidence score. The confidence score is a numerical value that states how certain the AI model is about its classification. Assuming the AI model detects a certain condition within a leaf with a score of 0.92%, it means the model is highly confident in its identification. if it’s around 45%, it may require human verification. Confidence scores in leaf disease classification improved model interpretability for farmers (Wang et al., 2023). For this to be usable, we will export the trained AI model via TensorFlow Lite and integrate it using Python to run the model locally. The output is then shown in a easy to read format for field inspectors with little technical background.