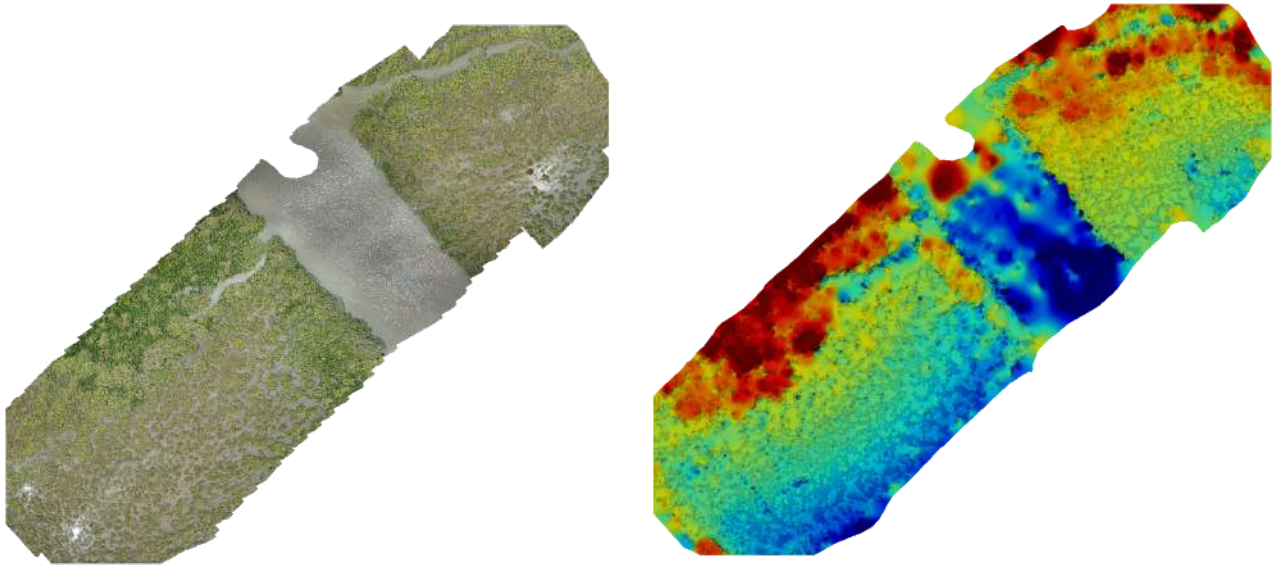# Mangrove Forest Monitoring in Indus Delta near Karachi, Pakistan

Orthomosaic and Digital Terrain Model (DTM) results for the mangroves survey in Indus Delta along the coastal area of Karachi, Pakistan

Pakistan Flying Labs team with community members and staff from the Sindh Forestry Department

OVERVIEW	
Flying Labs	Pakistan Flying Labs
Geographic area	Port Qasim area, Karachi, Sindh, Pakistan
Date range	April - September 2022

Sector program	EcoRobotics
Main SDGs	GOAL 13: Climate Action GOAL 14: Life Below Water

SCOPE	
Project stakeholders	Sindh Forestry Department, Government of Sindh, World Wildlife Fund (WWF), International Union for Conservation (IUCN), climate and mangrove experts.
People impacted	Local communities living near the Karachi coastal area
Number of people impacted	88 community members. 15 fishermen living near these mangrove forests.
Challenge	Mangrove forests play a vital role in combating climate change and largely facilitate the marine ecosystem in the surrounding areas of Karachi. In addition, the mangrove swamps, creeks and mudflats serve as a breeding ground for a diverse variety of marine life along the Sindh coastline, such as mussels, oysters, shrimp and fish, which move offshore as they grow. Some species of migratory birds equally use these swamps as wintering grounds. This ecosystem has been and continues to be badly impacted due to increased industrial waste, port activities and urbanization. This led to the depletion of mangrove forests in the Indus Delta. The conventional methods of mangrove health assessment applied by the Sindh Forestry Department entail expensive and time consuming on-site ground surveys. It is impractical to examine all the mangrove plants in the Indus Delta using traditional methods as only a few areas can be monitored using traditional techniques. Therefore, local communities, the Sindh Forestry Department and funding agencies lack a reliable mechanism for monitoring mangrove growth and identifying plant species and health issues in a timely manner.
Scope	This project focused on the mangrove forests in the Indus Delta which are spread across the coastline of Sindh Province. The project sought to use drone technology for the mapping and assessment of mangroves. Using the imagery captured thanks to

	drones, the following objectives were met within the area of interest:
	1. Quantifying mangrove cover and population. 2. Evaluating mangrove forest health. 3. Identifying different mangrove species, mainly Red Mangrove, Rhizophora mucronata, Ceriops tagal and Aegiceras corniculatum. 4. Identifying gaps for efficient plantation drives.
Outcome	Thanks to the captured data, we were able to identify areas where mangrove growth was insignificant and planting was required in those gaps. Another outcome was linked to quantifying different mangroves species and vegetation.
Impact	Through this project, apart from the outcomes mentioned above, Pakistan Flying Labs succeeded in the following aspects: ● We raised awareness among stakeholders about the usefulness of drones in other applications, such as mangrove seed spraying and forest and climate monitoring. ● Sindh Forestry Department showed their interest in engaging Pakistan Flying Labs for long-term technical support for training their operators to perform mangrove forest surveillance using drones.
Next steps	The Sindh Forestry Department was driven to adopt the use of drones as a way of not only monitoring the mangrove forests but also as tools for reforestation. They expressed a desire to work with Pakistan Flying Labs for a follow-up flight to assess the success of the interventions and arrange periodic monitoring of the mangroves in the Indus Delta and assessment for other similar projects using drones.

COMMUNITY ENGAGEMENT AND STAKEHOLDER SUPPORT	
Consent for data acquisition	Consent from Sindh Forestry Department was received prior to conducting the flights.

Activities to engage with the community	The local community members were engaged prior to conducting the flights and were made part of the surveying activity.
Community groups engaged with	Government officials from Sindh Forestry Department, community elders and children, a representative from the Federal Council for climate change.
Community attendance	15 members of the local communities along with the stakeholder representatives were in attendance.
Community feedback	The community wants to see similar projects, particularly for dispersing the mangrove seeds using drones. The officials of the Sindh Forestry Department were impressed by the results produced from the collected images and requested capacity building for their staff to conduct similar surveys.
Stakeholder support	We shared explanations on how to interpret the post processing results such as the NDVI and orthomosaic with the stakeholders. We facilitated capacity building for the Sindh Forestry Department staff to operate and use drones for field surveys.

DATA ACQUISITION	
Size of area	44 ha (0.44km^2)
Drone	DJI Mavic Pro 2
Sensor(s)	Hasselblad camera with a 1-inch CMOS sensor
Flight plan software	DJI GS Pro
Flight height	150 meters above ground
GSD (Accuracy)	2 cm/pix
Number of images acquired	513 images
Number of flights	4 flights
Time invested in data acquisition	2 days
Georeferencing	Onboard GPS

DATA PROCESSING & ANALYSIS	
Processing software	DroneDeploy

Processing time	4 hours
Data products	Orthomosaic, DTM, DEM
Analysis tools	ArcGIS Online
Analysis outputs	NDVI
Final outputs shared with stakeholders	High resolution images, orthomosaic, DTM, NDVI and DEM
Data sharing	Flash drive, Google Drive and email