Portagauge and Satellite Sea level monitoring system for the Southwest Indian Ocean – PASS-SWIO

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PASS-SWIO Project

PASS-SWIO, funded by the ESA Science for Society Programme EO Open Call, is a 12-month capacity building project which aims to establish a sea level monitoring system for Madagascar based on the installation and deployment of a low-cost relocatable tide gauge (Portagauge), which uses Global Navigation Satellite System interferometric reflectometry (GNSS-IR) technology, combined with the analysis of satellite altimeter sea level data to provide validation and wider scale knowledge on sea-level variability.

The project is working closely with the national Madagascar Meteorological Agency (DGM, Direction Générale de la Météorologie) who will take responsibility for the local maintenance and operation of the Portagauge, and who will be trained to carry out the data processing and analysis.

Discussions are being held with key stakeholders to review the project and agree a Road Map for the sustainable long-term implementation of a national sea-level monitoring system for Madagascar, which can serve as model for other island states and coastal countries in the South West Indian Ocean (SWIO) region and beyond.

Implementation Plan

The key aspect of the planned implementation (Fig. 2) is the coupling of satellite sea level data with data from a short-term deployment of an in-situ tide gauge (Portagauge). This enables ground-truthing of both satellite and in-situ datasets to local benchmarks and the derivation of meaningful information about historic long-terms trends and other low-frequency sea level changes following a short period of monitoring (~6 months) instead of the 40-year duration that is usually required of tide gauge records. Since the Portagauge, its sensors and communications systems are fully relocatable, its repeated redeployment at a new location every 6 months will allow a comprehensive set of ground-truthed altimetry-based sea level data-streams to develop, without the need for major capital investment in a network of permanent tide gauge installations.

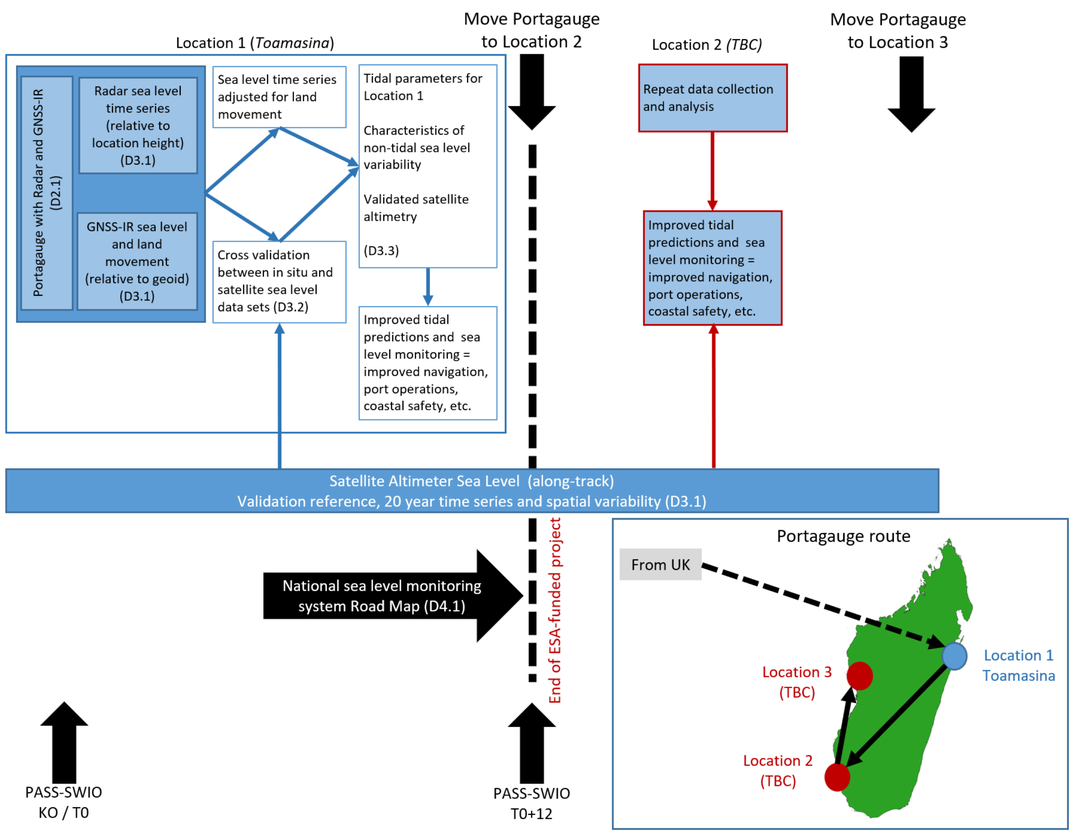

Figure 2. Project implementation diagram

Satellite sea level data for Madagascar

The use of satellite data to produce time series along-track "Total Water Level Envelope" (TWLE) is a well-established procedure, employed by NOC in previous projects (e.g. the UKSA-funded C-RISe, www.c-rise.info). The PASS-SWIO project will use the CMEMS sea surface height anomaly 1 Hz multi-mission along track time series data set, sub-selected for the Madagascar coast (Fig. 5). The processing and analysis of satellite altimeter data from 2010 to the most recently available, will provide a basis for cross-validation against in-situ data and information on spatial characteristics of variability – including annual and semi-annual cycles, long-term trends and inter-annual variability.

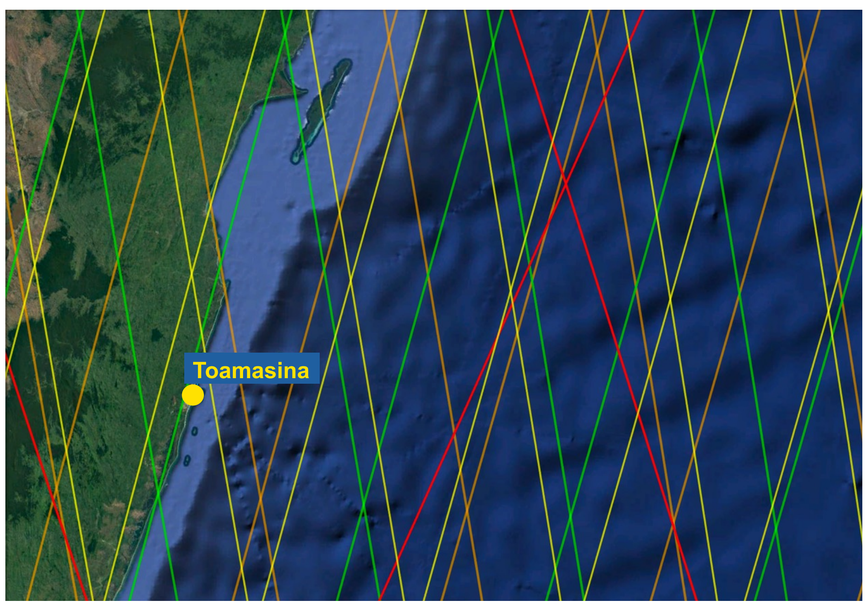

Figure 5. Toamasina with Jason (red), Envisat / AltiKa (yellow), Sentinel 3A (brown) and 3B (green) tracks

Importance of Sea Level Measurements

Madagascar has very limited tidal prediction (primarily based on model data) and currently has no national sea level monitoring capability, with only one functioning tide gauge (Fig 1), whilst an earlier tide gauge, in the cyclone prone north of the island, was swept away several years ago. Tidal information is vital for the safety of communities, infrastructure and commerce, and since short-term hazards are exacerbated by long-term increases in sea level, knowledge of longer-term changes is also essential. Improved information on sea-level and sea-level variability will result in enhanced safety in navigation and coastal activities (through better knowledge of tides), more accurate modelling of extreme events (such as storm surges associated with tropical cyclones), and will support better planning and management of the coastal zone through improved knowledge on long-term sea-level change.

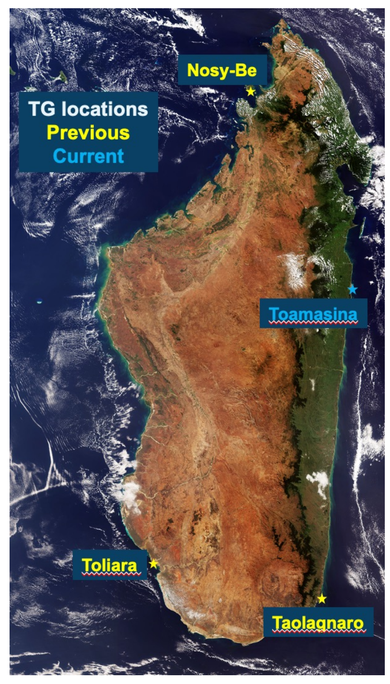

Figure 1. Locations of Tide Gauges in Madagascar

The NOC Portagauge

The Portagauge (Fig. 3), developed and built at the NOC, includes a conventional radar gauge and a GNSS receiver, which enables monitoring of relative sea level, absolute sea level and land motion relative to the geoid and to local datums. It is a stand alone system (Fig. 4), powered by batteries recharged by solar panels with a robust aluminium frame construction and a water tank for ballast and stability. Data is recorded on a datalogger and transferred by 4G mobile network.

Figure 3. Portagauge in the NOC workshop

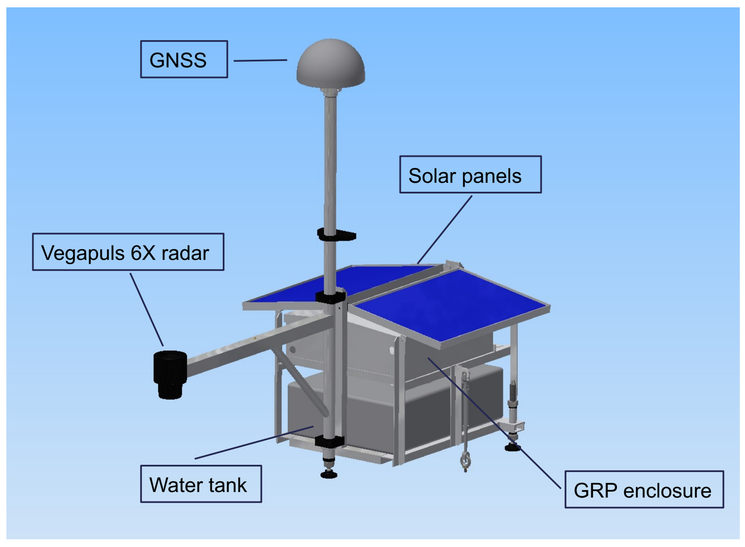

Figure 4. Design drawing for Portagauge

Sustainable Implementation Road Map

PASS-SWIO enables a demonstration of the proof of concept, with the deployment of the Portagauge at a single location (Toamasina) in Madagascar. A significant effort will be made to work with local stakeholders in the creation of a road map, which will plan for subsequent deployment of the Portagauge at other locations on the Madagascar coast, thereby creating a national sea-level monitoring system.

Following initial deployment, the Portagauge will remain in Madagascar as the property of DGM, who are receiving training in the installation and operation of the instrument and processing and analysis of the data. The team is working with Malagasy agencies (online and in-person) to understand requirements for sea level monitoring capability and set out a plan for future Portagauge deployments considering important port and harbour locations, requirements for regional coverage, logistical aspects (e.g. transport and local support) and funding options. This will culminate in a Sustainable Implementation Road Map which will establish a long-term, sustainable, national sea-level monitoring system for Madagascar and will serve as a model for other island states and coastal countries.

www.satoc.eu/projects/pass-swio - https://eo4society.esa.int/projects/pass-swio