Low-cost nearshore survey methodologies

for generating spatial datasets for hazard and risk assessments

Many applications of geospatial data in coastal environments require information about the local topography and bathymetry. However, because existing topographic and bathymetric data have been collected independently for different purposes, it is difficult, but necessary, to merge them together at the land/water interface, owing to differences in format, projection, resolution, accuracy, and datum. Use of the best available and most recent data is always recommended when conducting detailed hazard and risk assessment. However, these datasets are not always available in the countries.

RIMES has developed low-cost methodologies for generating nearshore bathymetric, topographic, and exposure datasets which can be used to supplement lack of high-accuracy datasets. The methodology involves the collection of nearshore (i) bathymetry through an ordinary single-beam fishing sonar and optimized survey route interval, (ii) topographic data through a combination of remote sensing and ground survey data, and (iii) building properties through windshield survey, for vulnerability assessment.

Low-cost survey methodologies

1. Bathymetric survey

Bathymetric data acquisition involves sonar survey, and tidal measurement for correcting raw sonar depth readings. Sonar survey is conducted in shallow water areas of up to 30 to 50 meter depths. The survey uses a commercial fish finder, and follows an optimized route design, with densified surveys in areas having local variation, e.g. abrupt changes in elevation due to rocks and corals, and presence of mounts or depressions. Existing sounding data, or nautical charts, are used to supplement survey data in deeper areas.

For tidal measurement, a temporary portable tide gauge is calibrated and installed near, or within the pilot site; data is recorded periodically by the tide gauge data logger. A temporary tidal benchmark, tied to existing benchmarks, is established to serve as connecting point between the sea and land survey data. Elevation in mean sea level (MSL, the common vertical reference used for bathymetric and topographic data) of the temporary tidal benchmark is determined from a leveling survey, which transfers the elevation from a known tidal benchmark to the temporary tidal benchmark.

The equipment used for sonar survey and tidal measurement have been tested against high-grade survey equipment, and results are found to be very satisfactory.

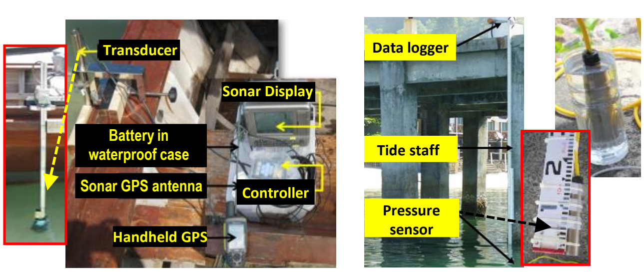

Figure 1. Sonar setup (left) and tidal setup (right)

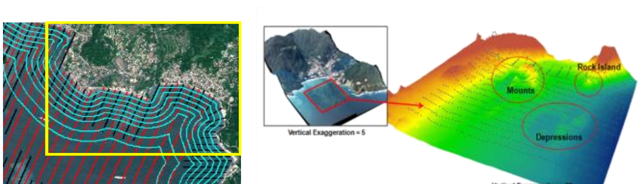

Figure 2. Optimized route design (left) and survey densification for areas with local variation (right)

2. Topographic survey

Topographic data collection involves post-processed kinematic (PPK) GPS survey for collecting ground control points for photogrammetry, and real-time kinematic (RTK) GPS survey for collecting elevation data along the road network. Remote sensing data is used to supplement areas that are inaccessible, and where GPS signal is not acceptable. GPS heights are transformed to the MSL through a datum correction value, determined by GPS observation on a known MSL elevation benchmark, or vice versa.

Shoreline is delineated to define the connection between land and sea. For steep slope or cliff areas, existing maps or images may be used. For gentle slope areas, e.g. beaches, a walking RTK GPS survey may be employed.

Survey of rivers that drain to the sea could be through sonar, pole, or walking RTK GPS survey, depending on water level conditions.

Figure 3. Baseline and PPK GPS survey for GCPs used in photogrammetry

Figure 4. RTK GPS survey along road network, shoreline, and mangrove

Figure 5. River survey by sonar, pole, and RTK GPS survey

3. Exposure survey

People, building, and critical facilities are considered the major exposed elements in risk assessment. Tsunami damage to buildings and critical facilities, for example, depends on the wave energy and capacity of these structures to resist the wave; while earthquake damage, on another hand, depends on the level of ground shaking and capacity of the structures to resist the movement.

Hence, an exposure survey focuses on: building materials/ construction type to determine structural vulnerability; height/ number of floors to identify opportunity for vertical evacuation in case of tsunami; building usage to evaluate population density, for determining the potential number of people who might be trapped during an event.; and the location of these buildings and critical facilities.

The exposure survey, or windshield survey, uses a digital video recorder with built-in GPS, set up in a vehicle that runs along the road network to collect building information.

Figure 6. Windshield survey at Barrio Barreto, Philippines

Survey data processing

1. DEM generation

A digital elevation model (DEM) is generated through integration of various bathymetric and topographic data sources, e.g. survey, map, aerial or satellite photogrammetry, freely available DEMs like SRTM and GEBCO, etc. These datasets, originally based on a different format, projection, resolution, accuracy, and datum are transformed to a common system to ensure seamless integration at the land/water interface.

Sonar survey data is processed using a script developed for automatic correction of sounding data, using tidal and draft data. Topographic elevation is generated through photogrammetry and integration of RTK GPS elevation data.

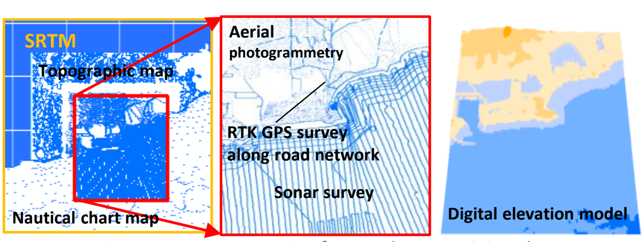

Figure 7. DEM generation for Hambantota, Sri Lanka

2. Exposure data inventory generation

Building images collected are interpreted for building properties, e.g. construction type, number of floors, and occupancy type, and linked to the building footprint map using open-source GIS platform.

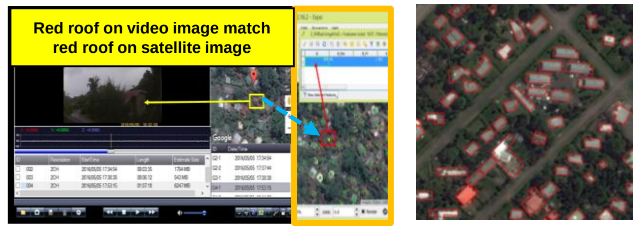

Figure 8. Building exposure data processing through open source GIS

Figure 9. Building properties based on structure and usage

Capacity building on field survey and data processing

RIMES organizes training on near-shore surveys and data processing. The training aims to enhance capacity in generating nearshore bathymetry, topography, and exposure data in the country. The training includes theory, practical exercises, interactive and participative lectures, discussion on case studies, and examples, field survey, and data processing.

The training is designed for technical officers who have responsibilities in generating (i) bathymetric data, e.g. Hydrographic Department, (ii) topographic data, e.g. Land Survey Department, and (iii) exposure survey, e.g. disaster management agency.

The **Regional Integrated Multi-Hazard Early Warning System** (RIMES) is an international and intergovernmental institution that is owned and managed by its Member States for the generation and application of early warning information. RIMES helps to build capacity of Member States in the observation and monitoring of seismic, tsunami, oceanic, meteorological, hydrological, and climate phenomena, and in the generation and communication of associated risks, for appropriate and timely user responses to warning.

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