Training/Workshop on

Tsunami Evacuation Maps, Plans, and Procedures and the UNESCO-IOC Tsunami Ready Recognition Programme for the Indian Ocean Member States

Hyderabad - India, 15-23 April 2025

Tsunami Inundation Modelling and Map

TIMM: Inundation Mapping Modeling Requirements: Ocean Bathymetry and Land Topography Digital Elevation Models (DEMs), Best practices for constructing DEMs

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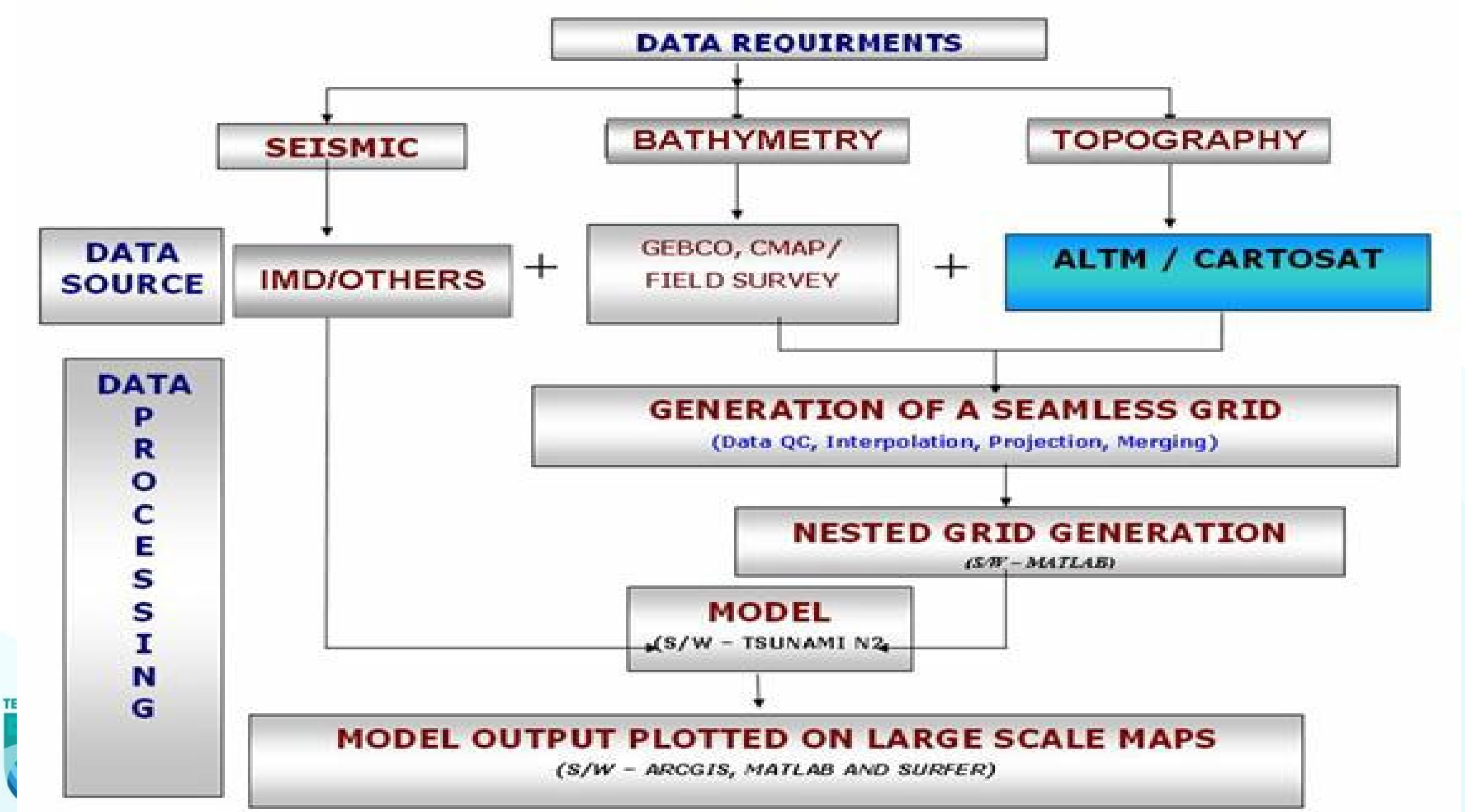
Dr R S Mahendra
Scientist-F, INCOIS

Tsunami Modelling and Mapping-Procedure

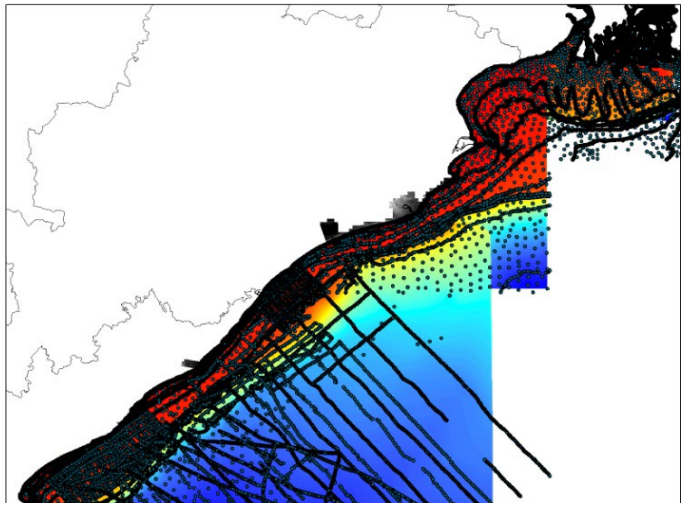


Bathymetry data, Sources and merging

•Define:
- **Bathymetry** = underwater elevation (ocean floors, lakes)
- **Topography** = land elevation

•Purpose: Why merge them?
- Create seamless land-sea DEMs
- Coastal flood modeling, marine navigation, ocean circulation models
- Improve accuracy of Earth surface representation

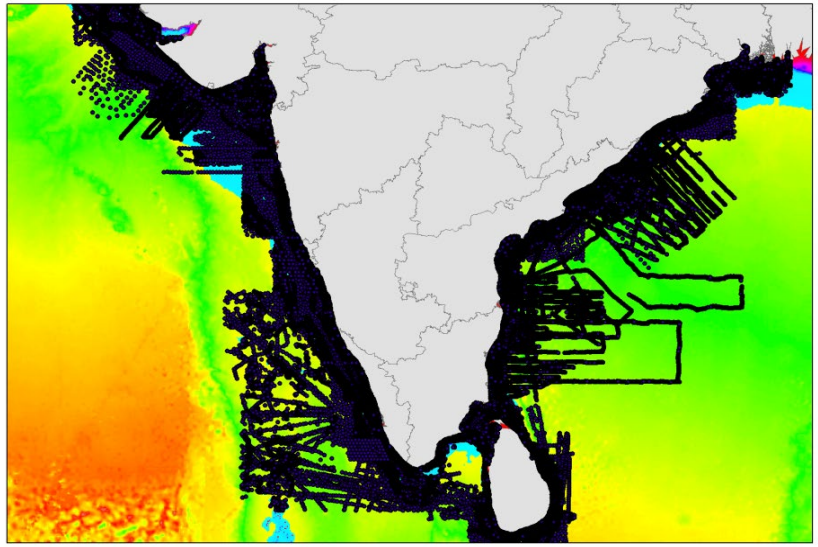
Example: NHO Charts, SBE, MBE from ship for deep areas, coastal Jetski fitted with SBM and GPS



Method of Generation of bathymetry data

Survey from sea
- Single Beam Echosounder (SBE)
- Multibeam echosounders (MBE)
- Sounding

Satellite:
- Optical characteristics and inhering water depth
- Wave characteristics
- Bathymetric LIDAR



BATHYMETRY	RESOLOTION	SOURCE
GEBCO	500 m	https://www.gebco.net/
ETOPO 2022	500 m	https://www.ngdc.noaa.gov

Bathymetry data, Sources and merging

Method of Generation of Topographic data
Survey from sea

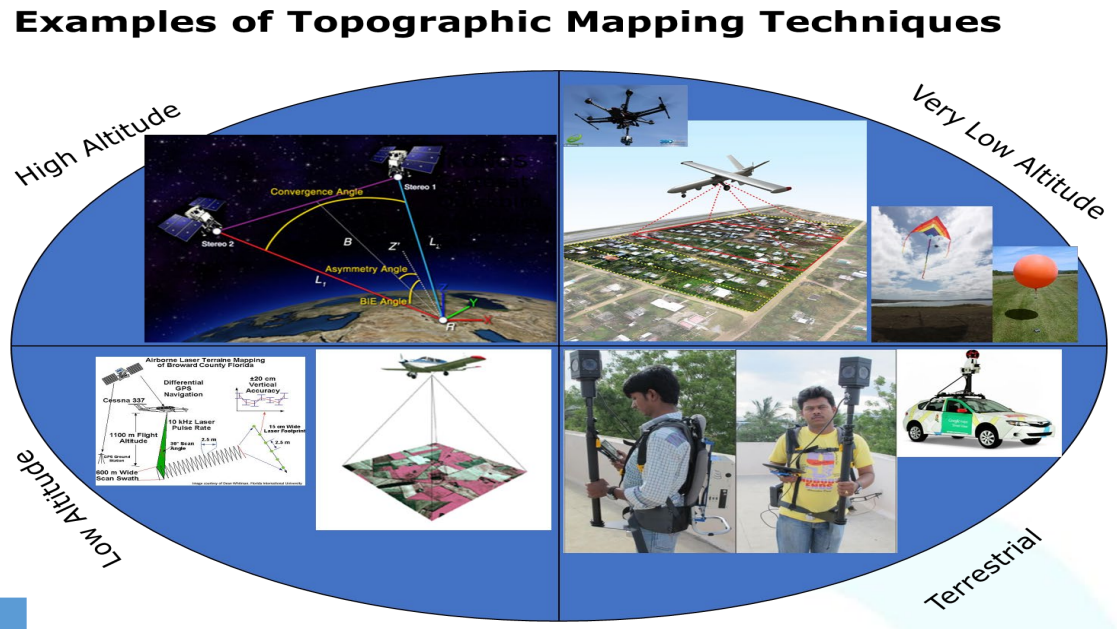
- GPS, RTK, Levelling, etc
- 360 degree street mapping

Remote Sensing (Photogrammetry and LiDAR mapping)

- Drones
- Aerial

Satellite:

- Oprical:Satellite Stereo
- Microwave: Interferometric

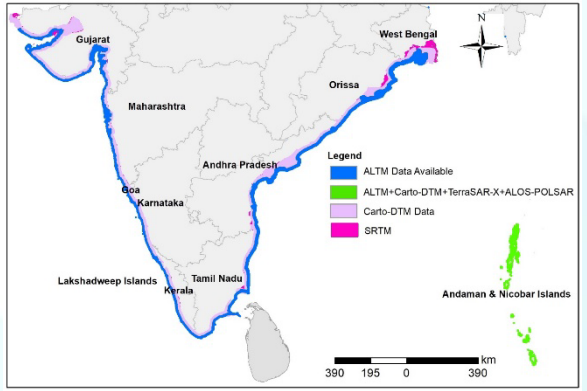


Opensource Global Topographic data sources

BATHYMETRY	RESOLOTION	SOURCE
SRTM (Shuttle Radar Topography Mission)	30 m	USGS EarthExplorer
Copernicus DEM (EU-DEM)	30 m	Copernicus Open Access Hub
ASTER GDEM	30m	NASA Earthdata
ALOS World 3D (AW3D30)	30m	ALOS Global DSM
MERIT DEM	90m	MERIT DEM Project Page

Topography data sources

- ALTM
- Carto-DTM
- Terrasar-x



Bathymetry and topographic data merging

Challenge	Details
Different Resolutions	Land data often finer than ocean data
Data Voids	Deep ocean areas lack measurements
Vertical Datums	Mean Sea Level vs. EGM96, NAVD88, etc.
Edge Matching	Seamless transitions at coastlines
Coordinate Systems	UTM vs geographic, projections
Units	Meters vs. feet, positive up vs. down

Merging Methods

1. Simple Overlay / Mosaic
- Use raster calculator or merge tools
- Priority to highest resolution or trusted source

2. Blending Zones
- Create transitional zones along coasts
- Use weighted averaging to smooth junctions

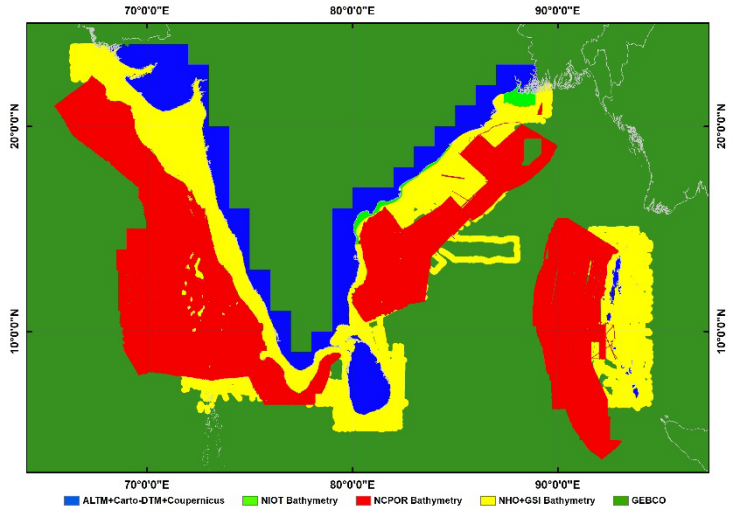
3. Interpolation for Gaps
- Fill in missing data using IDW, spline, kriging

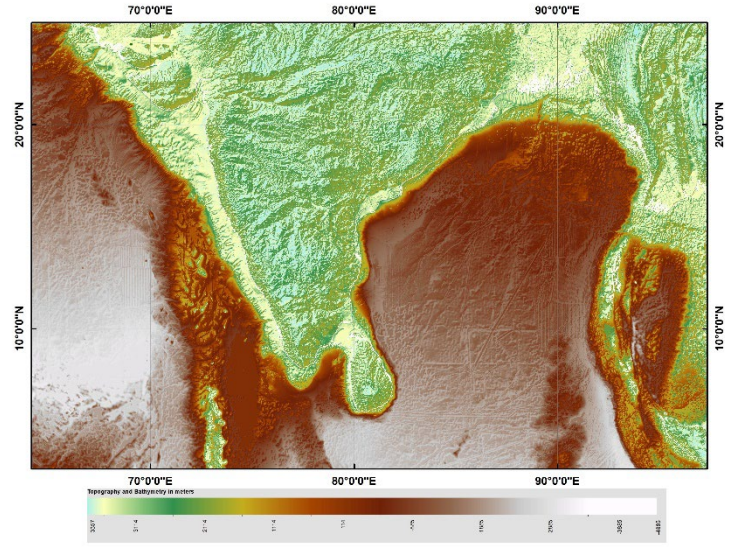
Tools
- **QGIS** – Free & open-source GIS platform
- **GDAL / Rasterio / xarray (Python)** – Programmatic access and analysis
- **Panoply** – Great for quickly viewing NetCDF/HDF data
- **Blender / 3D Mapping** – For visualizing terrain in 3D

Interpolation techniques

Method	Smoothness	Preserves Sharp Features	Speed	Good for Sparse Data	Notes
IDW	Medium	No	Fast	Yes	Simple & fast
Kriging	High	No	Slow	Yes	Statistically powerful
TIN	Low-Med	Yes	Medium	Yes	Vector-based
Natural Neighbor	High	Somewhat	Medium	Somewhat	Smooth + natural
Spline	High	No	Medium	No	Can oversmooth

Example





Thank you

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