References Frame in Practice Seminar
Operational Aspects of GNSS CORS

GNSS CORS for Hydrography

Geoscience, Energy and Maritime Division (GEM)

Salesh Kumar, Hydrographic Surveyor

saleshk@spc.int

Pacific Community
Communauté du Pacifique

19 September 2018
Suva, Fiji

Outline

- Introduction
- Work areas at GEM Division
- What is hydrography
- CORS in hydrography
- Some examples
- Conclusion

Pacific Community

The Pacific Community (SPC) is the principal scientific and technical organisation in the Pacific region, proudly supporting development since 1947. We are an international development organisation owned and governed by our 26 country and territory members.

The Pacific Community (SPC)

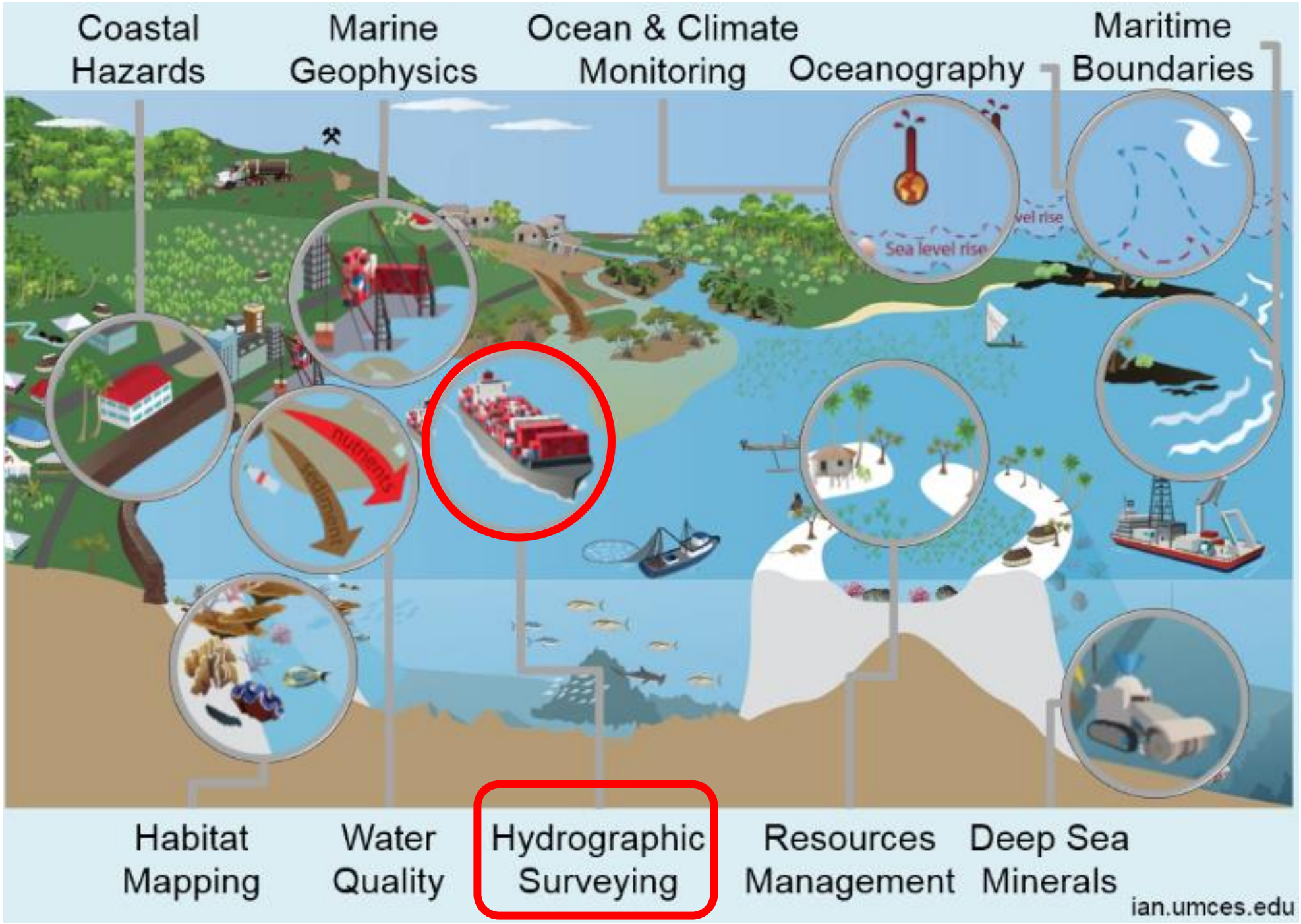
26
Member Countries and Territories

600 staff

14 Sectors

USD **100** million
annual budget

Our Work Areas



What is Hydrography

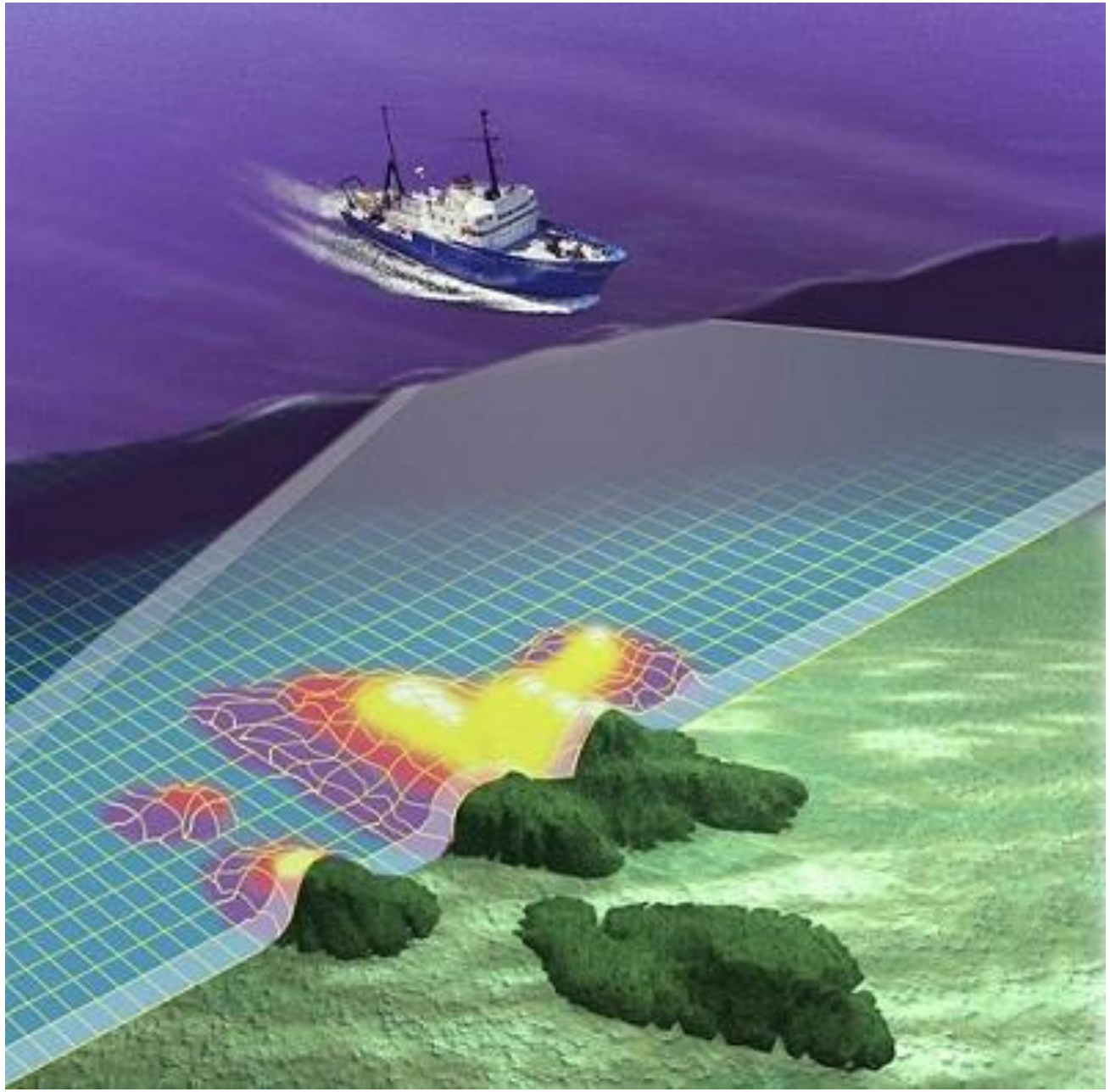
(26) 6 Idrografia SPOT Inglese - YouTube.MKV

- https://www.youtube.com/watch?v=4YyFowCAA0Y&feature=youtu.be

How can we map the seabed?

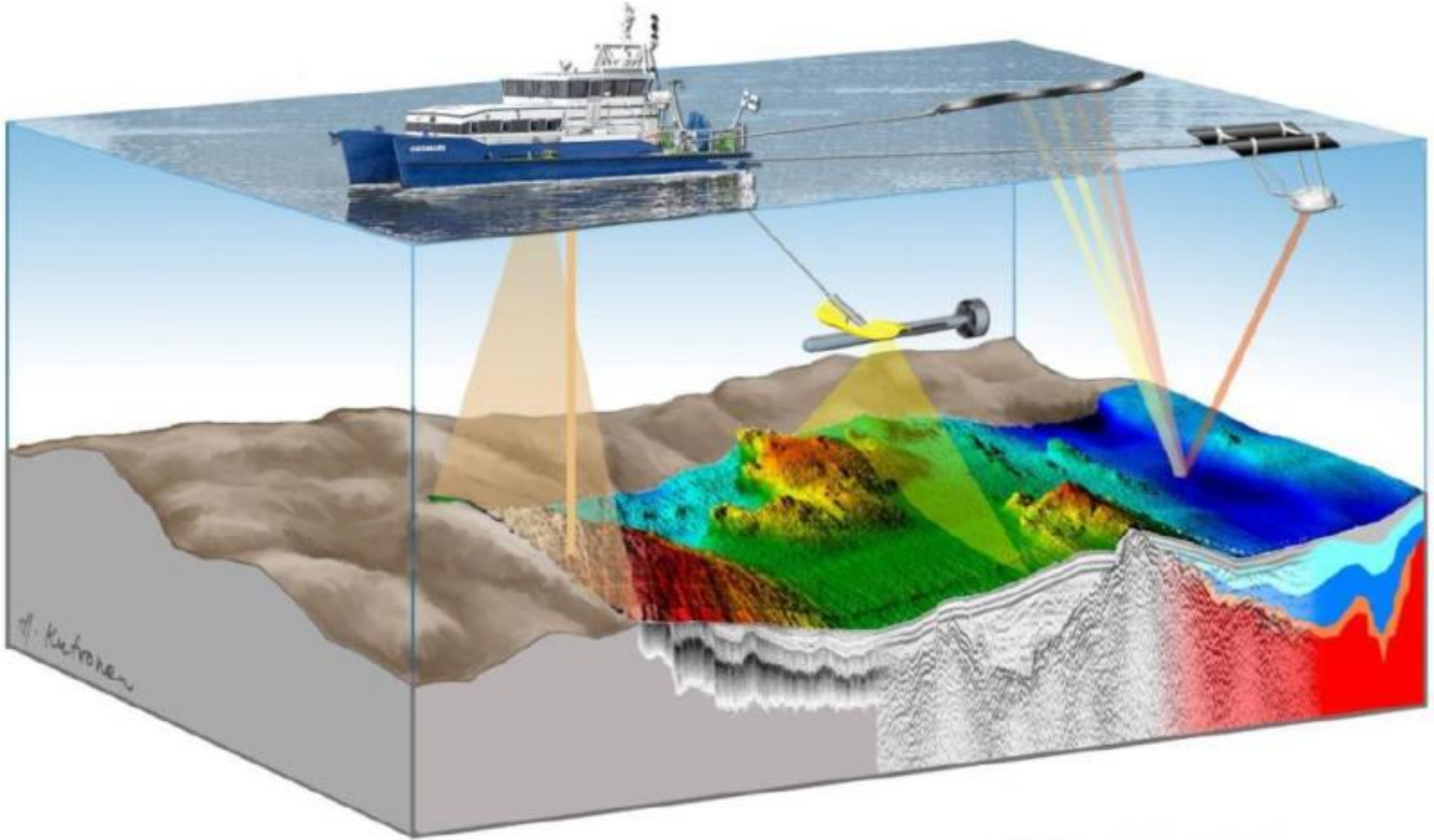
- Multibeam Echosounder
- Singlebeam Echosouders
- Sidescan sonars
- LiDAR Survey

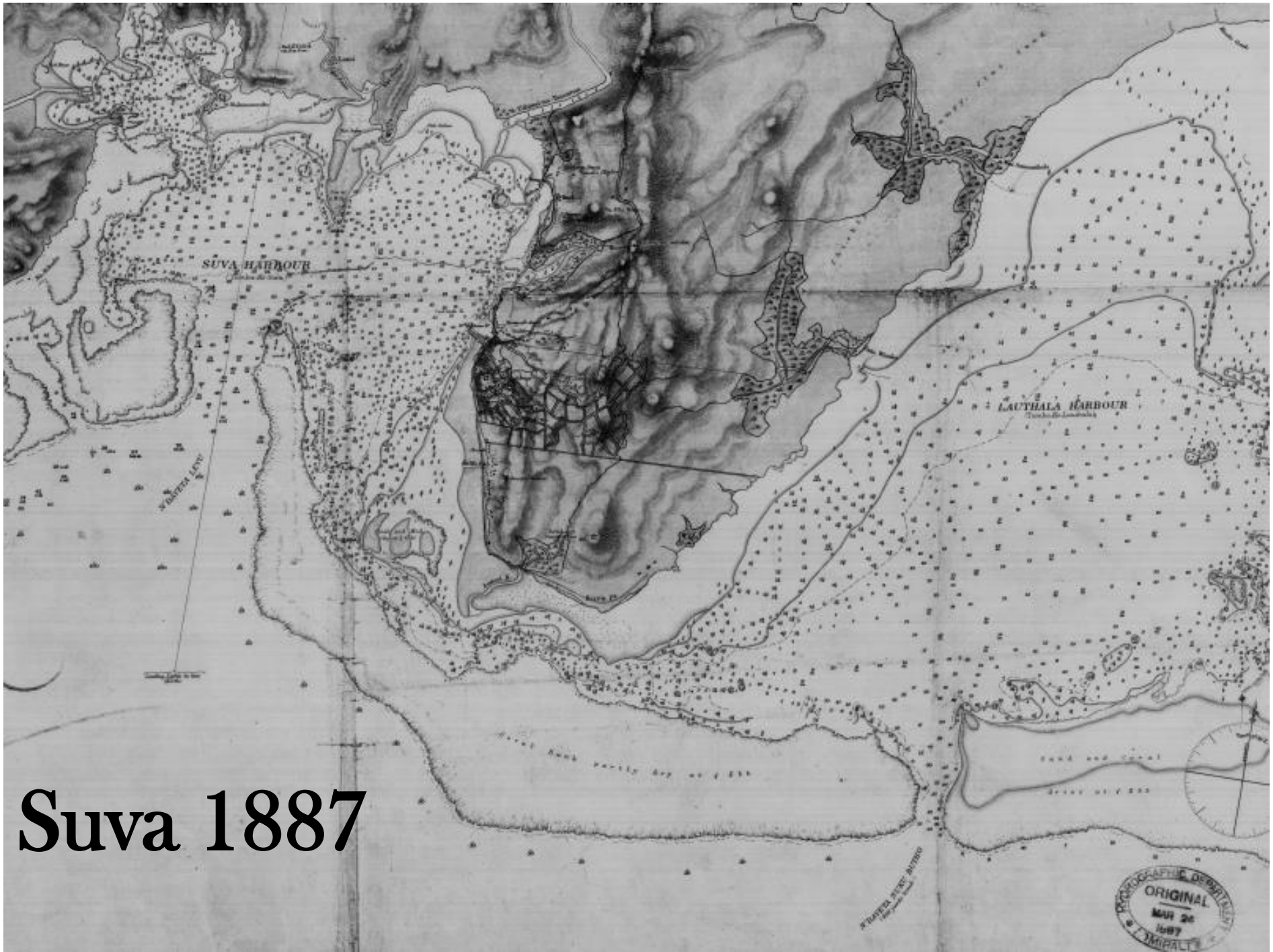
➢Vessel,
➢expertise,
➢operational resources, etc.



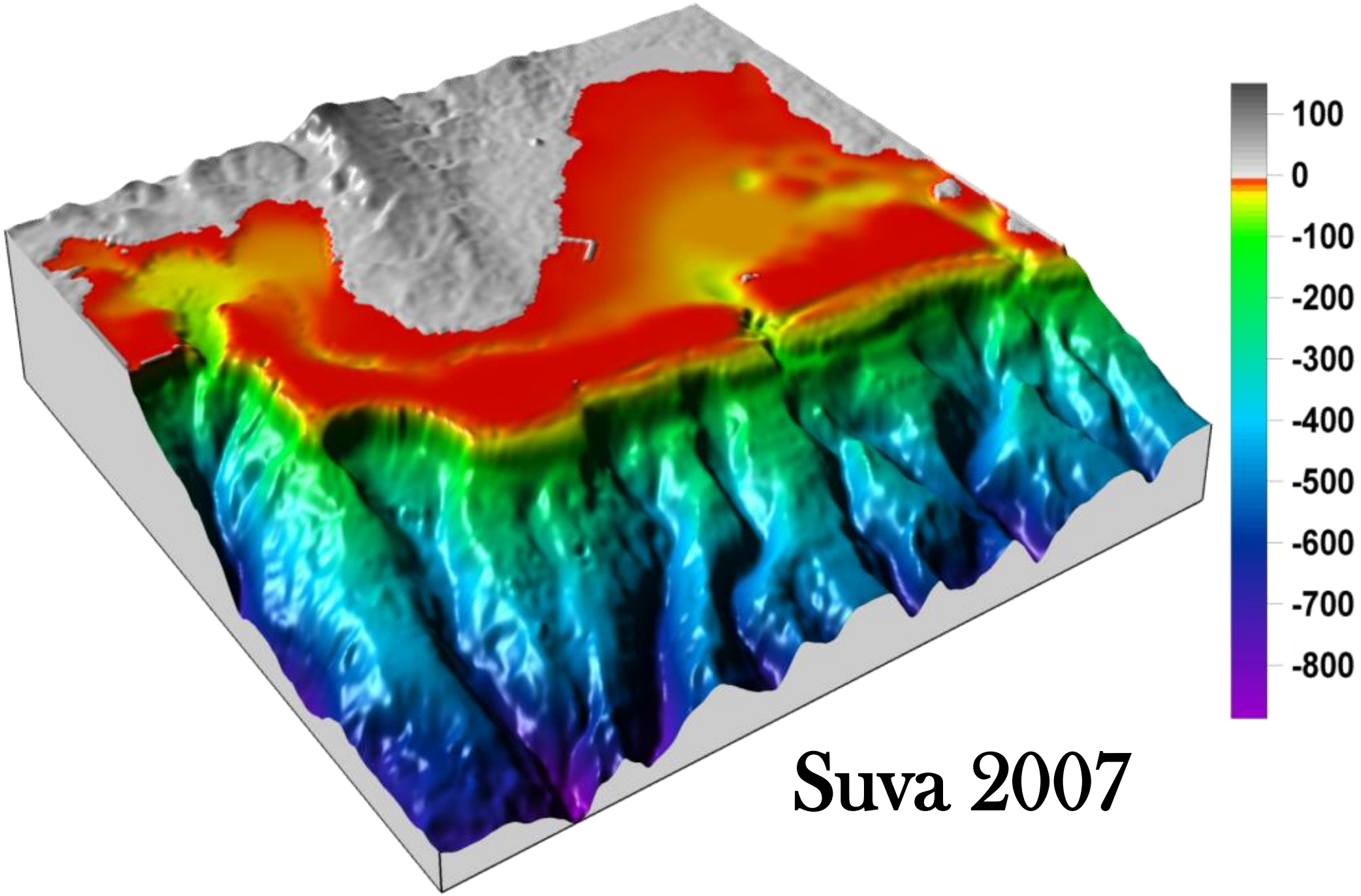
SPC has all the required toys (~USD 1M)

- Singlebeam echosounder, Multibeam echosounder, precision GNSS, sidescan sonar, magnetometer, boomer seismic, software, staff, etc.





Suva 1887


100
0
-100
-200
-300
-400
-500
-600
-700
-800
Suva 2007

Hydrographic surveying and ocean mapping use high accuracy GPS for three dimensional positioning (X, Y, Z)

Hydrographers interest: Vertical component

Positioning of objects in question are:
sea surface
Water column
Seafloor etc

FIG COMMISSIONS

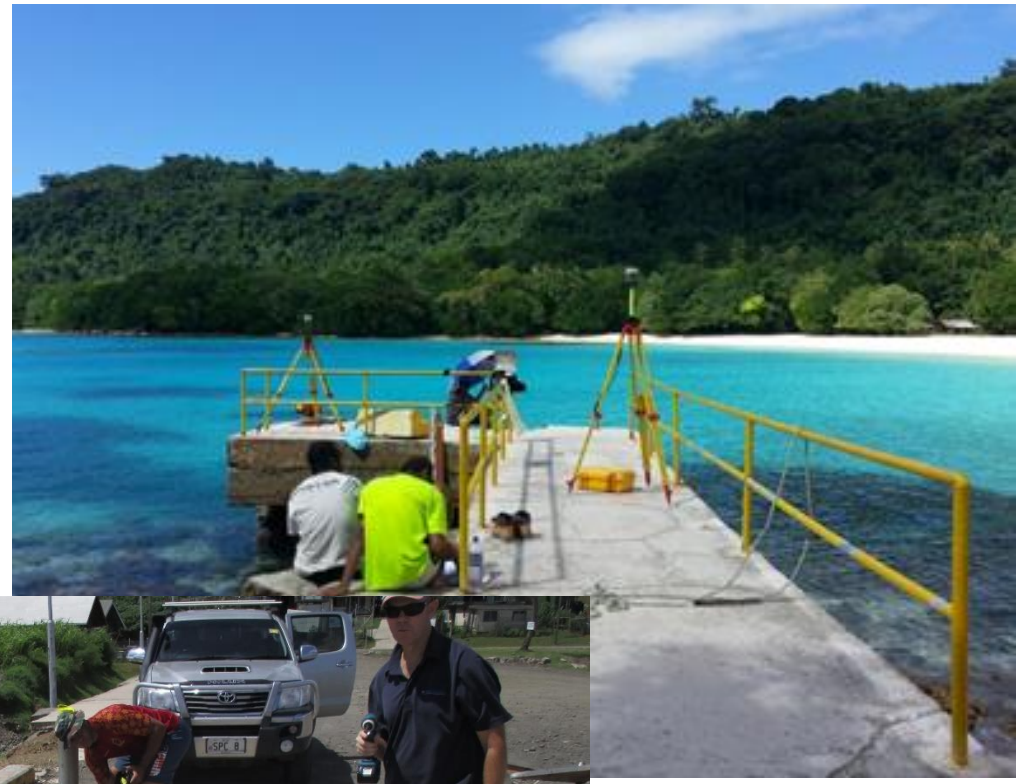
Commission 4 – Hydrography

Commission 5 – Positioning and Measurement

Hydrographic survey

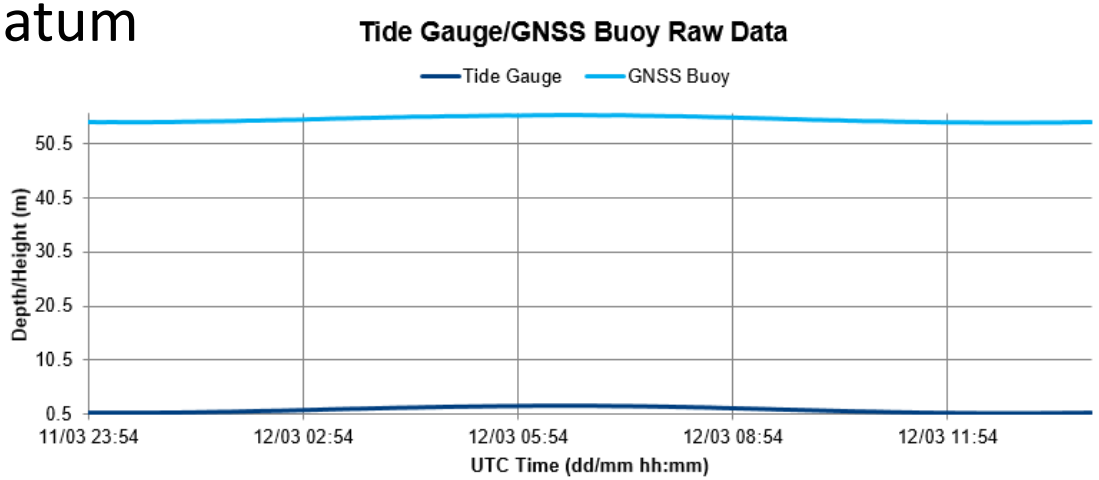
Tide Gauge Installation

- Installation required when there are no permanent tide gauges around the survey areas
- Usually left in situ for 35 days
- Tide gauge to pole calibration :
  - Manual method
  - GNSS method



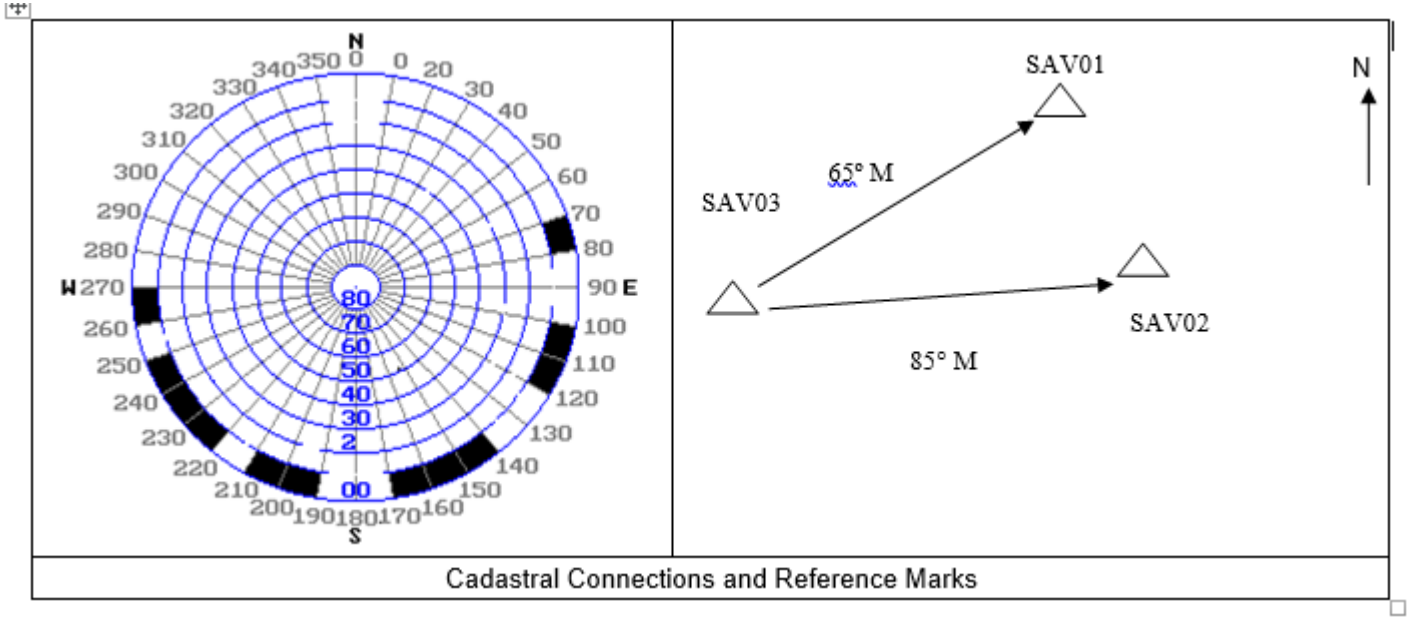
Tide Pole to gauge calibration(GNSS method)

- 2 GNSS GPS are used logging at the same time interval (usually 1 sec epoch)
- One on a known bench mark
- The other on a buoy or any moored boat etc
- The data sets are process in RTK Lib software
- Chart datums can be established from GPS tide buoys to estimate the mean water surface, relative to the ellipsoid. This datum is used to translate the ellipsoid related bathymetric data to chart datum



Hydrographic survey

Geodetic survey component



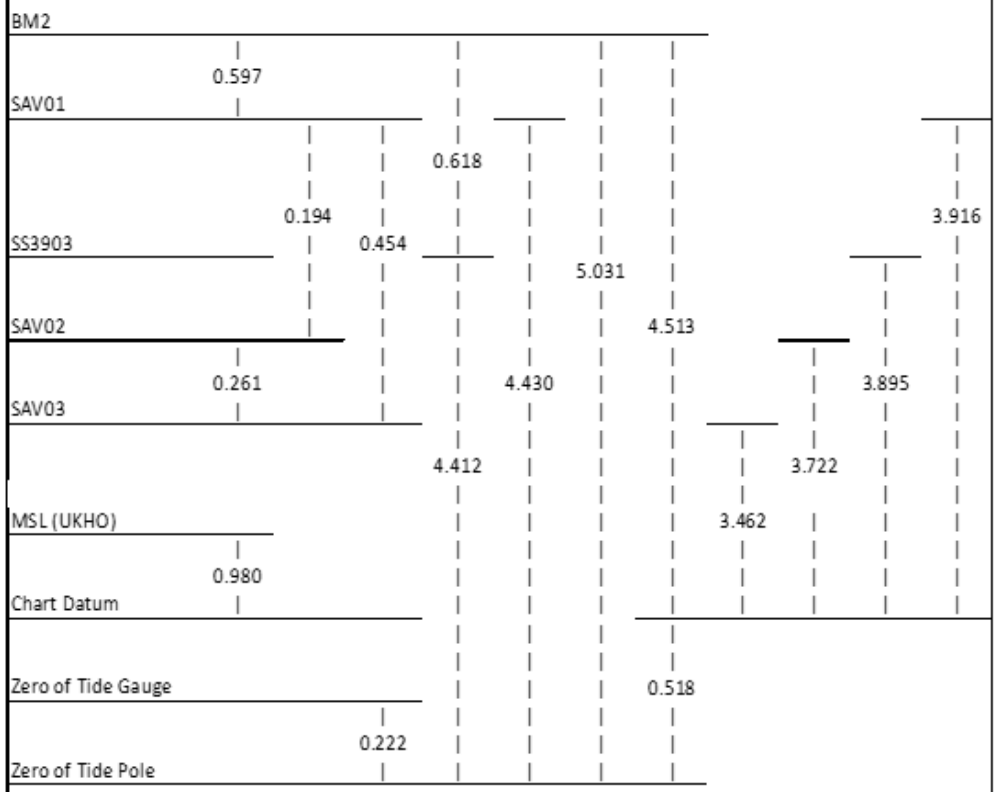
Vertical control Method
Geometric levelling (Spirit levelling method)

- Levelling are operations which allow the measurement of difference orthometric heights (or geoid elevations) between points or their difference in elevation.

TIDE STATION LEVEL SUMMARY - Savusavu Tidal Station (2017)

PROJECT DETAILS	
Project Title	Savusavu Hydrographic Survey
Project Number	FJ-SAV-2017
Client	Fiji Roads Authority (FRA)
Vessel	MRD Vessel "Vatutalei
Location	Main Jetty Savusavu, Fiji
Surveyor	Salesh Kumar
Date	11 March 2017

SOUNDING DATUM, TIDE GAUGE ZERO AND BENCHMARK LEVEL SUMMARY



SOUNDING DATUM SUMMARY

Chart Datum is	**4.513**	**m below BM2**	0.518	m above TIDE POLE ZERO
	3.895	m below SS3903	0.222	m above TIDE GAUGE ZERO
	3.916	m below SAV01		
	3.722	m below SAV02		
	3.462	m below SAV03		

APPROVALS

Compiled:	Salesh Kumar	Checked:	D. Mundy

Processing GNSS data

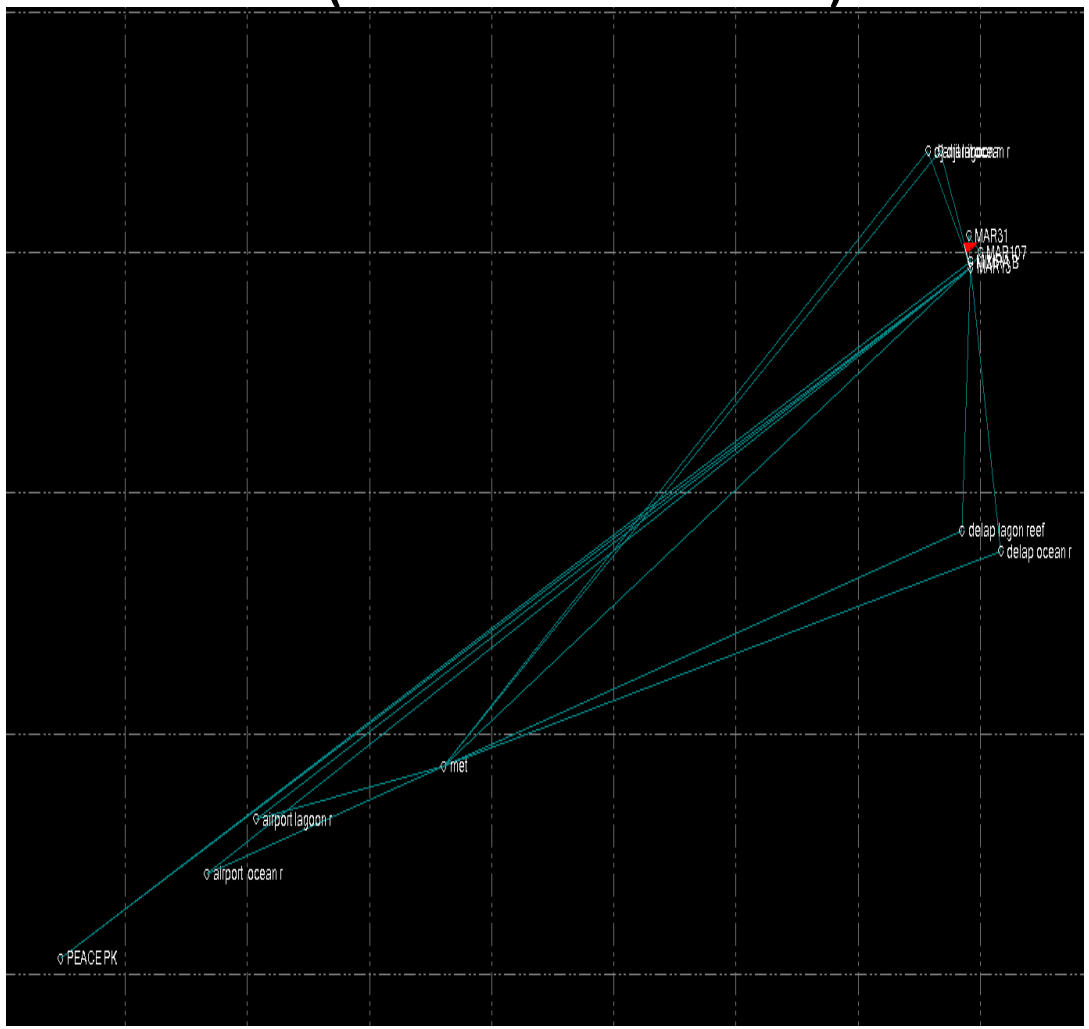
AUSPOS processing

3.2 Geodetic, GRS80 Ellipsoid, ITRF2008

Geoid-ellipsoidal separations, in this section, are computed using a spherical harmonic synthesis of the global EGM2008 geoid. More information on the EGM2008 geoid can be found at http://earth-info.nga.mil/GandG/wgs84/gravitymod/egm2008/

Station	Latitude (DMS)	Longitude (DMS)	Ellipsoidal Height(m)	Derived Above Geoid Height(m)
3903	-16 46 41.12435	179 19 32.15186	57.313	3.846
ASPA	-14 19 33.92855	-170 43 20.78493	53.477	20.853
AUCK	-36 36 10.21784	174 50 03.79081	132.678	97.745
KOUC	-20 33 31.27676	164 17 14.42022	84.126	23.679
LAUT	-17 36 31.71690	177 26 47.69511	89.644	31.684
MOBS	-37 49 45.85640	144 58 31.22603	40.592	36.000
NIUM	-19 04 35.48677	-169 55 37.46078	89.688	59.069
NRMD	-22 13 41.95857	166 29 05.59261	160.321	100.010
SAMO	-13 50 57.14252	-171 44 18.33870	76.759	39.518
THTI	-17 34 37.40983	-149 36 23.24238	98.029	90.349
TID1	-35 23 57.11471	148 58 48.00237	665.333	646.486
TONG	-21 08 40.96919	-175 10 45.15894	56.283	3.713
TOW2	-19 16 09.38560	147 03 20.48933	88.096	30.161
TUVA	-8 31 31.03538	179 11 47.59139	38.382	3.543

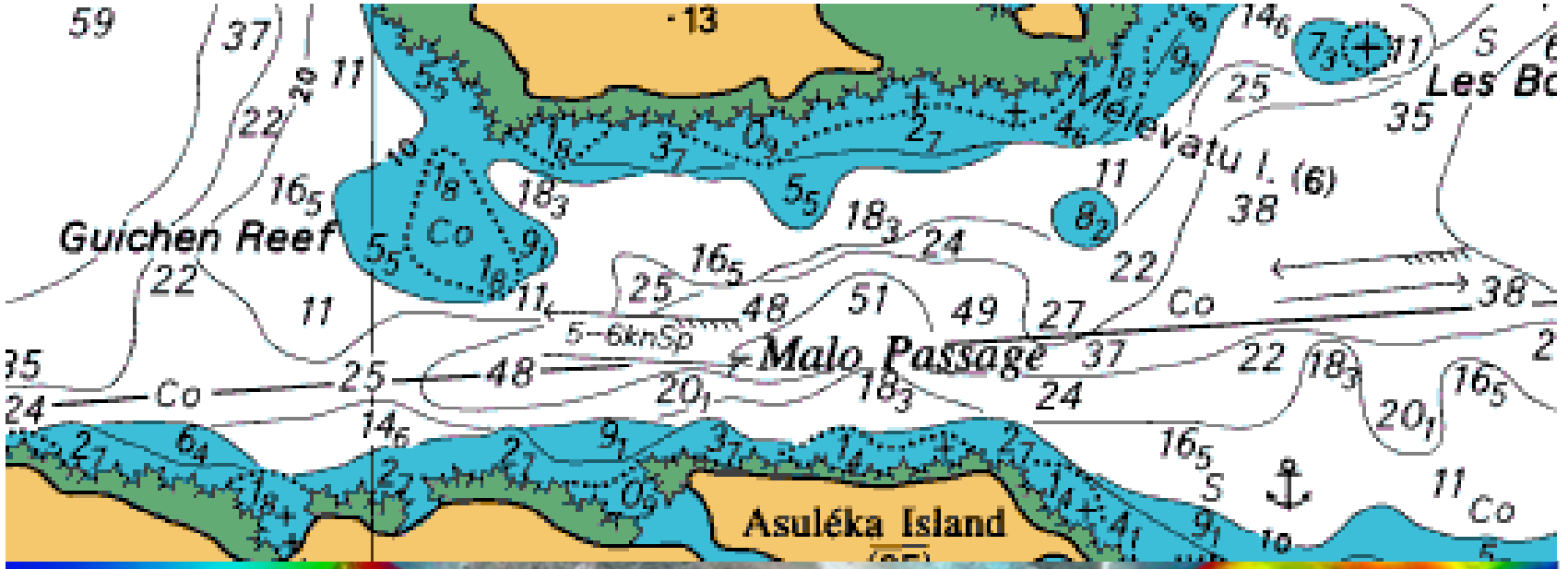
Post processing (manual method)

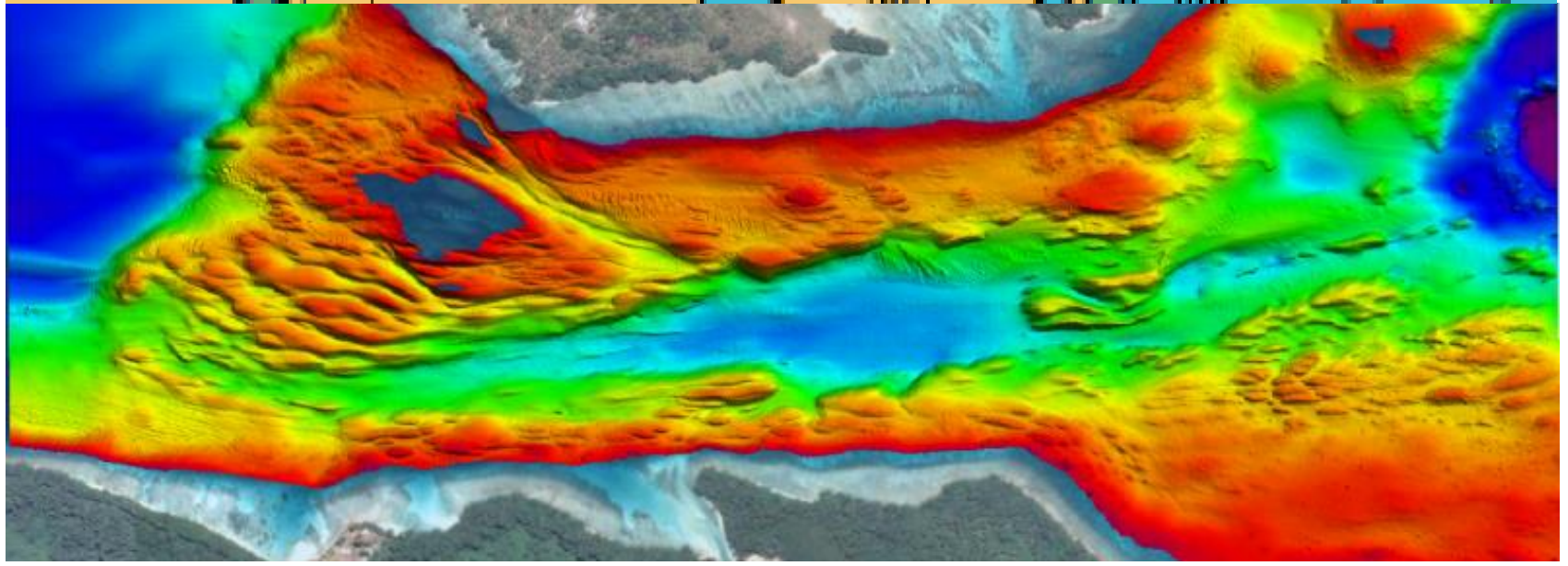


Malo Passage, Luganville, Vanuatu

For centimetric positioning in hydrographic surveying

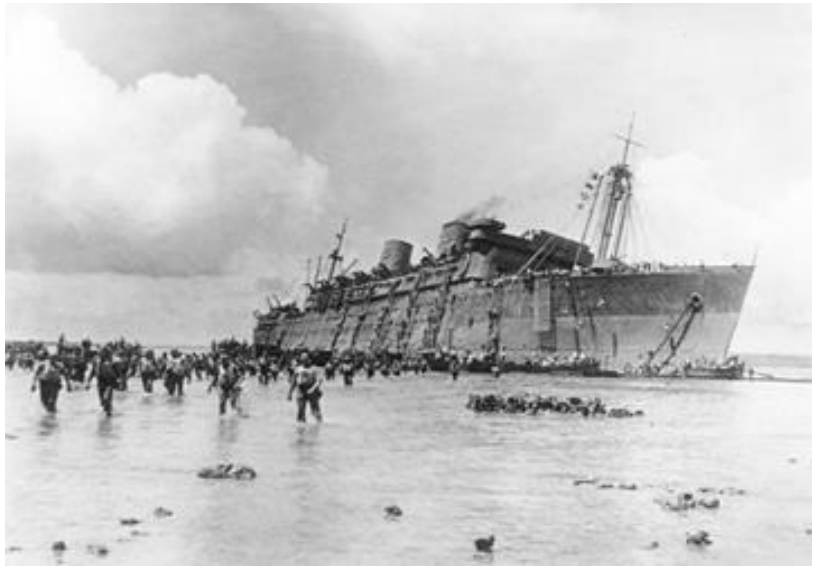
- based on the integration of GPS and inertial navigation systems (INS).
- using a network of GPS base stations to determine ephemeris, clock and atmospheric errors at the rover location.
- This technique uses the GPS observations from a Virtual Reference Station to compute a tightly integrated GPS/Inertial solution, with minimum baselines of over 100km.
- The PPVRS(post processed virtual reference station) and IAPPK(Inertially aided post-processed kinematic) methodologies
- available in the Applanix POSPac software

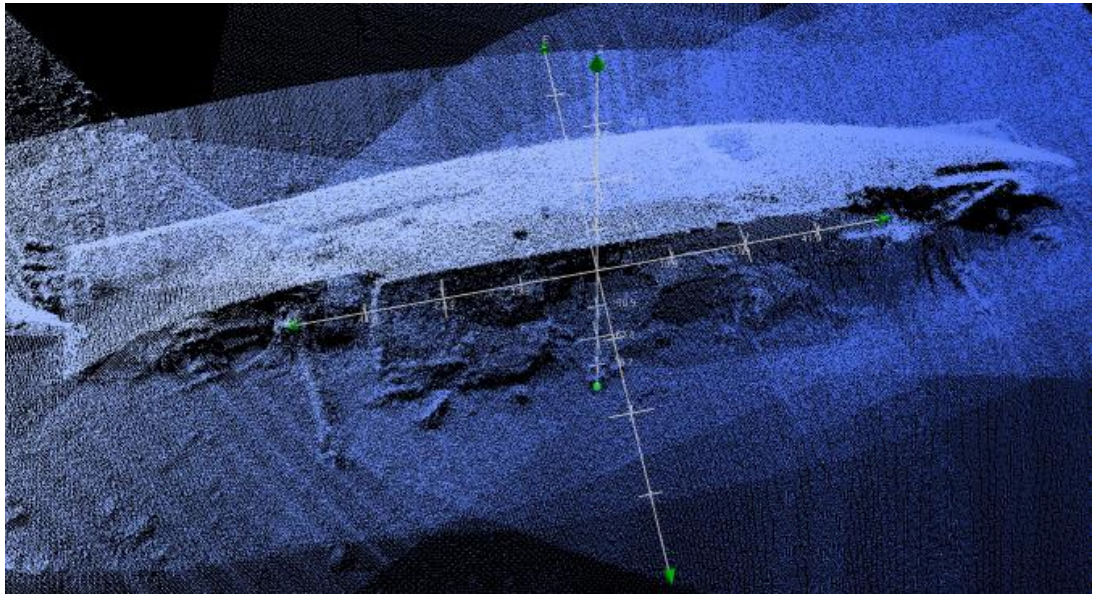


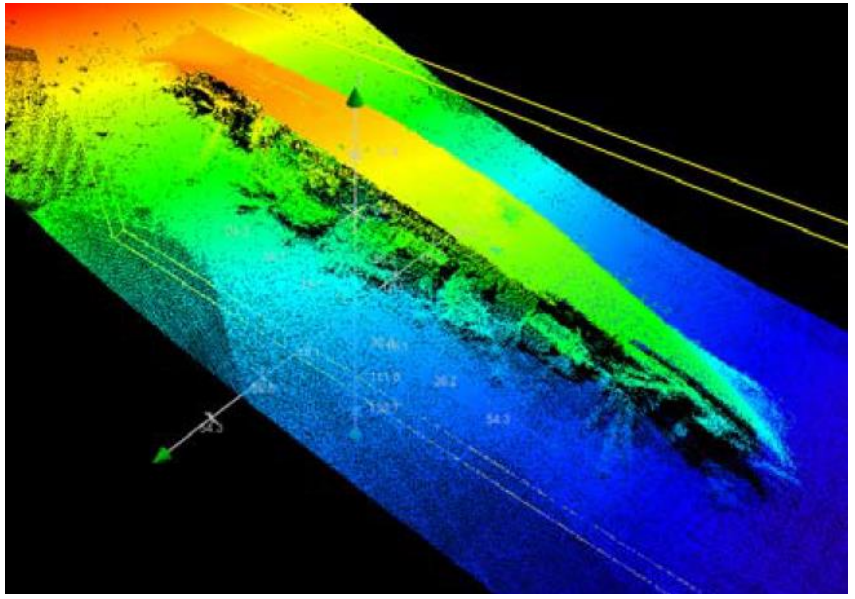


Uncharted ship wreck, Luganville

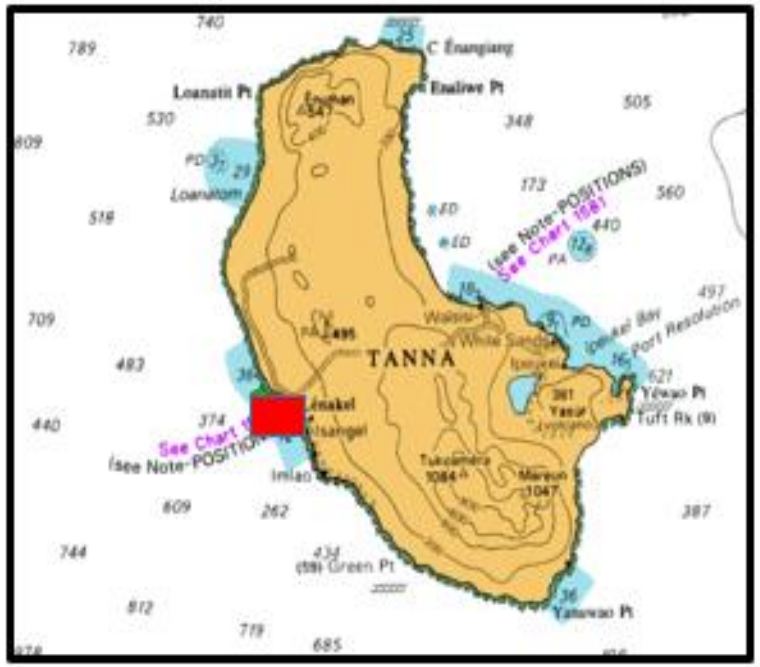
Multibeam data of SS President Coolidge

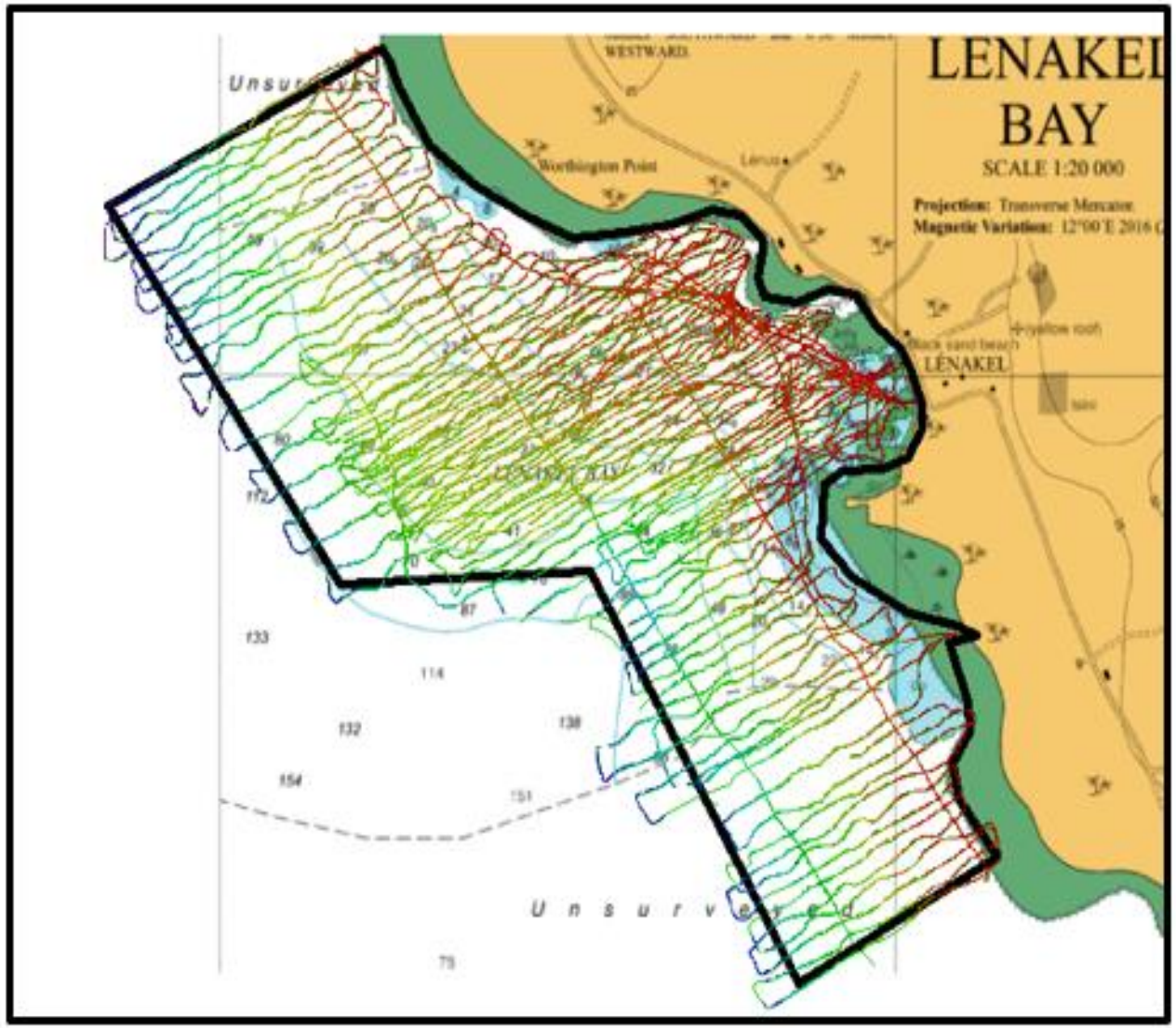




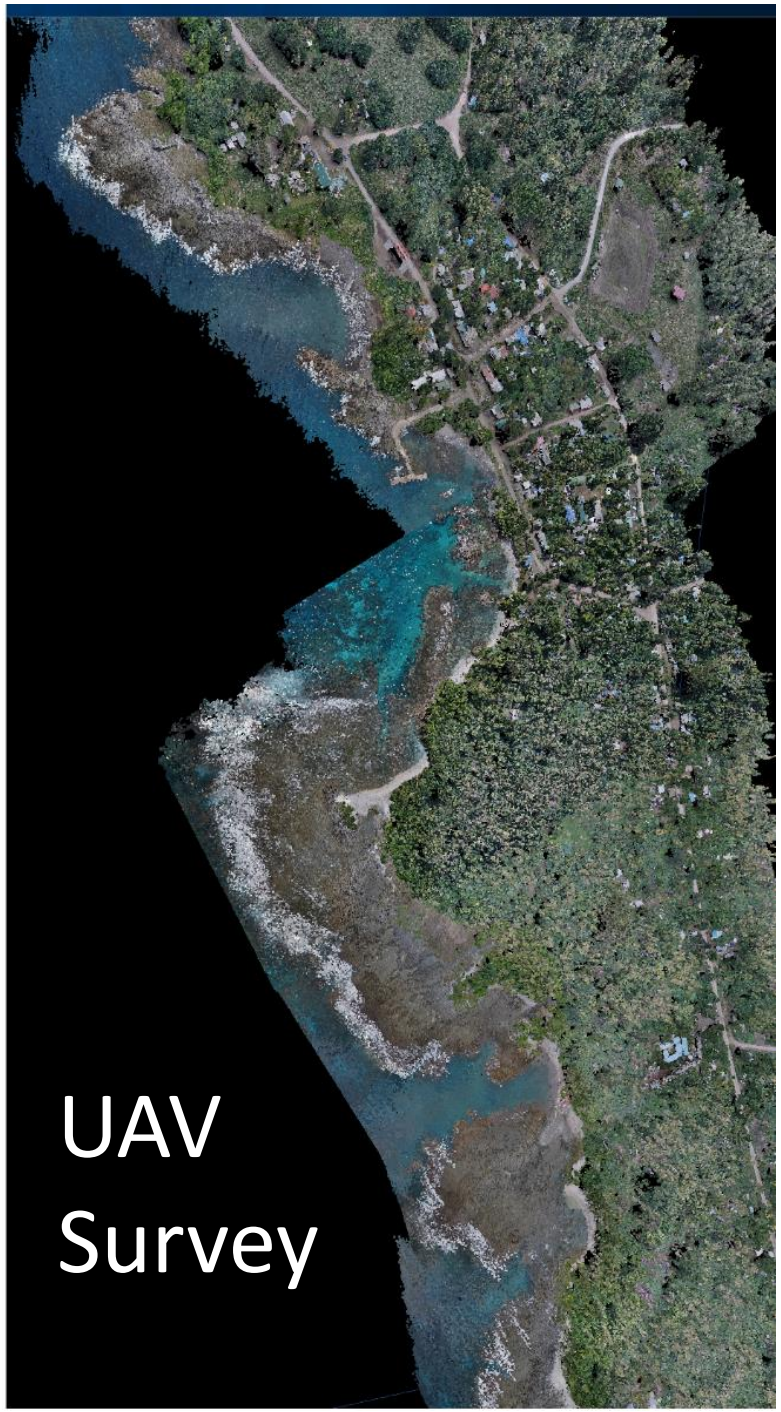


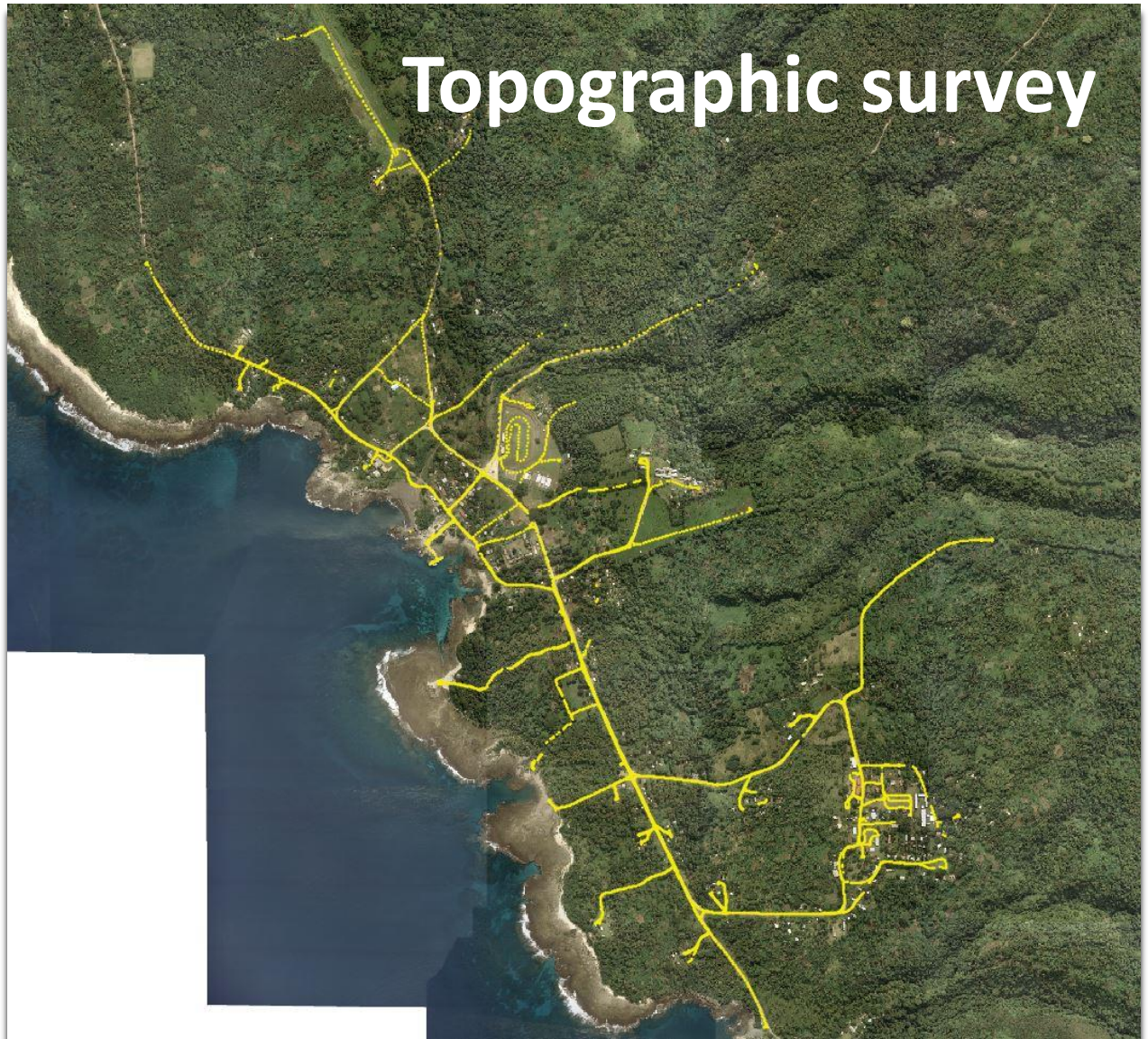
TC PAM – Hazard mapping, SBES Survey Tanna, Vanuatu 25th Nov – 12th Dec 2017



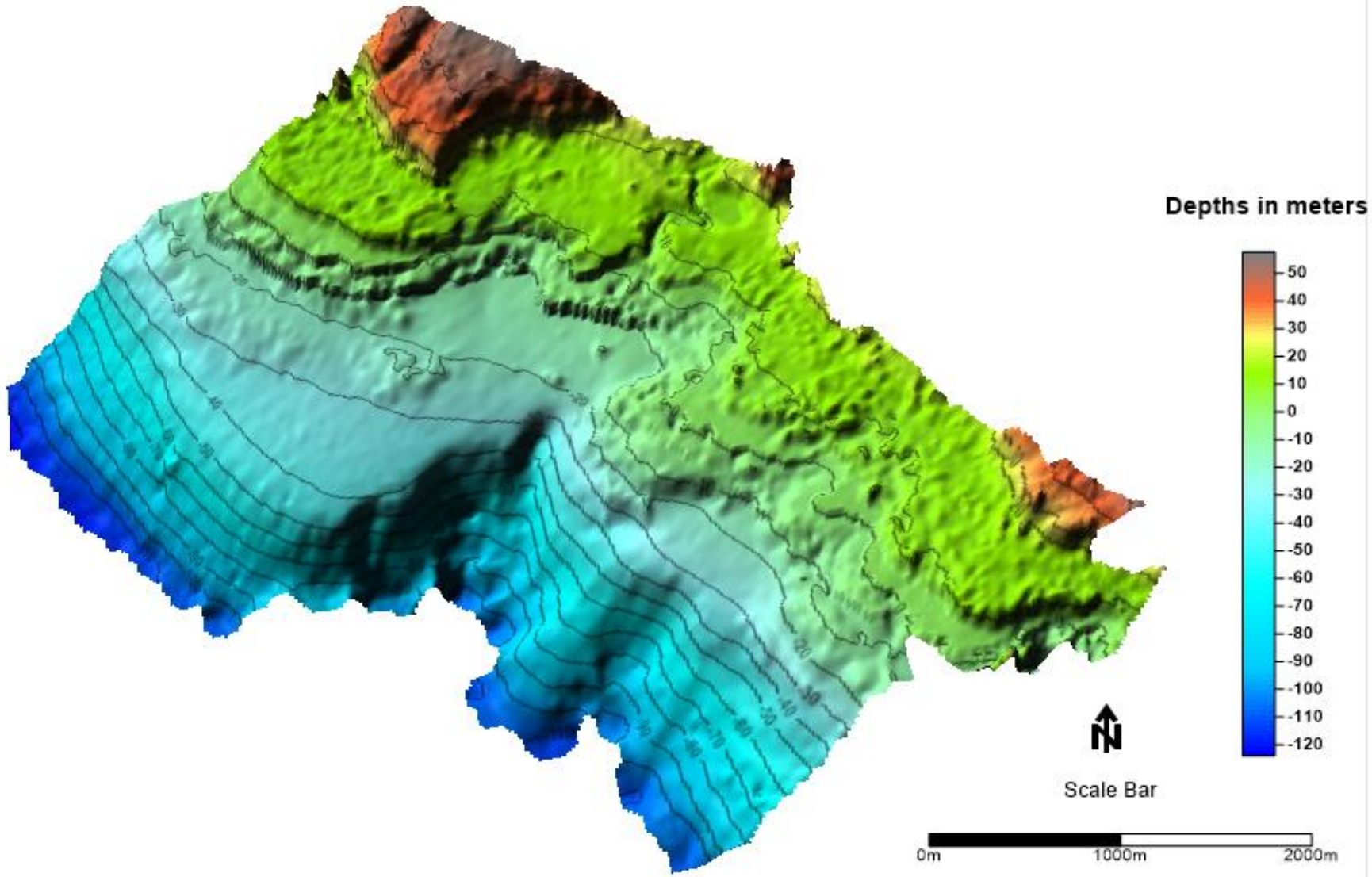


TC PAM – Hazard mapping, UAV and RTK GNSS Survey Tanna, Vanuatu 25th Nov – 12th Dec 2016





LENAKEL Coastal Terrain Model



Consequences of doing nothing in hydrography

- As the reliability of a nautical chart declines it will eventually be removed from publication.
- The lack of digital charting products will see the withdrawal of cruise ships and a decline in tourism.
- Potentially massive impacts on the national and local economies as Hydrographic Services have been shown to have a cost-benefit ratio of more than 1:10 – FOR CRUISE SHIP TOURISM THIS CAN BE 1:200

CONCLUSION

- GPS has been used for horizontal positioning in hydrography for many years.
- CORS data plays a very significant role in Hydrography
- In order to use the vertical component effectively, high-accuracy GPS processing techniques are/must be used
- **The more CORS data/stations , the higher the accuracy of our survey data**


VINAKA