BATHYMETRY DATA EXTRACTION USING MULTISPECTRAL DATA PROCESSING TECHNIQUE

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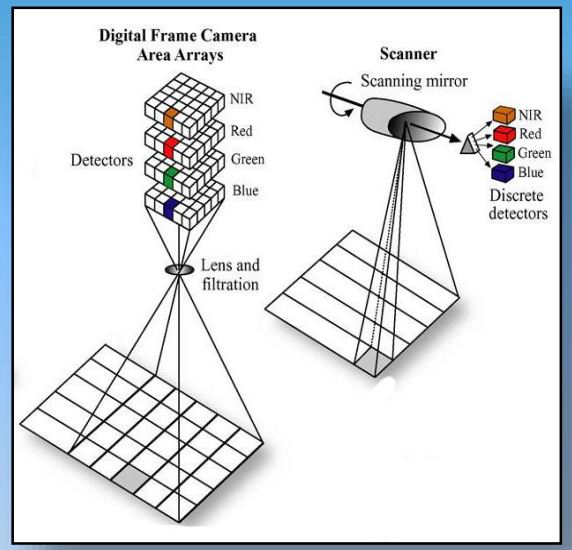
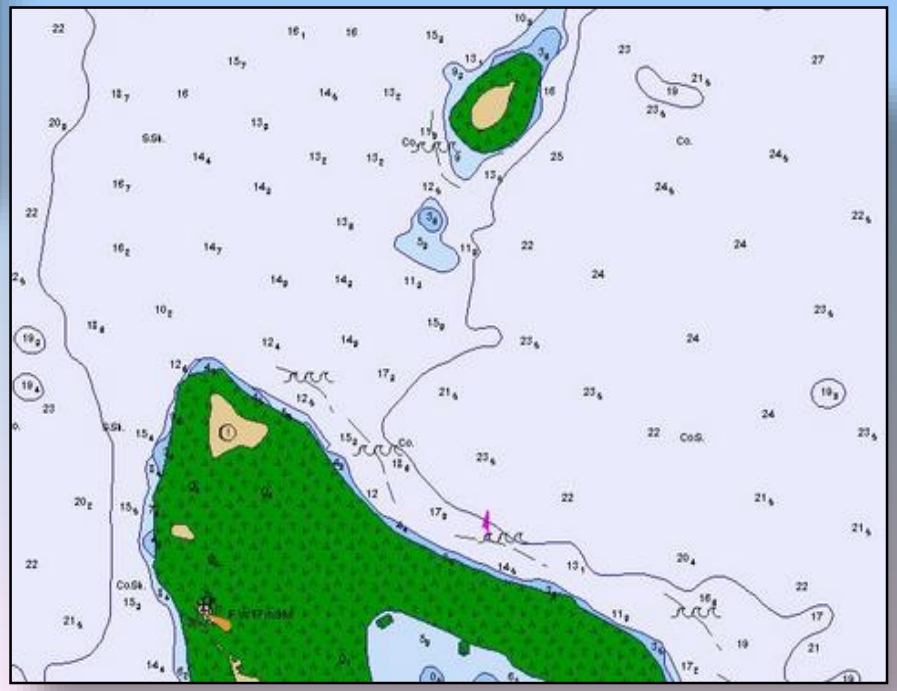
INTRODUCTION

- Multispectral Data (MSD)
  - Components of MSD
    - Spatial Resolution.
    - Spectral Resolution.
    - Radiometric Resolution.



Components of Multispectral Data (JR Jensen)

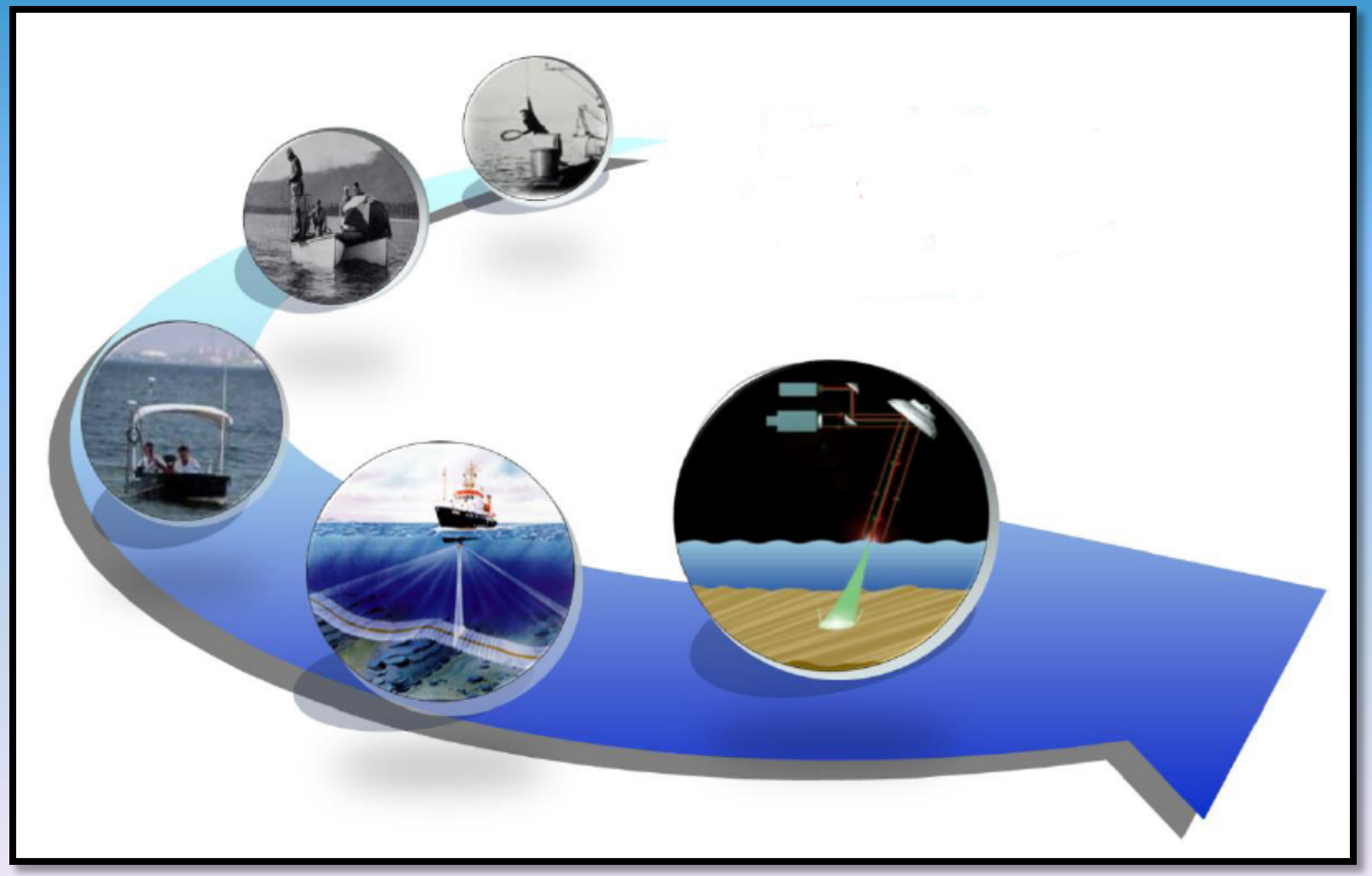
- Bathymetry Data
  - Components of Bathymetry Data
    - Soundings (Water Depth).
    - Isobaths (Depth Contours).
    - Under water Rocks, Corals Reefs and Objects (Shoals).
    - Bottom Extraction (Sea-surface Classification).



Components of Bathymetry Data (NHO)

- Processing Model
  - Log Ratio Model

INTRODUCTION



Evaluations of Hydrographic Data Collection Techniques

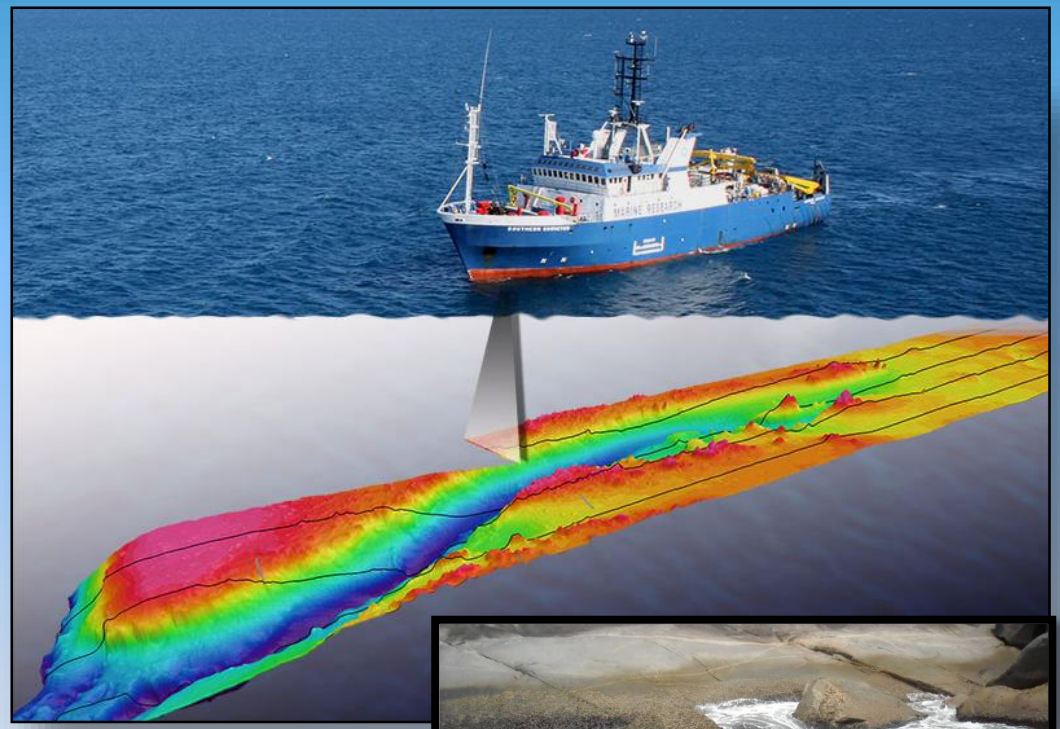
MOTIVATION

- Bathymetry is one of the most continuously varying dynamic phenomena of the Earth.
- The conventional techniques at present hazardous, high-cost, with low temporal resolution.
- Satellite Data having no risk, low cost, high temporal resolution can support to study this varying nature more effectively.
- The bathymetry was derived using different models from different remote sensing data.
- The bathymetry is not directly measured, it is inferred.

Risk involved during Hydrographic Survey (NHO)

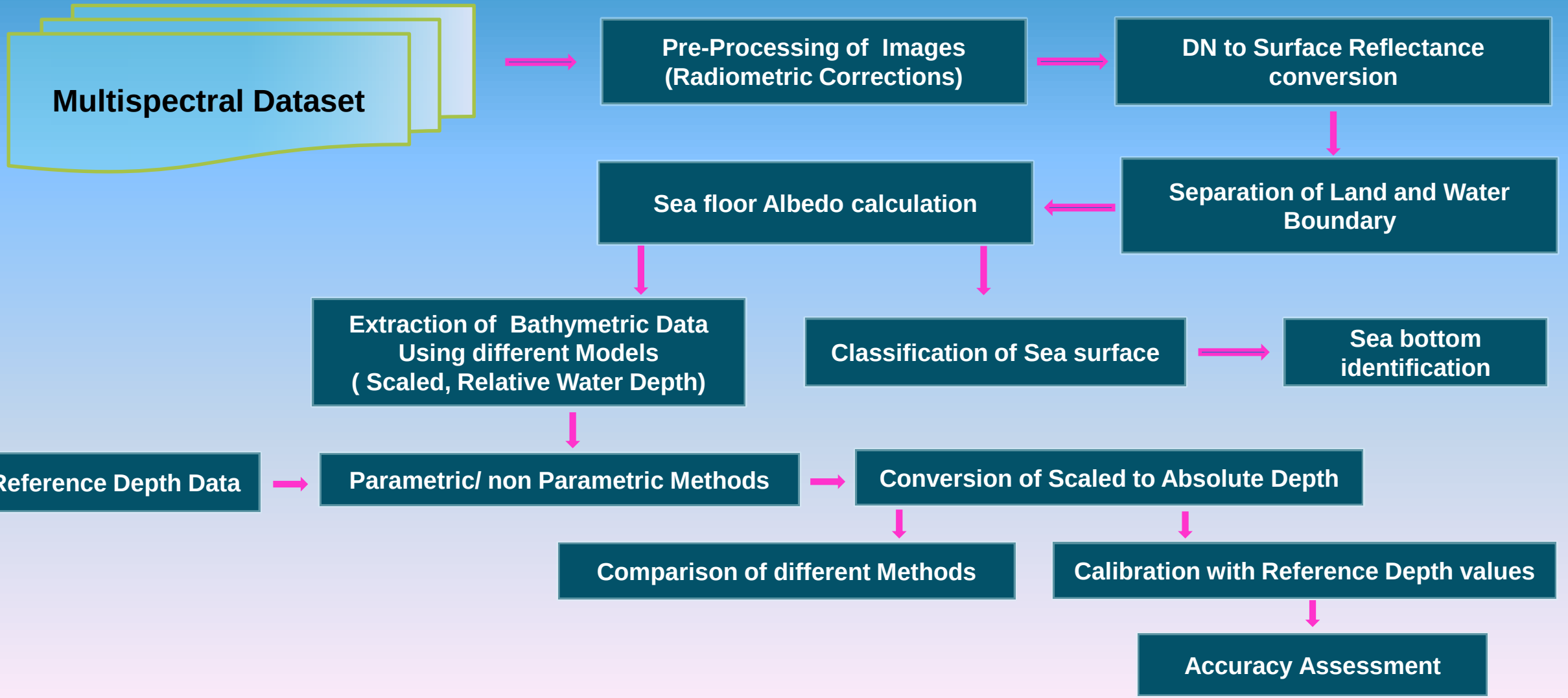
MOTIVATION

- The problem of data resolution is now resolving after upcoming high resolutions sensors.
- The real application of these models for charting standards are still need to be proved.
- The proposal is aimed to extract bathymetry data using multispectral bands not for charting or navigation, but can be used for environmental and marine activity.

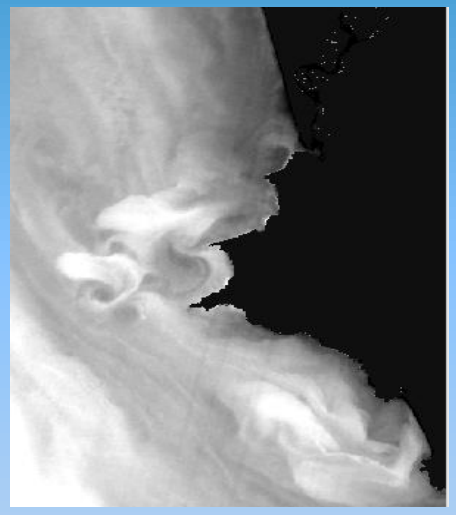


Bathymetric Data Collection (NHO)

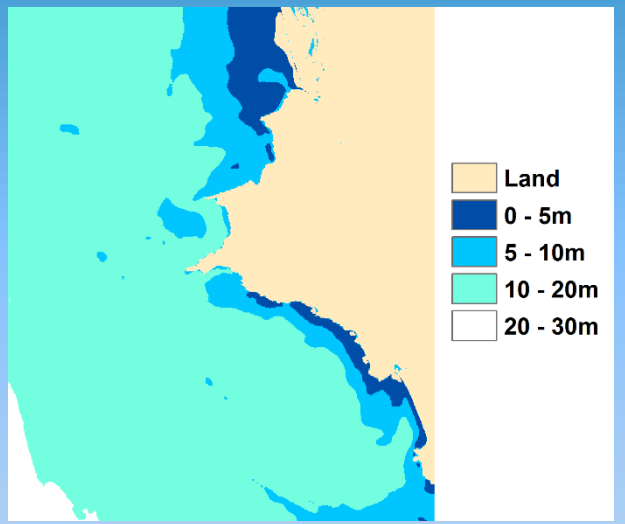
FLOW CHART


Multispectral Dataset
Pre-Processing of Images (Radiometric Corrections)
DN to Surface Reflectance conversion
Separation of Land and Water Boundary
Sea floor Albedo calculation
Extraction of Bathymetric Data Using different Models (Scaled, Relative Water Depth)
Classification of Sea surface
Sea bottom identification
Reference Depth Data
Parametric/ non Parametric Methods
Conversion of Scaled to Absolute Depth
Comparison of different Methods
Calibration with Reference Depth values
Accuracy Assessment

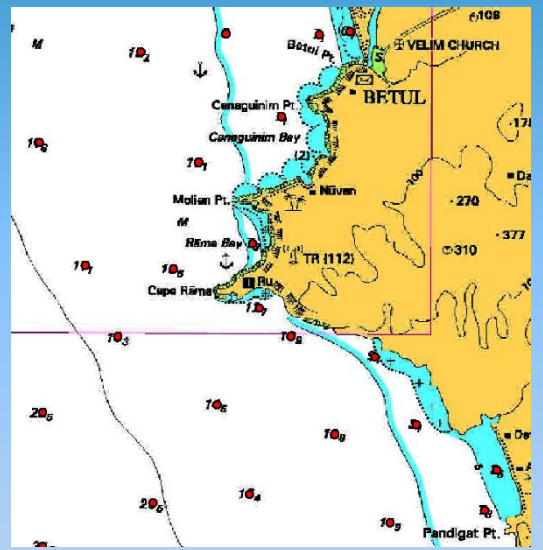
APPROACH



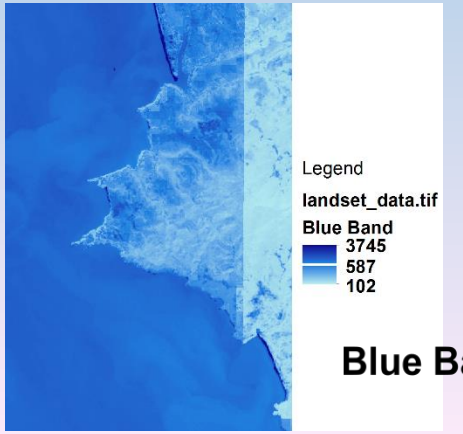
Identifying Land / Water



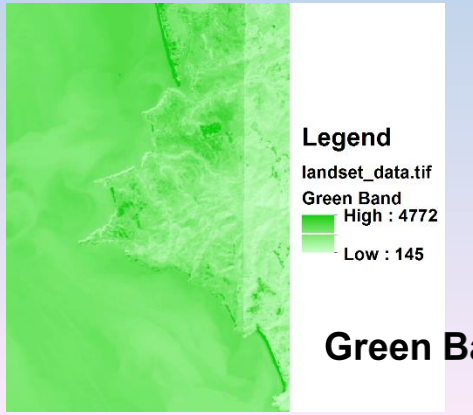
Satellite Derived Depths



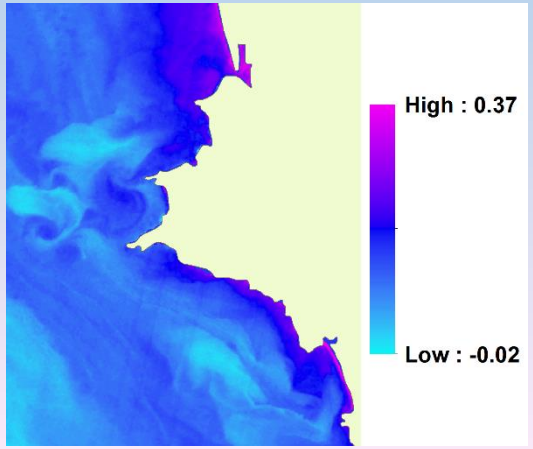
Calibration Data



Blue Band



Green Band

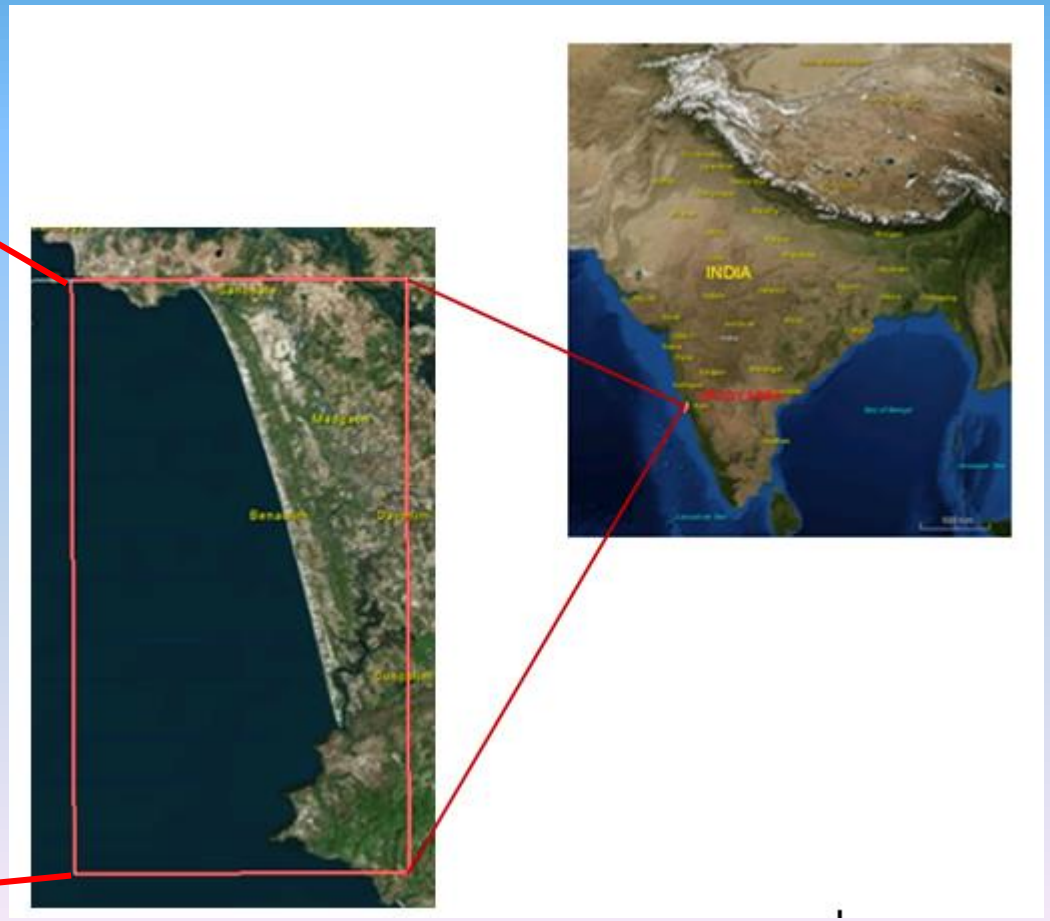


Applying the Log Ratio algorithm

STUDY AREA

INDIA - WEST COAST
BETUL 73˚55´E, 15˚10´N

Data Extent **ULX 73 51 10.0125 E (73.85278°) ULY 15 22 23.6536 N (15.37324°)**
LRX 73 59 40.6109 E (73.99461°) LRY 14 59 32.4581 N (14.99235°)



Non-availability of high resolution images, using low resolution mid-scale bathymetry will be extracted.

DATA & SOFTWARE USED

Data

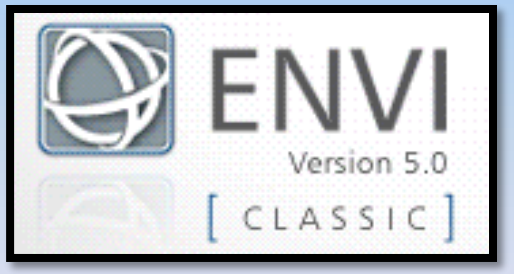
- Landsat 8 (OLI)
- Sentinel 2A (MS)
- Navigational Chart 215

Image of Landsat 8 Satellite (USGS)

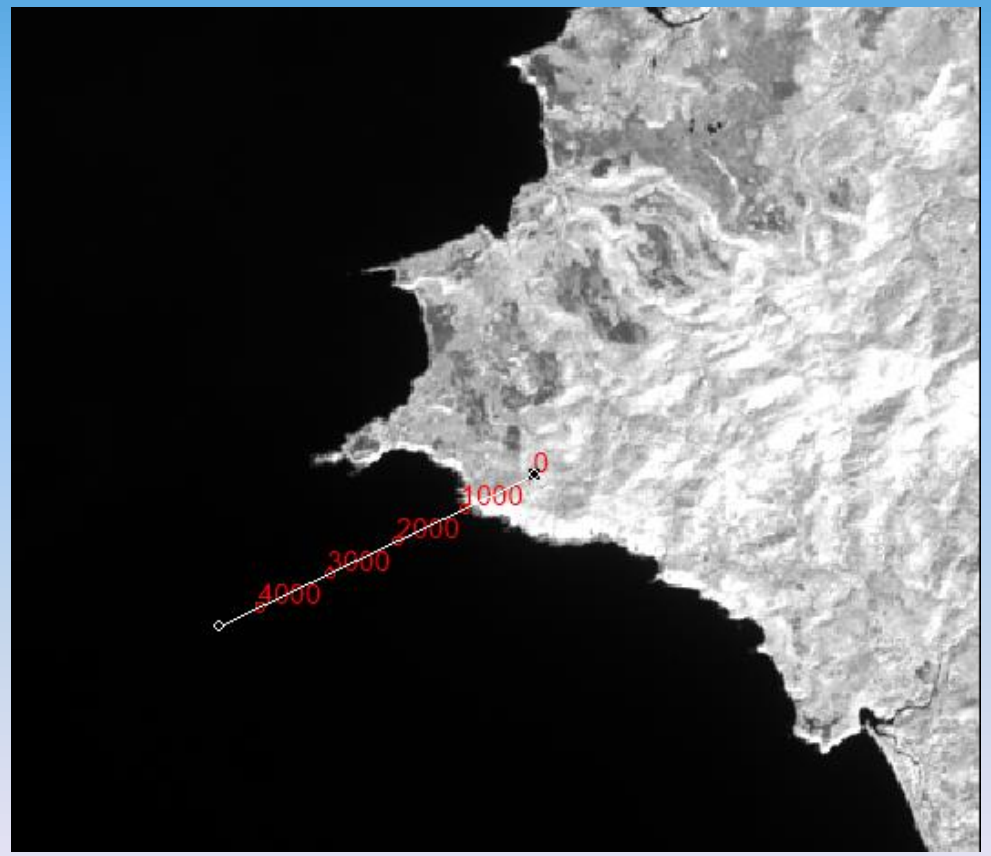
Image of Sentinel 2 Satellite (ESA)

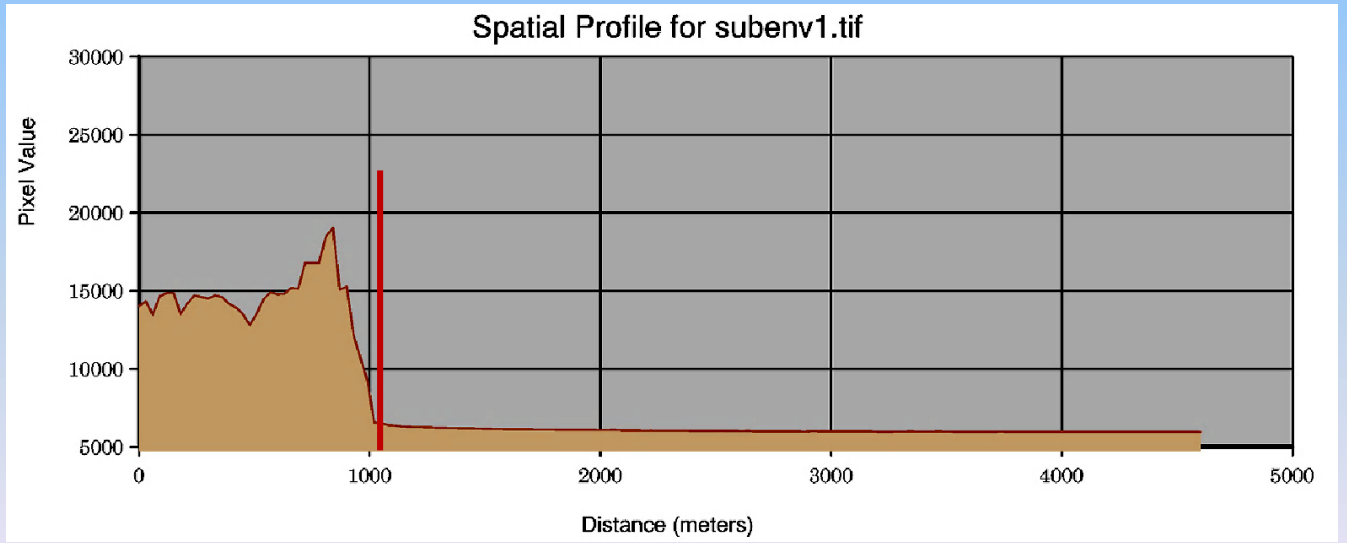
Software Required

- ENVI™ (Image Processing s/w)
- ArcMap™(GIS s/w)
- MS Excel™ (Statistical s/w)



LAND/WATER SEPARATION





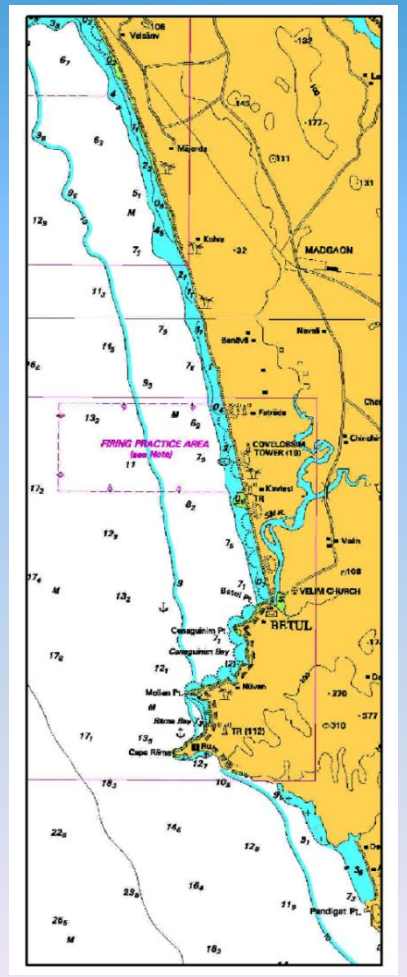
Land /Water separation

CORRECTIONS EFFECT

DN VALUES (WITHOUT CORRECTION)

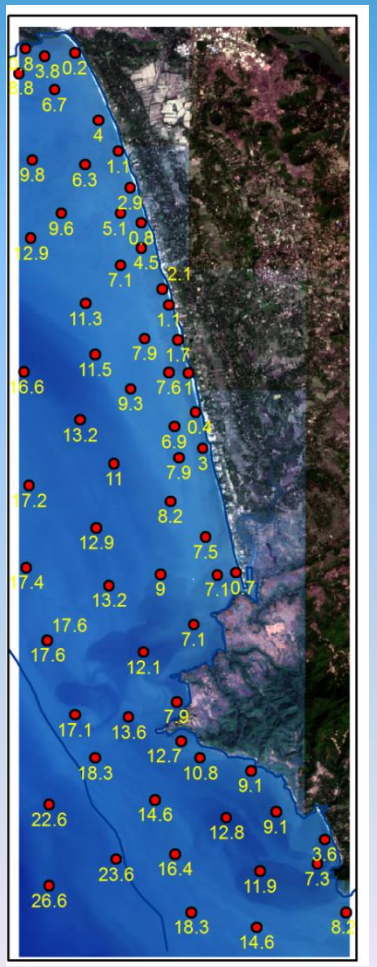
REFLECTANCE VALUES (WITH CORRECTION)

IN-SITU DEPTHS



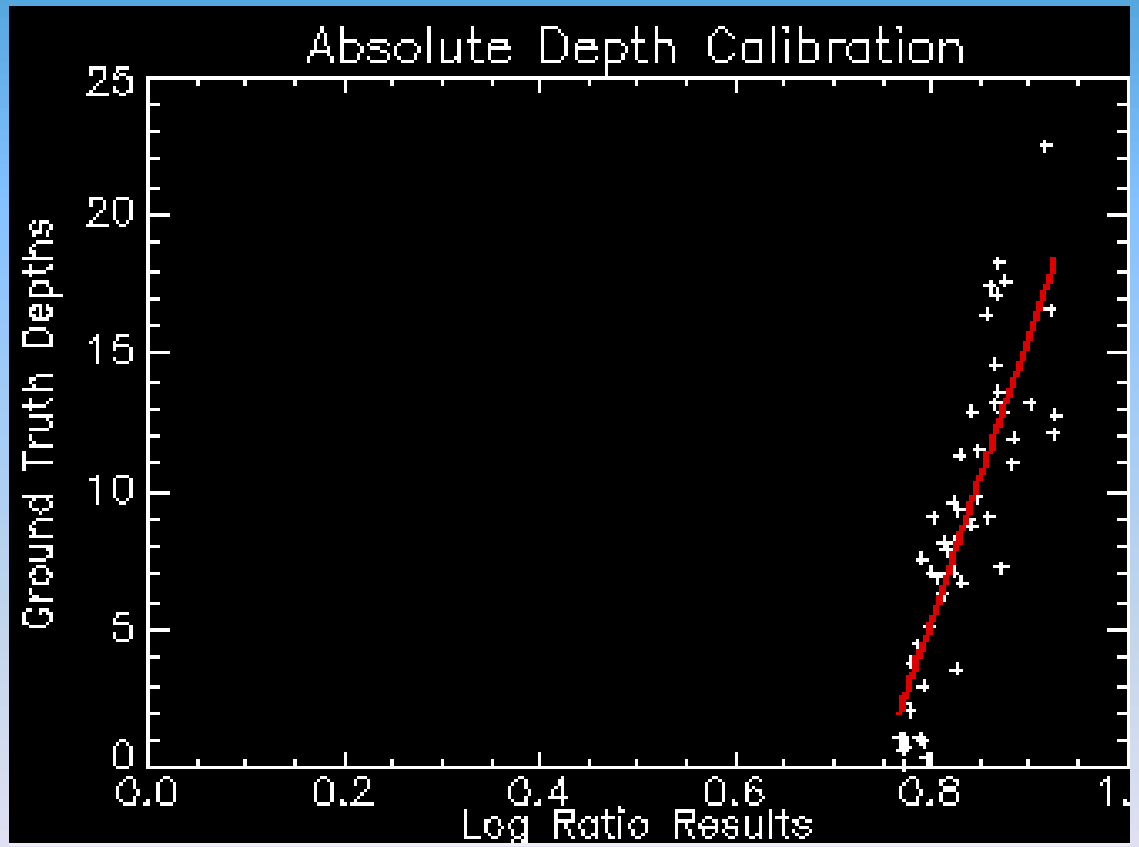
Navigational Chart

Geo-referenced Chart & Image



Control Depths (Soundings)

DEPTH CALIBERATION

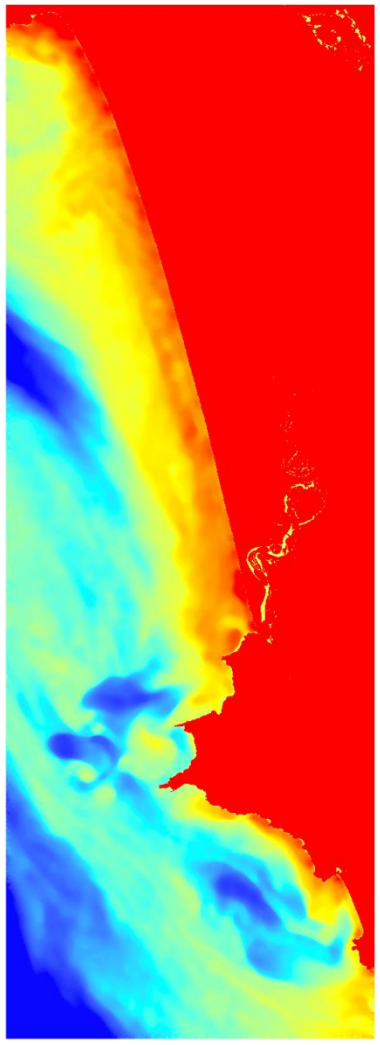


Absolute Depth Caliberation for 64 control points

Ground depth = [(-23.1373)+(28.8656)*Log ratio]

R Squared=0.700 (1.0 is perfect fit)

LANDSAT 8 DERIVED DEPTHS



RELATIVE DEPTHS

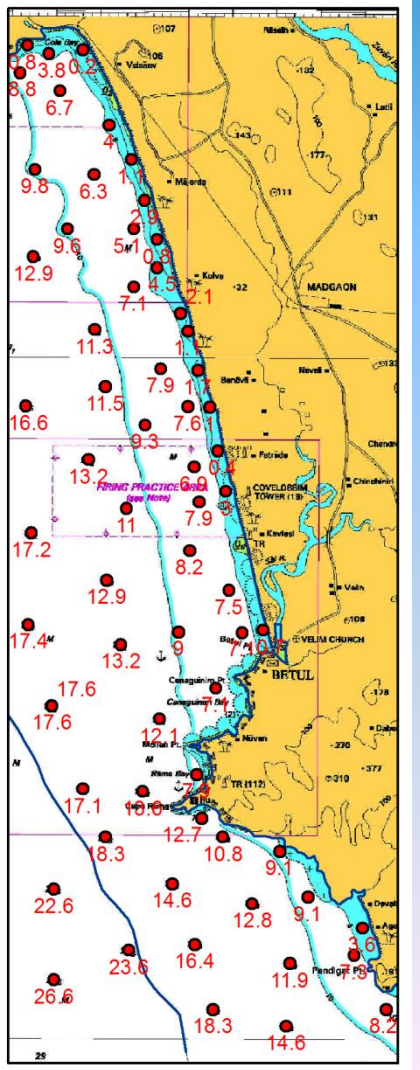
Legend

Landsat derived Depths

High

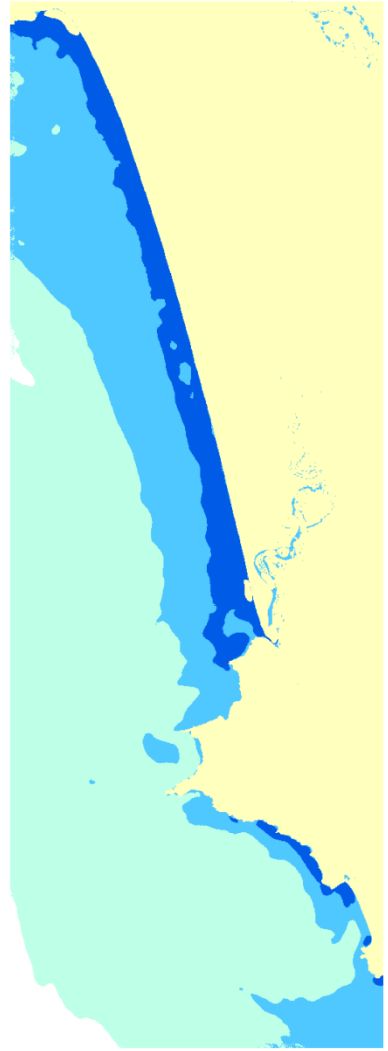
Low

+



IN-SITU DEPTHS

=



ABSOLUTE DEPTHS

Legend

Landsat derived Depths

Land Area

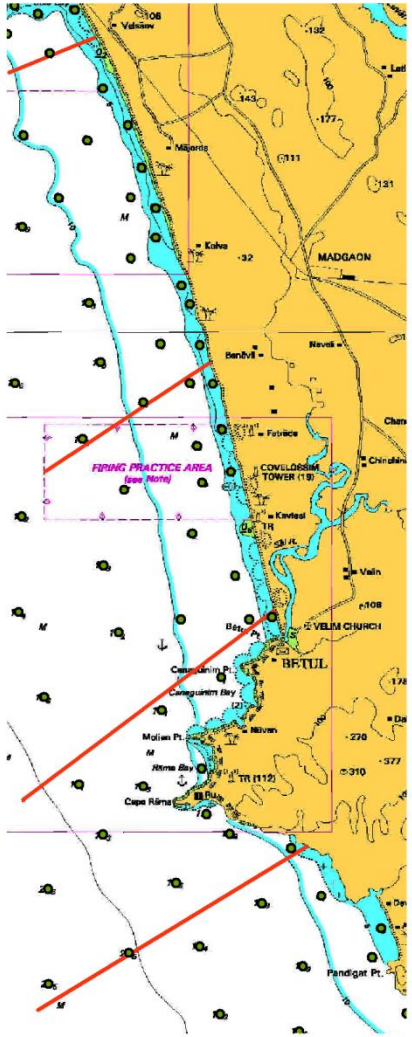
0 - 5m

5 - 10m

10 - 20m

20 - 30m

GENERATION OF DEPTHS SURFACE



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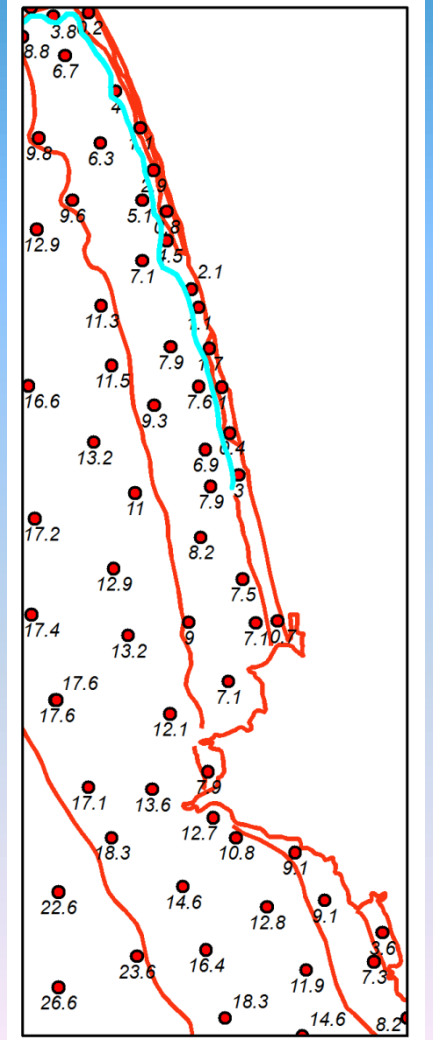
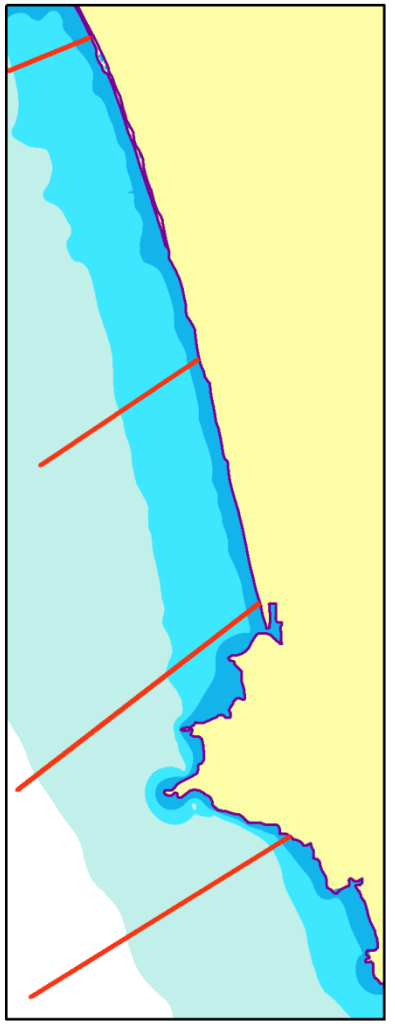


SOUNDINGS+CONTOURS

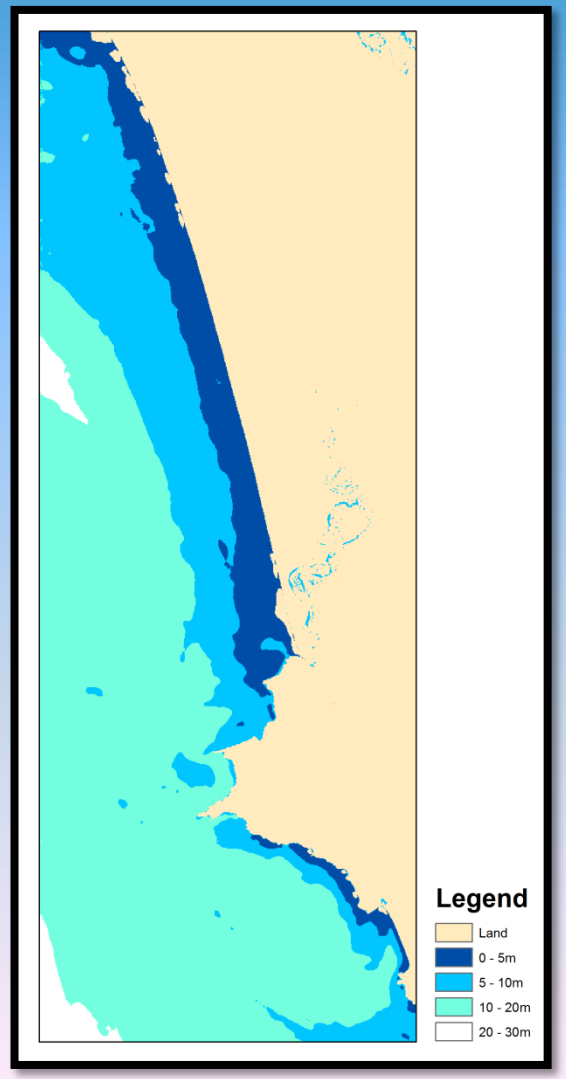
=

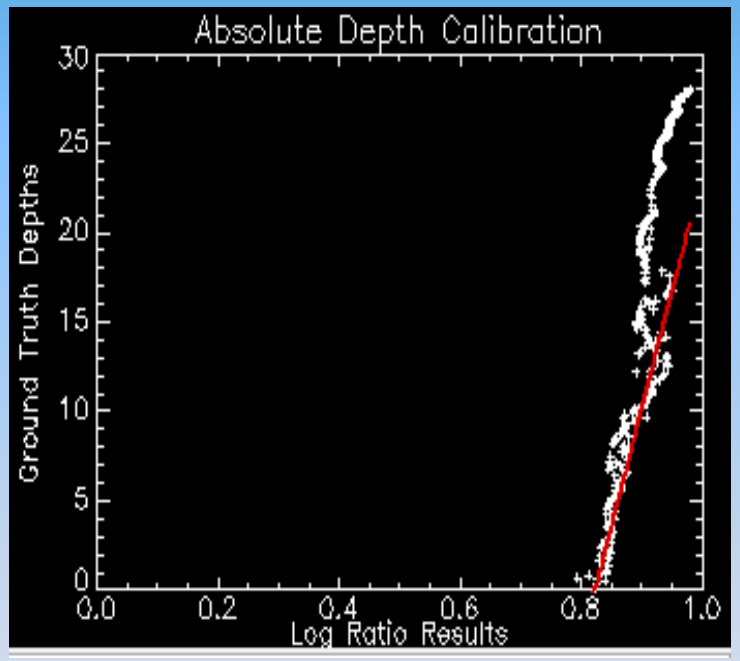


FID	Shape *	length
0	Polyline	12028.1
1	Polyline	12092.8
2	Polyline	7521.75
3	Polyline	3519.08

DEPTH SURFACE & LOCATION OFPROFILES

DERIVED BAHYMERY (FOR PROFILES)

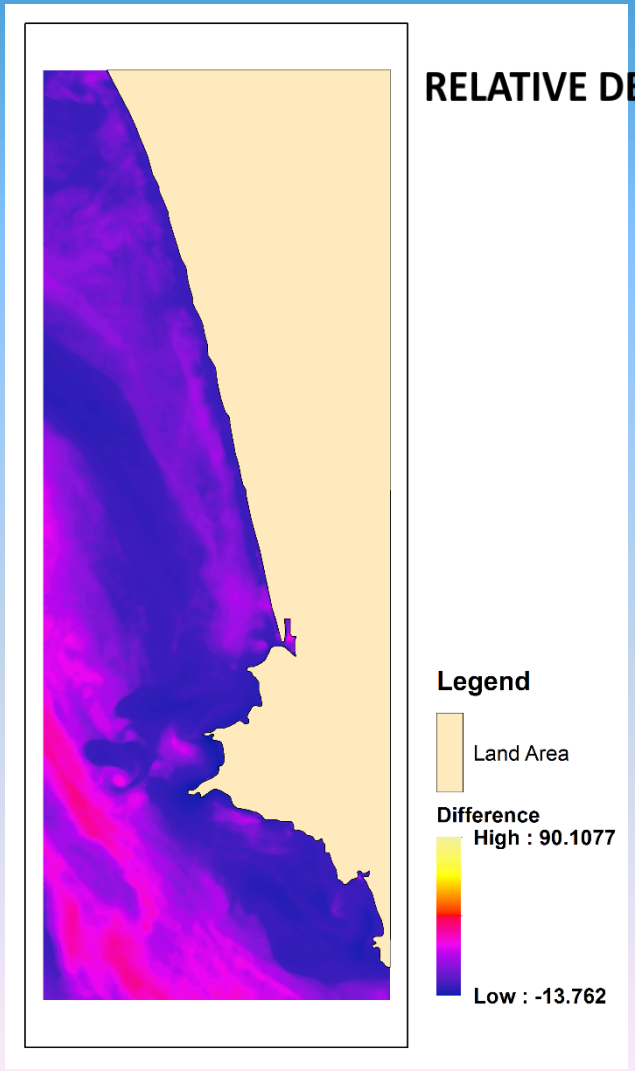


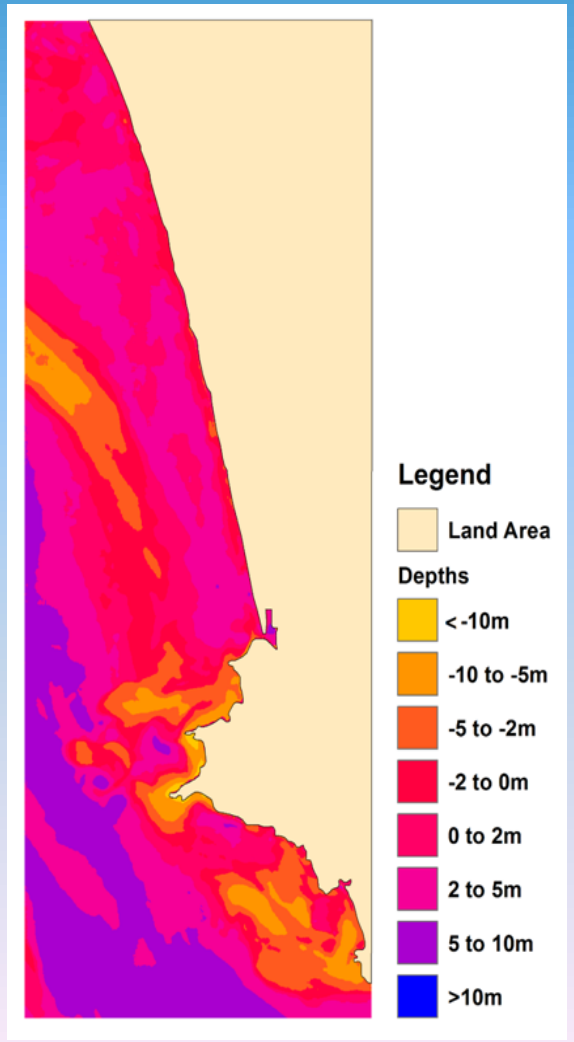


Ground depth = [(-94.5643)+(122.232)*Log ratio]

R Squared=0.816 (1.0 is perfect fit)

DERIVED DEPTHS ERROR





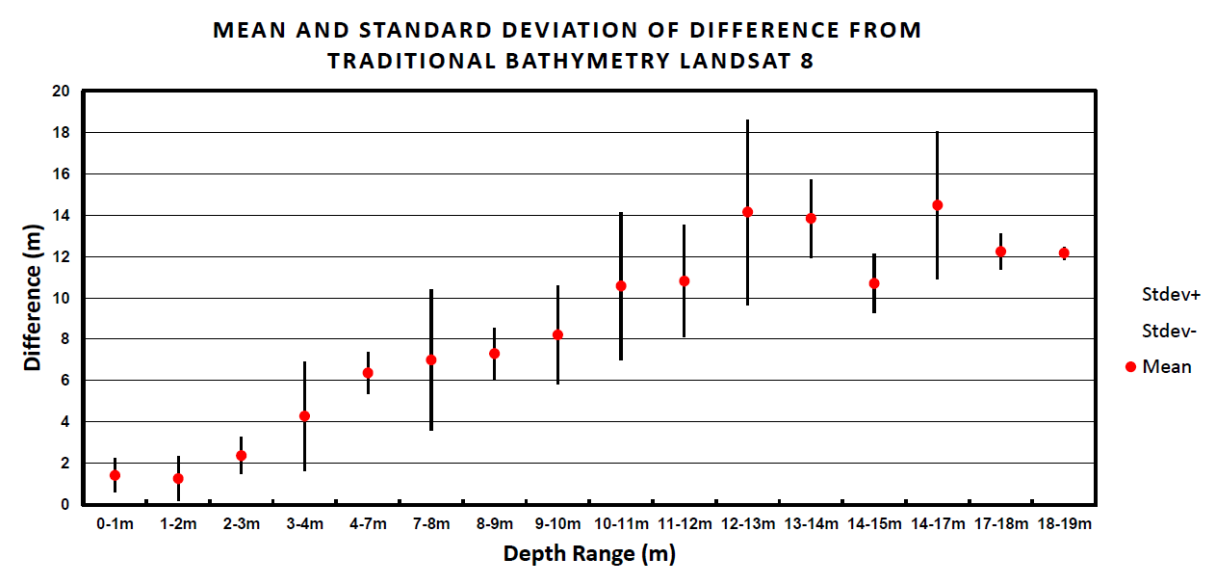
DEPTH ERROR IN DEPRH RANGES

Filename: [Memory7] (494x1345x2)
Dims: Full Scene (664,430 points)

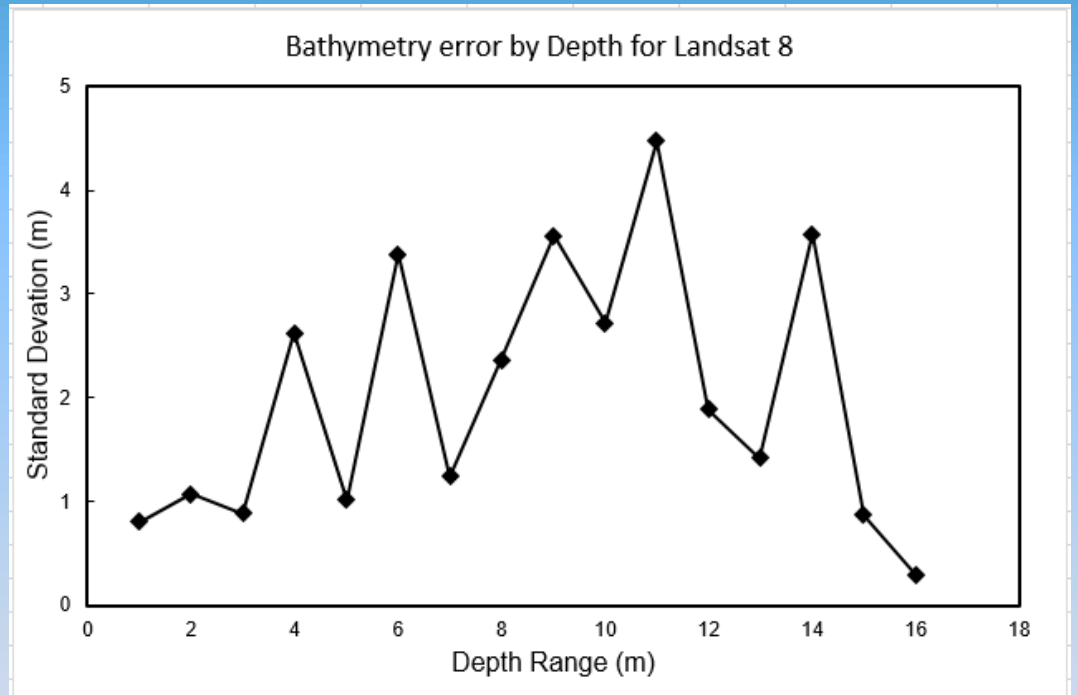
Basic Stats	Min	Max	Mean	Stdev
in-situ	0.000000	29.730515	6.949386	7.572640
derived	-94.564301	27.667702	5.782572	8.150446

Correlation	in-situ depths	Derived depths
in-situ depths	1.000000	0.768286
Derived depths	0.768286	1.000000

STATISTICAL ANALYSIS OF LANDSAT 8 DERIVED DEPTHS

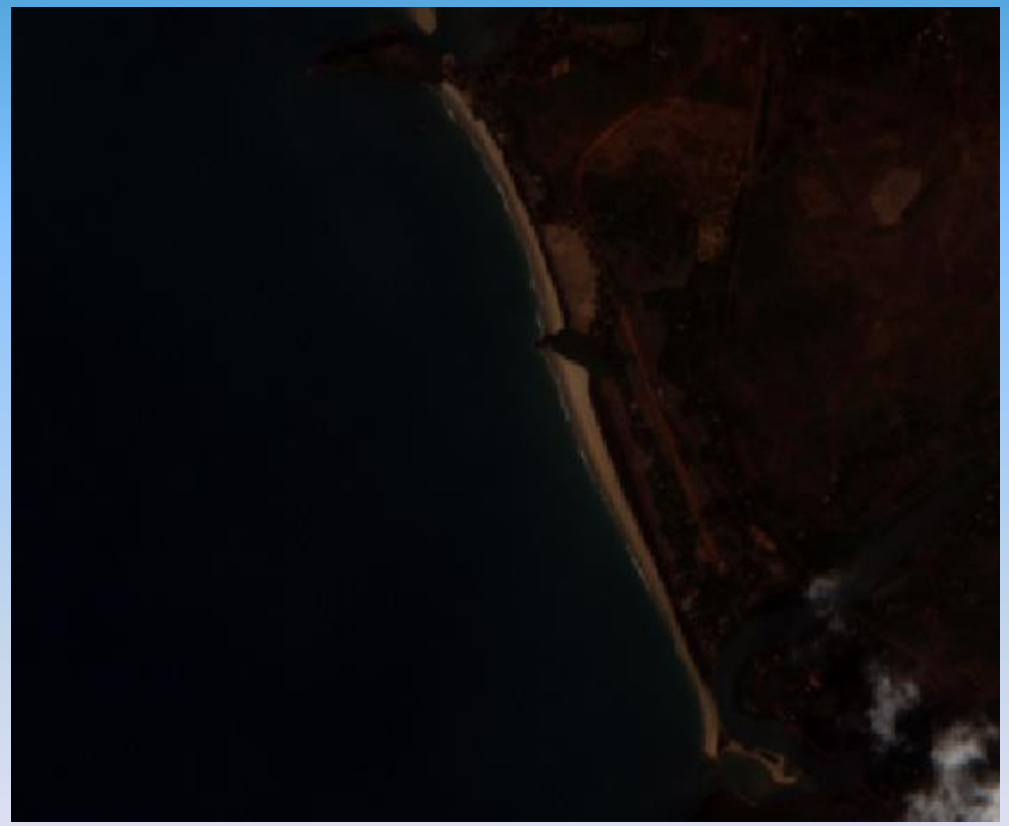


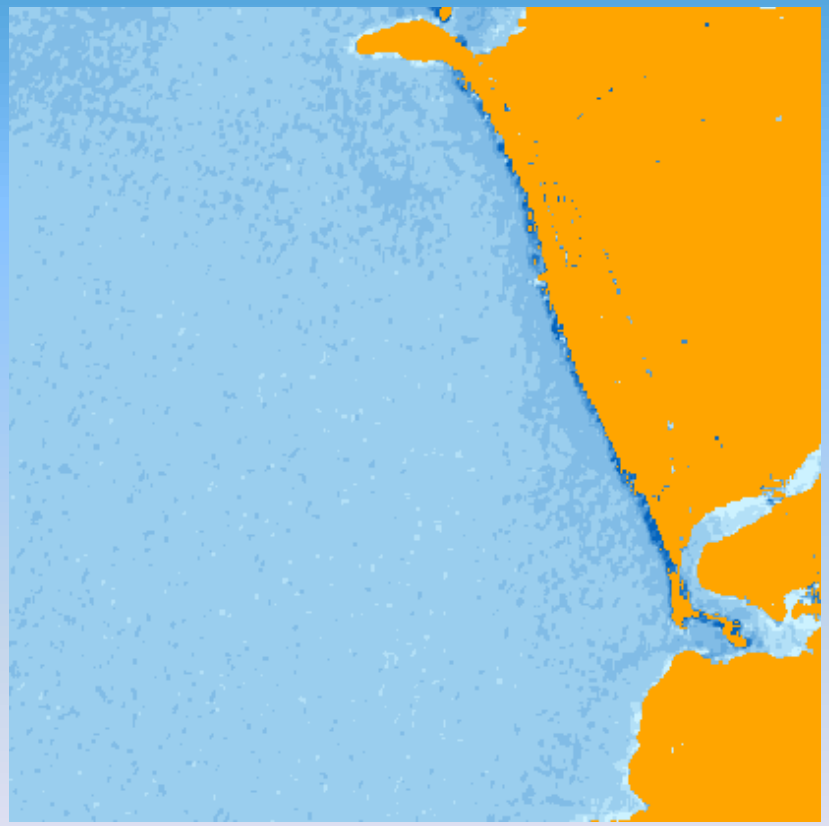
Mean and standard deviation of calibrated imagery derived depth error when compared to Charted depths.



Standard deviation of calibrated imagery derived depth error when compared to Charted depths.

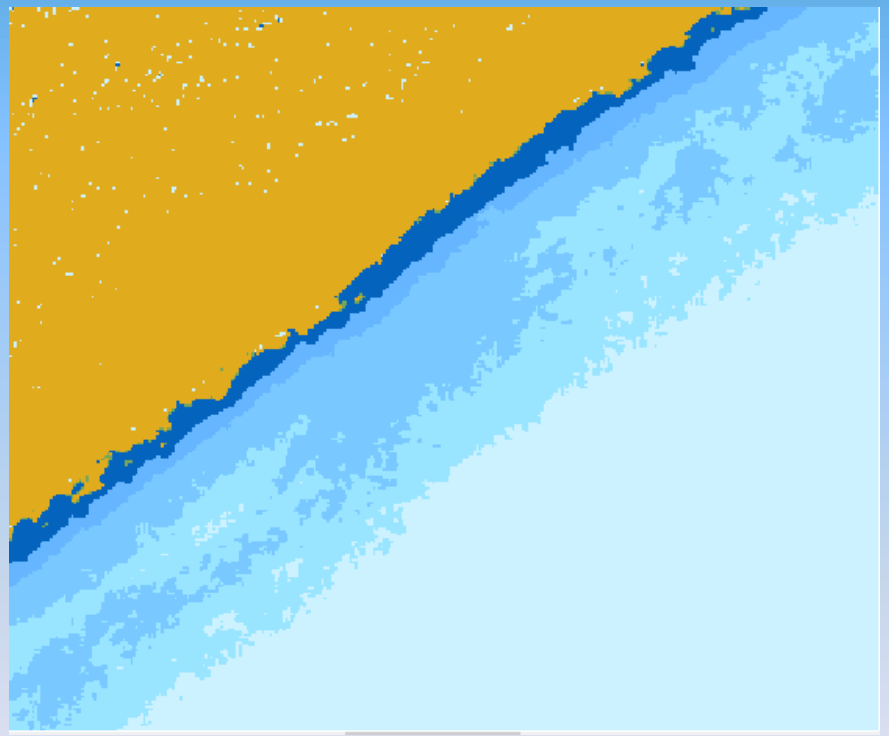
SENTINEL 2 DERIVED RELATIVE DEPTHS





West Coast of India

Quick Bird 2 DERIVED RELATIVE DEPTHS



East Coast of India

CONCLUSIONS

- The radiometric corrected data produces more accurate results.
- The model used for current study shows accuracy level around 70 to 80 % based on the considered control points.
- The derived depths can be calibrated for any required vertical datum, or tidal information can be used for calibration of vertical reference.
- The procedure can be used as a reconnaissance tool for investigation of coastal areas most frequently changing, before using customised techniques.
- The current method can be used for downscaling of small scale surveys.
- The approach will be very useful to study Marine Navigation Hazards due to Natural disasters.
- The effect of high resolution data-set on the accuracy and resolution need to be examined for charting applications.
- IRCC-I report also emphasises benefit of Satellite Derived Bathy data for risk management.

Thank You