Integrated Coastal Zone Management

A process to

- *promote security of life and livelihood of the coastal communities*
- *to protect the ecosystems that sustain productivity of the coastal areas*

while promoting sustainable development

OBJECTIVES

- Assist GoI in building national capacity for implementation of comprehensive coastal management approach in the country

- Piloting the integrated coastal zone management approach in states of Gujarat, Orissa and West Bengal.

COMPONENTS

1) National ICZM Capacity Building

2) Development and Implementation of State Level approaches to ICZM in Gujarat

3) Development and Implementation of State Level approaches to ICZM in Orissa

4) Development and Implementation of State Level approaches to ICZM in West Bengal

National ICZM Capacity Building
Component 1

Objective

Establish and support an appropriate national institutional structure for guiding and coordinating coastal zone management

Sub-Components

(a) Hazard line and Coastal Sediment Cell Mapping;

(b) Mapping of ESAs

(c) Establishing a new national institute for sustainable coastal zone management

(d) National Level Capacity Building

Development and Implementation of State Level approaches to ICZM – Components 2, 3, 4

OBJECTIVE

to develop and empower state level authorities to adopt appropriate ICZM approaches consistent with national strategies

SUB-COMPONENTS

(a) institutional strengthening of state level coastal zone authorities

(b) pilot investments consistent with local ICZM priorities around three themes of

- **coastal resource conservation/ protection**
- **pollution management**
- **community livelihood enhancement and adaptation to threats from sea-level rise.**

Memorandum of Understanding

between

जहाँ है हरियाली ।
वहाँ है खुशहाली ।।

MoEF

SoI

DELINEATION OF HAZARD LINE

Delineate hazard line in mainland coastal areas of India based on

Expert Committee 2005:

(a)Elevation **(b) Geomorphology**

(c) Seal Level Trends

(d) Horizontal Shoreline Displacement

Expert Committee 2006:

(a)Coastal Inundation Levels (Flood Line)

(b)Rate of Coastal Displacement (Erosion Line

Scope of Work

- Preparation of base map upto a maximum width of 7km from shoreline elevation on 1:10,000 scale & 0.5 m contour Interval
- 3-D digital elevation model (DEM)
- Flood Line
- Erosion hazard line
- Composite hazard line
- Demarcation of Composite Hazard Line on Ground

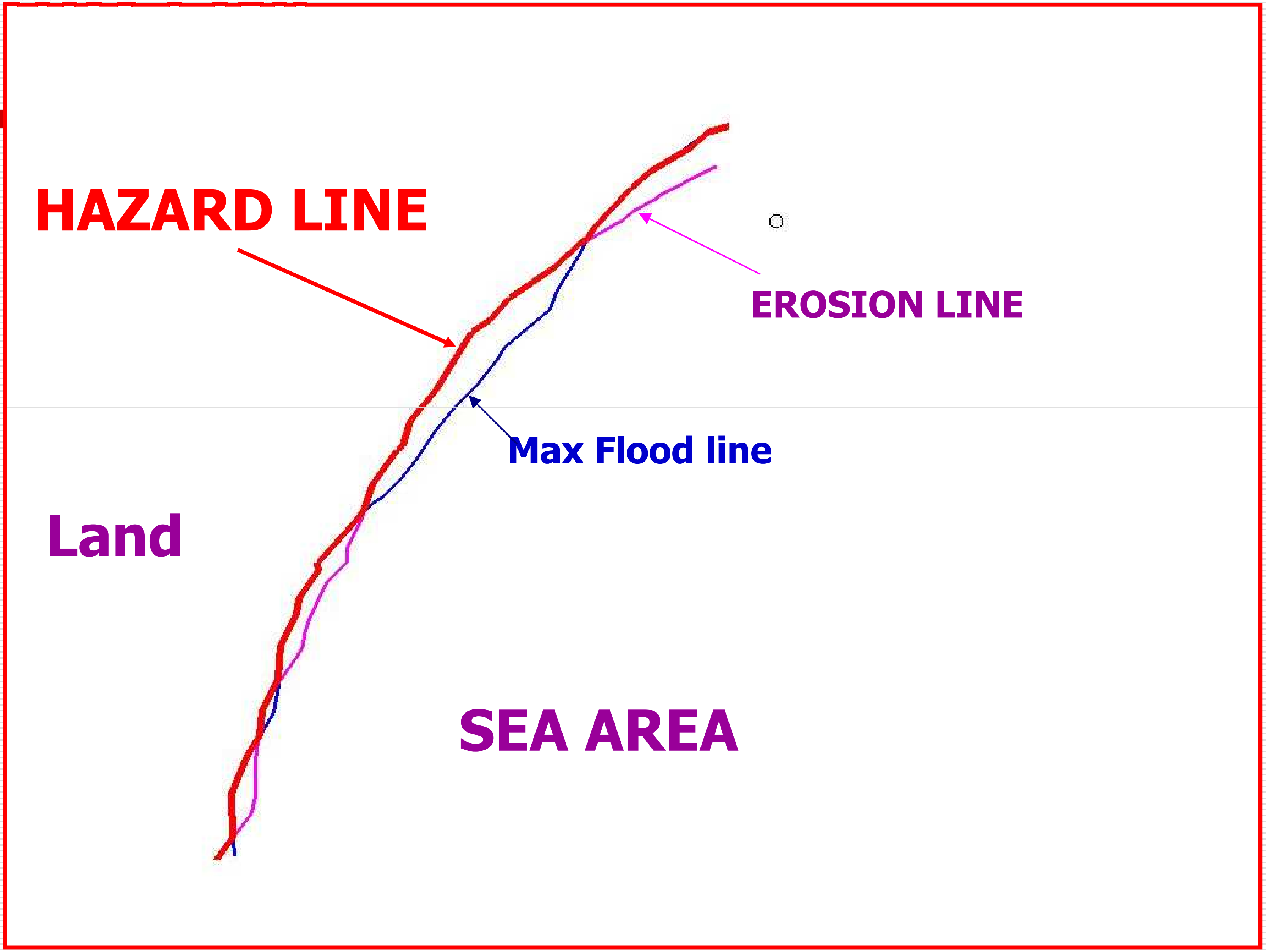
Flood Line

- Based on 100 year return interval flood elevation
- Averages of all available historic flood heights (except episodic events) from major & minor ports used for prediction of 100 year flood inundation
- Flood level maps and scenarios shall be developed between two adjacent ports
- Flood Line will be plotted on 0.5 metre contour interval DEM to determine the areas inundated by the estimated floods of 100 year return interval

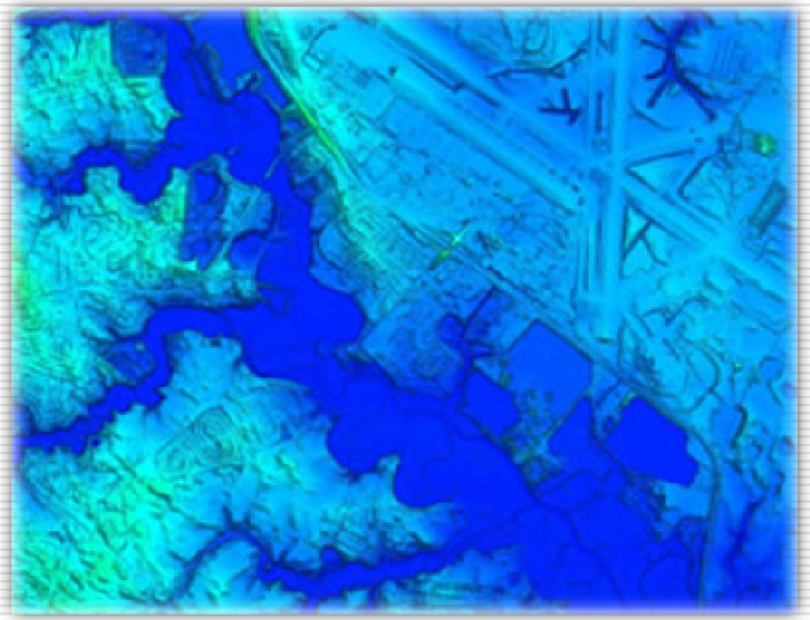
Erosion Line

- SoI Toposheets and satellite imageries since 1967 shall be used for comparing shorelines
- Simple AP shall be applied to predict shoreline displacement
- Based on existing shoreline trends, AP shall be made for year 2110
- Delineate shoreline trend on 0.5m elevation contour map

HAZARD LINE



Shoreline Change



Composite Hazard Line Maps - Content

- Important landforms
- Important landmarks for location identifiers – such as outer periphery of settlements, important roads connecting villages, major water bodies with attributes collected from maps available with SoI
- In thickly forested areas contours will be generalized
- Disputed/classified/disturbed/VA/VP areas shall be excluded, in case special permission not sought by MoEF.

Pillar Construction/Benchmark

- **The composite hazard line will be marked on the ground by Iron Pegs in private land and stone pillars will be erected on govt. land (subject to MoEF getting approvals/concurrence from respective State Govt/local bodies/other agencies who own such land**

Additional Work

- **LIDAR Bathymetry & Mapping of Andaman & Nicobar and Lakshadweep Islands**

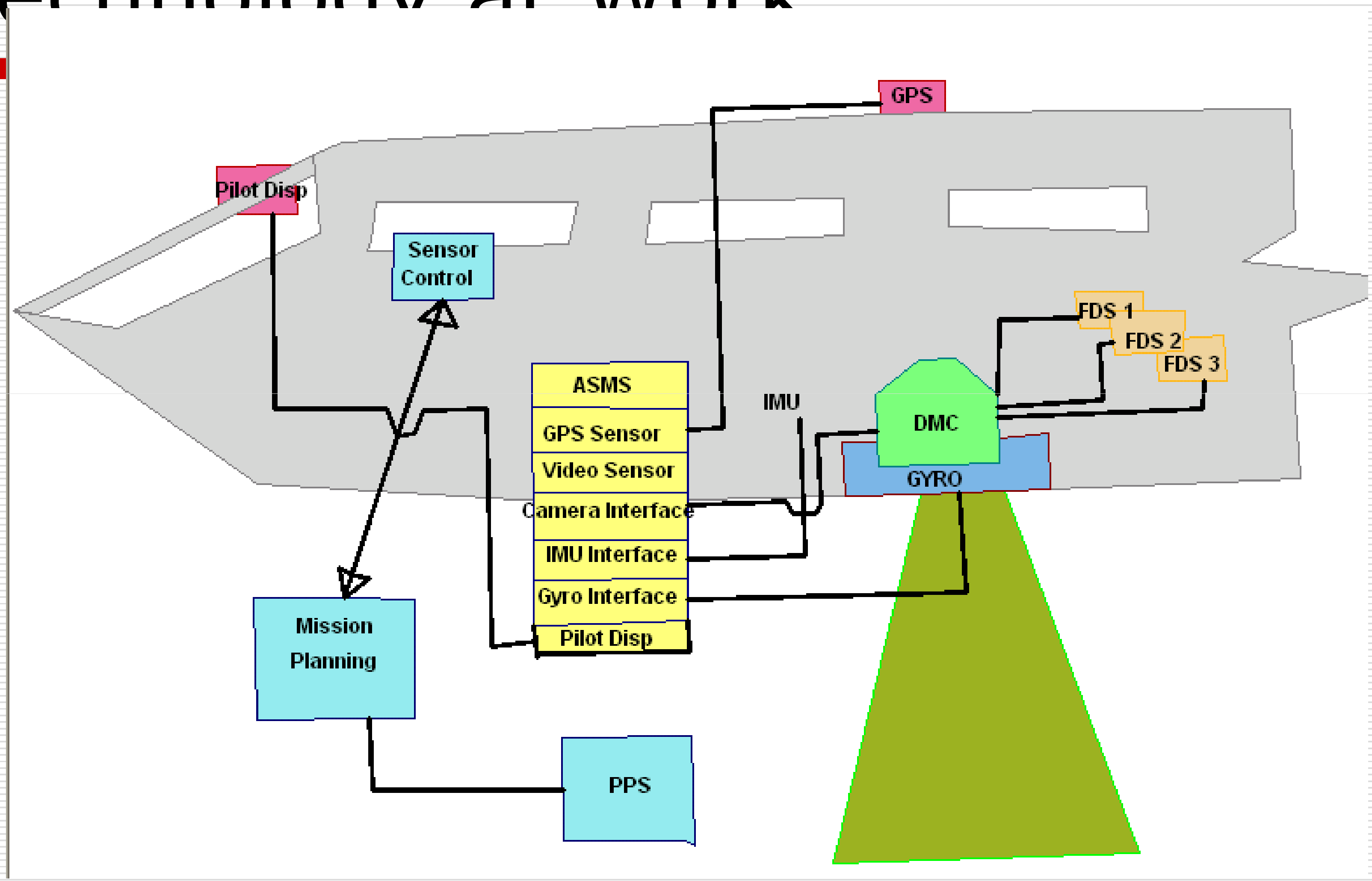
JOURNEY SO FAR

Aerial Photography

Shoreline Mapping

What better way to monitor the approximately 8,000 Km of Indian coastline than from a bird's eye view?

Technology at Work



Details of Cameras Used

DMC I/ II 230

- Large format frame cameras
- One of the first digital cameras to be certified by USGS
- 8 synchronously operating camera CCDs – imagery acquired is digitally mosaiced
- 8 lenses instead of single lens in film camera
- Electronic Forward Compensation

Camera Details - continued

- Focal length = 120 mm / 92 mm
- 7680 X 13824 / 15552 x 14144
- Pixel Size: 12 X 12microns / 5.6 X 5.6 microns
- Maximum resolution 2 cm
- Integrated GNSS/IMU system
- Gyro-stabilized mount
- Electro-mechanical shutters (1/50 to 1/300 s)
- Data storage on ruggedized RAID hard-disks (solid state) - MDRs

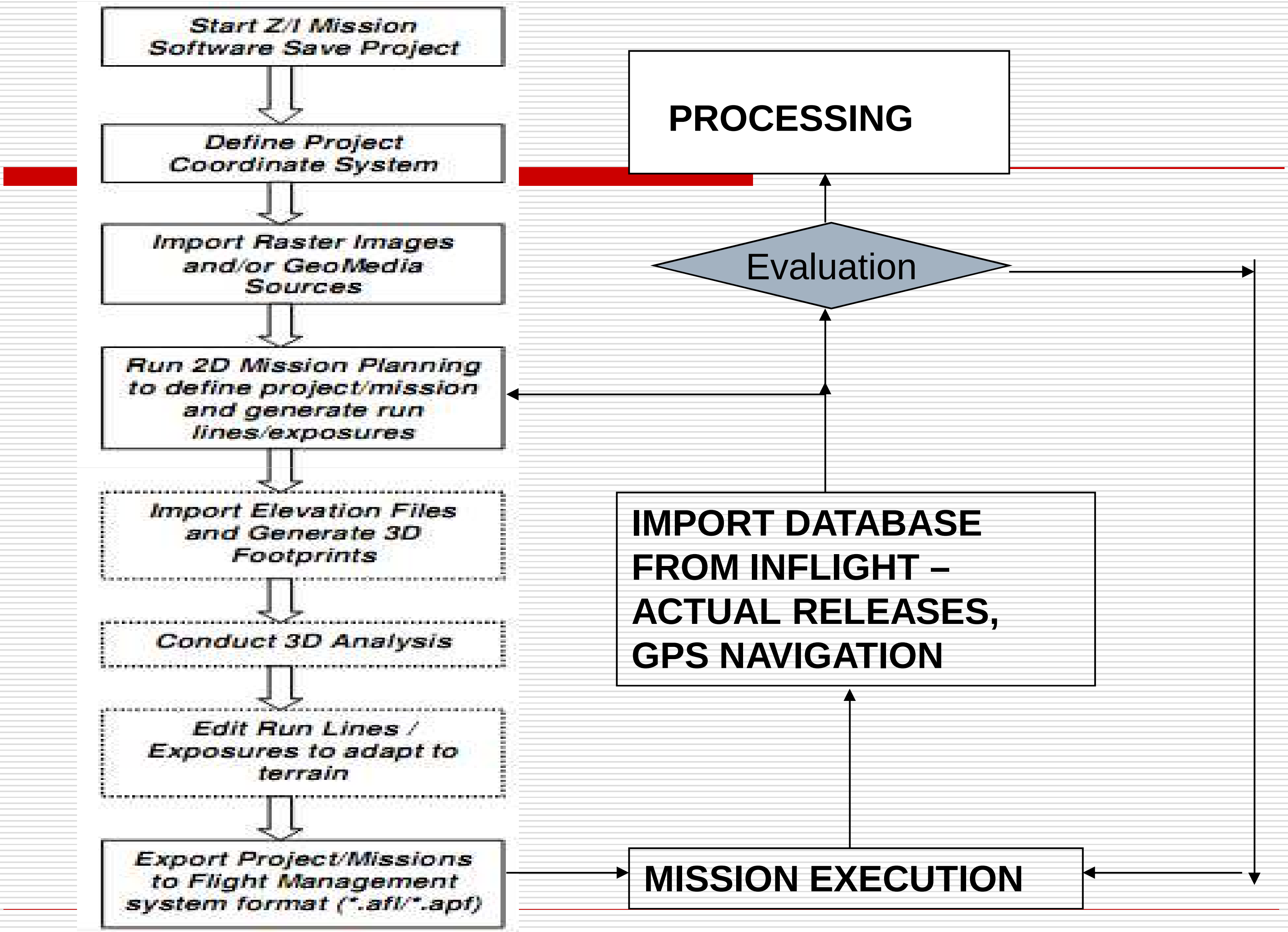
Specifications of Aerial Photographs

- 9 cm GSD
- 60% (+/- 5%) Forward Overlap
- 25% (+/- 5%) Lateral Overlap
- RGBI merged with PAN Imagery – Perfectly co-registered
- Raw Imagery -12 bit (4096 levels)

End to End Digital Workflow

- Optimized flight planning, which is the key to cost effective airborne image acquisition
- Flight Management System
- Flight evaluation/Reporting enables good quality control at an early stage of the workflow
- Project management considerably increases mission productivity and cuts overall cost. Mission Planning & Inflight Database can be imported/exported

Planning / Execution/ Processing



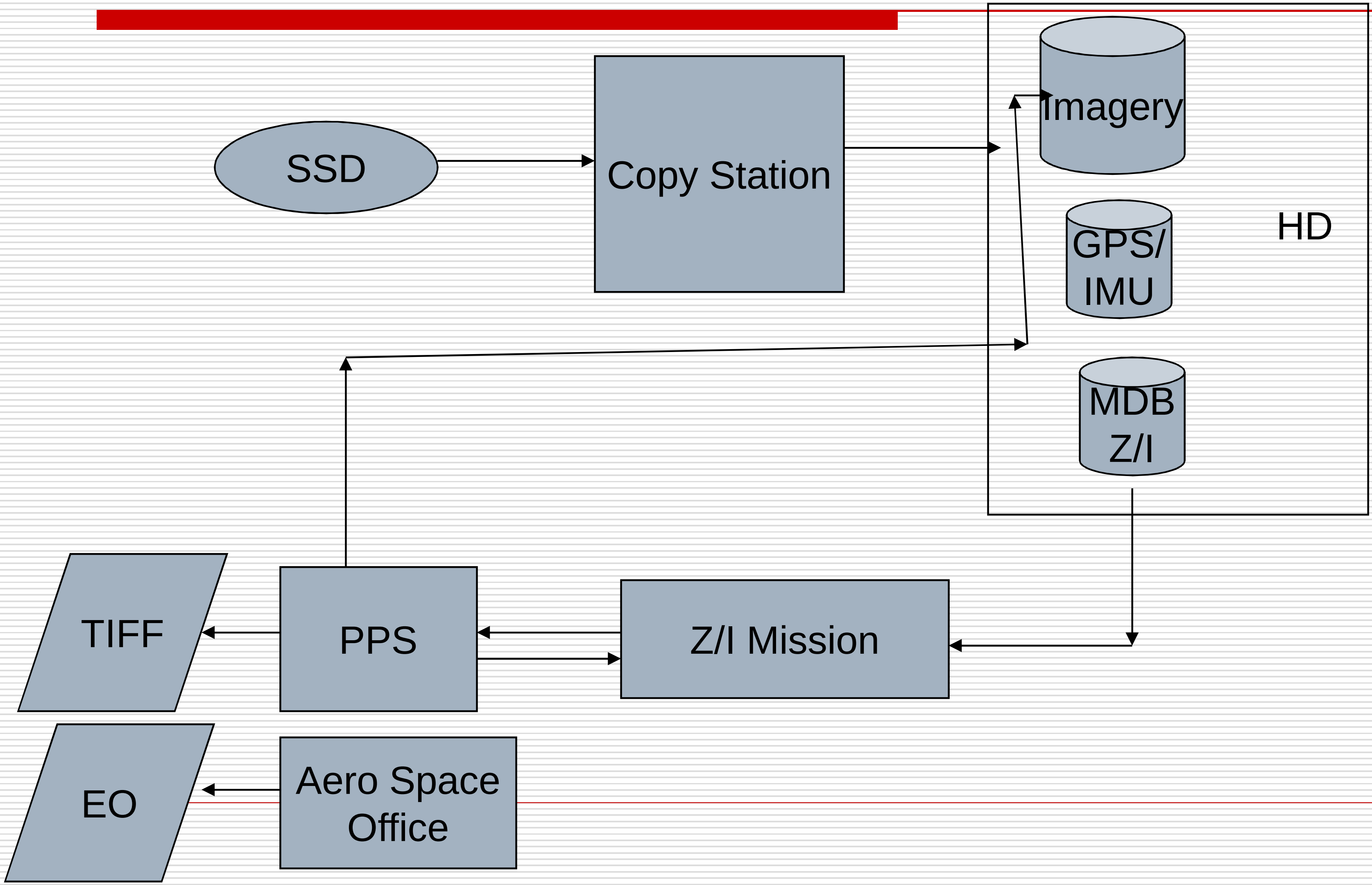
Flight Planning

- Rasters & vectors can be imported as backdrop
- All mission elements meticulously planned & edited in 2D
- 3D Mission Planning Check
- Complete solution for photography requirements GSD, overlaps in terrain variation

Flight Management System

- ASMS
- Automatic Exposure Control System (will fire inside box only)
- Real Time Video, exposure thumbnails & footprints available to pilot

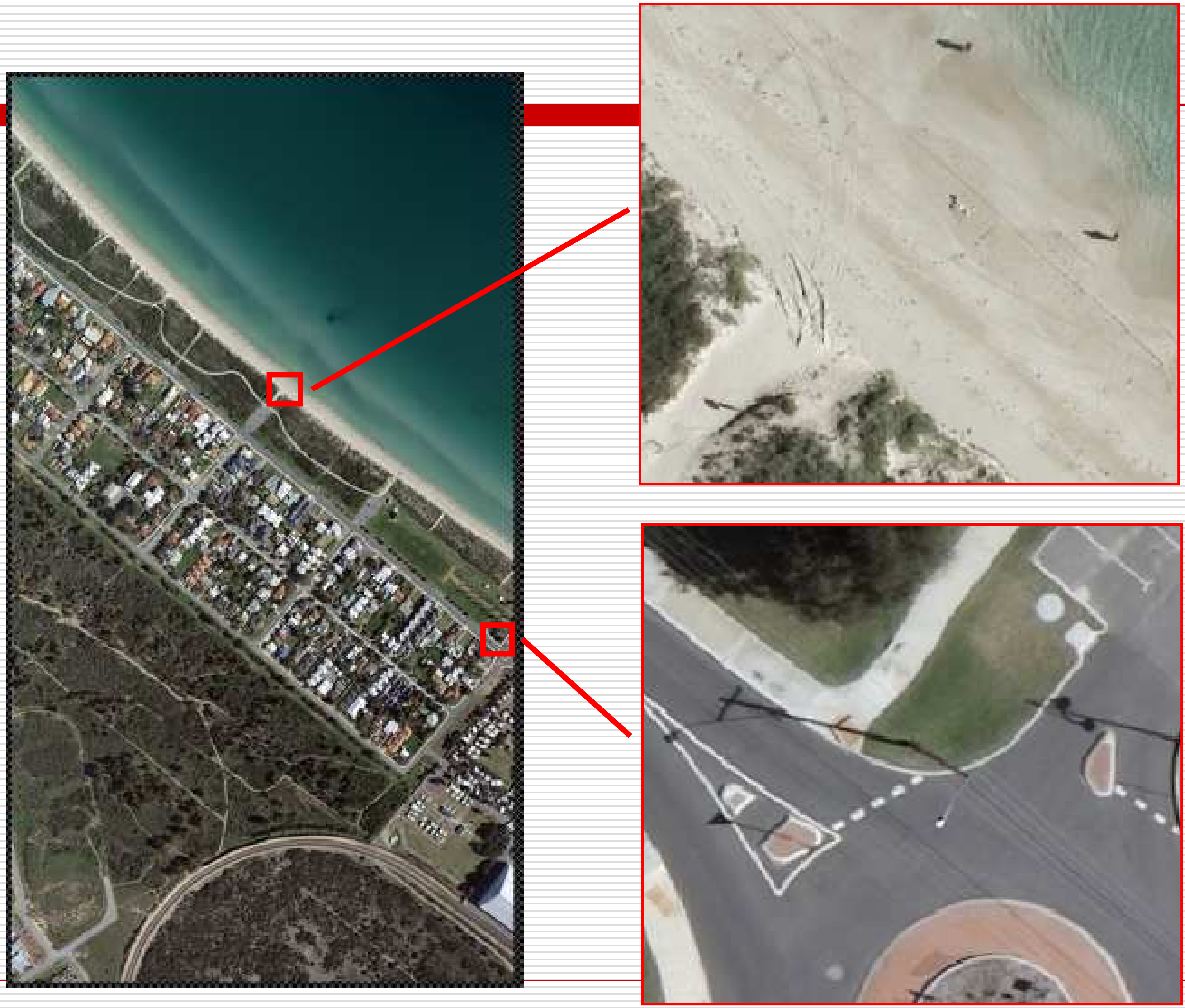
Downloading/ Processing



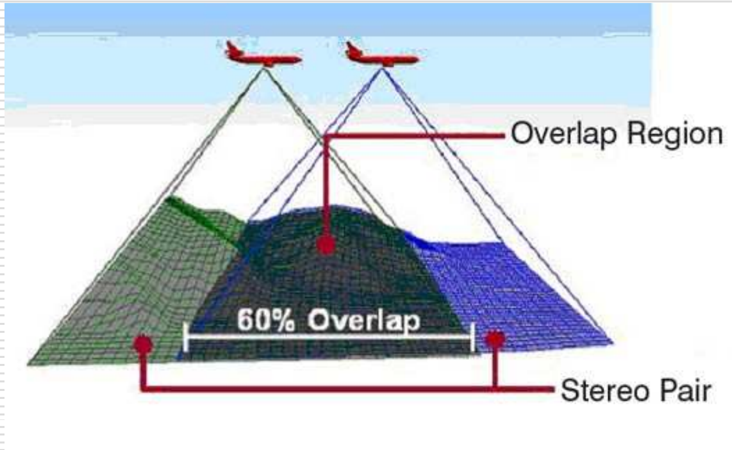
GPS/IMU

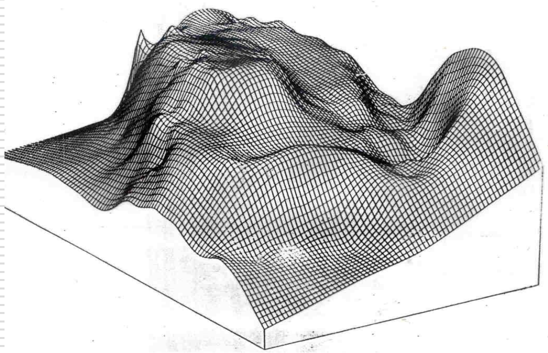
- Post flight HF IMU data is optimally integrated with survey grade LF GPS data
- Smoothed Best Estimate of Flight Trajectory
- X,Y, Z & Kappa, phi, omega

SAMPLE IMAGERY



4. DIGITAL PHOTOGRAMMETRY





(Status – Contract Awarded)

4. DIGITAL PHOTOGRAMMETRY

- **Photogrammetry Block Control By GPS & Levelling**
- **Aerial Triangulation &Creation of DEM and Ortho Image**
- **Generation of 0.5m Contours**
- **Stereo Digitization**

AERIAL TRIANGULATION

Note: Preliminary AT is part of this contract. A detailed and accurate AT will be done in the next contract after measuring post pointed controls

BCPs

- Radial Line Method
- Loop Closure Check
- Positional Accuracy 4 Cm

Aerial Triangulation

- Planning
- Adjustment
- DEM

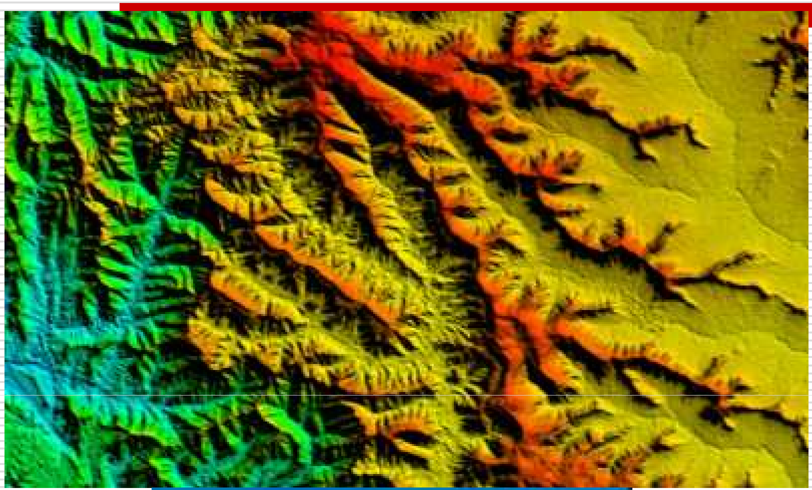
Mass Points

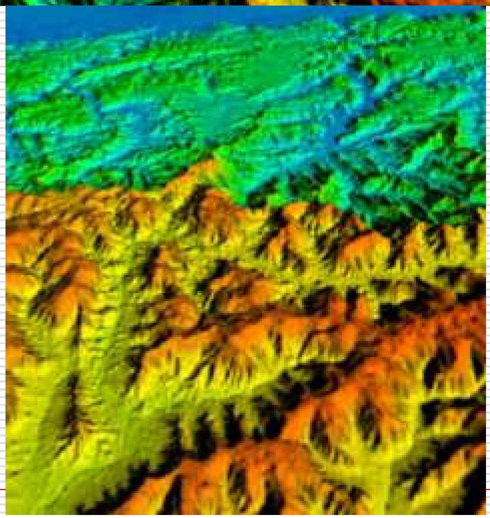
No. of Mass Points	**1,736,000,000**
Break lines	**50%**
Total Height Points	**2,604,000,000**

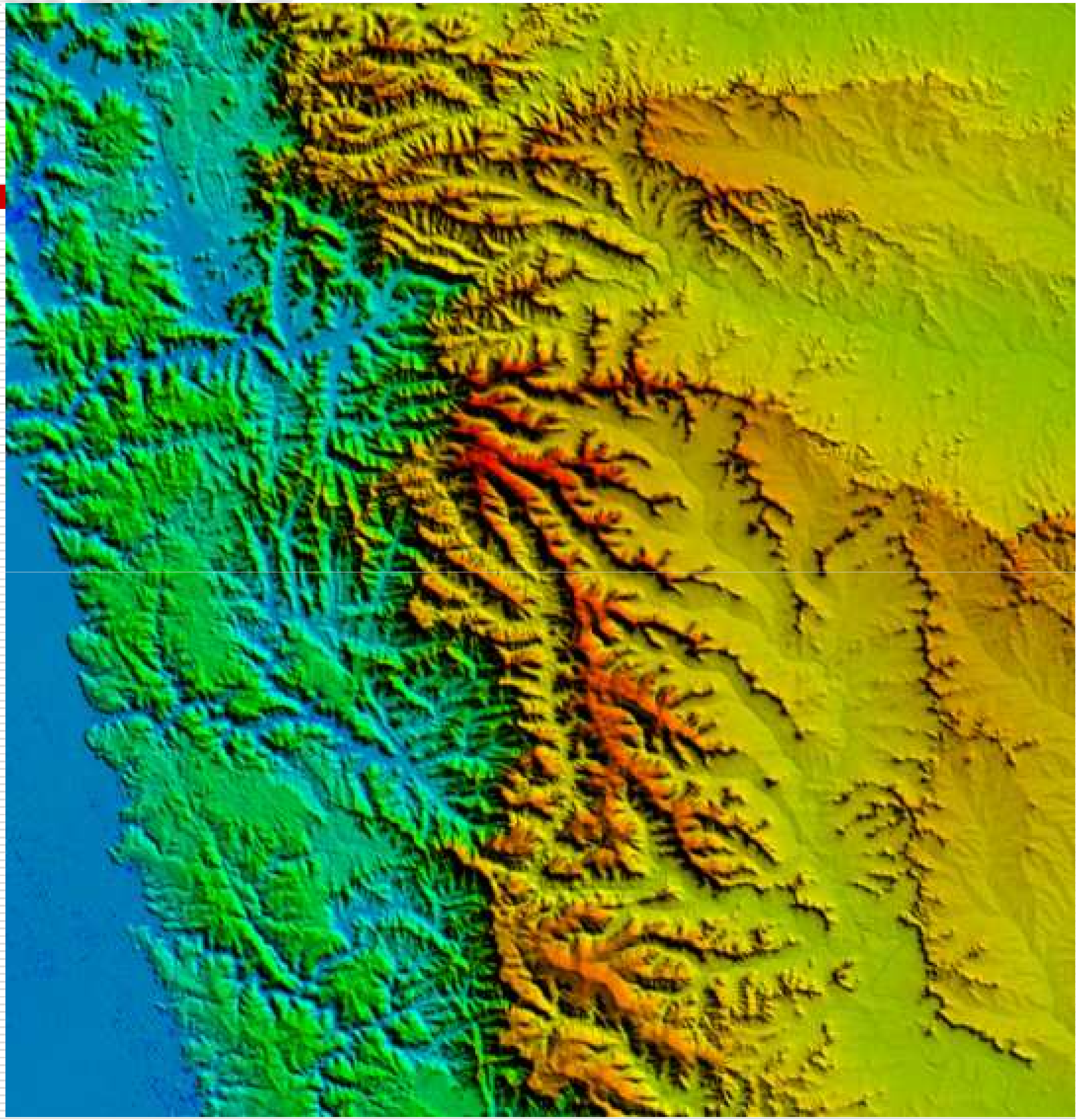
DEM

- Density of Mass Point@ 5 m
- Omission of Break lines
- Checking of TIN

DIGITAL TERRAIN MODELS







3. TIDAL DATA ANALYSIS

By Geodetic & Research Branch,

Survey of India, Dehradun.

(Status – Completed for all Primary and Secondary Ports)

Tidal Data Analysis

- ❖ Survey of India is one of the premier organizations in the world having more than 130 years of expertise in tidal data acquisition.

- ❖ It is a large store house of tidal data , collected from major part of its area of responsibility.

- ❖ Presently Survey of India is maintaining a huge network of permanent tidal stations , located along the Indian Coast and Islands.

- ❖ These tidal stations are equipped with state-of-the-art digital tide gauges , co-located with dual frequency GPS receivers and real time data transmission facilities through dedicated VSAT network.

Determination of Tidal Heights for 100 yrs return period

- ❖ Estimated tidal heights for 100 years return period have been determined for the ports having tidal records for at least 10 years. 21 such tidal stations have been identified in the east and west coast for determining the tidal level for 100 years return period.

Methodology

i. **Provide minimum 10 years of historical tide gauge data for all ports within the state boundary for which long term observations are available.**

ii. **Determine the Annual Maximum Water Level for each year and each port.**

iii. **Reduce Annual Maxima from Chart Datum to IMSL and tabulate.**

iv. **Rank order the data**

v. **Calculate Weibull distribution and plotting positions of all the available data.**

vi. **Fit regression line to plotted data and extrapolate to 100 years.**

- **Kandla --- 4.06**
- **Vadinar --- 4.08**
- **Okha --- 2.27**
- **Veraval --- 1.77**
- Mumbai --- 3.00
- Marmagao --- 1.64
- Karwar --- 1.94
- Mangalore --- 1.27
- Cochin --- 1.01
- Thangachimadam --- 1.38
- Tuticorin --- 0.96
- Nagapattinam --- 1.45
- Chennai --- 1.46
- Visakhapatnam --- 1.83
- Paradip --- 2.36
- Sagar --- 4.01
- Haldia --- 4.78
- Diamond Harbour --- 4.80
- Garden Reach --- 5.89
- TRIBENI ---- 8.25

Primary Port at ODISHA

- PARADIP 36 years (1966-2006)

Gaps 1975, 1977, 2000-2001,

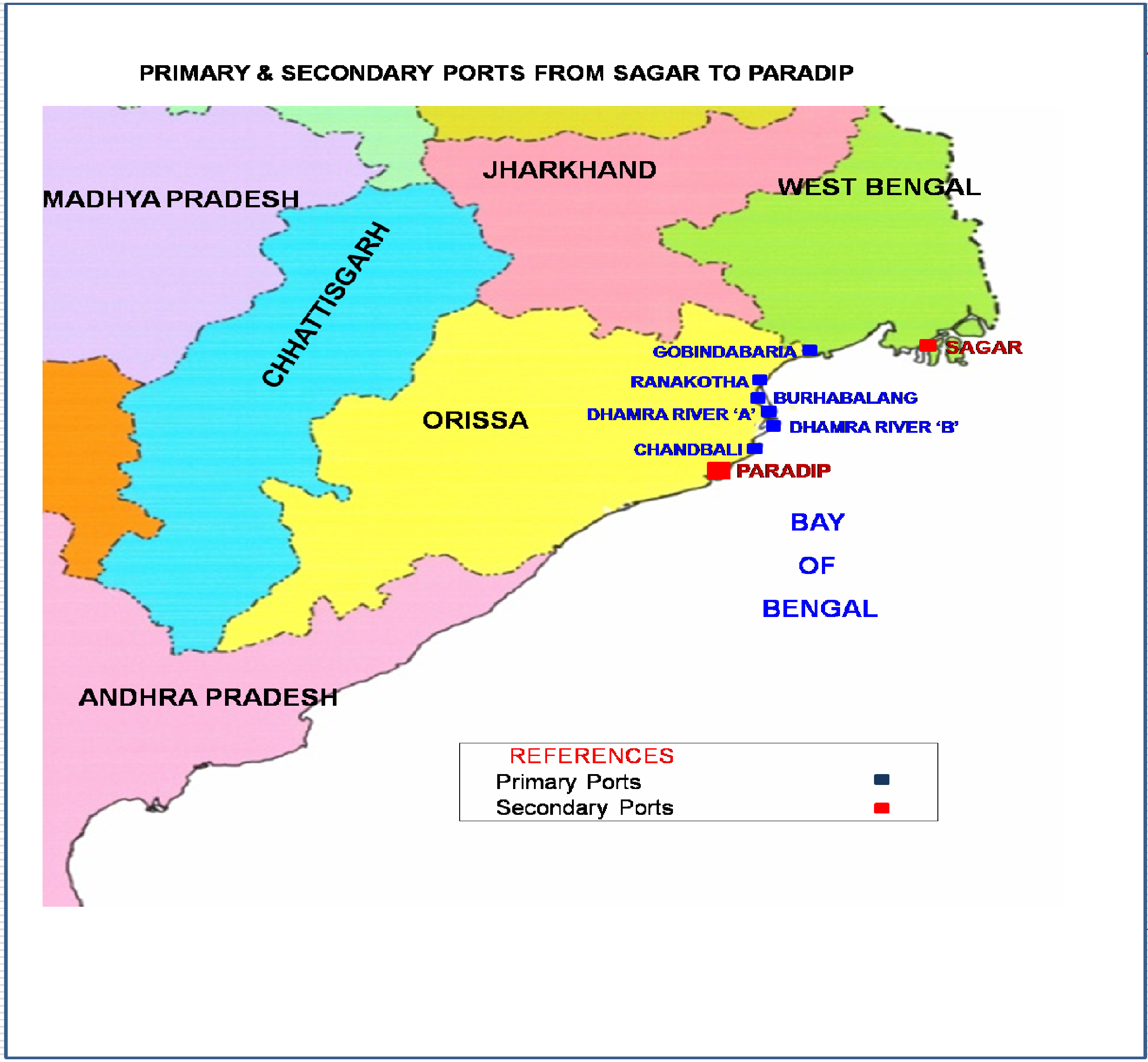
SoI pattern FTG was in use.

Secondary Ports at Odisha

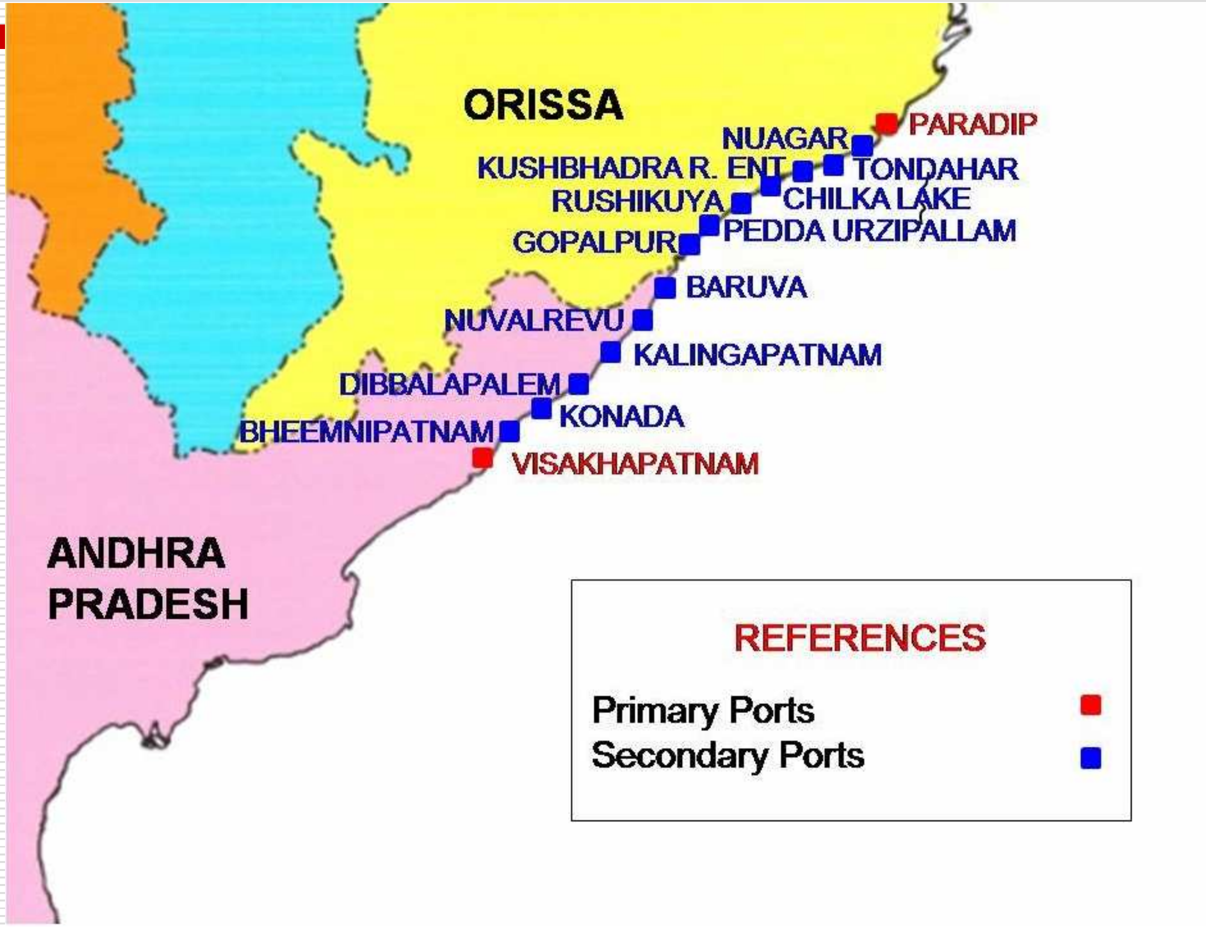
- **Gobindabaria (Daryapur) Rasulpur River**
- **Ranakotha (Kirtania Jalpahi)**
- **Burhabalang**
- **Dhamra river site`A`**
- **Dhamra river Chardia Site`B`**
- **Chandbali**
- **Nuagar (Devi River)**
- **Tondahar**
- **Kushbhadra River Entrance**
- **Chilka Lake mouth(Arakhakud)**
- **Rushikulya**
- **Pedda Urzipallam**
- **Gopalpur**

PORTS OF INDIA

PARADIP & SAGAR

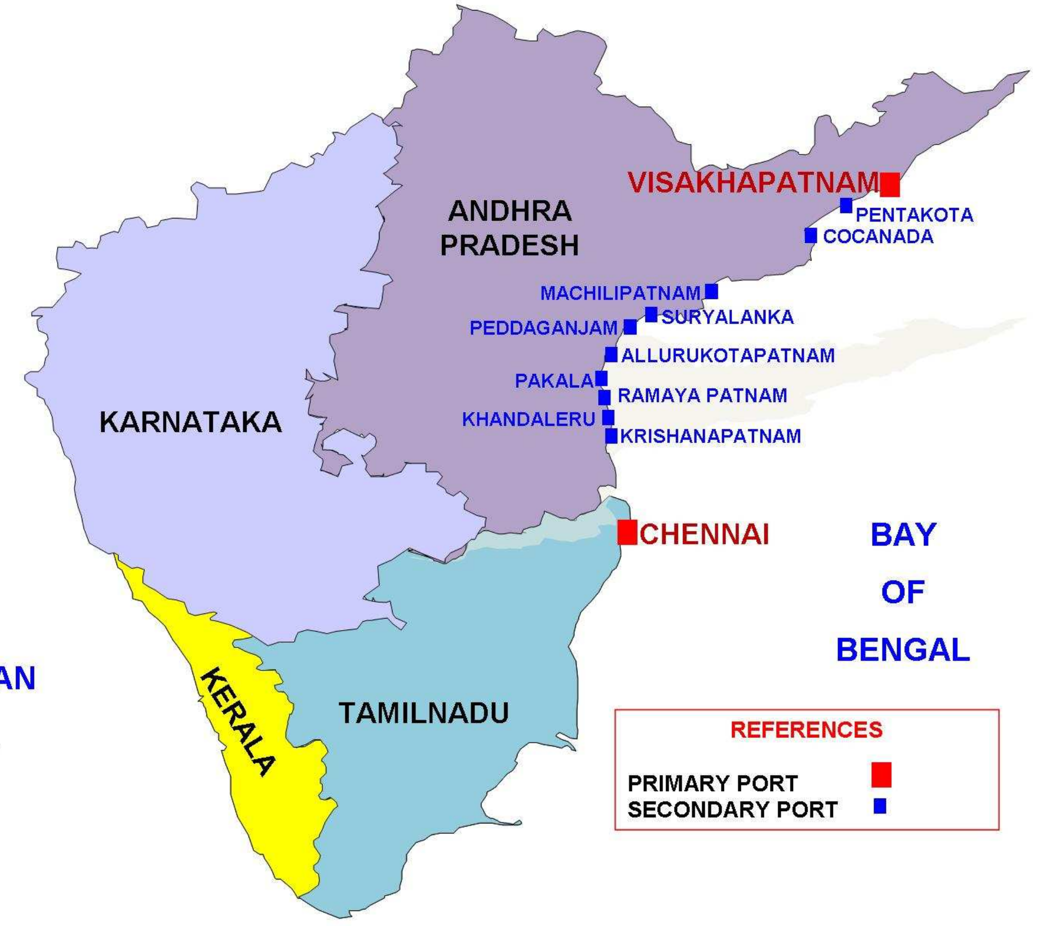


PARADIP & VISAKHAPATNAM

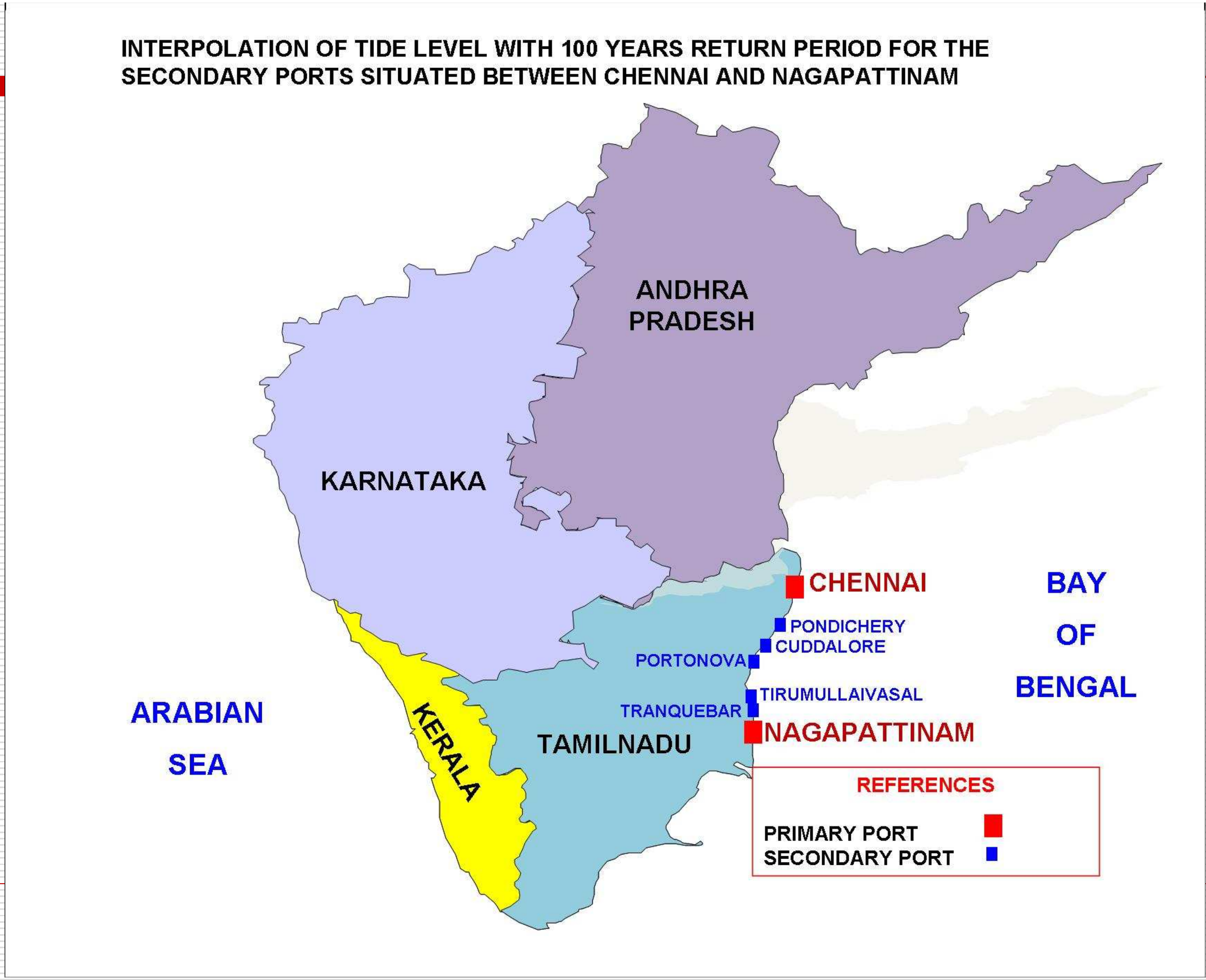


VISAKHAPATNAM & CHENNAI

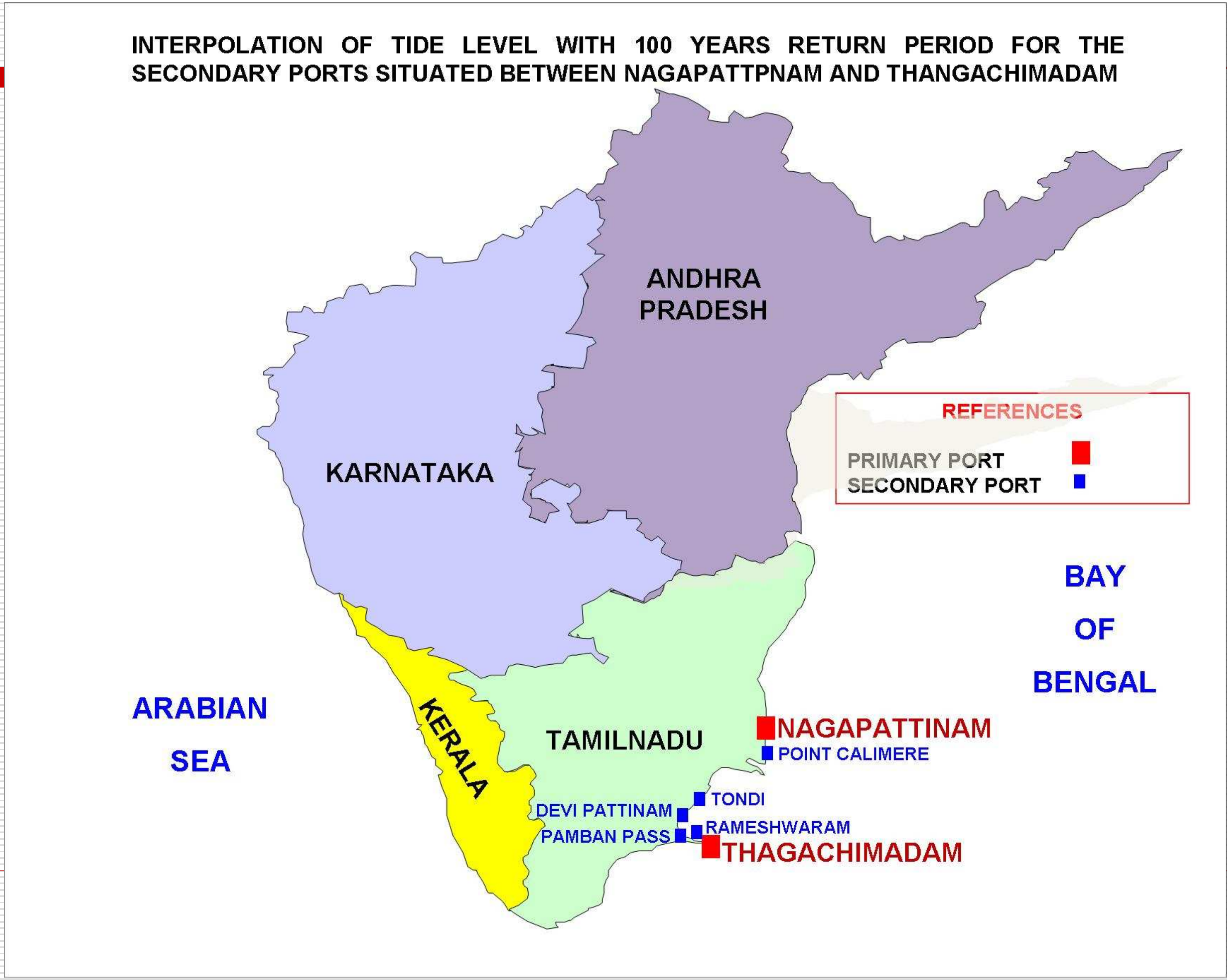
INTERPOLATION OF TIDE LEVEL WITH 100 YEARS RETURN PERIOD FOR THE SECONDARY PORTS SITUATED BETWEEN VISAKHAPATNAM AND CHENNAI



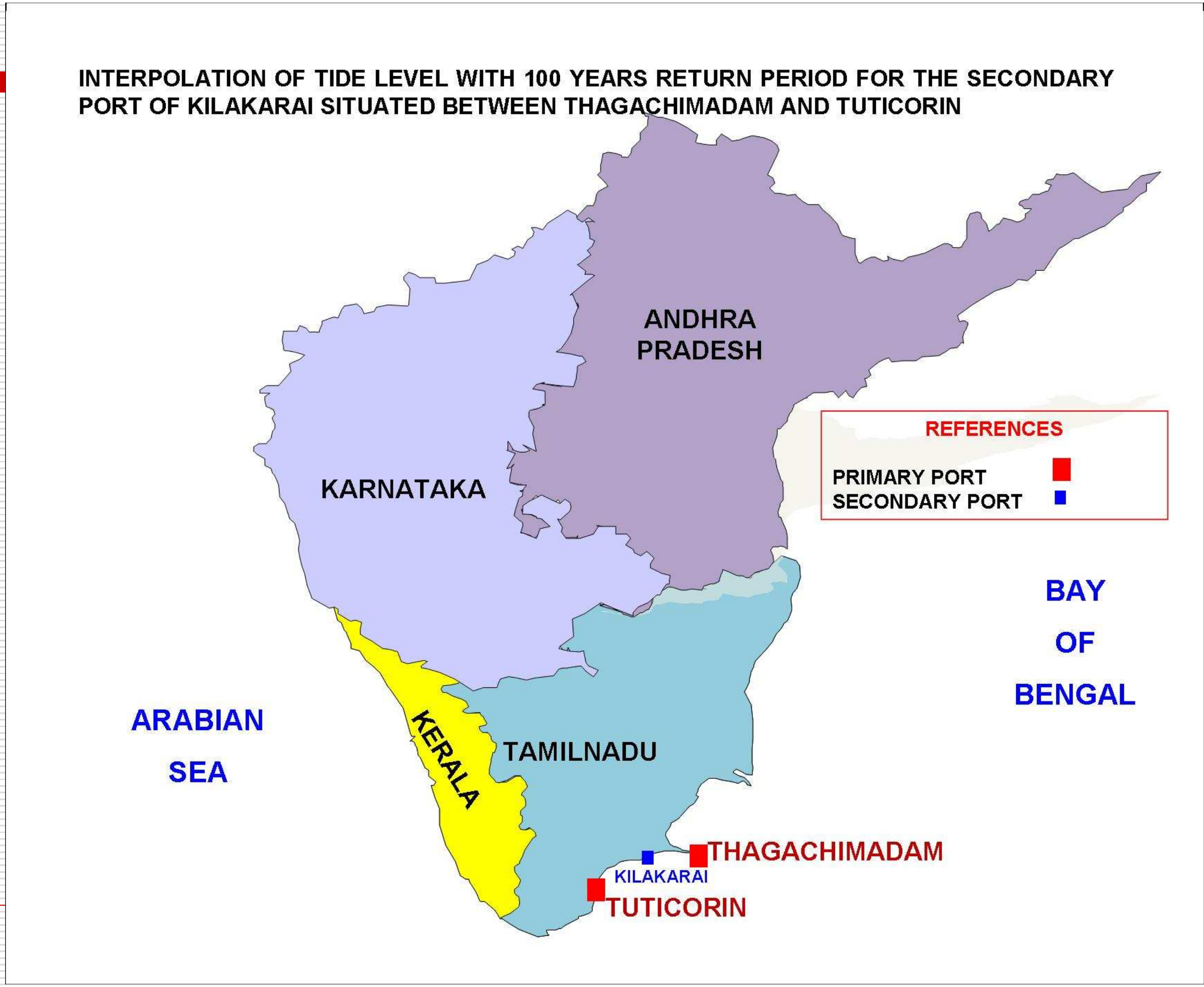
CHENNAI & NAGAPATTINAM



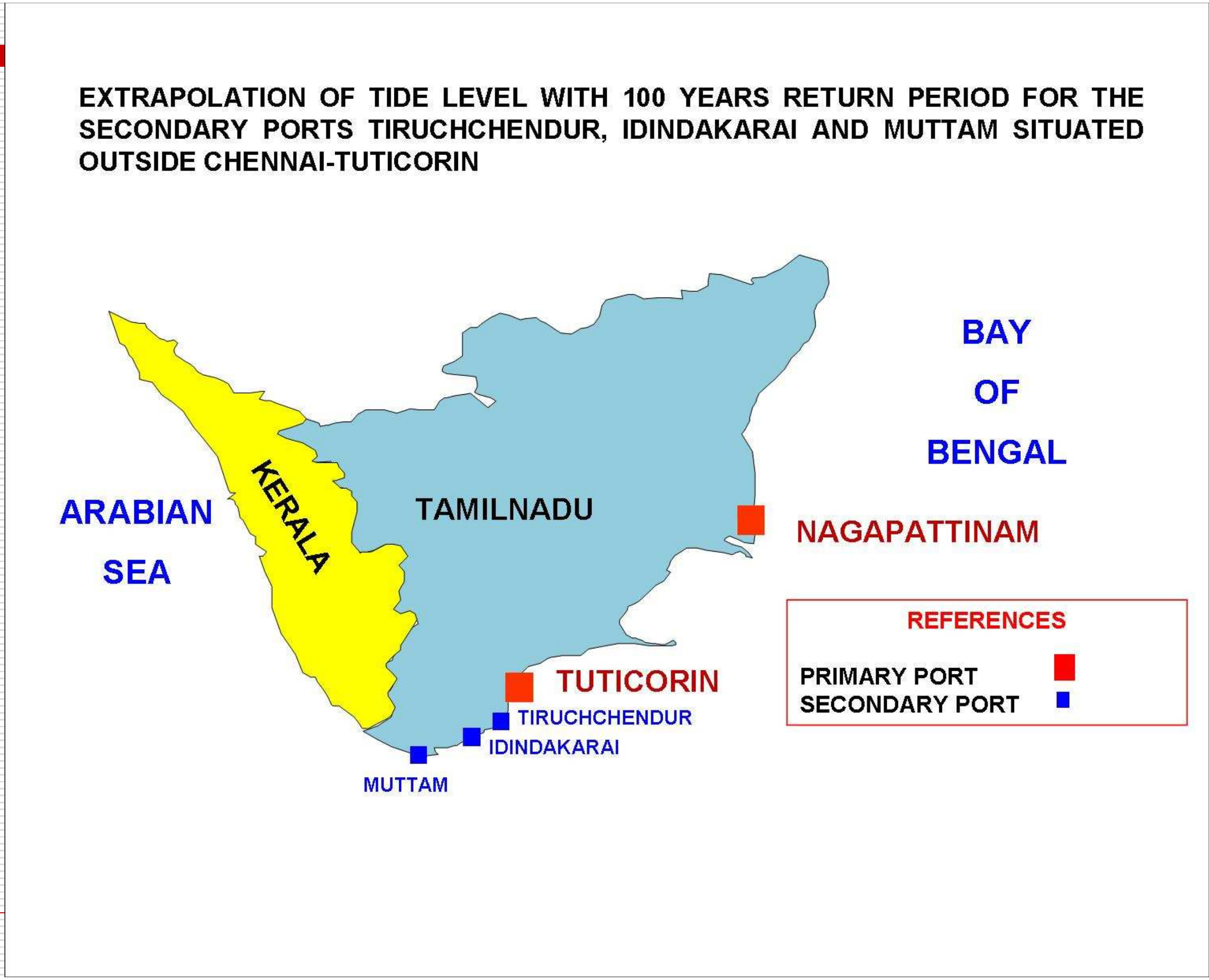
NAGAPATTINAM & THAGACHIMADAM



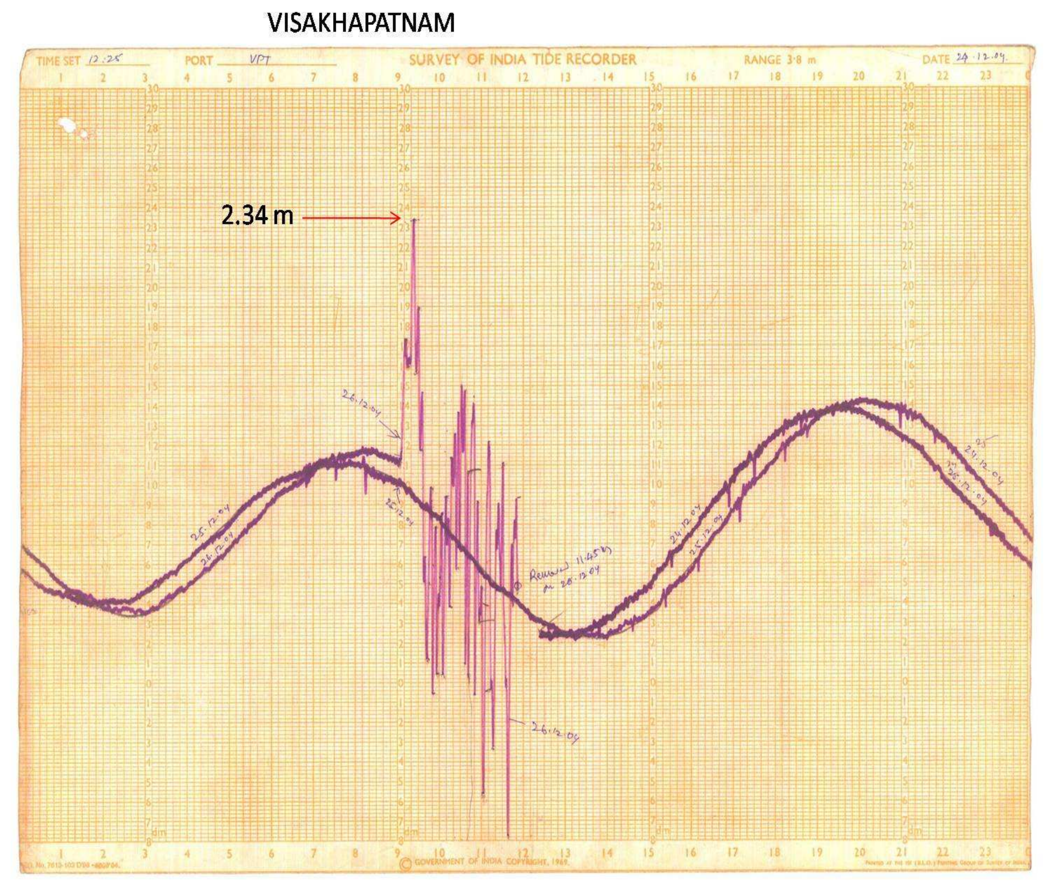
THAGACHIMADAM & TUTICORIN



SOUTHERN TIP



VISAKHAPATNAM DURING TSUNAMI



Interpolation Of Return Period Tidal Elevations

- Compute 100 year Return Period Max Elevations values at each of the 21 primary ports.

- Compute 100 year Return Period values at each of the 131 Secondary Port using 2 neighboring primary ports
- This will give 100 year RPs at about every 30 km.

- Draw a base line for measurements and make Transects at every 500 m.
- Linearly Interpolate at Transect points using 2 neighboring Primary / Secondary ports.

SEA LEVEL RISE

- Use extreme elevation data of 100 year return period at 21 major and 131 minor ports computed by G & RB, SOI.
- Interpolate at other Transect points using linear interpolation.
- Inundation modeling with help of tidal heights and DEM to delineate Flood line.

Interpolation Of Return Period at Secondary Ports

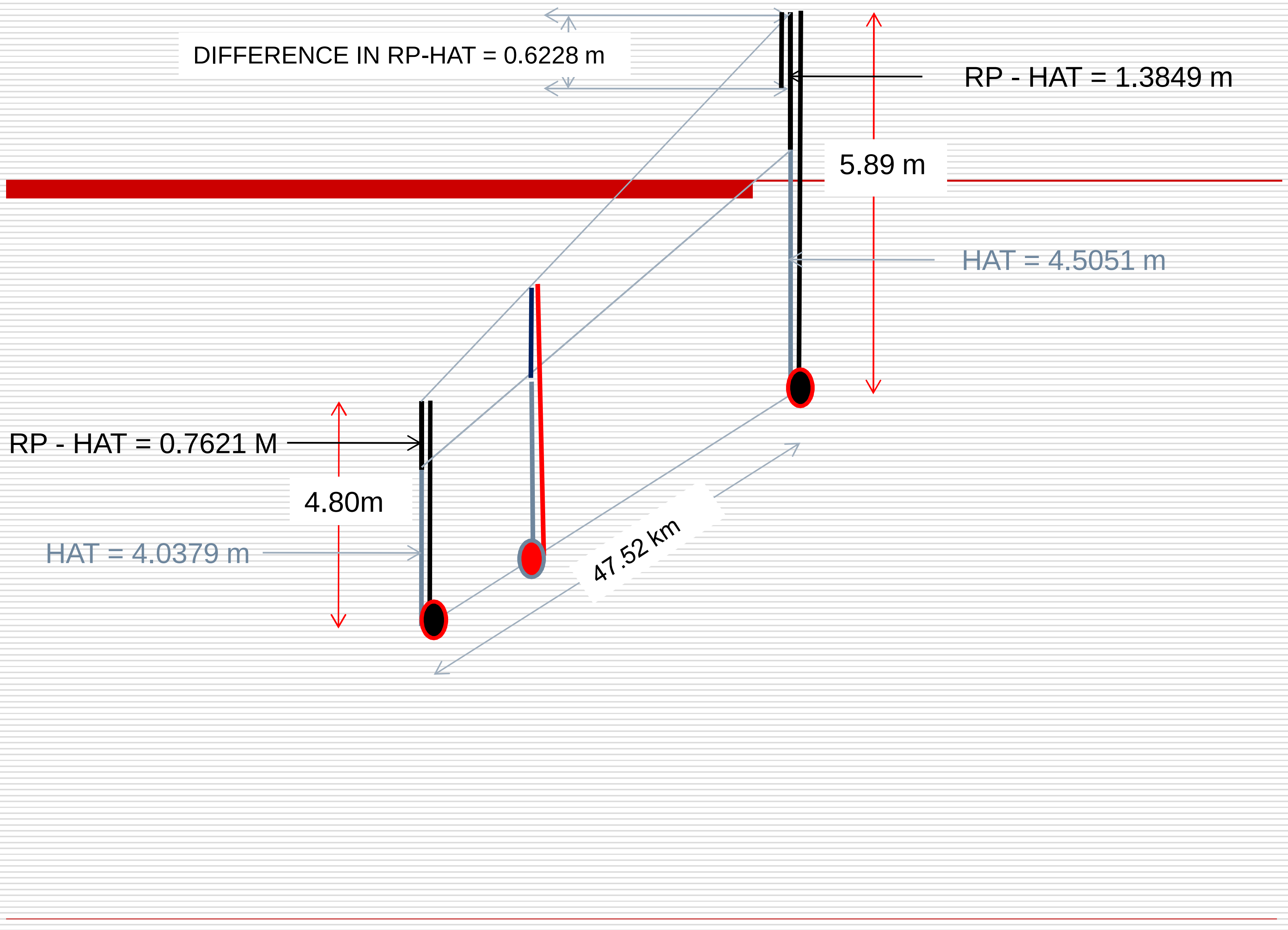
- 100 years Return Period for major port M1 (Known Station) = 5.89 m
- 100 years Return Period for major port M2 (known Station) = 4.80 m

- Distance between M1 & M2 = 47.52 km
- Distance between M1 and Secondary port S = 21.46 km

- **Indirect Interpolation:**
- Tidal Ht. for 100 year RP-HAT of M1 =5.8900-4.5051 = 1.3849
- Tidal Ht. for 100 year RP-HAT of M2 =4.8000-4.0379 = 0.7621

- Correction for S = 1.3849+

{(0.7621-1.3849)*Distance from M1 (21.46)}/Total Distance(47.52) =1.1036 m


DIFFERENCE IN RP-HAT = 0.6228 m
RP - HAT = 1.3849 m
5.89 m
HAT = 4.5051 m
RP - HAT = 0.7621 M
4.80m
HAT = 4.0379 m
47.52 km

Interpolation Of Return Period

Primary Ports

Secondary Ports

Transect Points

Linear Interpolation at Transect Points

Two ports (primary / secondary) will be taken

at a time:

$$(y - y1) / (x - x1) = (\Delta y / \Delta x)$$

Based on Equation of line or Similar Triangles

Tidal Data Coverage .....

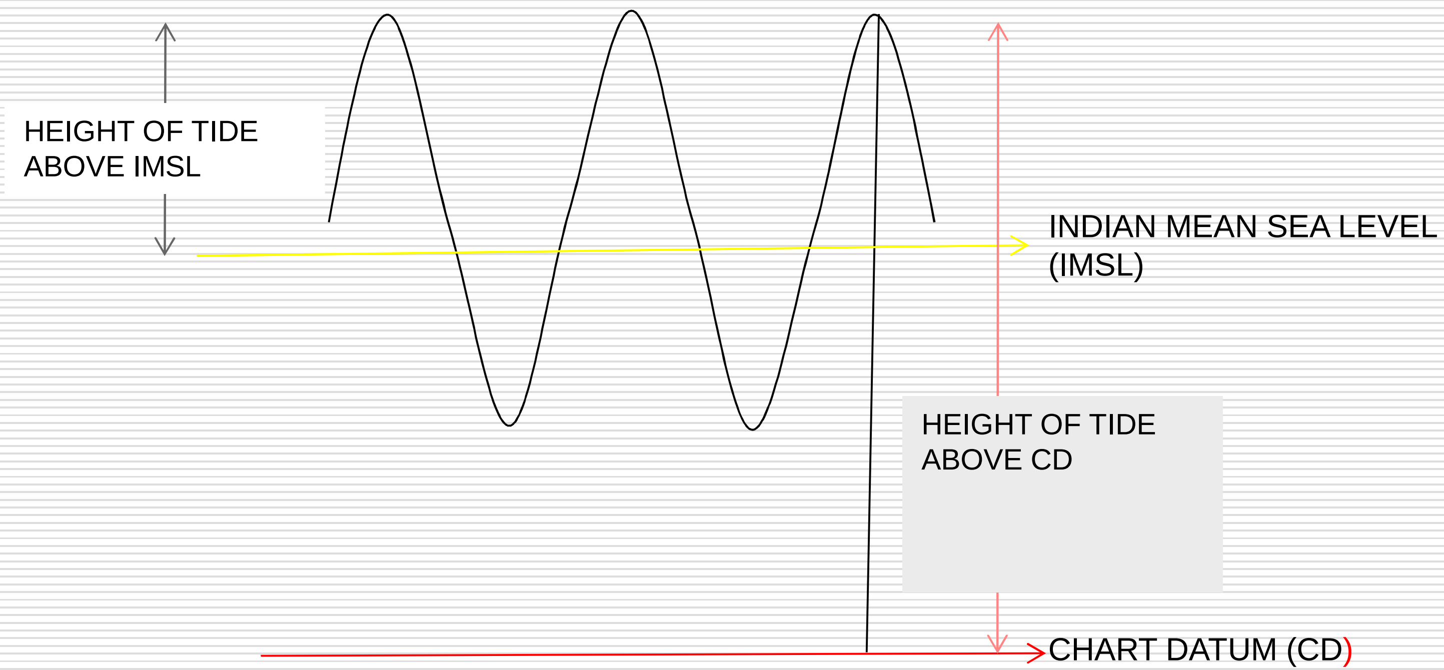
- All available Data up to 2010 will be used after checking for quality.

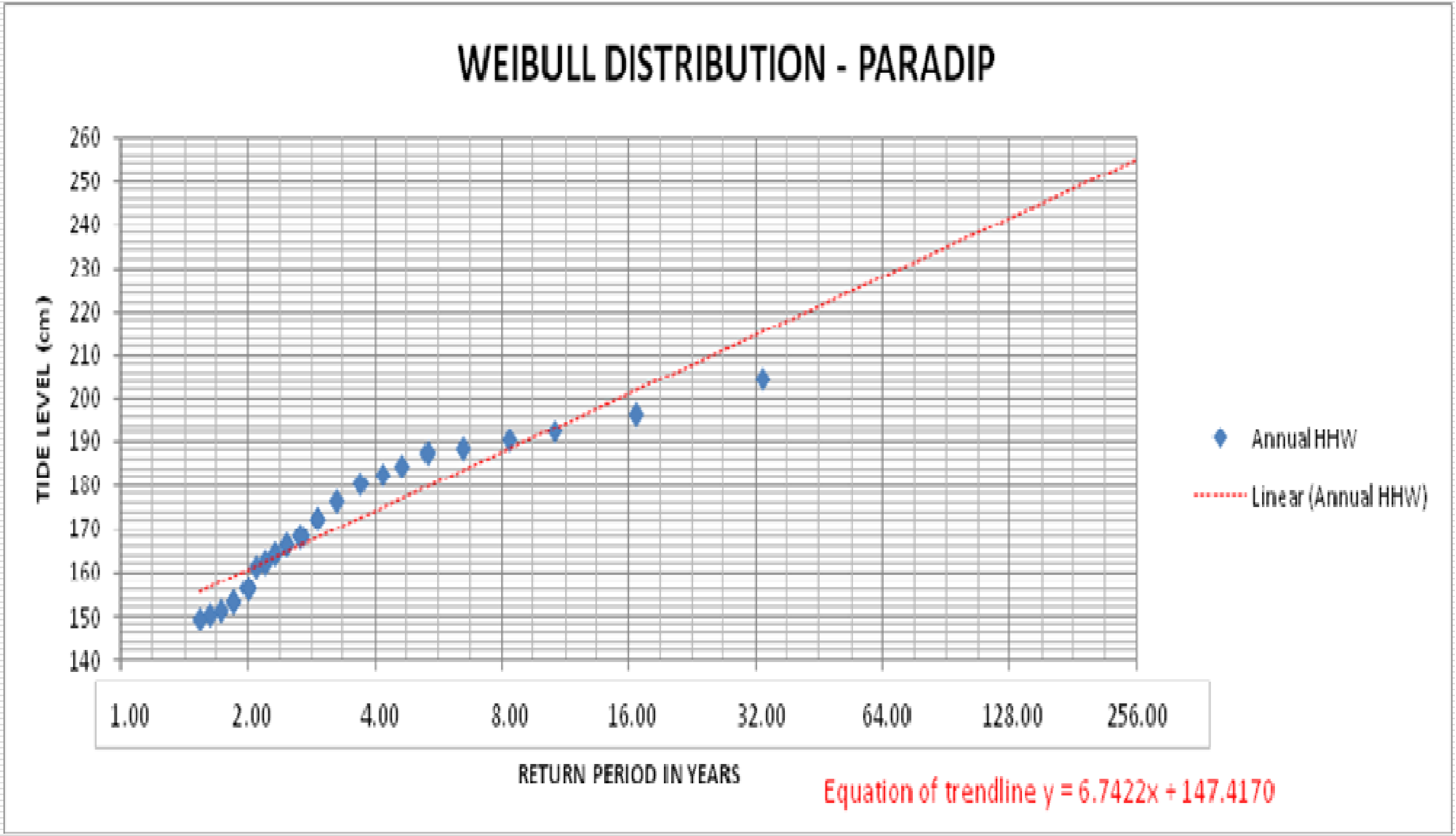
- Month-wise distribution / availability of data will be checked.

- Regularity of Missing Data will also be checked.

- Tsunami / Cyclone data will also be included.

Converting Chart Datum IMSL




WEIBULL DISTRIBUTION - PARADIP
TIDE LEVEL (cm)
260
250
240
230
220
210
200
190
180
170
160
150
140
1.00
2.00
4.00
8.00
16.00
32.00
64.00
128.00
256.00
RETURN PERIOD IN YEARS
Annual HHW
Linear (Annual HHW)
Equation of trendline y = 6.7422x + 147.4170

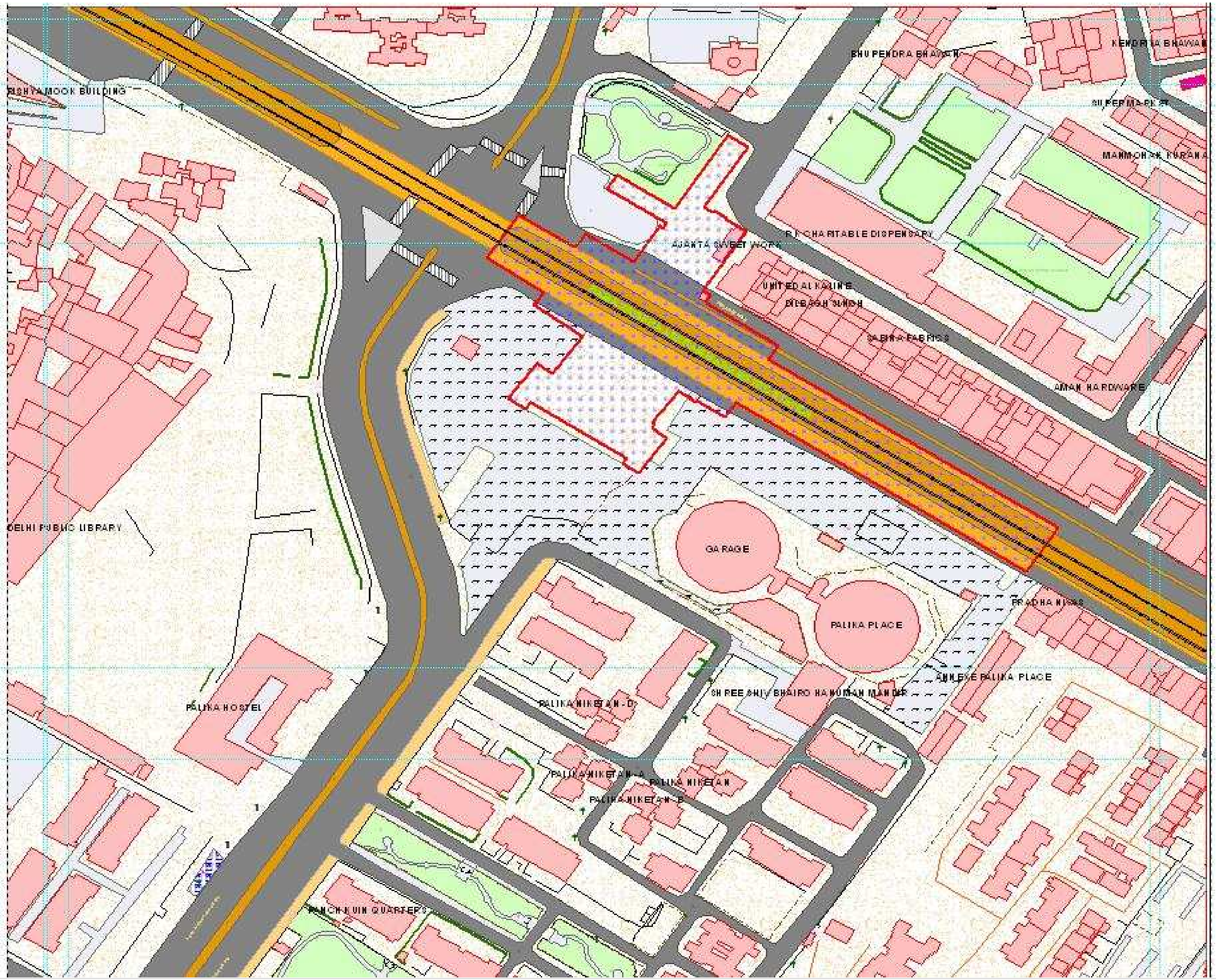
Digital Ortho Photos

Each image has latitude/longitude coordinates embedded in the image along with metadata.

Independent Images

Sample Ortho

DIGITIZATION OF FEATURES AS PER DATA MODEL STRUCTURE



PATH AHEAD

MARINE GIS

Just as fish adapted to the terrestrial environment by evolving into amphibians, so GIS must adapt to the marine and coastal environment by evolution and adaptation.

M. F. Goodchild (2000)

Organize the data

- The aerial photography is mine of data
- Need to manage it scientifically
- GIS is the best way to organize data
- But the challenges of Marine GIS are unique in itself

ICZM Plans

- Will be based on the foundation data-sets generated by Aerial Photography/Photogrammetry

Challenges of Marine GIS

- how to best handle the temporal and dynamic properties of shoreline and coastal processes?
- how to deal with the inherent fuzziness of boundaries in the ocean?
- the great need for spatial data structures that vary their relative positions and values over time ?

Standard Data Model –Adaptation in Marine GIS

- Data model to handle 4-D Data for more precise & explicit representation of 3D space and time
- Standardize generic feature classes and build on the core feature classes

Core Feature Classes – Marine GIS

- Shorelines
- Tracks & Cruises
- Time Duration Features
- Time Series Features
- Location Series Observations
- Instantaneous Measured Observations
- Survey Transects
- Scientific Mesh
- Mesh Volume
- Bathymetry

Need for Standardization

- Data Structure
- Catalog Service
- Observations & Methods
- Object Reference Model
- WMS/WFS(T)/WCS/WMTS/WPS
- GML/KML

Remote Sensing - Applications

- NDVI – Normalized Difference Vegetation Index
- NIR Sensitive to vegetation bio-mass.
- NIR Penetrates haze & Land-water boundary.

THANK YOU