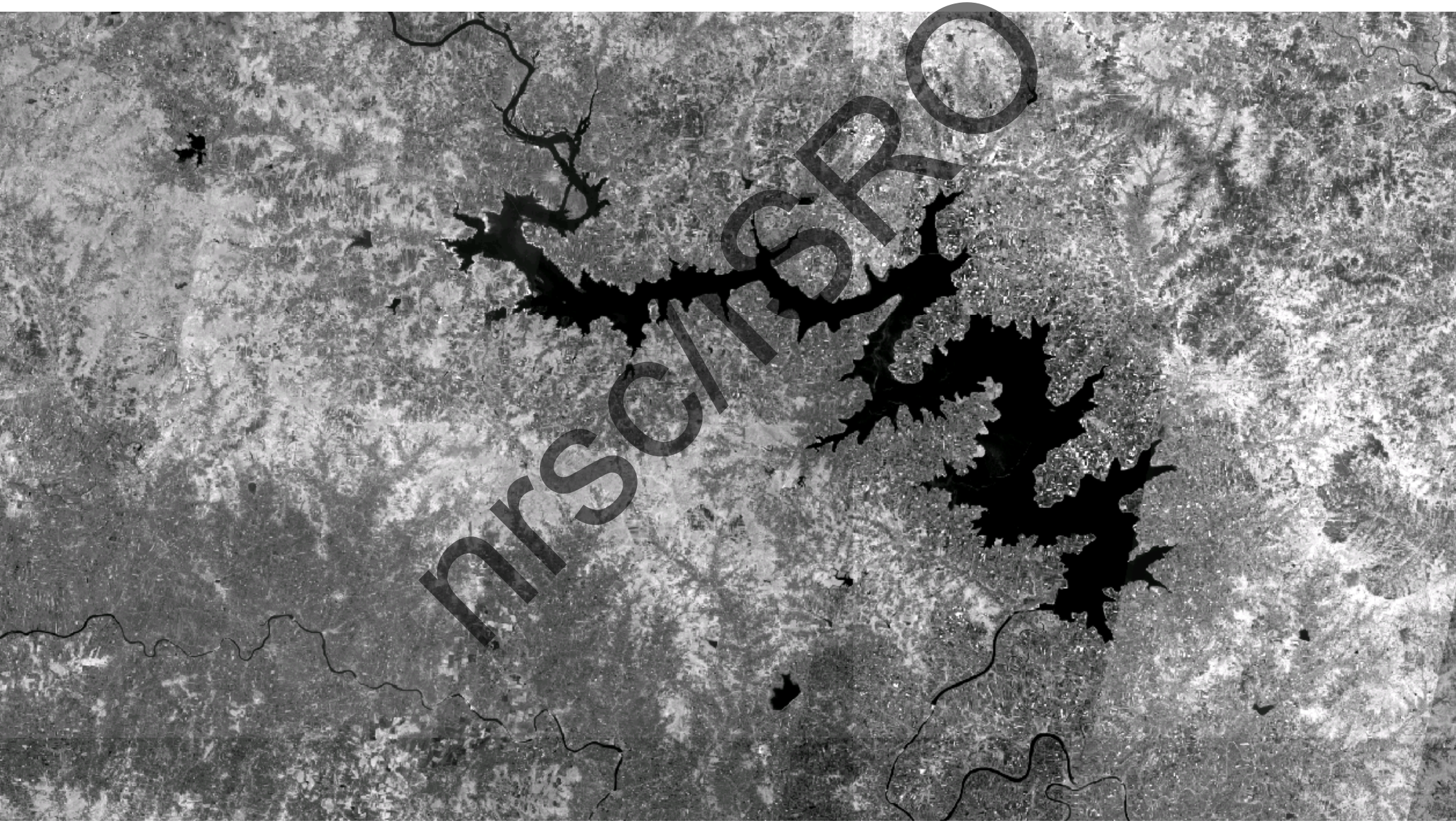
Water bodies Flattening

(CartoDEM Ver.3)



DOCUMENT CONTROL SHEET

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	Project Team /Authors				
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	Generation of CartoDEM Ver.3 (DPPA &WAA)	CartoDEM Team IODP & PQ Group			
	Affiliation of authors	NRSC / ISRO, Hyderabad			
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16	**Abstract :** Flattening of DSM over Inland water bodies & sea coastlines in CartoDEM v3 is the main objective of the study for improving the DSM over India. This document describes the inputs and methodology for extraction of water bodies layer using a semi automated image processing techniques, flattening of water bodies in DSM and sea masking. Several examples showing the water bodies				

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Methodology

Falttening of DSM over Inland water bodies & sea coastlines in CartoDEM v3

Elevation values created from automated DSM generated methodologies normally create artifacts on water bodies. These need to be flattened. In order to flatten the elevation values, the following data processing steps are performed.

1. **Creation of 1° x 1° ortho images (Cartosat-1 Aft sensor) using 7½' x 7½' ortho image tiles.**

2. **Extraction of water bodies in a semi-automated way and generation of single water body layer for the entire India.**

3. **Editing of DSM elevation values in automated way over water bodies using the extracted water body shape files. Single elevation value is computed using the shoreline DEM values of the water body and used to edit the DSM over it.**

4. **In addition to flattening inland water bodies, DSM over coast lines and sea are edited and a single elevation value (-255 m) is applied. However, DSM over islands is preserved.**

5. **Water body information in a a tile is provided along with CartoDEM (freely downloadable)**

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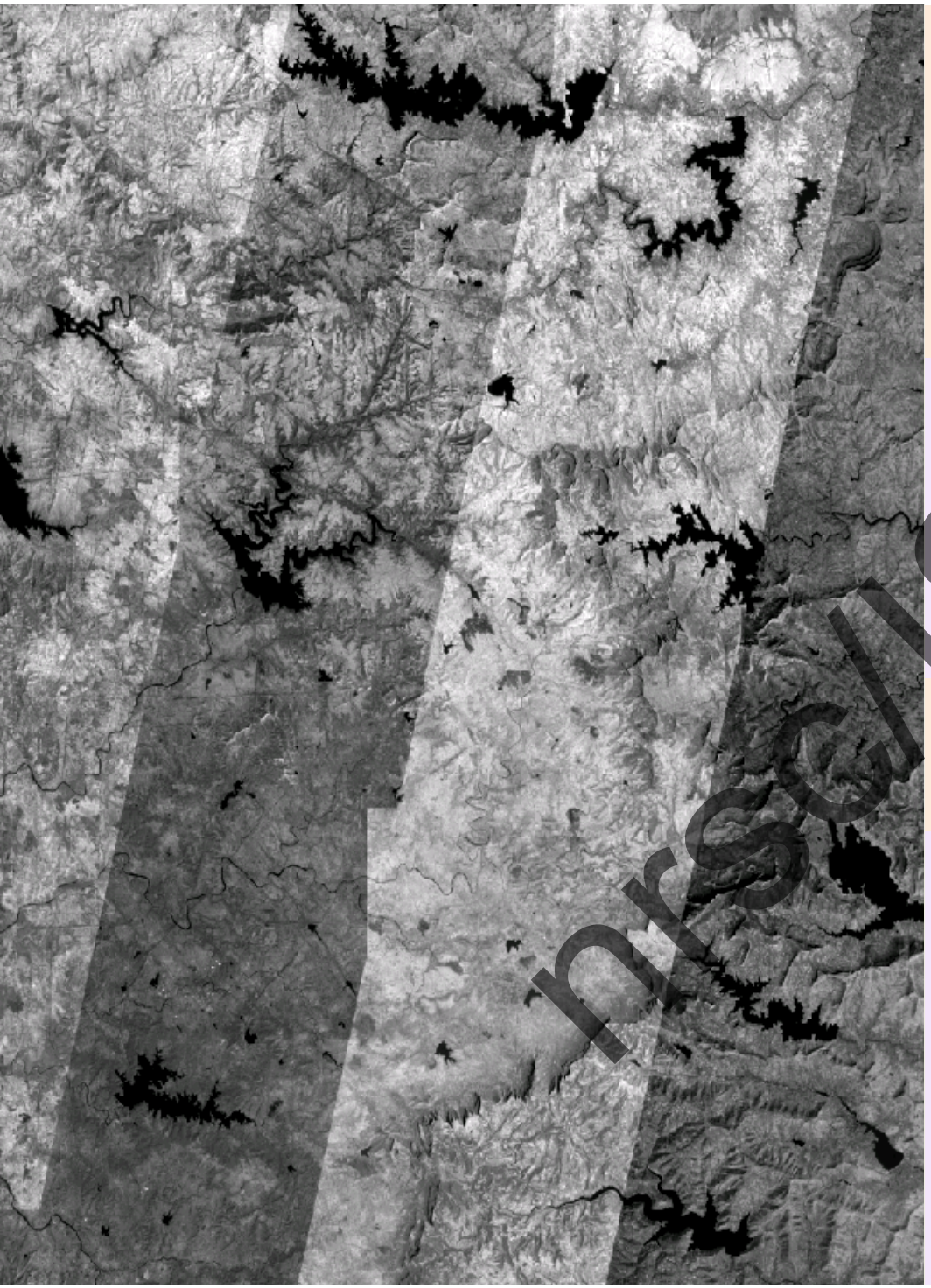
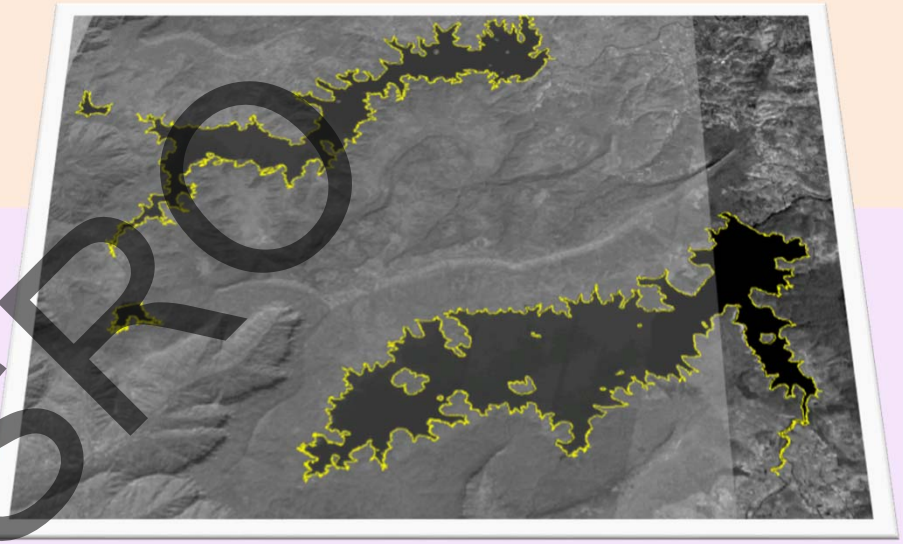


Extraction of Water bodies from Cartosat-1

for Flattening of water bodies in Carto DEM Ver.3



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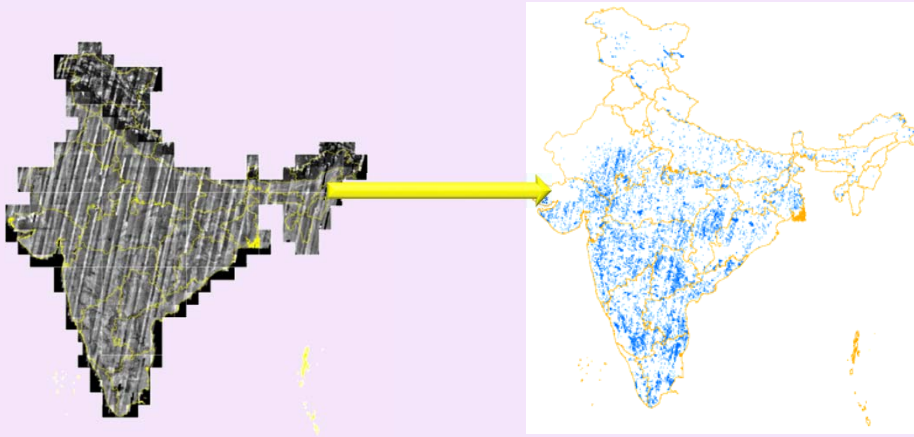
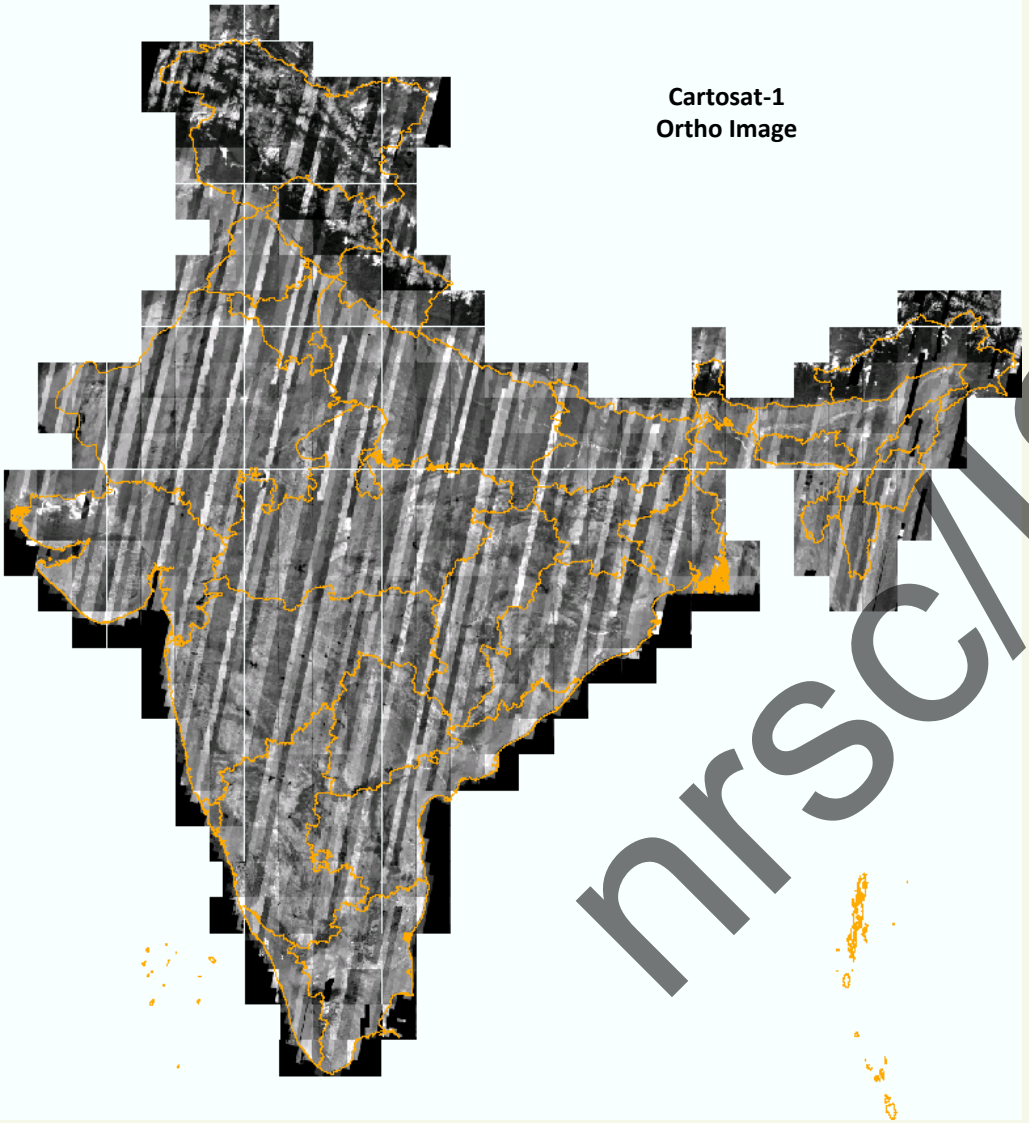


Extraction of Water bodies from Cartosat-1

for Flattening of water bodies in CartoDEM V3



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- *A semi-automated water bodies extraction algorithm is developed which consists of iso-clustering of Cartosat-1 PAN images, selection of suitable classes representing water pixels (tile wise , region specific attention was provided), a software tool for water body delineation*

- *The extracted water layers refers to a reference water layer (Greater than 2ha) over India, identifies water pixels which are hydro connected and groups them to clusters for extraction of water body layer.*

- *CartoDEM orthoimages are the inputs for water bodies extraction*

- *Conceptually, the DEM values will be picked up along water body boundary as input for determining the elevation of each water body . Each of the water body will be assigned flat elevation vlaue in CartoDEM .*

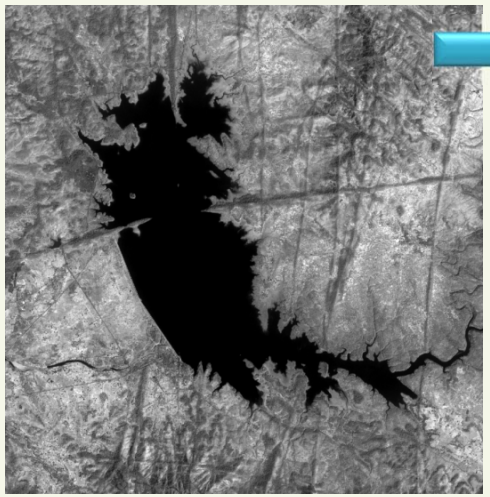
- *There are about 374 tiles - Cartosat images of 1º x1º size over India are used in this study and they are processed tile wise to delineate water body layer over India. India water body layer consists of ~56000 water bodies. This will be the input for flattening of water bodies in CartoDEM.*

- *Methodology for water body extraction is given in the next page. Sample water bodies showing Cartosat images overlaid with algorithm derived water layer are also shown subsequently in this report for visualisation of sample results .*

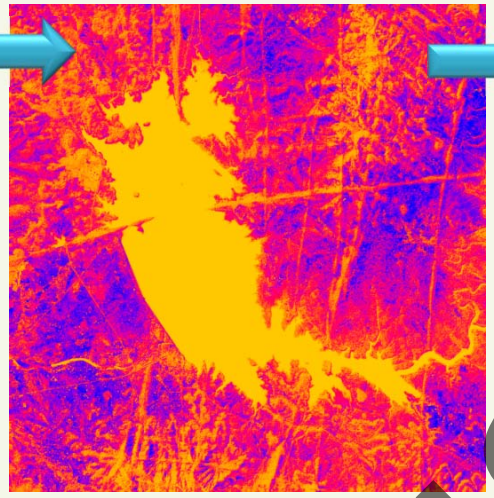
METHODOLOGY

Extraction of Water bodies from Cartosat-1

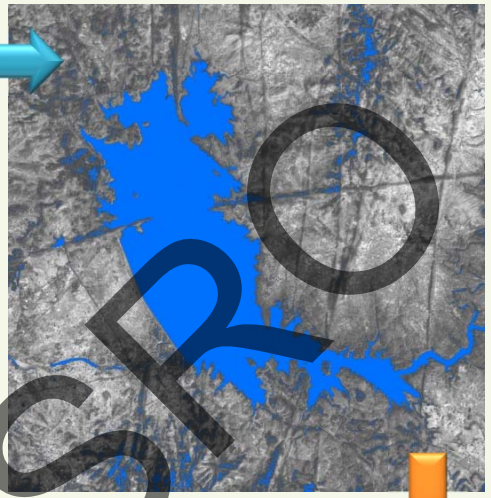
for Flattening of water bodies in Carto DEM V3



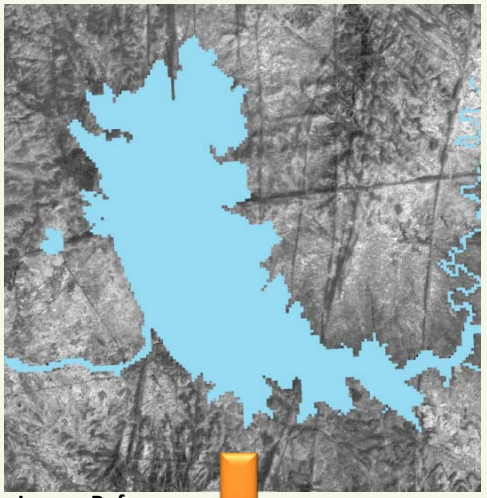
Cartosat-1 Image



Isoclustered Image

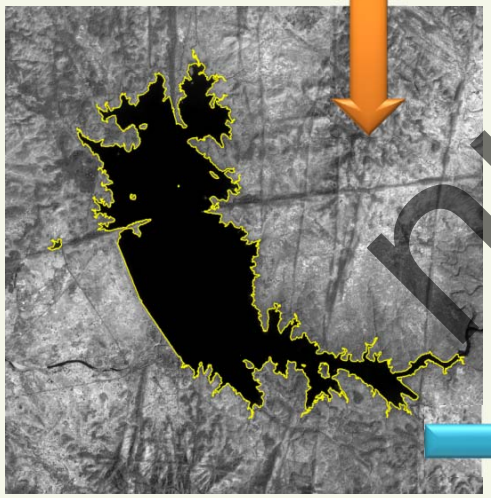


Labeling water pixels
(each Tile , region specific analysis)



Legacy Reference
water layer

Software : Algorithm for water body extraction



Extraction of water body boundary

Final water body Shape file

Process

- Tile wise Iso clustering of Cartosat-1 images, labeling classes, implementation of algorithm is carried out .
- Repeated the above procedure for 374 tiles (1^{o}x1^{o} images) .
- Generated India Mosaic- Water bodies layer.
- Verification of each water body (greater than 5Ha – 20000No.) is carried out and editing where ever required
- Further, thematic accuracy can be improved for smaller water bodies (< 5ha : ~ 36000 No.) through manual digitization

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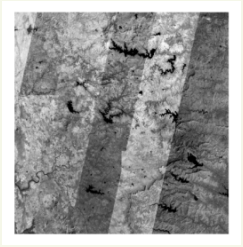
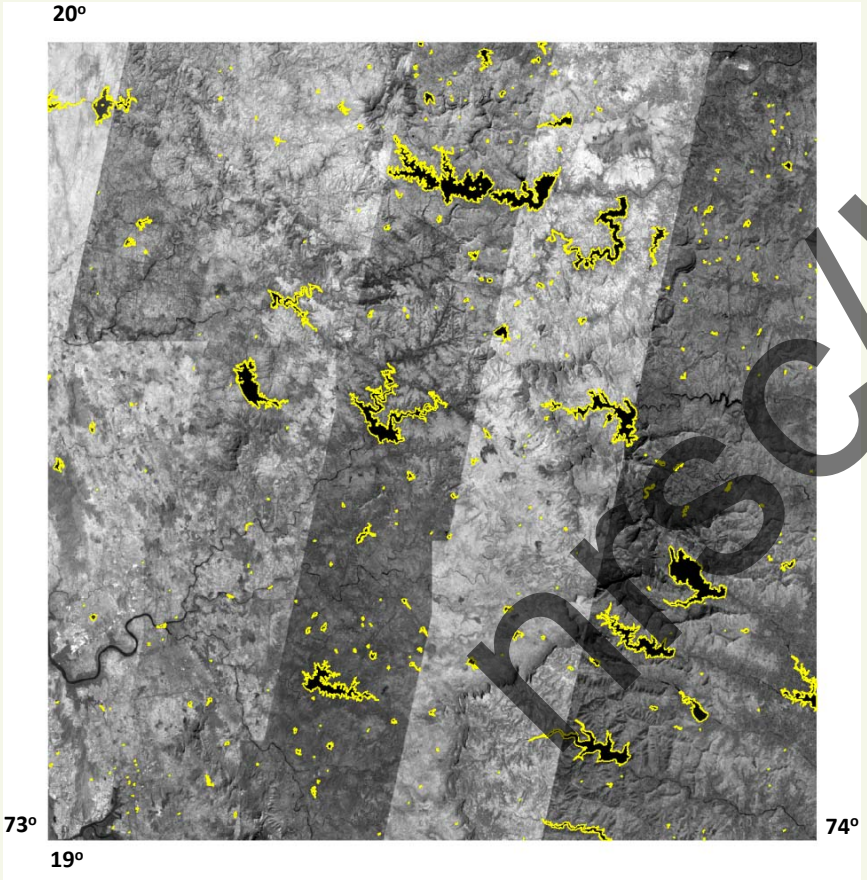
Tile wise Result

Extraction of Water bodies from Cartosat-1

for Flattening of water bodies in Carto DEM V3





India – Water Bodies layer

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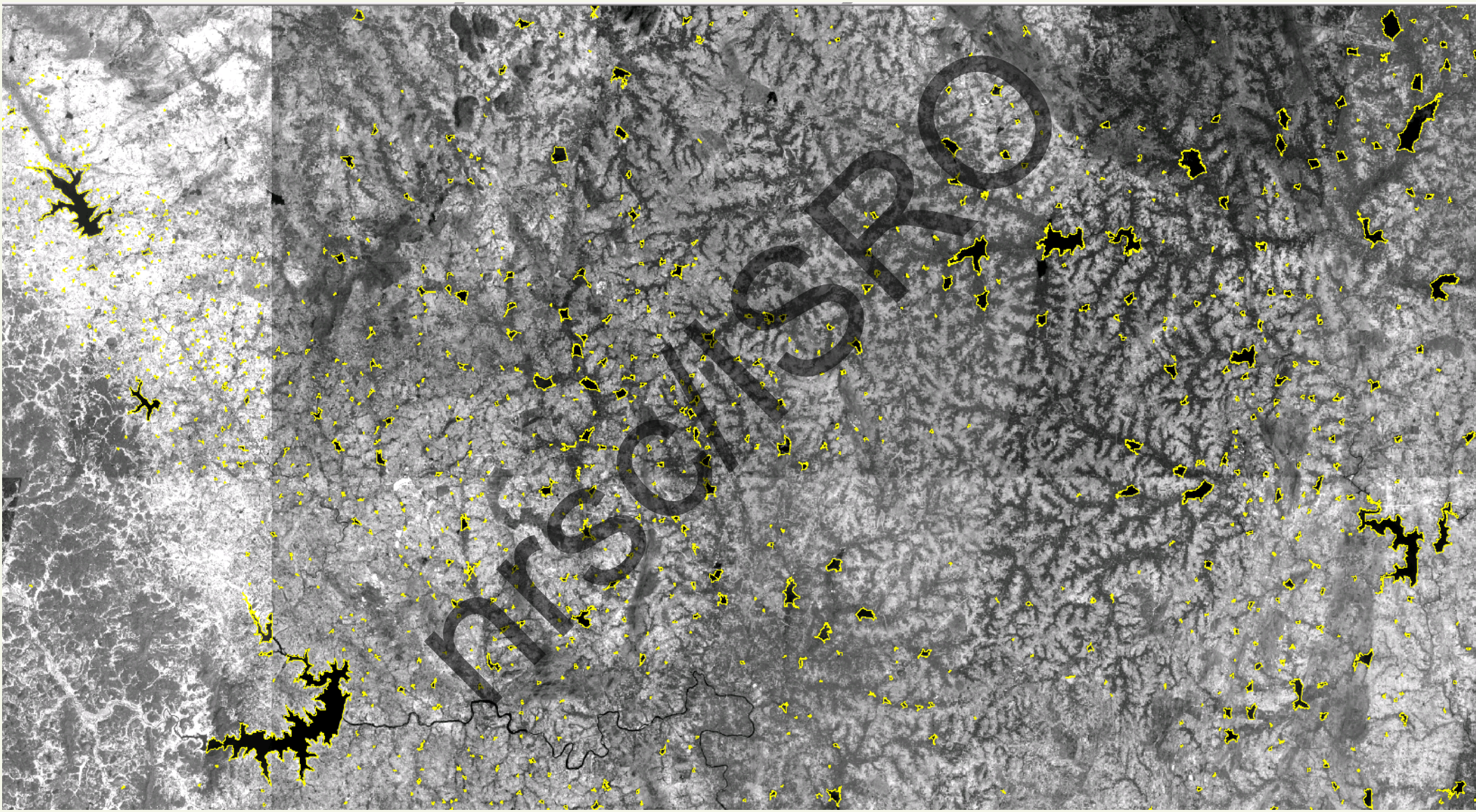
SAMPLE Results

Extraction of Water bodies from Cartosat-1

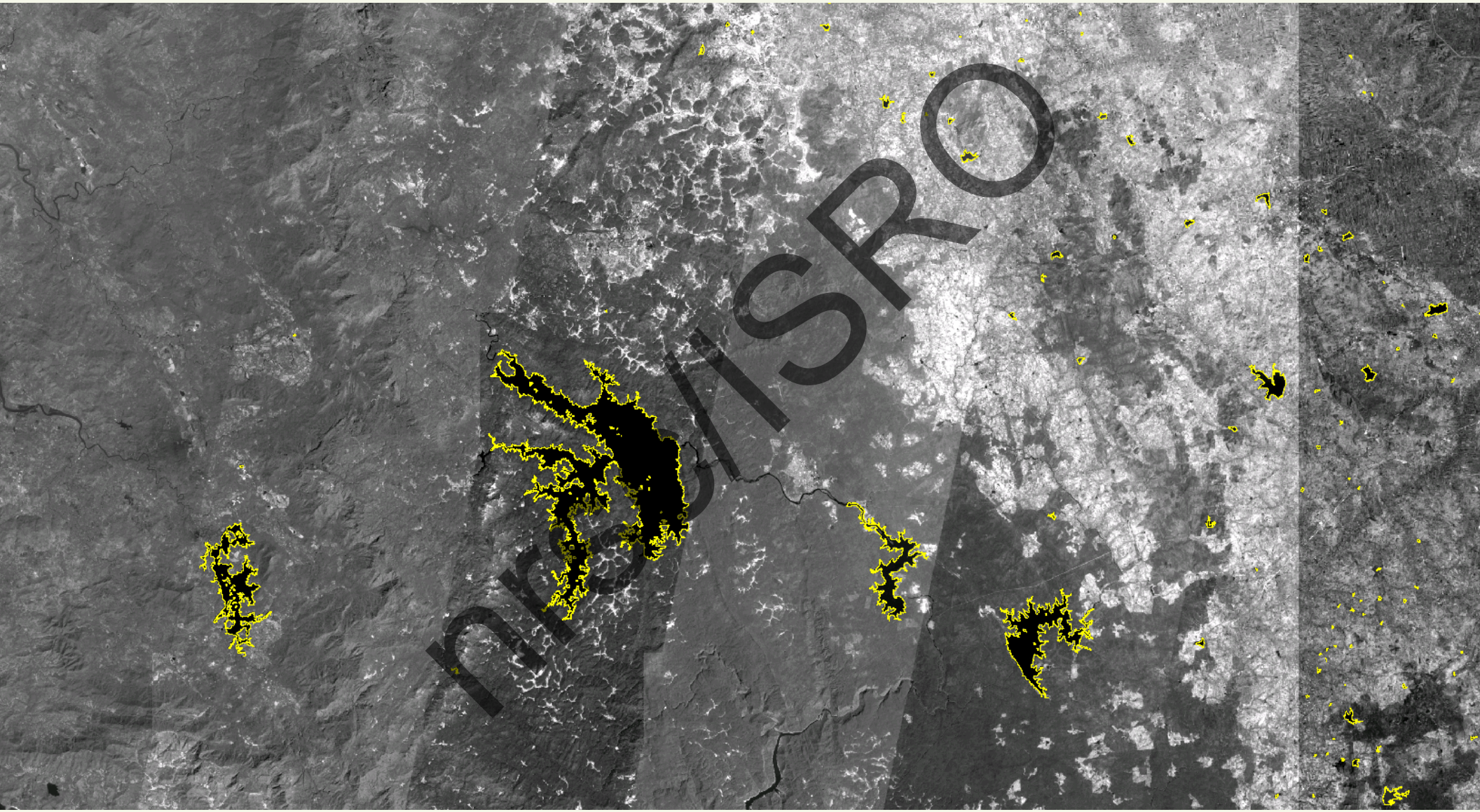
for Flattening of water bodies in Carto DEM V3



SAMPLE Results

Extraction of Water bodies from Cartosat-1

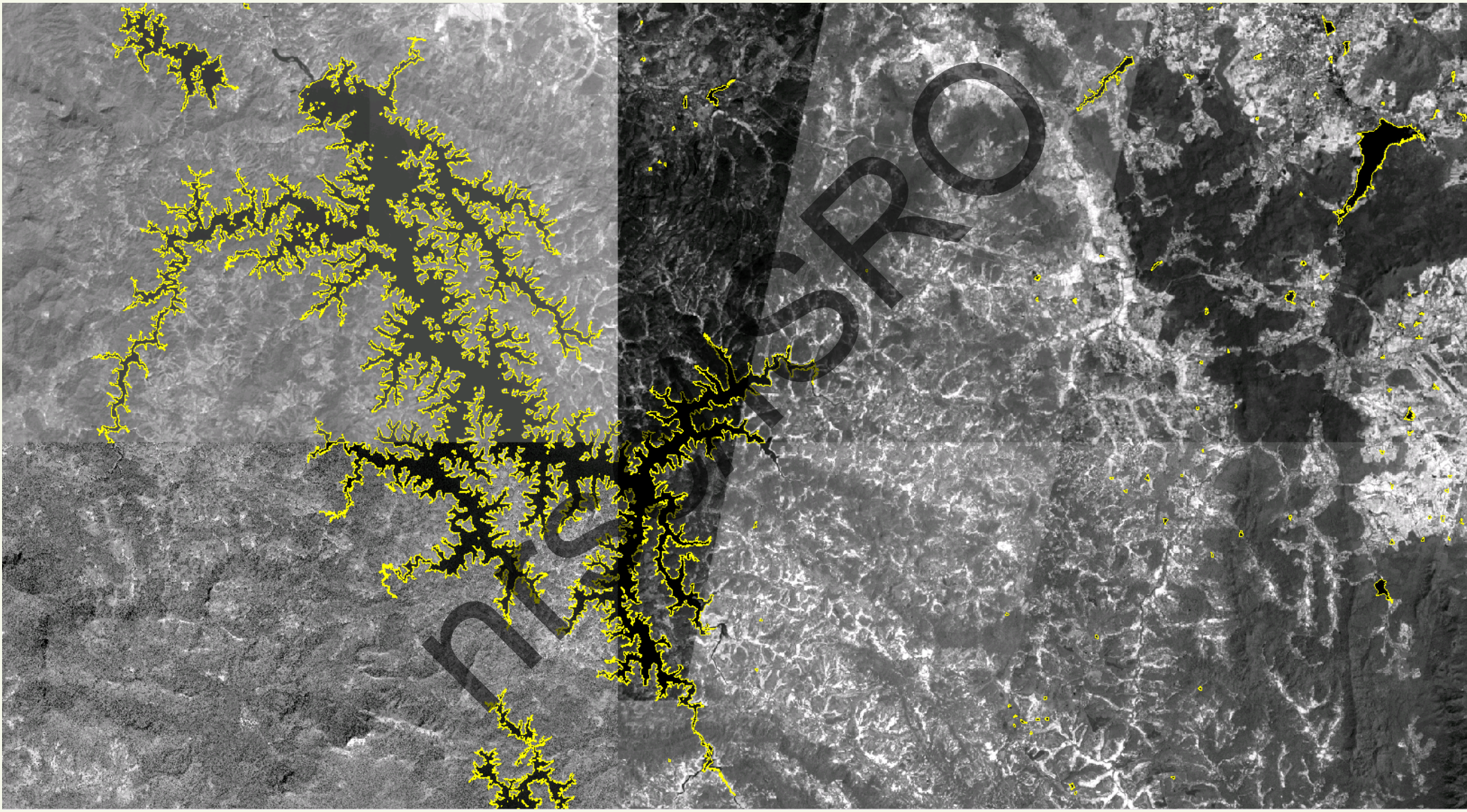
for Flattening of water bodies in Carto DEM V3



SAMPLE Results

Extraction of Water bodies from Cartosat-1

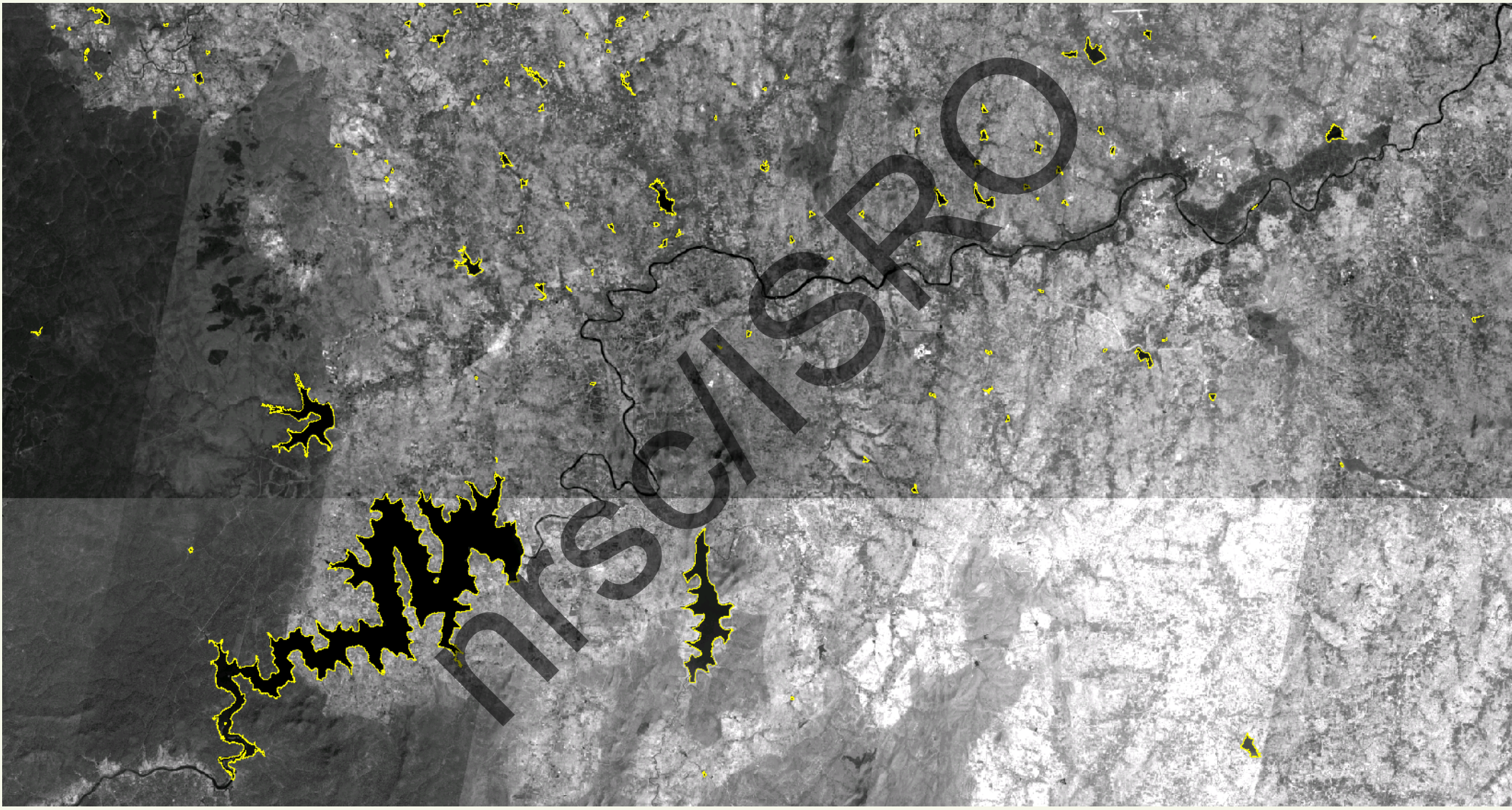
for Flattening of water bodies in Carto DEM V3



SAMPLE Results

Extraction of Water bodies from Cartosat-1

for Flattening of water bodies in Carto DEM V3

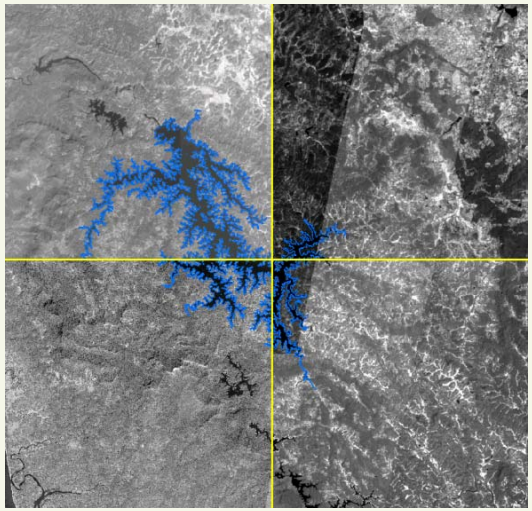


WB delineation - Issues – Resolving

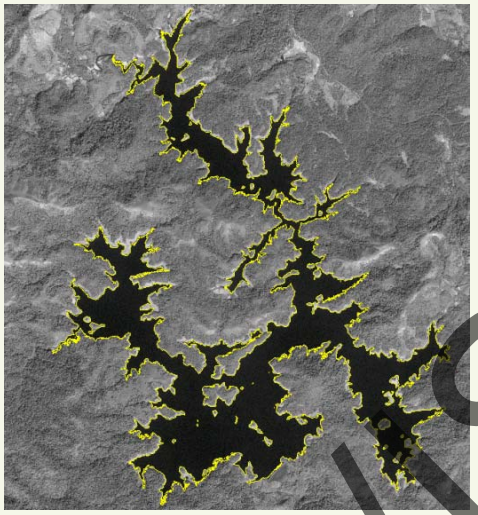
Extraction of Water bodies from Cartosat-1

for Flattening of water bodies in Carto DEM V3

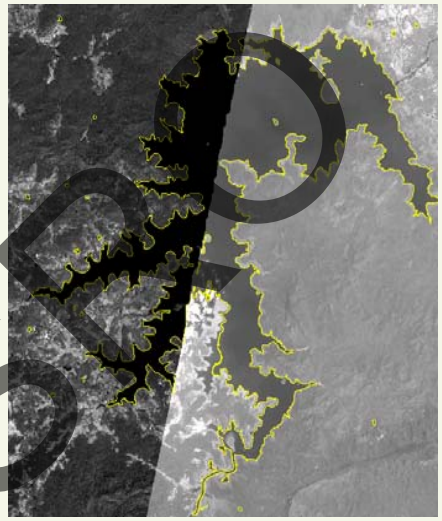
While, carrying out the water bodies delineation, the following issues are largely dealt to ensure the thematic accuracy except in smaller water bodies . However, there is scope for improvement in the following scenarios .



Merging of Water body covered in more than one tile – to ensure flattening to a single value

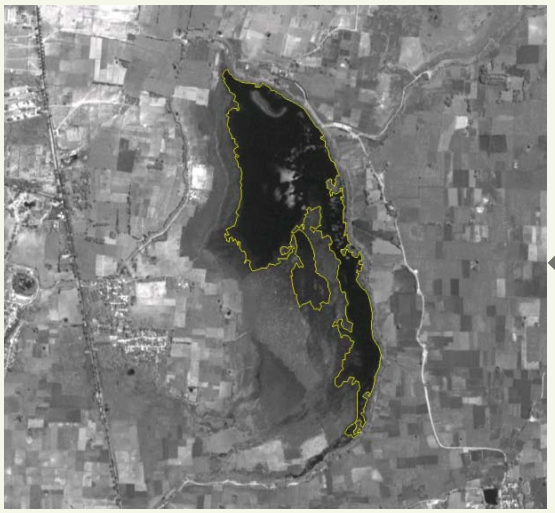


Removal of islands

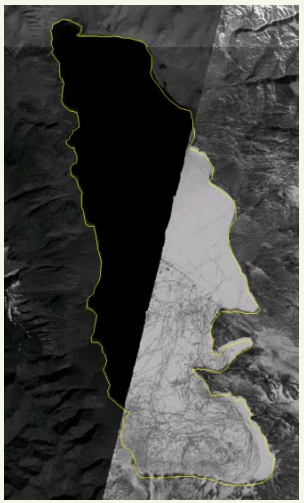


Water body imaged over two different dates (spreads are different)

Smaller water bodies artificial storages



Partially filled tanks / tanks with vegetation



Delineation in Glaciated areas

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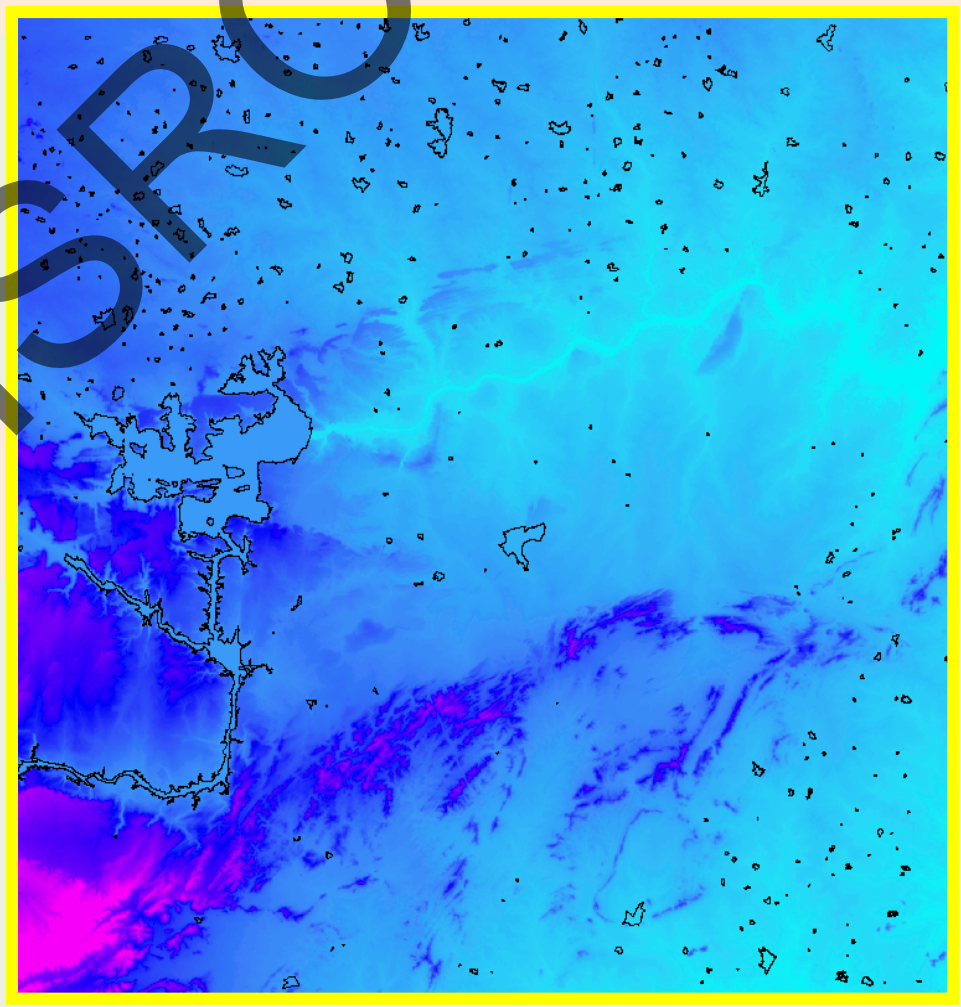
Software for flattening of water bodies
- Towards improvement of CartoDEM Ver.3



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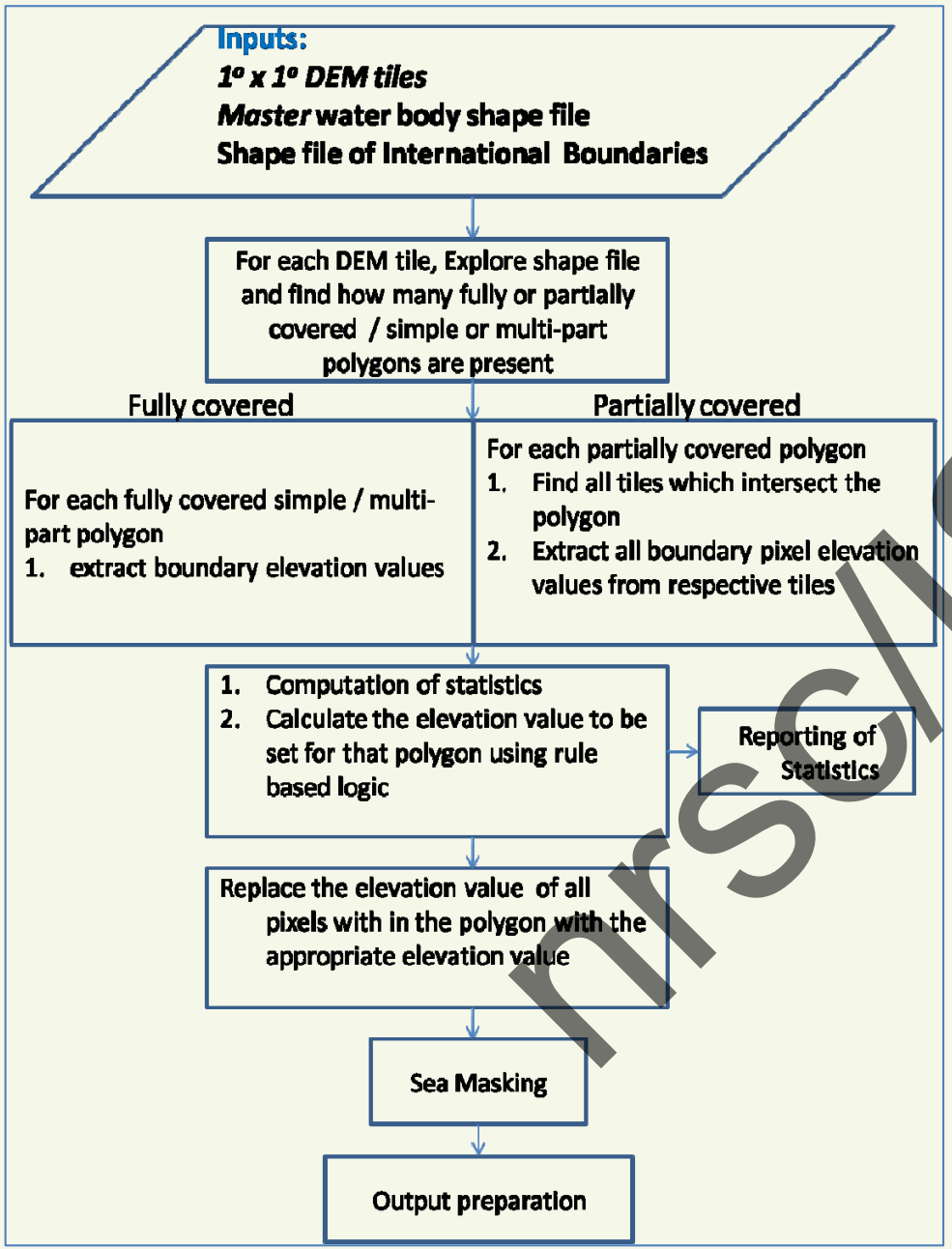
Brief Methodology



Flattening of water bodies in Carto DEM V3

- *Flattening of water bodies in CartoDEM, the Indian National DSM, is done by developing an automated software for quick processing.*

- *The inputs are 1º x 1º DEM tiles in GeoTIFF format, shape file containing water body polygons extracted from Cartosat-1 ortho imagery in a semi-automated manner*

- *In the first step of metadata preparation, all tiles are examined and their respective corner coordinates are stored in a metadata file for use by the flattening software*

- *For each of the DEM tile, how many water body polygons are falling with in the tile is evaluated. Distinction is made between polygons fully covered and partially covered with in the tile. Both simple polygons and multi-part polygons are handled*

- *In the case of water body polygon fully present in the tile, all the polygon boundary pixel elevation values are used for arriving at the elevation value to be used for that entire polygon. Each pixel with in the bounding box of the polygon is tested for whether the pixel is inside or outside and accordingly, the elevation value of the pixels with in the polygon are set.*

- *In the case of polygon falling in multiple tiles, all the required tiles which intersect that polygon are used and respective boundary pixel values from all the tiles which contribute to that polygon are extracted and used for setting up the elevation value for that polygon. This ensures consistent elevation value for that polygon across tiles.*

- *Multi-part polygon, which is a single polygon, but contains several small polygons (rings) are handled in a slightly different way. This kind of polygons arise in case of bigger reservoirs and reservoirs which have islands. In this case, the core boundary is used for arriving at the appropriate elevation value. Islands of the bigger water bodies are preserved in this fashion. Cases of multi-part polygon falling in different tiles is also handled.*

- *Using single statistic for arriving at the value to be set for a polygon leads to errors and accordingly a rule-based logic is implemented . At no point of time, the elevation value set is not less than or more than the boundary pixel elevation values and always less than the mean of the boundary elevation values, so as to ensure smooth transition with land is enforced.*

- *Complete statistics of each polygon are reported for cross validation*

- *Sea and other area masking as necessary is part of the software*

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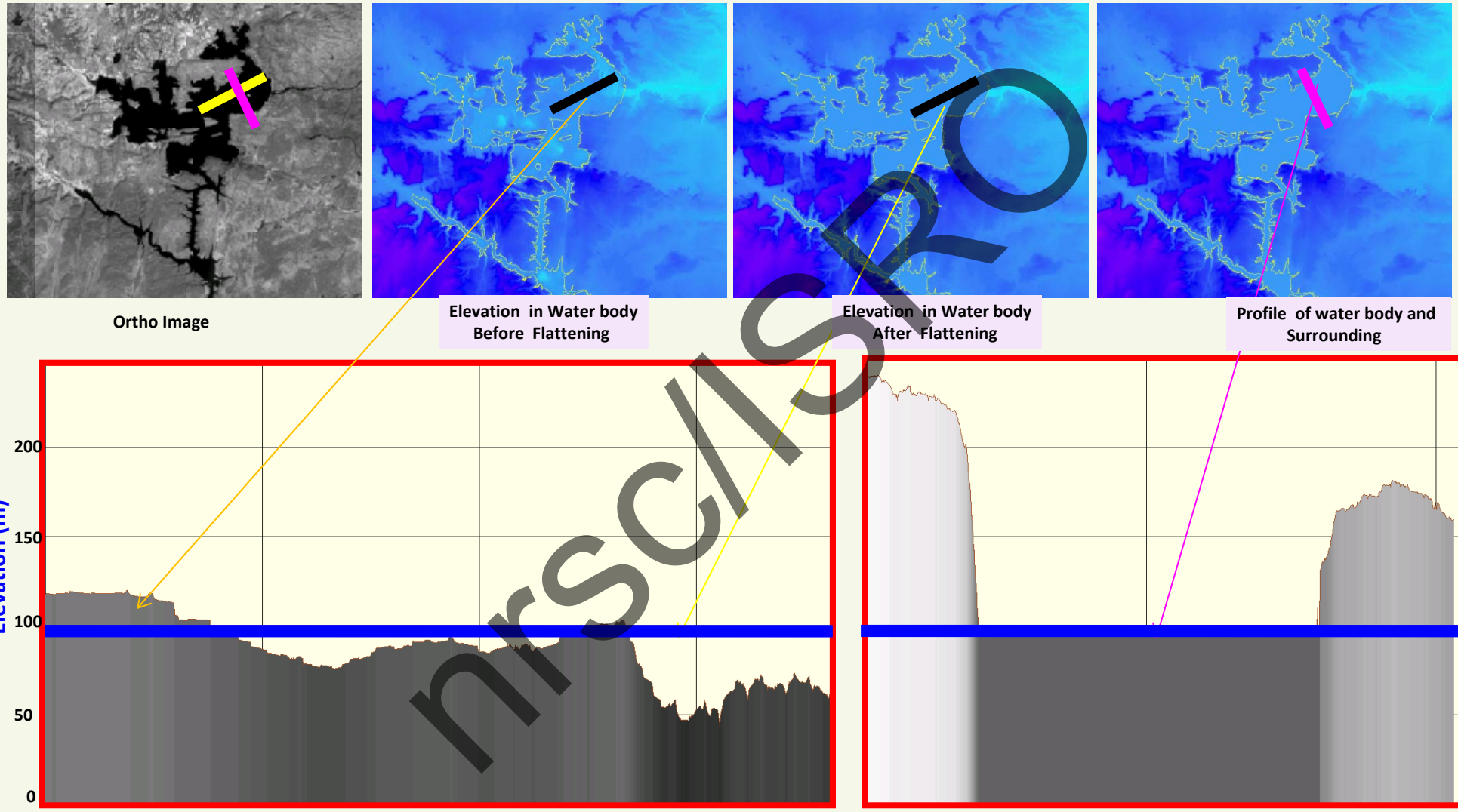
Water body Flattening – Example through elevation profile Information



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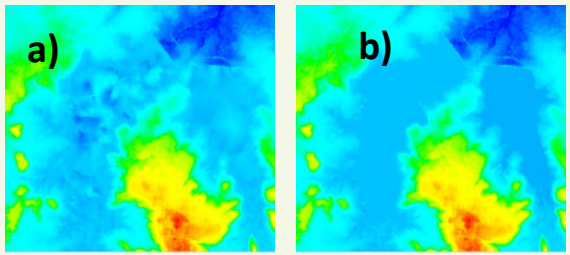
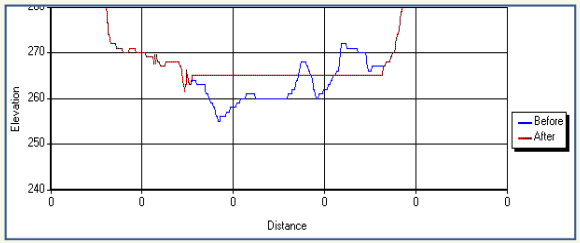
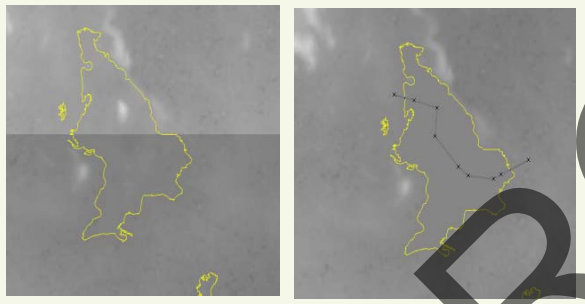
Water bodies are flattened after delineation of water bodies as a post processing activity. Elevation values from boundary pixels are picked up and statistics were extracted to assign flattened value of each of water body. Tools were developed for verifying the statistics and to verify the consistency of newly assigned elevation value.

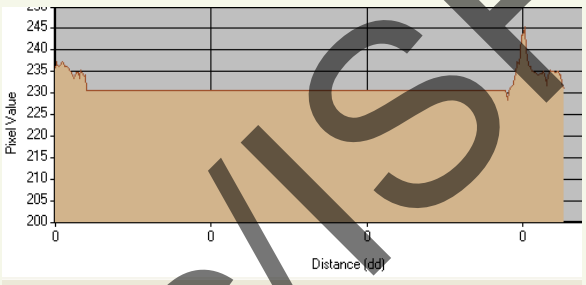
Water body Flattening – Example through elevation profile Information





Water body flattening





Consistent elevation value for water bodies spread across different tiles

```
Input DEM File: D:\CDEM_Data\Tiles32\sw_16000_77000_e43x_dem.tif
No. of Water Bodies: 300
No. of Full Polygons: 294
No. of Partial Polygons: 6
```

ID	MIN	MAX	Mean	SD	Out Val	NPixels
5766	262.61	265.66	263.90	0.64	263.26	29
5767	291.24	295.90	294.11	1.56	292.55	29
5768	266.48	270.15	267.87	1.01	266.86	37
5769	277.84	282.91	280.21	0.96	279.25	70
5770	197.48	203.28	201.04	1.20	199.84	58
5771	281.92	288.30	284.86	1.68	283.18	79
5772	293.54	301.60	297.02	1.23	295.79	220
5773	290.26	296.07	292.64	1.09	291.56	188
5774	198.25	200.08	199.24	0.40	198.85	43
5775	198.36	207.05	204.21	1.33	202.87	339
5776	207.72	216.60	212.06	1.19	210.87	513
5777	197.56	208.10	200.89	1.91	198.97	60
5778	188.65	215.04	206.45	2.63	203.82	497
5779	198.97	205.28	203.42	1.06	202.35	251

Reporting of Statistics

Masking of Sea Portion

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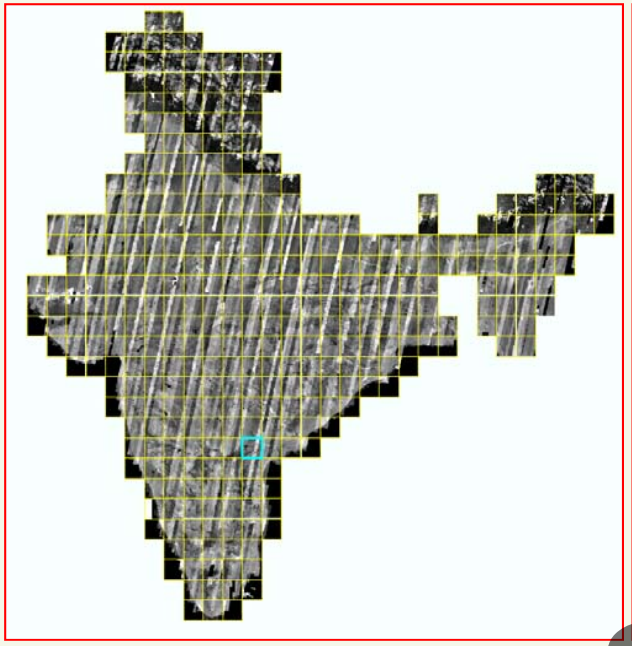
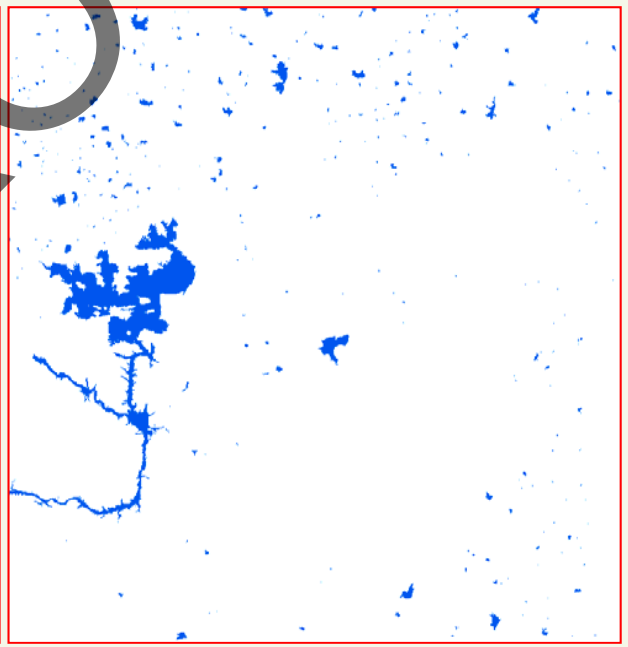
Files Downloadable from Bhuvan for CartoDEM Ver.3



Selection of Grid

1. CartoDEM Ver.3 (30m Posting)



2. Water body layer

3. Meta Data File

4. Gap layer wherever applicable
(DSM values filled with SRTM /ASTER)

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http://bhuvan.nrsc.gov.in/data