

A composite image showing a portion of the Earth from space, with a Digital Elevation Model (DEM) map overlaid. The DEM map is divided into four quadrants by a white crosshair. The map uses a color gradient to represent elevation, with green for lower elevations and yellow/orange for higher elevations. The background is a dark blue space with stars and a portion of the Earth's surface showing continents and oceans.

WorldDEM™

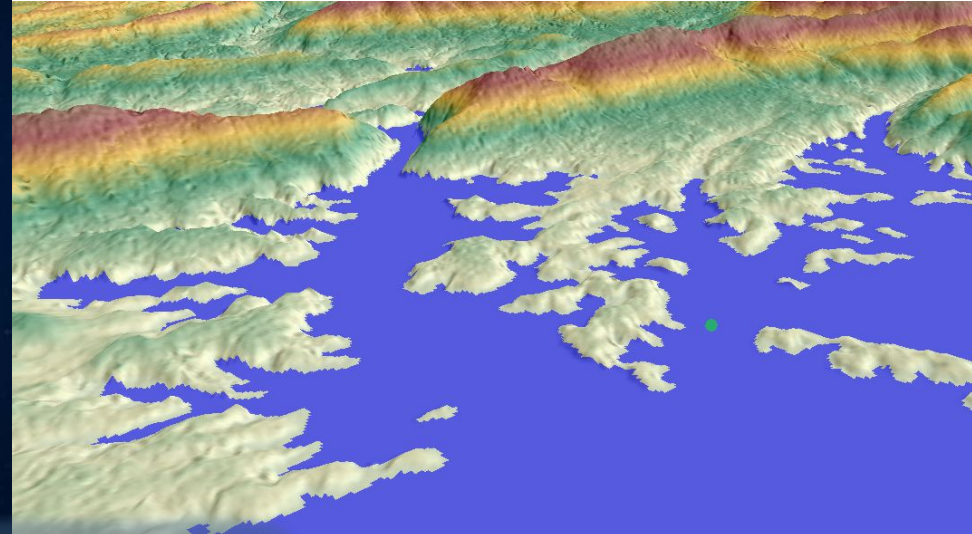
A consistent Global Water Body Mask based on WorldDEM™

Stefan Mühlbauer

March 2015

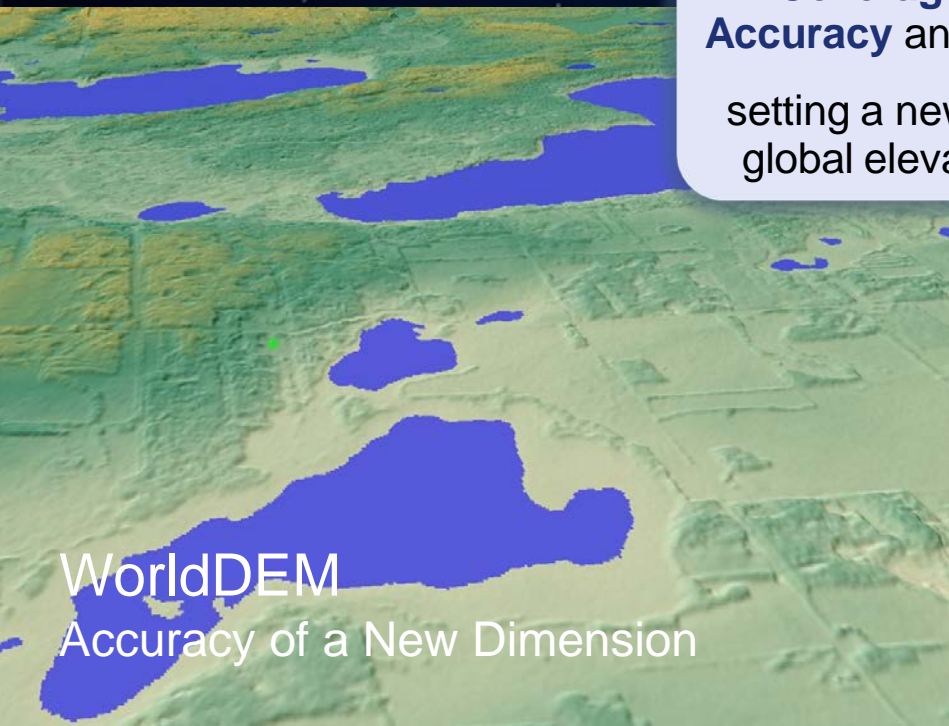


WorldDEM
Standardized Global DEM

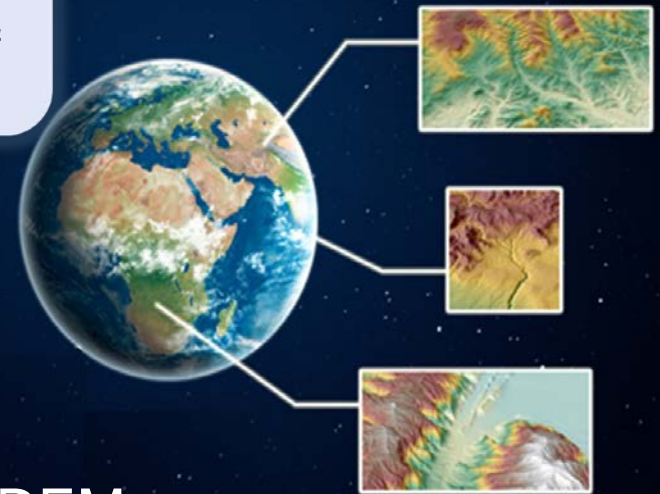


WorldDEM
Unrivalled Quality and Coverage

The unique and unrivaled combination of
Coverage, Quality, Accuracy and Availability,
setting a new standard of global elevation models



WorldDEM
Accuracy of a New Dimension



WorldDEM
Easy & Instant Access

WorldDEM and TanDEM-X Mission

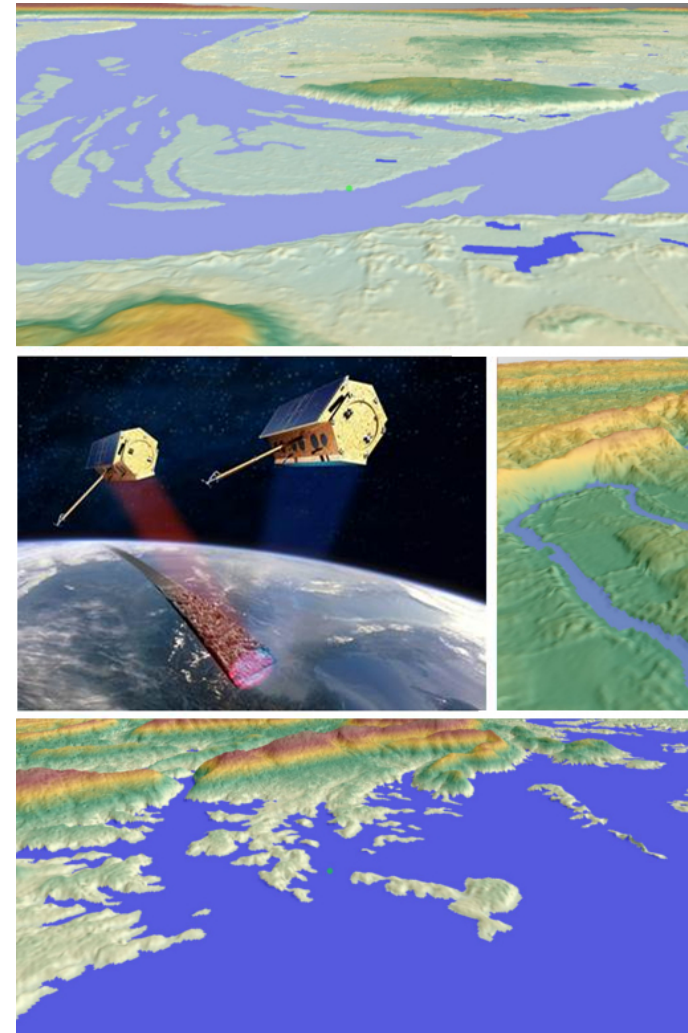
HOW has WorldDEM become possible

■ TanDEM-X Mission

- Twin Satellites: TerraSAR-X & TanDEM-X flying in a very close and precise formation
- Mission Goal: homogeneous, high-quality global DEM (taking advantage of the twin constellation by using interferometry)
- Data acquisition within 3 years only from one unique source

■ Public-Private Partnership (DLR/Airbus Defence and Space)

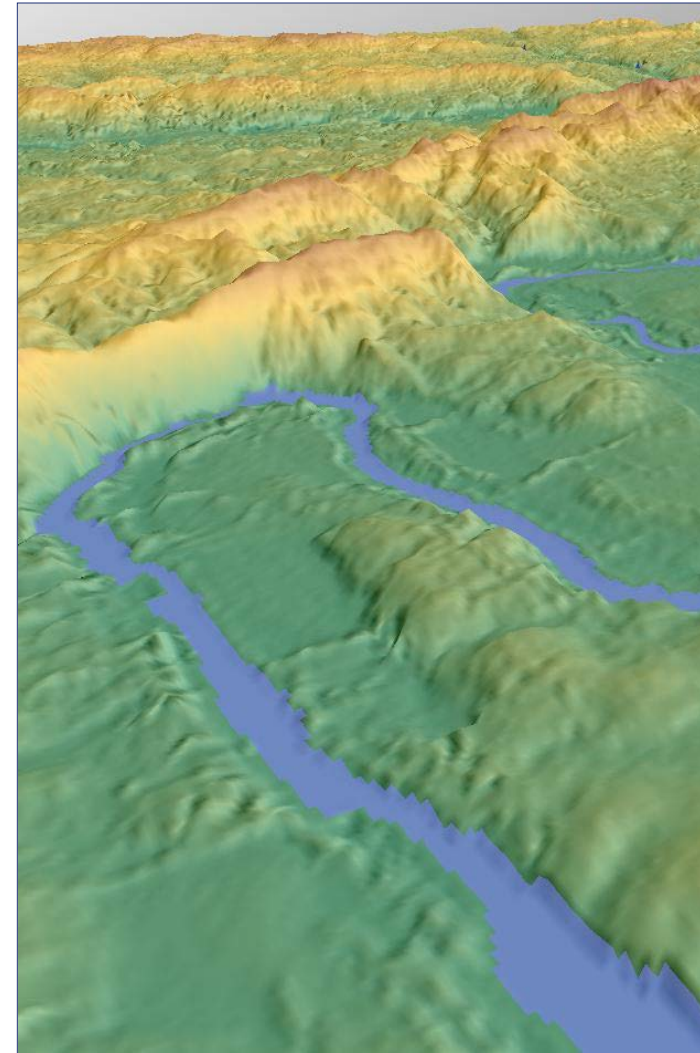
- Airbus DS holds commercial exploitation and marketing rights: (responsible for the adaption of the elevation model to the needs of the user)



WorldDEM and TanDEM-X Mission

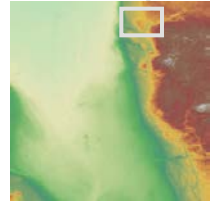


- **First worldwide, consistent and seamless DEM product**
 - Covering the entire Earth's land mass (pole-to-pole)
 - ~12m pixel size
 - Relative vertical accuracy <2m/<4m (dep. on slope)
 - Absolute vertical accuracy < 4m
 - Absolute horizontal accuracy < 6m
- **WorldDEM started to become available beginning 2014**
- **The working units are mostly 1° x 1° tiles, ~20.000 tiles cover the entire Earth**



WorldDEM - Level of Detail

Close-Up

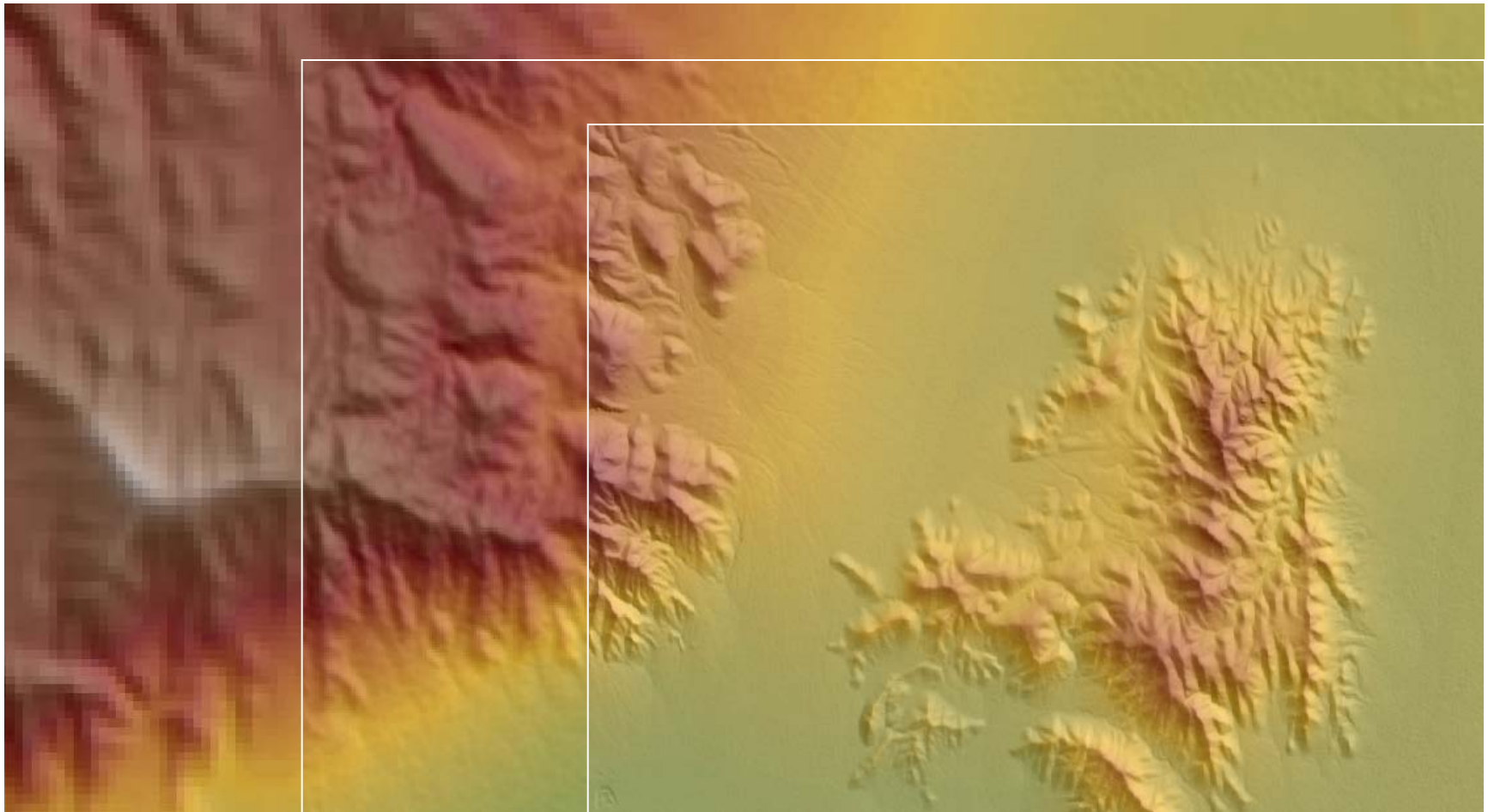


Death Valley
N26W118

SRTM 90

SRTM 30

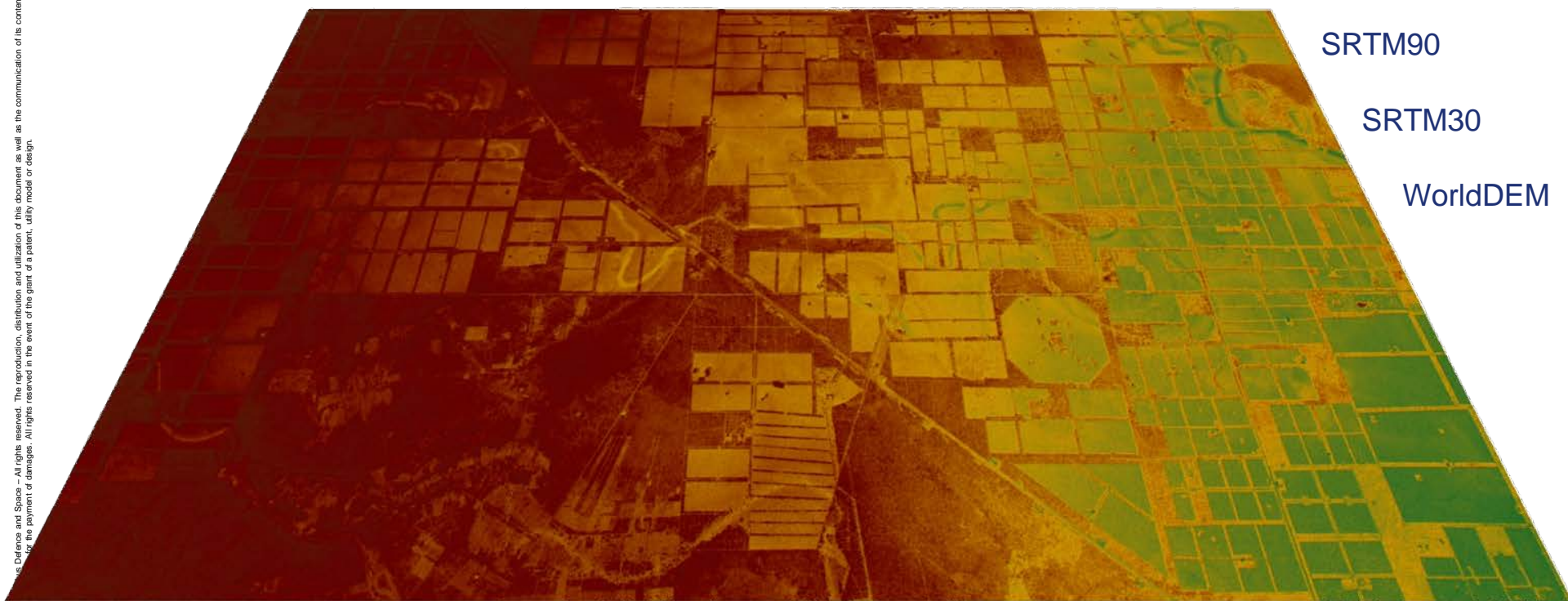
WorldDEM



TanDEM-X SAR amplitude

WorldDEM - Level of Detail

Paraguay, NW of Filadelfia



SRTM90

SRTM30

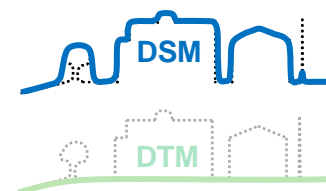
WorldDEM

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WorldDEM Product Line

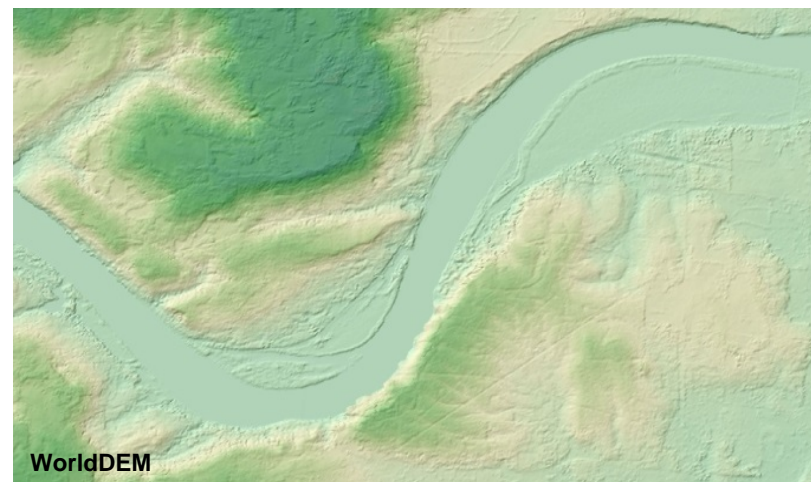
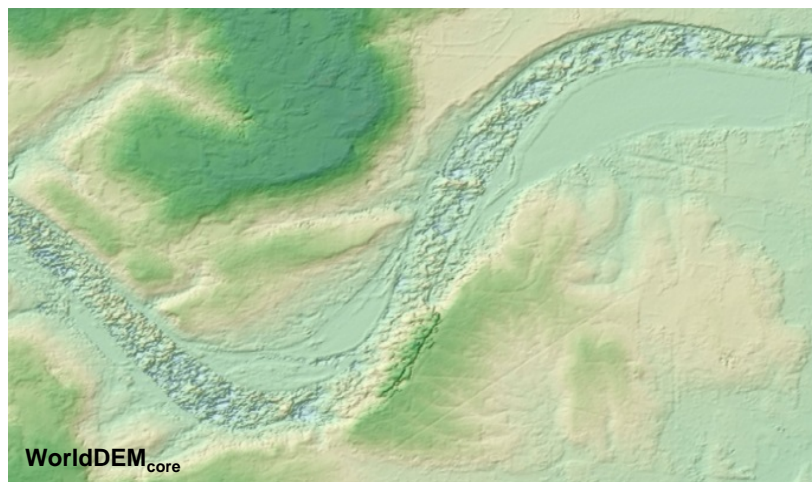
Digital Surface Model (DSM) representing the surface of the Earth including heights of buildings and other man-made objects, trees, forests and other vegetation



Two variants:

WorldDEM_{core} - unedited DSM (including erroneous surfaces)

WorldDEM - edited terrain features & water bodies



WorldDEM_{core}

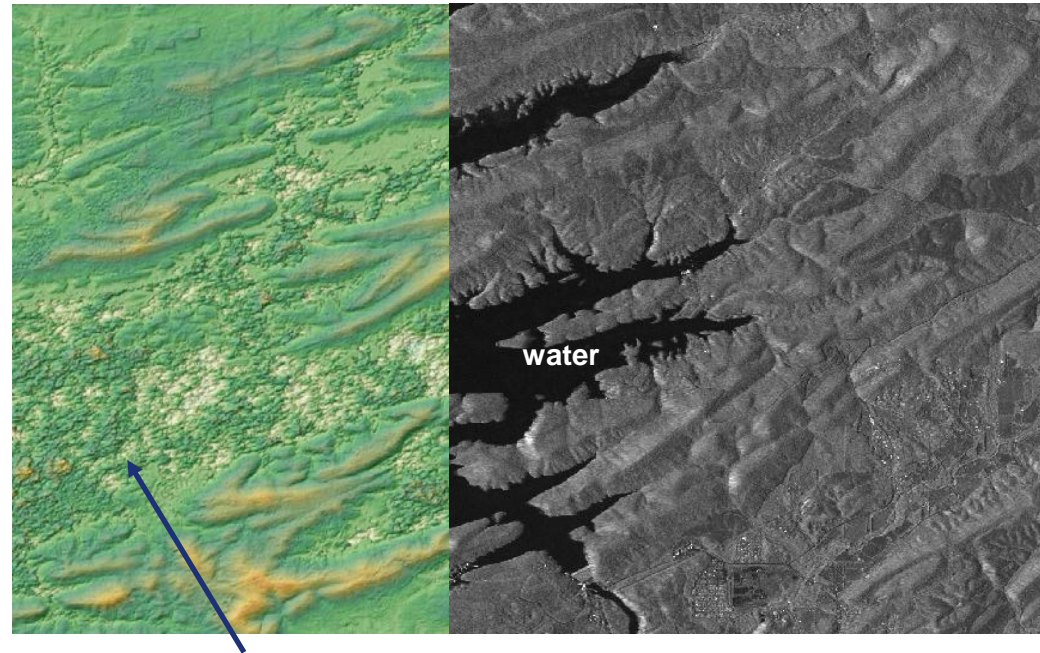
Unedited Digital Surface Model – Includes typical radar processing artefacts

■ Terrain Artefacts

- Typical radar outliers that have no relation to the relief height
- Voids and data gaps
- Processing artefacts (steep terrain)

■ Water Artefacts

- All water bodies are artefacts
- they appear as rough surface or voids



No editing of water bodies

WorldDEM_{core}

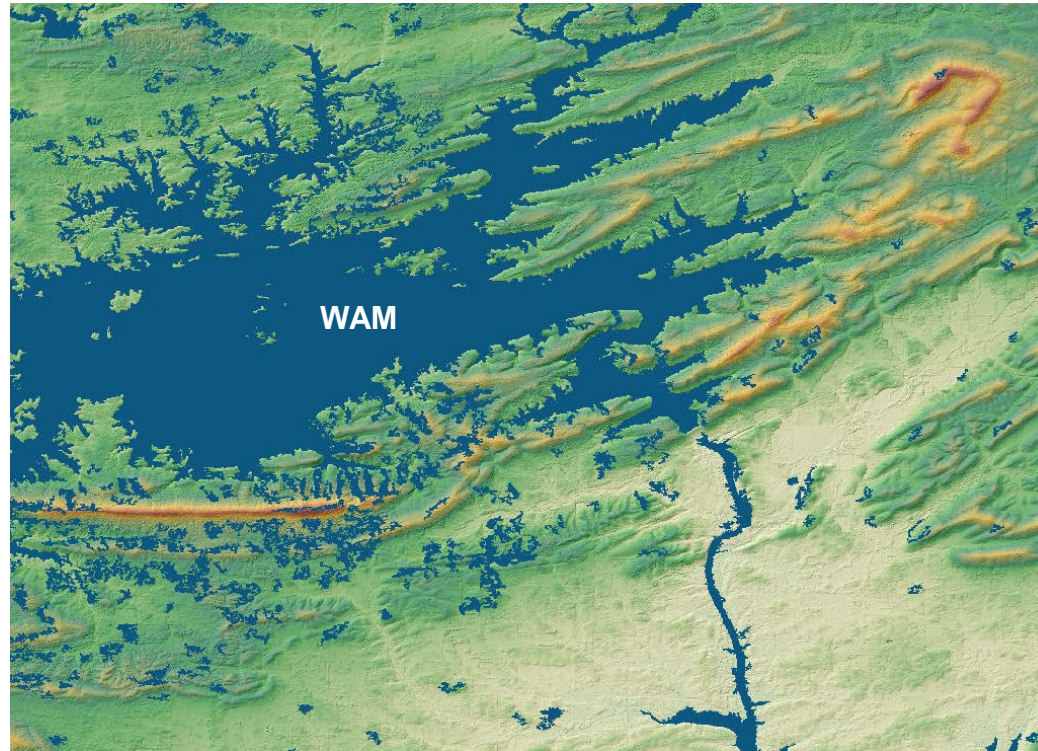
Unedited Digital Surface Model – Includes auxiliary masks as the WAM

- **Water Body Indication Mask**
 - is part of WorldDEM_{core} product
 - global availability

Reduced Reliability



**For a correct integration in the
WorldDEM ALL water bodies
have to be edited!**



Water Body Indication Mask (WAM)

WorldDEM

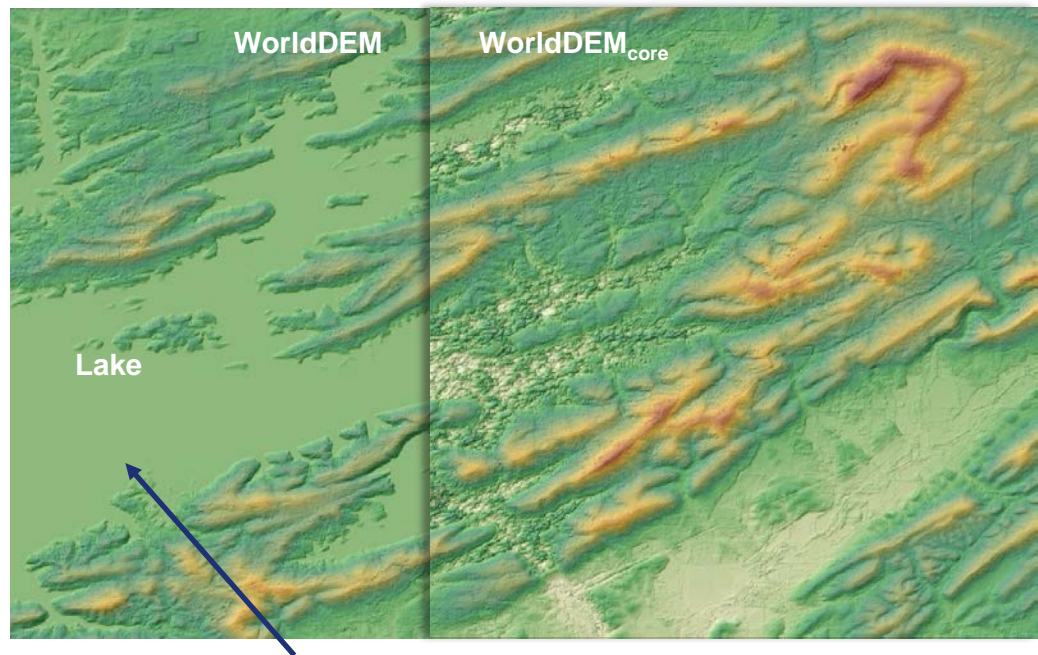
Edited Digital Surface Model

Following editing steps and rules are applied:

Water body editing

- **Lakes & reservoirs:** set to single elevation
 - Water bodies: width: >50m, length: >150m
- **Ocean** elevation is set to 0 m
- **Rivers & canals:** flattened with monotonic flow (0,5m steps)
 - Water bodies: width: >50m, length: >300m
- Coastal infrastructure features and bridges are removed

All edited water pixels are stored within a Water Body Mask that will be globally available as additional information layer to the WorldDEM™



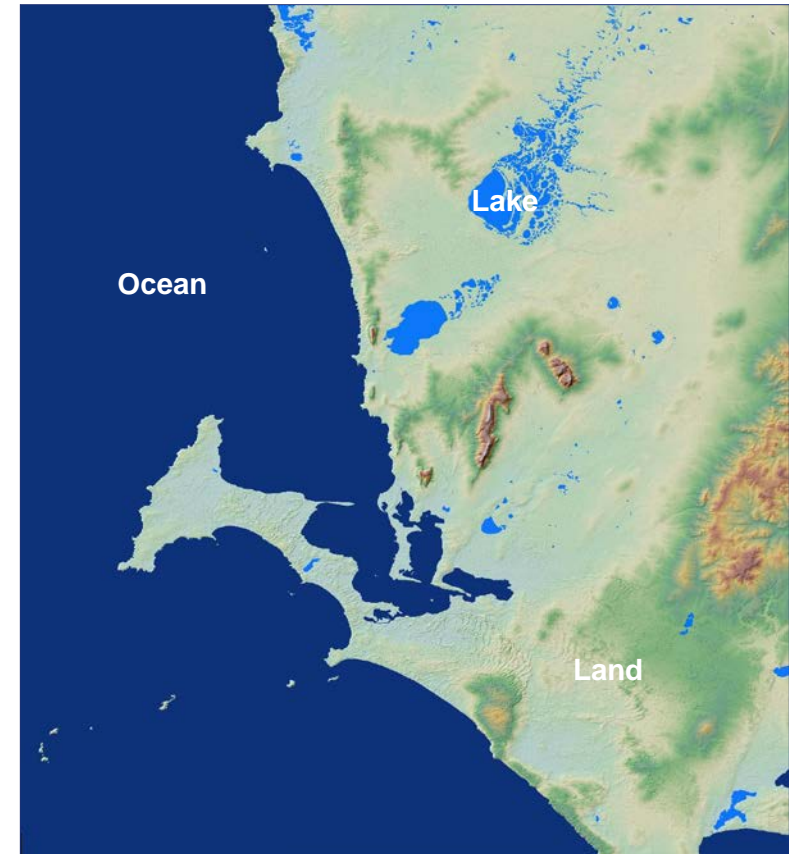
Water bodies are flattened

WorldDEM

Globally consistent Water Body Mask (WBM)

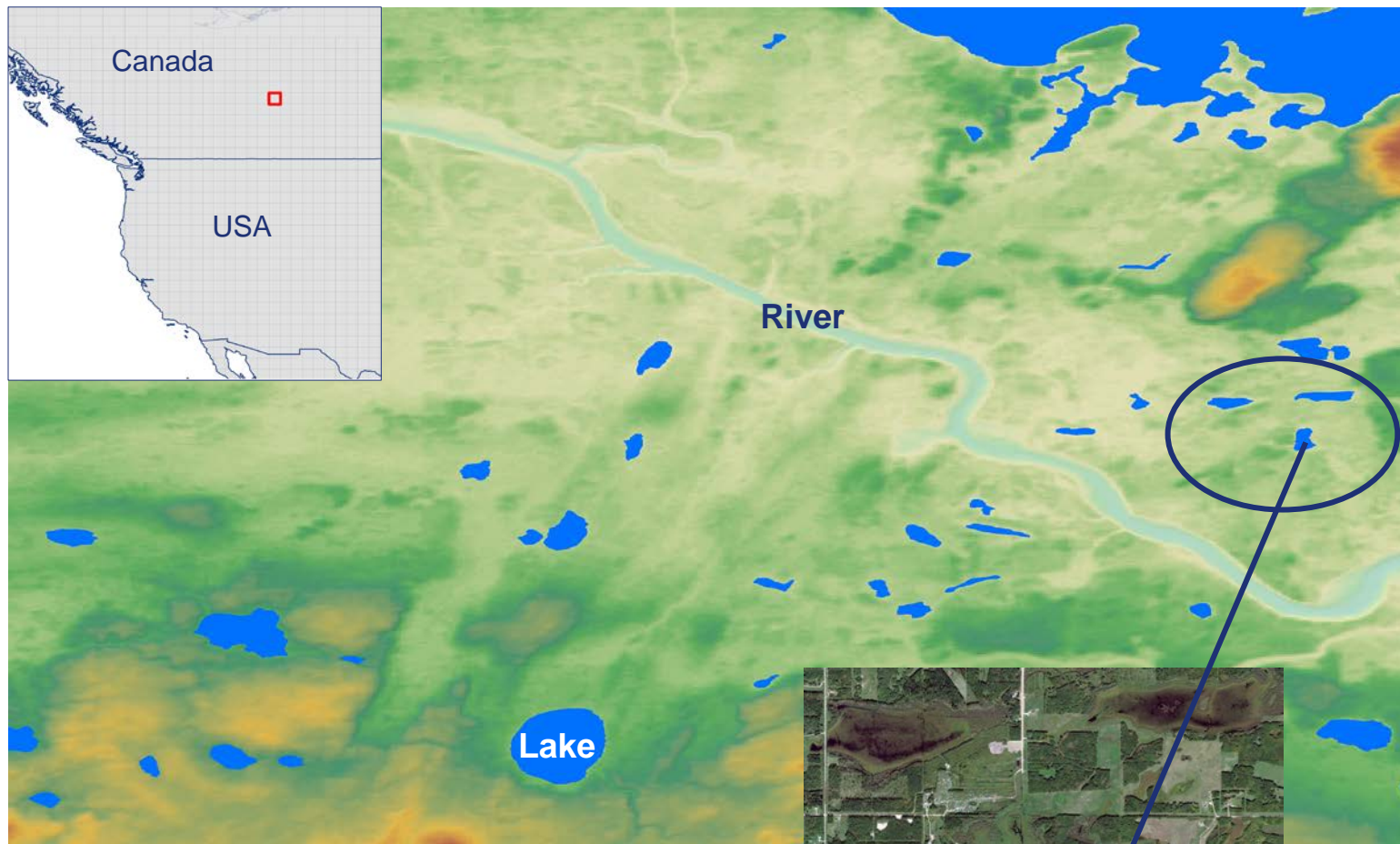
Features of the WBM

- **Side product** of the editing process from WorldDEM_{core} to the end-user DEM (WorldDEM™)
- **Precise and refined water mask** in comparison to the Water Body Indication Mask
- **Distinction** between
 - Ocean
 - Lakes/Reservoirs
 - Riverswith specific flattening algorithms, minimum mapping units for each water type
- **Intersection with height values**
- **Global availability and consistency**



Water Body Mask, Australia (S35E135)

WorldDEM Water Body Mask



**WorldDEM
(12m)**

**SRTM Water
Body Data
(90m)**

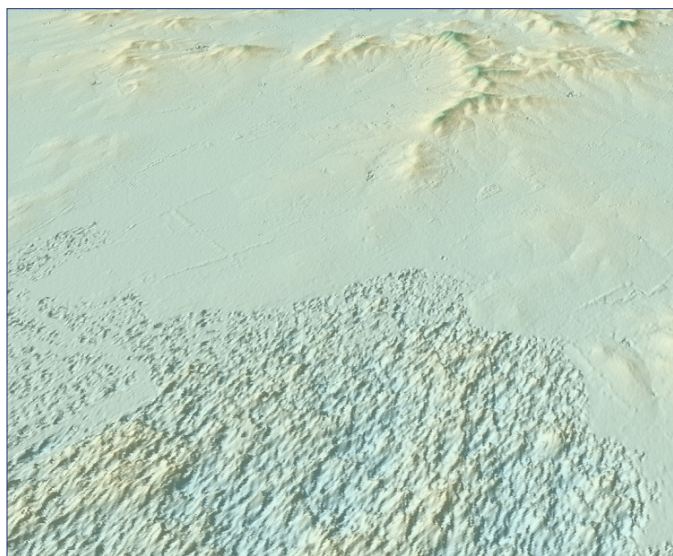
**Water Body Mask,
Canada (N54W111)**

variable water level/
silted-up lake

Editing Water Bodies

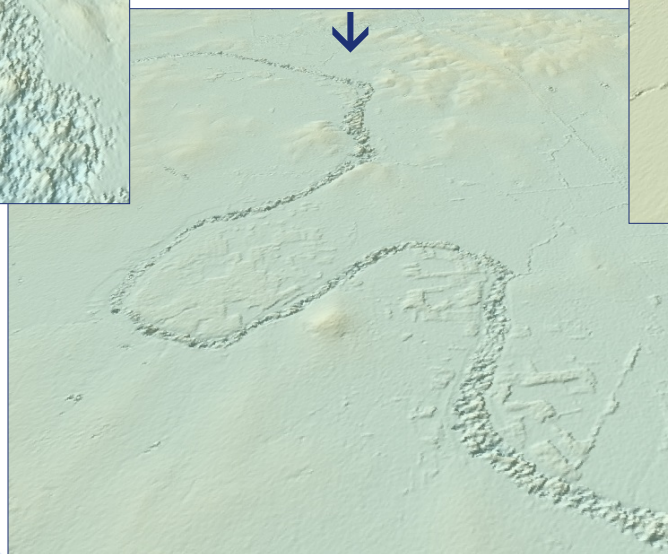
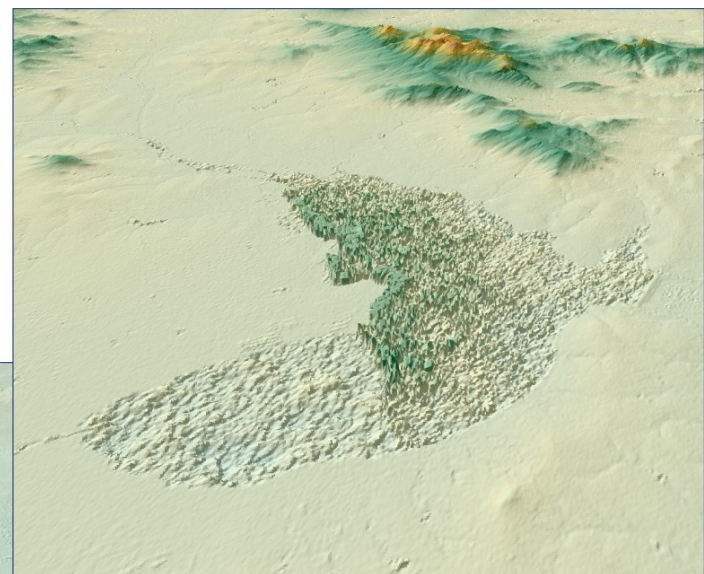
HOW is the Water Body Mask obtained?

All water features in WorldDEM_{core} data require hydrological editing



← Ocean
Lake →

River

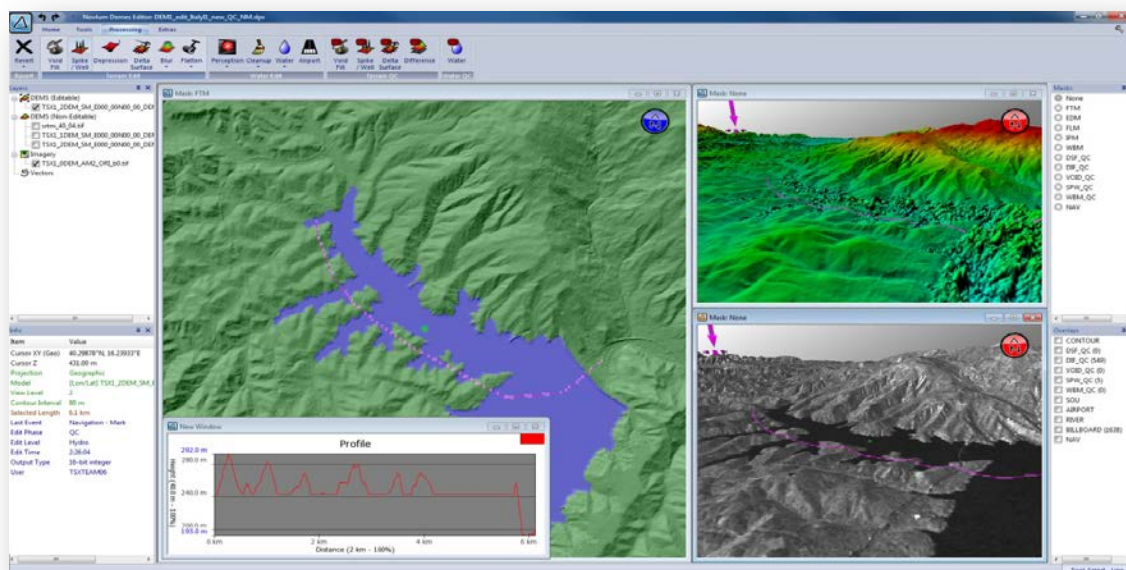


Editing Water Bodies

Software for editing WorldDEM_{core} data – adequate tools for water editing
DEMES

Water Body Editing

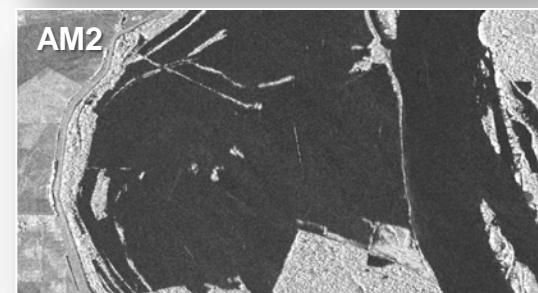
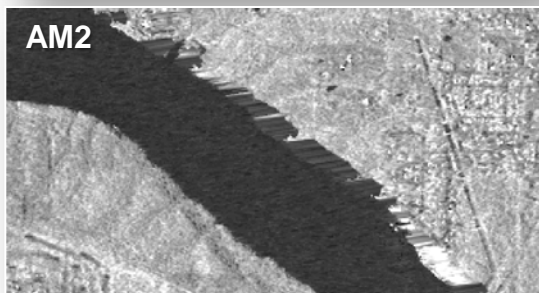
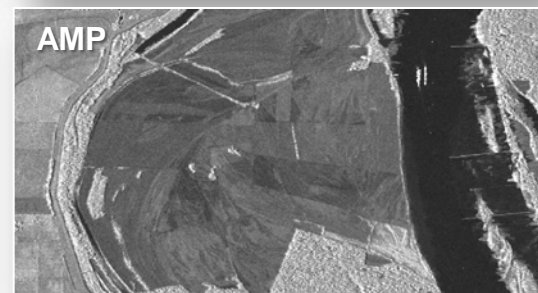
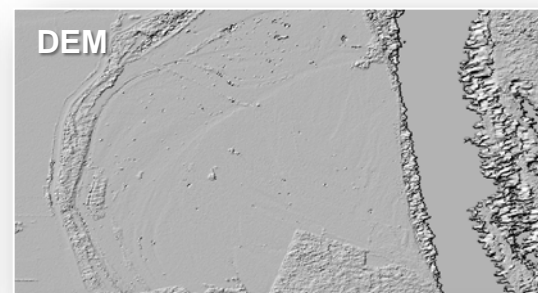
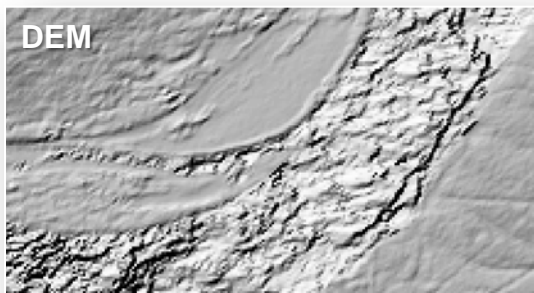
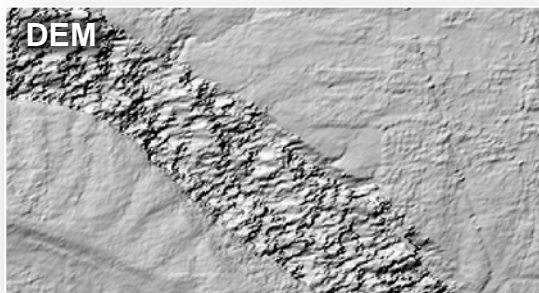
1. Delineation of water bodies (automatic and manual)
2. Classification into Ocean - Lake - River
3. Implementing Water Bodies in the DEM (machine driven)



DEMES Editing software

Editing Water Bodies

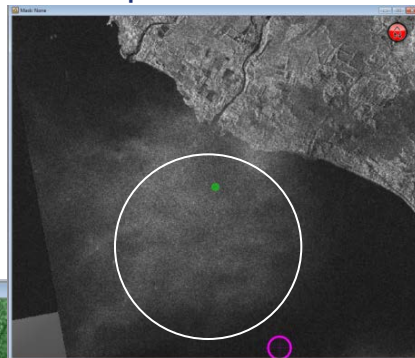
Elevation model and intensity images are the only information source



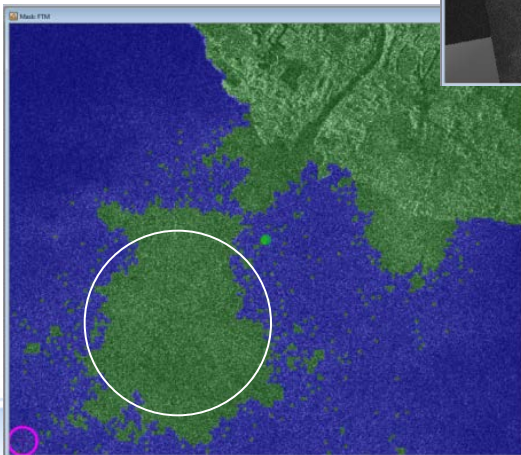
Editing Water Bodies

- **Perception Tool (automatic delineation)**
 - Automatic or semi-automatic classification of feature class **Land** and feature class **Lake** (Perception classifies all water features as Lake – largest class)
 - Perception uses **grey values** of **AMP images**, threshold can be calibrated

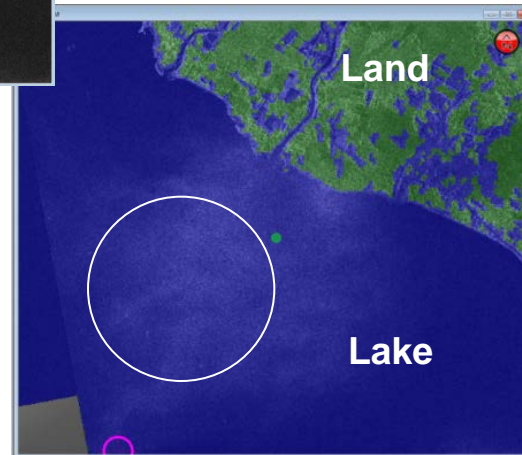
Example with cloud



Result: Auto. Perception



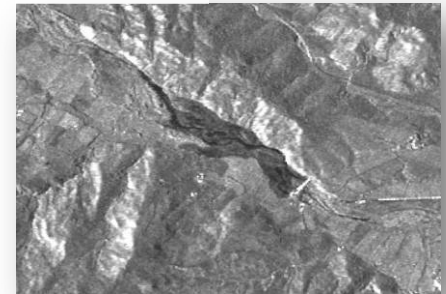
Result: Calibrate Perception



AMP_{MIN}

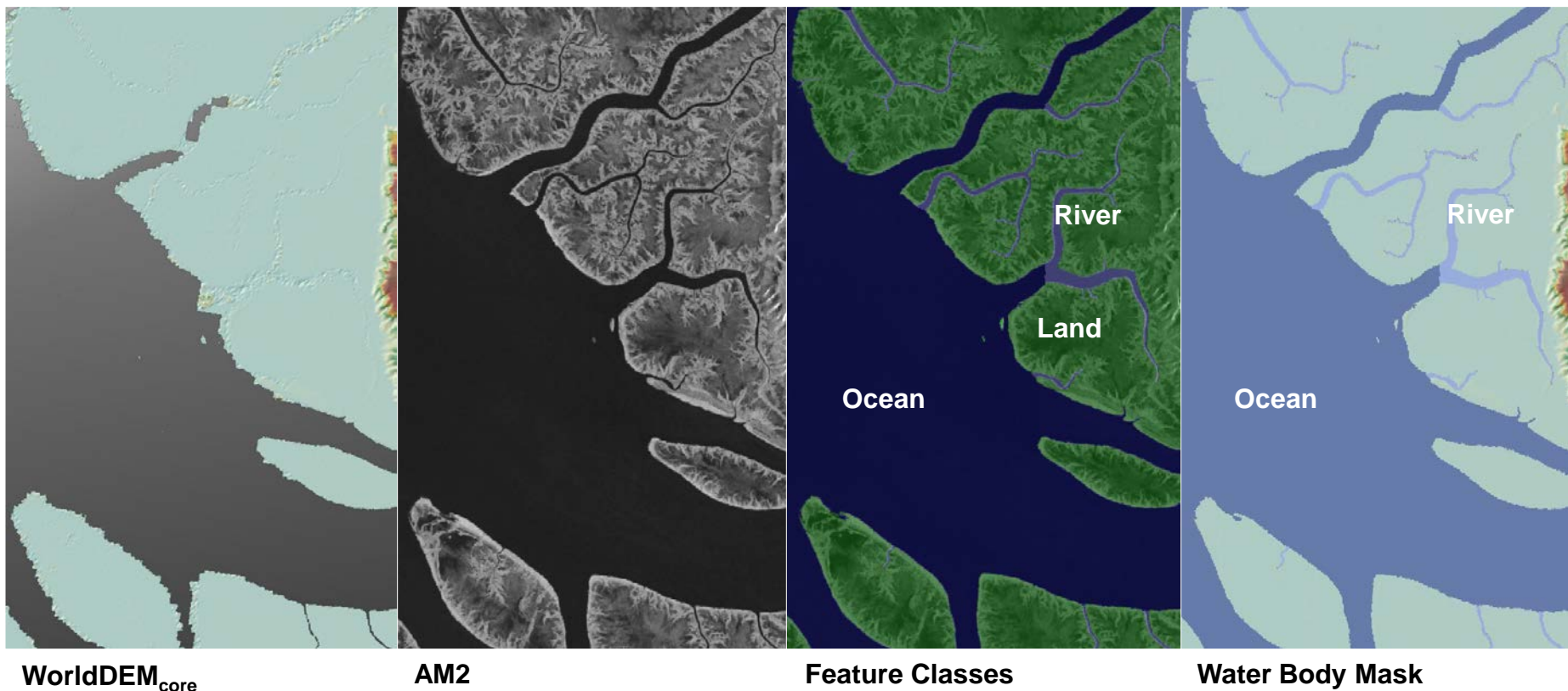


AMP_{MEAN}



Editing Water Bodies

Implementing Oceans

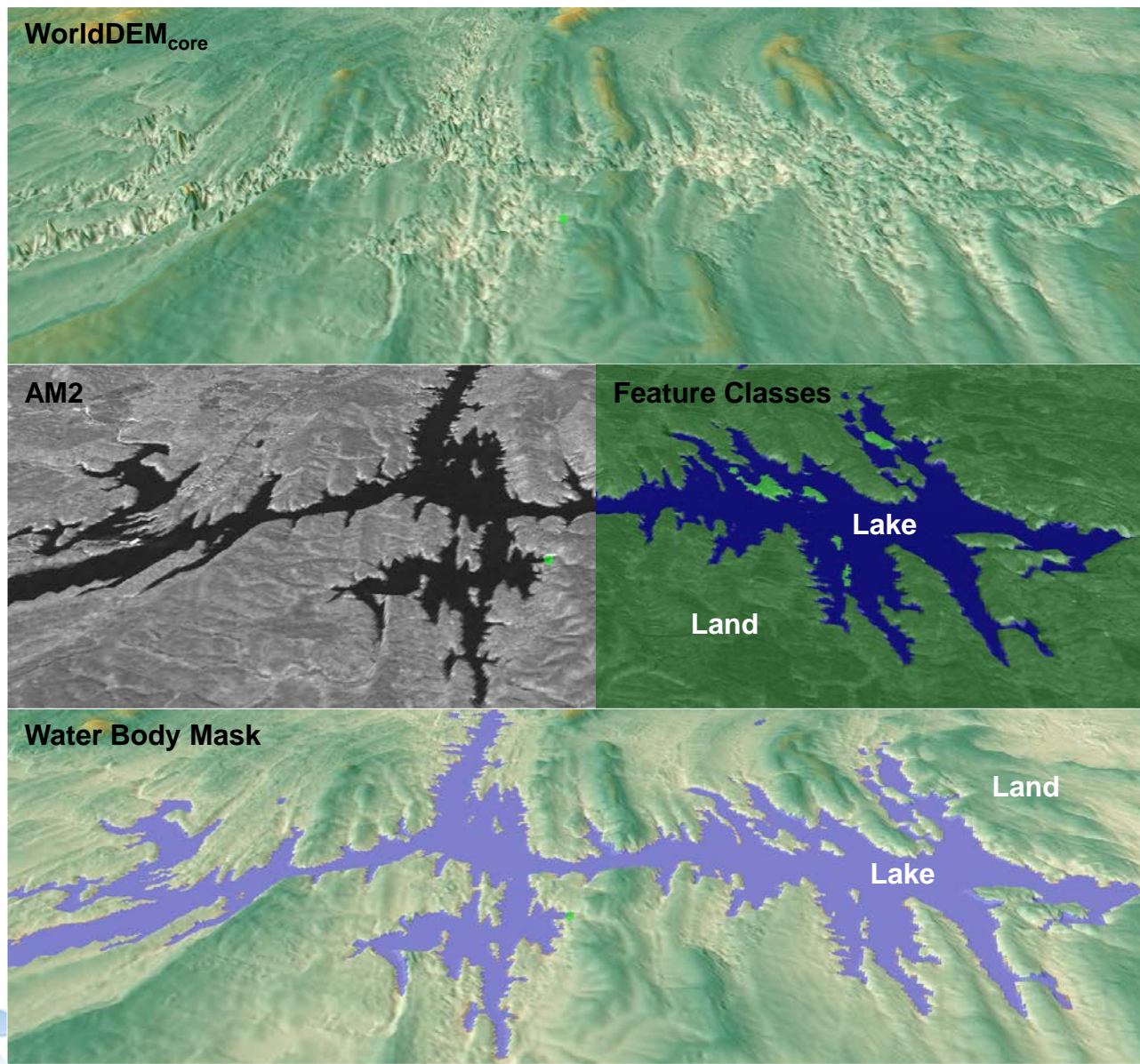


Editing process

Editing Water Bodies

Implementing Lakes

Editing process

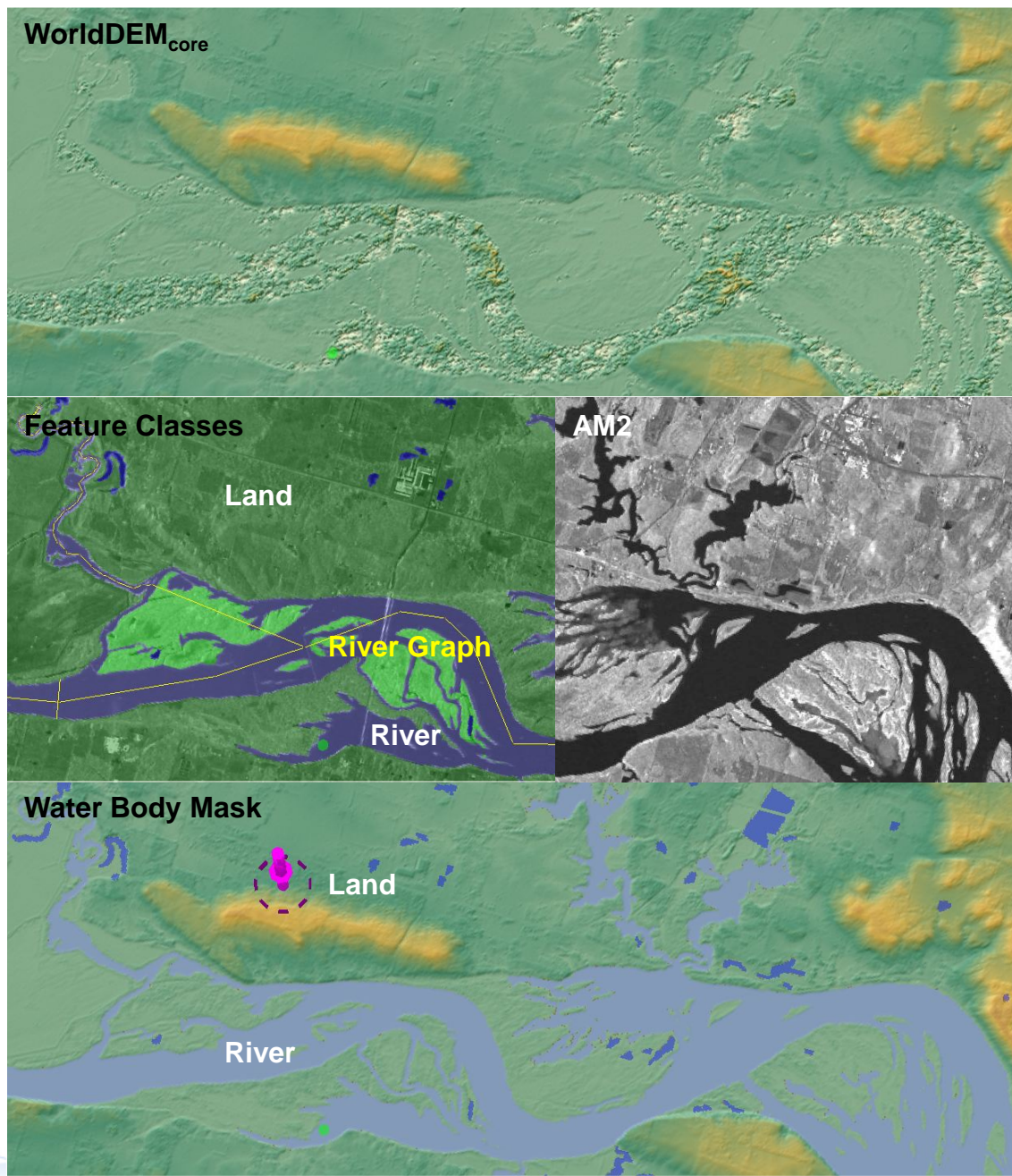


Editing Water Bodies

Implementing Rivers

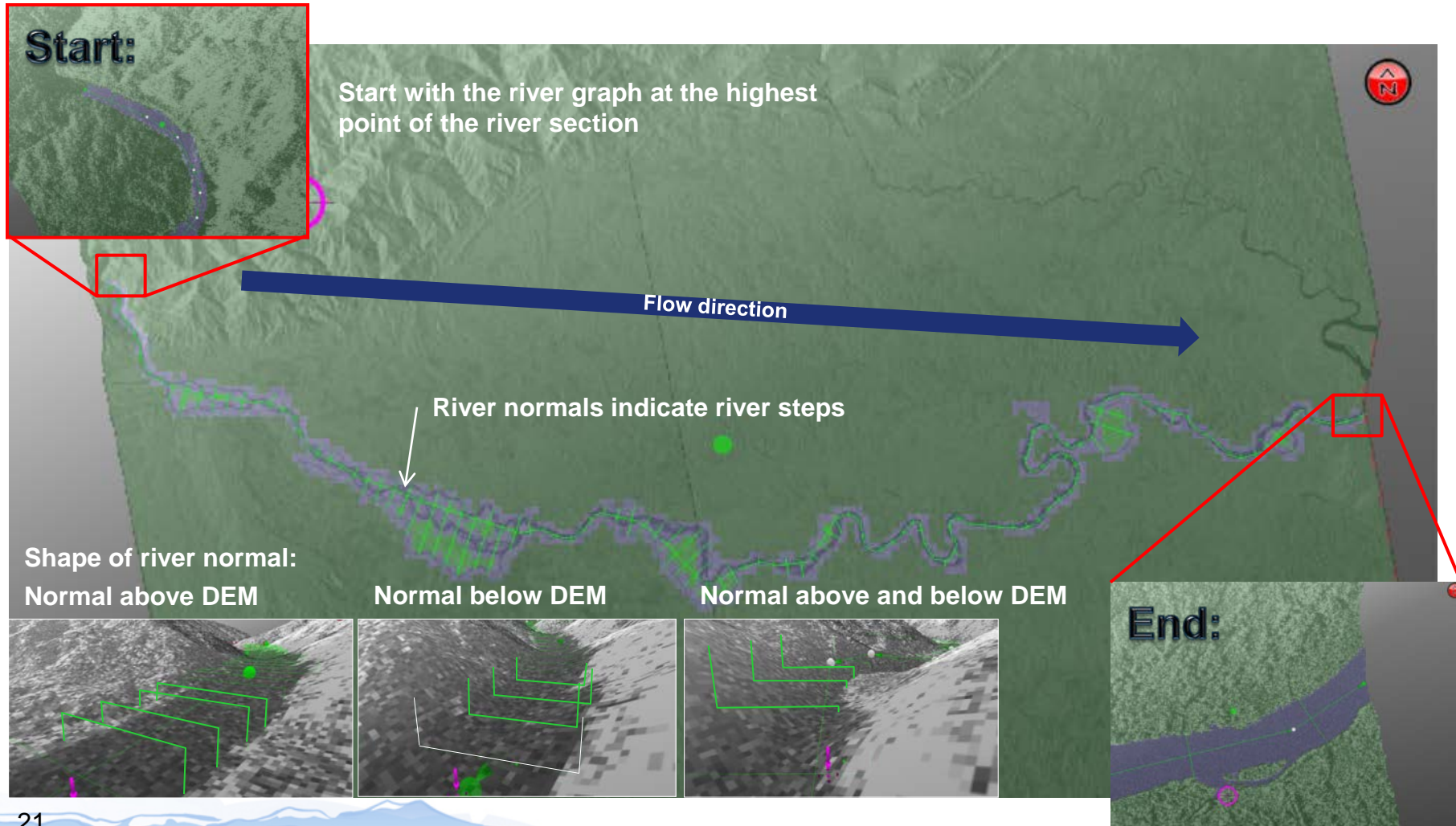
1. Classification into River
2. Create River Graph
3. Flatten Rivers

Editing process

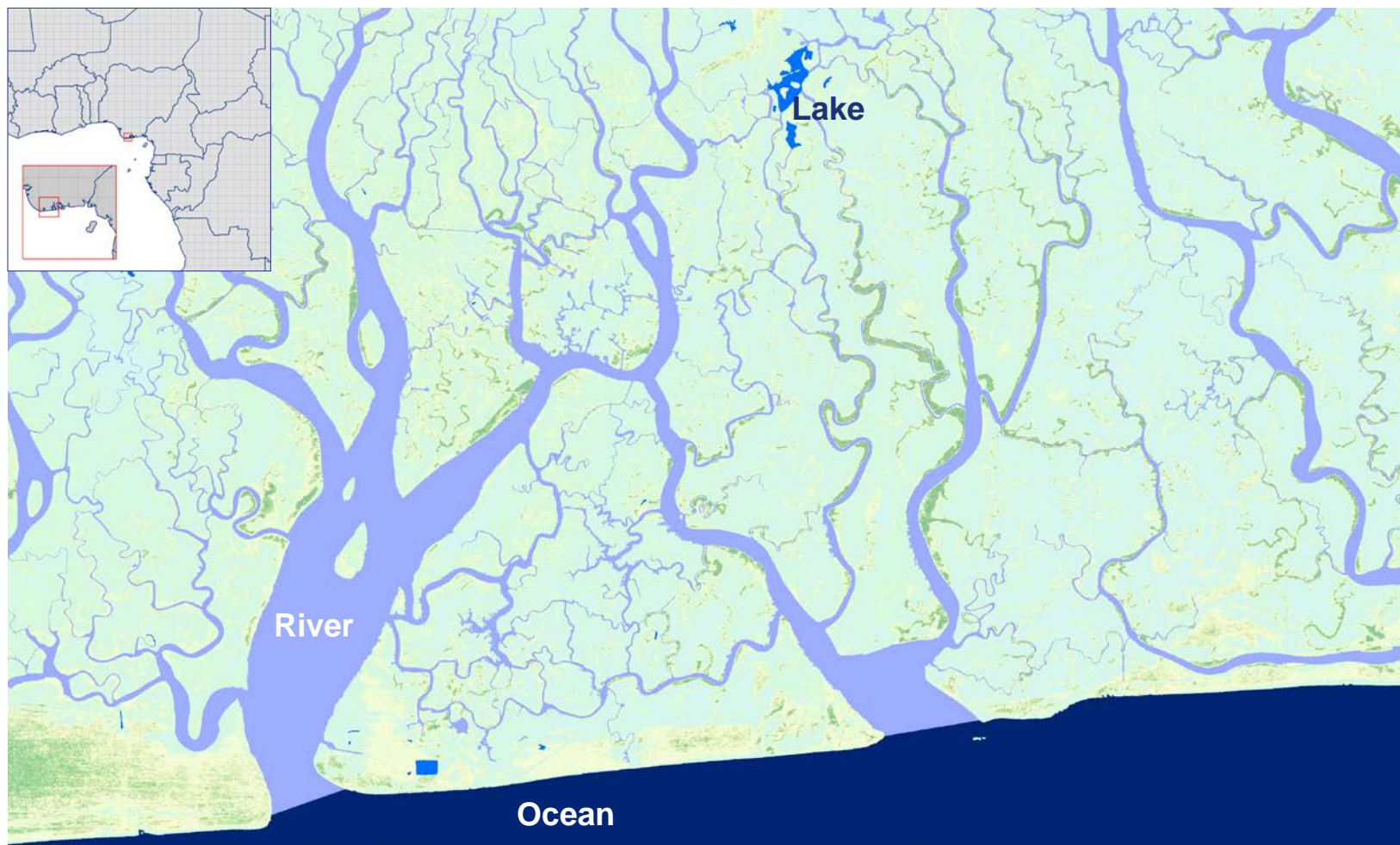


Editing Water Bodies

River Graph – height estimation for rivers



WorldDEM



**Water Body Mask,
Nigeria (N04E006)**

WorldDEM

Level of Effort

**Estimation of linear shoreline kilometer per editing feature class,
if global DEM is edited:**

~2
mil. km

~21
mil. km

~6
mil. km

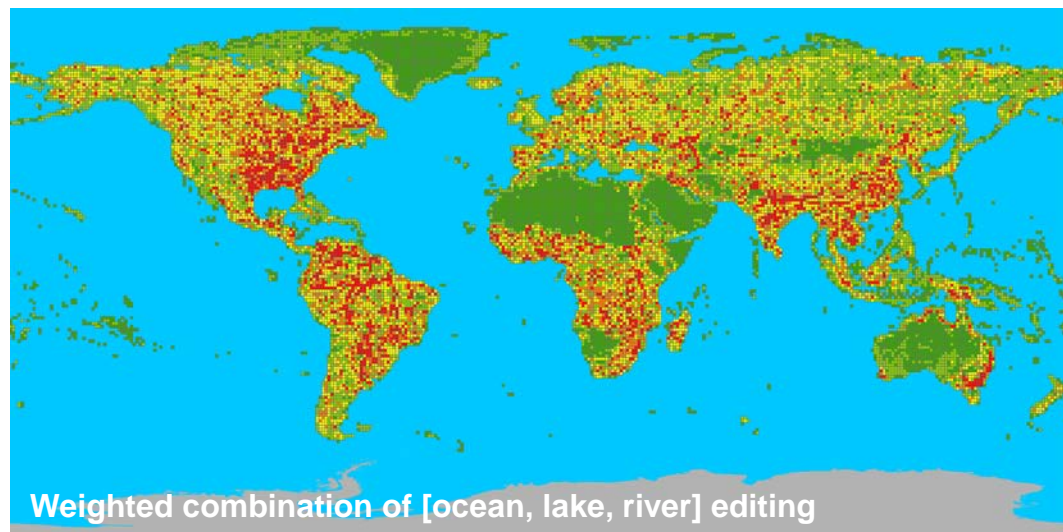
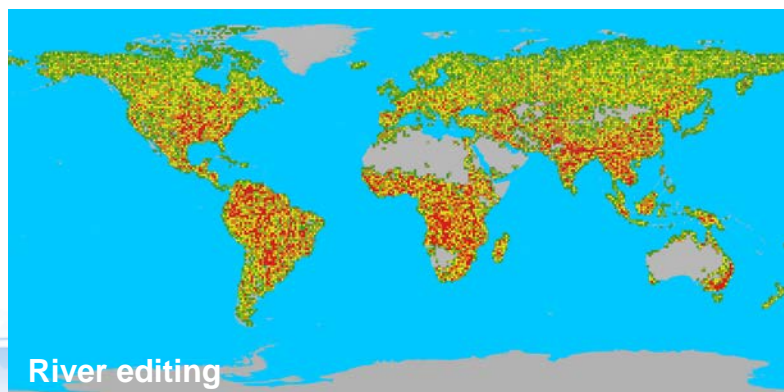
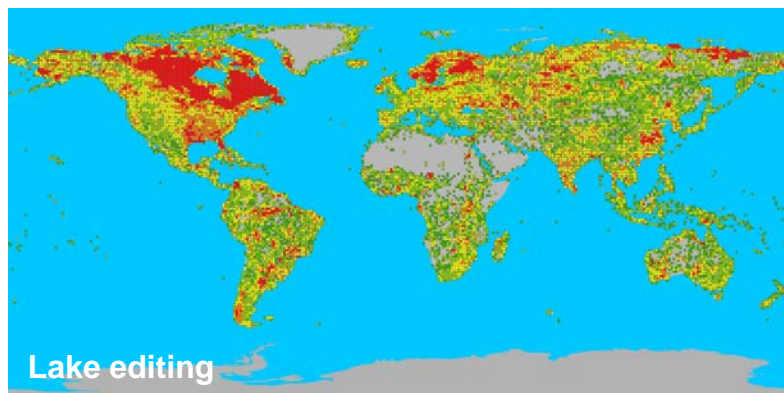
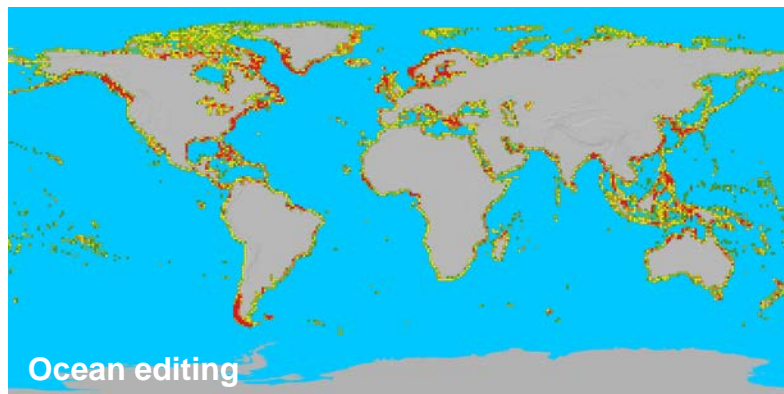
Ocean

Lake

River

~29 mil. km

Hydrologic classification of GeoTiles



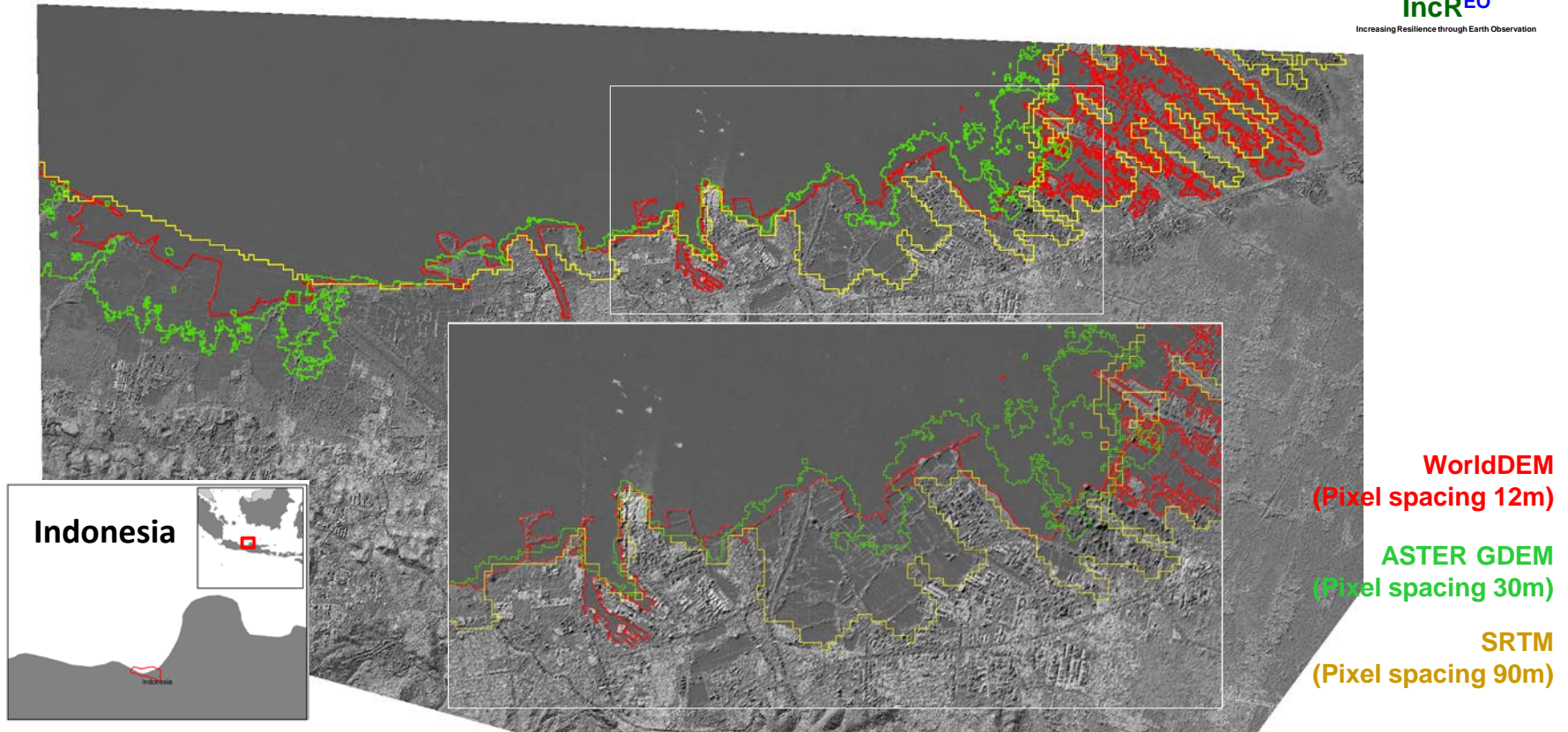
* Antarctica excluded

Global Ocean Shoreline Layer

Derived from the Ocean Mask

- Represents the water-land-mark (mean high water) at the time of data collection
- Global Ocean Shoreline layer can be used to model Sea Level Rise

IncR^{EO}
Increasing Resilience through Earth Observation



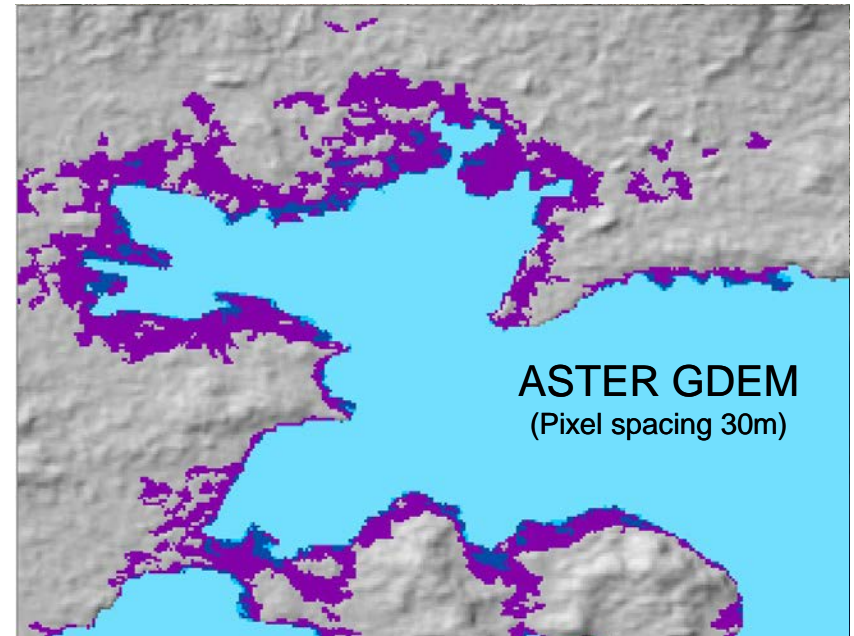
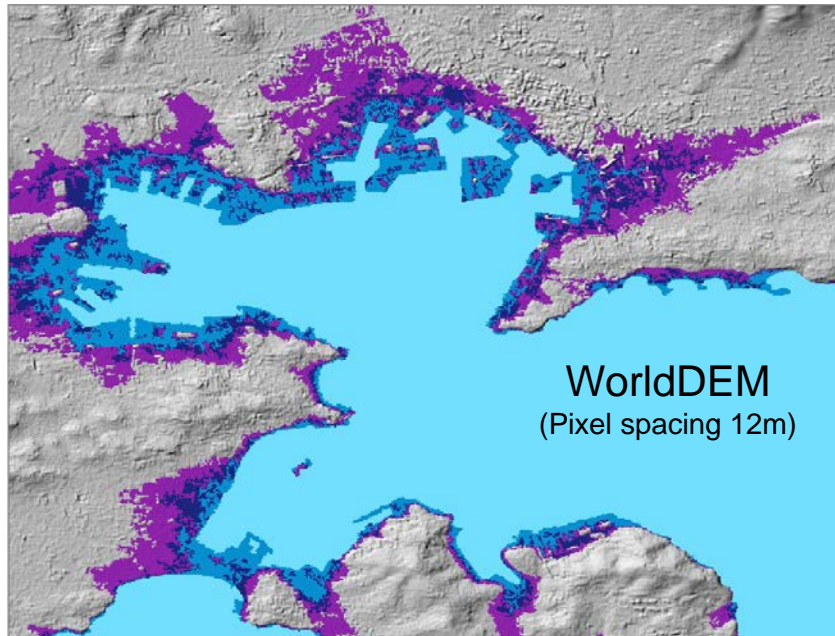
Quality of Elevation Reference is decisive for the Ocean Shoreline Layer

Case Study: Global Sea Level Rise-up – a Proven Fact

Geomorphological & hydrological impact in human and natural environment

- loss of soil to the sea
- Increase of saltwater intrusion (e.g. danger of drinking water reservoirs in coastal areas)
- Increase of storm surges, frequency of cyclones and floodings

IncREO
Increasing Resilience through Earth Observation



Sea Level: 0 m
Sea Level: + 3 m

Sea Level: + 5 m
Sea Level: + 10 m

Test site: Toulon, France

Quality of Elevation Reference is decisive in Flood and Sea Level Rise modelling

A topographic map of a mountainous region, likely the Alps, showing a large lake on the left and a winding river on the right. The terrain is color-coded by elevation, with green for lower areas and brown/orange for higher peaks. The text "Thank you!" is centered over the map.

Thank you!