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## EU-DEM Upgrade

### Documentation EEA User Manual

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## 1. INTRODUCTION. GENERAL DESCRIPTION

EU-DEM was derived from SRTM, ASTER GDEM and Russian topographic maps. It was created in the frame of Preparatory action for Copernicus Reference Data Access (RDA) in 2009-2012. Recommendations for EU-DEM upgrade have been provided by the experts from the JRC, Eurostat and EEA.

The objective of EU-DEM upgrade is enhancement of quality of the previous version of EU-DEM, correcting geo-positioning issues, reducing the number of artifacts, improving the vertical accuracy using ICESat as reference and ensuring consistency with EU-HYDRO 2015. The aim also was to implement several quality control process to assure the quality of the data.

This document includes an user guide of the EU-DEM upgrade, including a summary of what has been improved compared to the first version of EU-DEM and focus on the dataset specification, requirements/limitation of the software/hardware, description features and recommendations of use.

## 2. BASIC CONCEPTS

Digital Elevation Models (DEMs) provide fundamental information that is required across a broad set of application areas, each with different technical and usage requirements. The EU-DEM has been developed in response to an urgent need for continent-wide elevation data at 25m x 25m posting, and at an overall vertical resolution of approximately 5m (European Commission 2009).

Some examples of these application areas are:

- Drainage network generation, river basin, tributary rivers analysis. Flood modelling and flood risk management.
- Thematic mapping applications for different purposes.
- Visibility and coverage studies: Radio and network coverage, visibility, etc.
- Orthorectification of satellite images.
- Generation of shaded relief images at European level.
- In general any study that needs terrain elevations at European level at a maximum resolution of 25m posting.



### 3. MAIN SPECIFICATIONS AND TASK SUMMARY

#### 3.1 EXISTING DATASETS

EU-DEM has arrived from a fusion processing chain including both horizontal and vertical shifting as well as smoothing of the input layers as SRTM, ASTER GDEM and Russian topographic maps. Recommendations for EU-DEM upgrade have been provided by the experts from the JRC, Eurostat and EEA. Direct contact to some of the experts has been taken for further elaboration of their initial comments for the EU-DEM upgrade. Issues of particular importance for the EU-DEM upgrade as identified by the experts are (Preparation\_for\_EUDEM\_upgrade final, DHI Grass):

- Ensure proper fixing/alignment of coastline/islands delineation.
- Fixing river step downs (cf. ensure correct hydro-enforcing).
- Possibility for obtain, use and merge DEM for Scandinavian countries.
- Effort to rework EU-DEM such that a reasonable match between catchments as contained in 'CCM2' (Catchment Characterisation and Modelling), 'ECRINS' (European catchments and Rivers network System) and EU-Hydro is achieved. This may also imply looking into where these models differ significantly and why.

#### 3.2 REFERENCE SYSTEM

The reference system used in EU-DEM upgrade was:

- ETRS89-LAEA (EPSG code 3035)
- Ellipsoid GRS80
- Vertical datum EVRS2000 with geoid EGG08

#### 3.3 RESOLUTION AND ACCURACY

The resolution and accuracy for EU-DEM upgrade was:

- Pixel size: 25 metre resolution.
- Vertical accuracy of +/- 7 meters RMSE

#### 3.4 GEOGRAPHICAL COVERAGE MAPPING UNITS

EU-DEM upgrade covers 33 EEA members: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Liechtenstein, Lithuania, Luxemburg, Malta, Netherlands, Norway,

Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and United Kingdom.

6 cooperating countries: Albania, Bosnia and Herzegovina, the Former Yugoslav Republic of Macedonia (F.Y.R.O.M.), Montenegro, Serbia and Kosovo.

### 3.5 FORMATS

The formats used in EU-DEM upgrade were.

- Geotiff 32 bits
- Contiguous dataset divided into 100x100 kilometers tiles
- Nodata value is -32767.

### 3.6 IMPROVEMENTS

The following improvements were achieved during EU-DEM upgrade:

-Correction of geo-positioning issues in Malta and Lampedusa islands, ensuring the absence of this kind of issues in the rest of the dataset.

-Bias adjustment with ICESat to improve the vertical accuracy.

-Screening and removal of artefacts in the previous version of EU-DEM, including the presence of blunders (i.e. negative or positive anomalies). More than 75.000 artifacts detected and corrected.

-Ensured consistency with EU-HYDRO to produce a better river network topology. This includes:

- Consistency of the coastline with the EU-HYDRO coastline, including the removal of DEM values outside the EU-HYDRO coastline.
- Use of the EU-HYDRO coastline to smooth the gradient to the coast in flat regions.
- Burning of EU-HYDRO water bodies to set EU-DEM to the minimum height inside the water body, smoothing the boundaries.

The quality of the data has been assured by several quality control process performed by sub-contractors and EEA, including a statistical comparison with ICESAT to confirm the improvement of the bias and visual checks to QA the correct execution of the different tasks.

The result of EU-DEM upgrade is a Digital Elevation Model of reference in a contiguous dataset for the entire European region with these improvements:

## 4. REQUIREMENTS FOR USE DATA

The data is provided in GeoTIFF format 32 bits, in a contiguous dataset divided into 100x100 kilometers tiles. To use it properly it is necessary a GIS/CAD software or any software that allows to work with Digital Elevation Models (DEMs).

## 5. INSTALLATION AND CONFIGURATION

The EU-DEM dataset doesn't need installation. It is only necessary to uncompress the TIFF files and use them in any GIS/CAD software. The configuration of the data depends on the GIS software used. There are many commercial and Open Source software packages able to open the EU-DEM dataset.

## 6. DATA MODEL

EU-DEM upgrade is presented in Geotiff 32 bits format. It is a contiguous dataset divided into 100x100 km tiles, resulting in a total of 1992 tiles of 4000x4000 pixel at 25m resolution. The Vertical accuracy is +/- 7 meters RMSE.

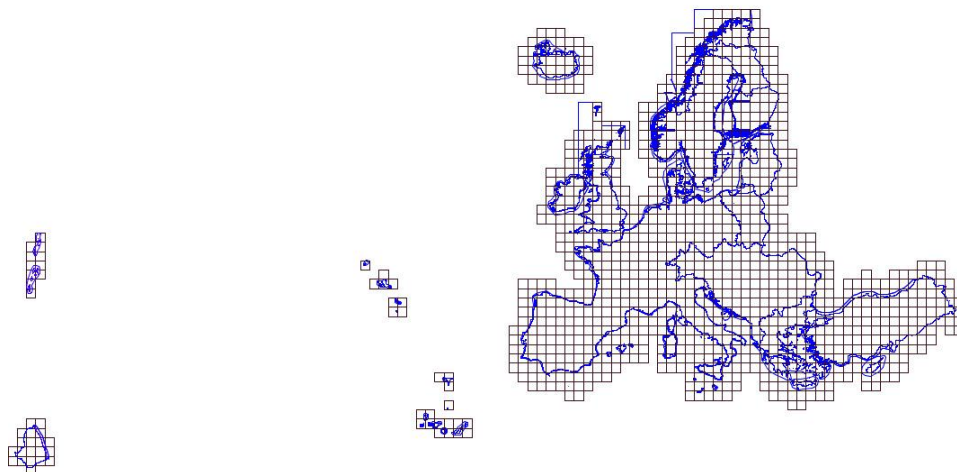


Figure 6-1. EU-DEM Tiles.

The reference system is ETRS89-LAEA (EPSG code 3035), Ellipsoid GRS80 and vertical datum EVRS2000 with geoid EGG08.

### Geographical Coverage Mapping Units:

- 33 EEA members: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Liechtenstein, Lithuania, Luxemburg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and United Kingdom.
- 6 cooperating countries: Albania, Bosnia and Herzegovina, the Former Yugoslav Republic of Macedonia (F.Y.R.O.M.), Montenegro, Serbia and Kosovo.

Nodata value is -32767.

## 7. FAQs

In this section is included the frequently asked questions related to the EU-DEM upgrade dataset.

### Download data:

I can't download the dataset. What do I do?

The web explorer doesn't allow downloading the data because it is not updated or this is not the proper web explorer. Update your web explorer or try to download with another web browser.

### Open data:

I can't open the dataset. What do I do?

First of all, you must be sure that the dataset is properly downloaded. Then extract the dataset from the zip file using one of the unzip software (WinZip, WinRAR, 7-Zip...). Finally load the dataset into the GIS/CAD software taking into account the parameters (software parameters differ from one to another: file format, workspace, projection...).

### Data management:

What is the meaning of the attributes?

EU-DEM only have the elevation attribute for each pixel of the Geotiff images.

### Additional information:

You can find additional information of the dataset in the EEA webpage or asking your question via EEA forum: <http://community.eea.europa.eu/>

## 8. PROBLEMS SOLVING

In this section is included the problems solving related to the EU-DEM upgrade dataset.



- If the dataset is corrupted, it is recommended to download the data again and unzip the dataset. If it still corrupted, it would be very useful to inform to the EEA in order to fix that problem.
- If the dataset downloading is slow, check the internet connection and/or confirm that the EEA webpage is working properly.
- The dataset doesn't contain a predefined symbology. Each user can define its own symbology.
- If some errors are detected in the dataset, please inform as soon as possible to the EEA via forum: <http://community.eea.europa.eu/>
- For additional and advance information of the EU-DEM upgrade dataset, contact to the EEA for technical documentation.

## 9. RESTRICTIONS TO USE AND RESOURCE CONSTRAINTS

EEA standard re-use policy: unless otherwise indicated, re-use of content on the EEA website for commercial or non-commercial purposes is permitted free of charge, provided that the source is acknowledged (<http://www.eea.europa.eu/legal/copyright>).

## 10. ADDITIONAL INFORMATION

In this section is included the flyer for the EU-DEM Upgrade.

## Introduction:

EU-DEM was derived from SRTM, ASTER GDEM and Russian topographic maps. The objective of EU-DEM upgrade is enhancement of quality correcting geo-positioning issues, reducing the number of artifacts, improving the vertical accuracy using ICESat as reference and ensuring consistency with EU-HYDRO 2015.

### Recommendation for use:

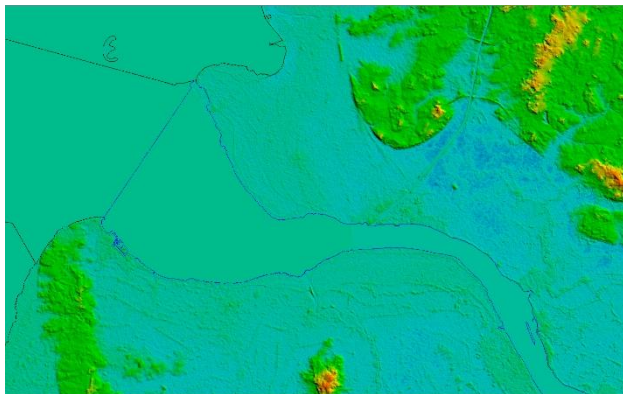
- Digital Elevation Model of reference in a contiguous dataset for the entire European region.
- Drainage network generation, river basin, tributary rivers analysis. Flood modelling and flood risk management.
- Thematic mapping applications for different purposes.
- Visibility and coverage studies: Radio and network coverage, visibility, etc.

### Reference system:

- ETRS89-LAEA (EPSG code 3035), Ellipsoid GRS80 and vertical datum EVRS2000 with geoid EGG08.

### Resolution and accuracy:

- Pixel size: 25 metre resolution.
- Vertical accuracy of +/- 7 meters RMSE.



Example of the burning of rivers and coastline. Elba river.

### Geographical Coverage Mapping Units:

- 33 EEA members: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Liechtenstein, Lithuania, Luxemburg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and United Kingdom.
- 6 cooperating countries: Albania, Bosnia and Herzegovina, the Former Yugoslav Republic of Macedonia (F.Y.R.O.M.), Montenegro, Serbia and Kosovo.

### Formats:

Geotiff 32 bits. Contiguous dataset divided into 100x100 km tiles.

### Improvements:

- Correction of geo-positioning issues in Malta and Lampedusa islands, ensuring the absence of this kind of issues in the rest of the dataset.
- Bias adjustment with ICESat.
- Screening and removal of artefacts in the previous version of EU-DEM, including the presence of blunders (i.e. negative or positive anomalies). More than 75.000 artifacts detected and corrected.
- Ensured consistency with EU-HYDRO to produce a better river network topology. This includes:
  - o Consistency of the coastline with the EU-HYDRO coastline, including the removal of DEM values outside the EU-HYDRO coastline.
  - o Use of the EU-HYDRO coastline to smooth the gradient to the coast in flat regions.
  - o Burning of EU-HYDRO water bodies to set EU-DEM to the minimum height inside the water body, smoothing the boundaries.

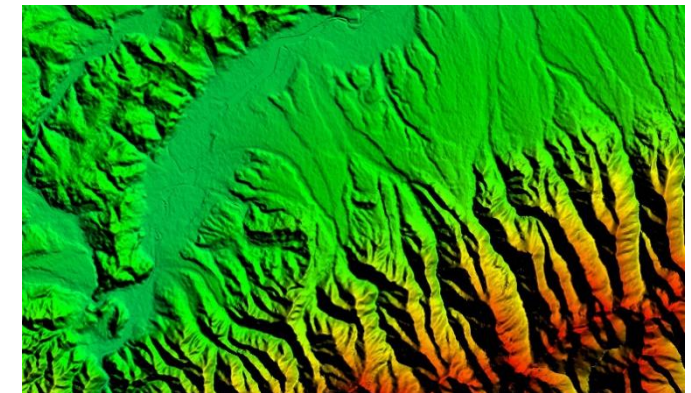
## Resource constraints

EEA standard re-use policy: unless otherwise indicated, re-use of content on the EEA website for commercial or non-commercial purposes is permitted free of charge, provided that the source is acknowledged (<http://www.eea.europa.eu/legal/copyright>).

## Data quality

The quality of the data has been assured by several quality control process performed by sub-contractors and EEA.

- Statistical comparison with ICESAT to confirm the improvement of the bias.
- Visual checks to QA the correct:
  - o Removal of artifacts.
  - o Absence of geo-positioning errors
  - o Consistency with EU-HYDRO.
  - o Completeness



Example of EU-DEM in Danube basin

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<http://www.eea.europa.eu>



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# Copernicus Land Monitoring Service - Local Component: EU-DEM

