Generation of a DEM for the upper Oueme Catchment using ASTER and SRTM Data

Génération d´un MNE pour le bassin de l´Ouémé supérieur utilisant des données ASTER et SRTM

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Introduction

Digital Elevation Models (DEM) are important for a broad range of applications. They are used to analyse topography, landscapes and relief visually or mathematically, to generate orthophotos and to model hydrological and geomorphological parameters, e.g. flow direction, flow accumulation, aspect or slope.

Until the developement of this new dataset the upper Oueme Catchment was covered by the GTOPO30 with a horizontal grid spacing of 30 arc seconds (~1km). Since the beginning of 2004 data of the **S**huttle **R**adar **T**opography **M**ission (SRTM) with a resolution of 3 arc seconds (~90m) are available. With ASTER Data it is now possible to generate a DEM with a resolution of 30 meters.

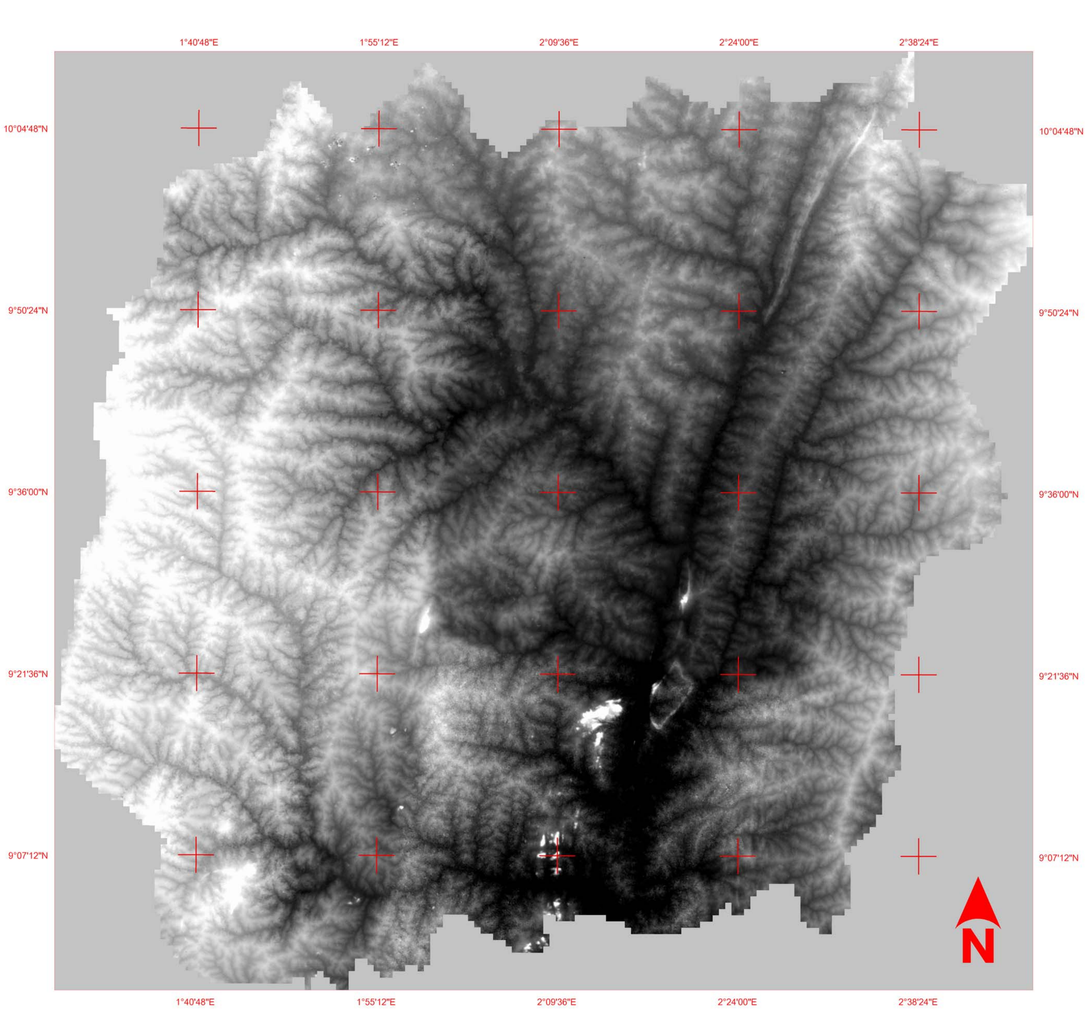
Data

The ASTER Instrument is flying on board the Terra Satellite and offers the possibilitie to extract height information from stereo pairs. The instrument consists out of three subsystems recording in different spectral ranges. The one recording in the visible and near infrared has a resolution of 15m and uses two telescopes, so that the third band (0.76µm - 0.86µm) is recorded nadir looking as well as backward looking with an angle of 27,6°. Due to the recording in different angles the same object has different positions in the two images (parallaxe). The higher the elevation of an object or pixel is, the larger is the parallaxe. Therefore, it is possible to calculate the elevation and extract digital elevation models from ASTER Stereo Data. In principle, it is possible to generate absolute and relative elevation models. For absoulte DEMs it is necessary to include ground control points which were ideally taken in the field with a differential GPS. In this work, a relative DEM was extracted by using tiepoints and height information from topographic maps and SRTM data.

One ASTER image covers an area of ~60km^2. To cover the area of the Upper Oueme Catchement 14 ASTER scenes (Level 1A) were needed.

Generation of the DEM

The DEM of each ASTER image or of stitched image tiles - some images could be stitched as they were recorded during the same overflight and have therefore the same orbital parameters - was generated with the OrthoEngine of PCIs Geomatica 9.3. Starting with the input of the raw images the next steps are the determination of tiepoints, the caculation of epipolar images and the extraction of the DEMs. In most cases it is then necessary to edit the DEMs manuelly as there are parts in the DEM where the height extraction failed. This occurs mainly in areas with a low reflection in the near infrared, e.g. at water bodies or shaded areas. Smaller areas can be interpolated with good results. Bigger "holes" occured due to cloud coverage. These areas were replaced by SRTM Data, which were resampled to the DEM output resolution of 30m. Due to the properties of radar data, the SRTM dataset is not affected by cloud coverage and therefore very usefull for the generation of DEMs in tropical regions. In a final step the extracted DEMs were mosaiced.



Mosaic of the generated digital elevation models for the Oueme cathcment. (The higher parts appear bright and the lower parts dark)

Mosaique des modèls numérique d´élevation générés pour le bassin de l´Ouémé. (Les parties élevées apparaissent claires, les parties plus basses foncées)

Accuracy and Conclusion

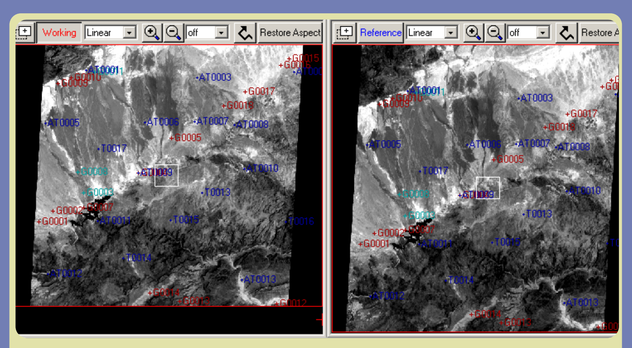
The resultant DEM was checked by calculating sinks, flow directions and flow accumulations. The generated orthophotos and generated contourlines were compared to 1:50.000 and 1:200.000 topographical maps. The DEM was also compared to the SRTM Data. All tests showed high consistency and good results.

Additionally, the elevation of 15 geodetic points was compared with the elevation of the DEM at the same points with the following result:

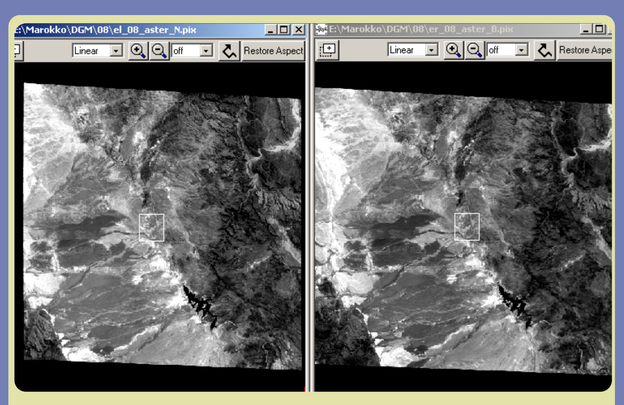
Mean Error: 2.09 Meter

RMS Error: 14.65 Meter

Finally, it can be stated that the generation of digital elevation models from ASTER data is a very suitable method if only low resolution, or no data at all exists. Compared to other methods like digitizing (old) maps, the use of high resolution imagery or aerial photos, the extraction of height information using ASTER is a very time and money saving procedure from which many further applications can benefit. Due to the integration of SRTM data it is now a valuable method for tropical regions as the frequently occurring cloud coverage can be masked out.



Input of GCPs (red) and Tiepoints (blue) to the raw images.
Left: Nadir Image
Right: Backward Image
Insertion des points d´appui au sol (rouges) et des points de liason (bleues) dans les images brutes.
À gauche: image au nadir
À droite: image prise en arrière



Calculated epipolar images with a removed Y-parallax.
Images épipolaires calculées avec parallaxe Y élimine.

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