



Quality Assessment of Elevation Data Products in the Bundeswehr

Dr. Carola Braun
Bundeswehr Geoinformation Office (BGIO)

Joint Agency Commercial Imagery Evaluation (JACIE) Workshop
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Agenda

- Introduction
- User Requirements
- Evaluating Elevation Data Products - Examples
- Conclusion



Task

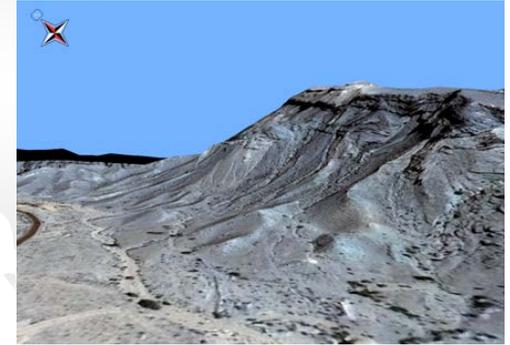
The Bundeswehr Geoinformation Service (BGIS) is to identify mission-relevant environmental impacts, to evaluate them according to space and time, and to support and advise users with the help of prepared geospatial and environmental information.

BGIO: central agency of BGIS





- BGIO supplies quality controlled geoinformation to users in the Armed Forces, including commercial satellite imagery and elevation data
- Applications of Digital Elevation Models:
 - Orthorectification
 - GIS-Analysis (Cross Country, Flood, LOS)
 - Realistic 3D-Visualization
 - Contour Lines
 - Mission Planning of Weapon Systems
 - Simulation Purposes





1. Repetitive investigations are carried out => to identify the need of the users
2. Quality assessments of elevation data products are continuously performed => to meet future challenges

>> Questionnaire <<

**application
purpose**

**data format
description**

contents of data

user ideas

**provision of data
coverage**

**future
challenges**



- Elevation Data Products generated using:
 - Matching Techniques from optical stereo images (spaceborne, e.g. WorldView, Pleiades and aerial images)
 - Interferometric Processing (NEXTMap, SRTM, TanDEM-X)
 - Laser Scanning (airborne)
- Quality of offered elevation data products is heterogeneous!

**Provision?
(time, coverage)**

**processing
techniques?**

satellite missions?

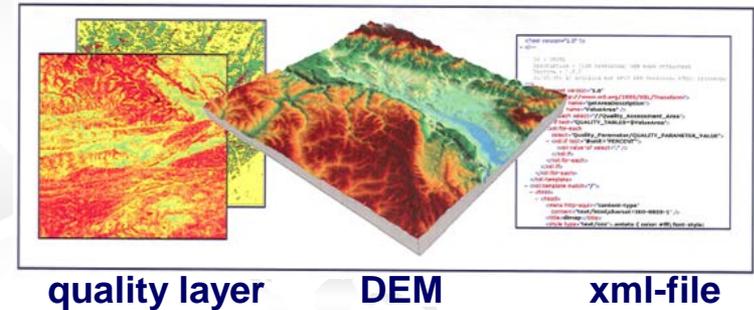


Objectives:

- Improvement of DEM by using internally best available data
- Verification whether the purchased data fulfills requirements of product specification

Selected reference areas:

- urban and rural areas, forests
- flat, medium, steep terrain



Comparison to Ground Control, if available:

- ⇒ accuracy values
- ⇒ non-numerical description of characteristics/ limitations of data

Quality control process is constantly adopted



Evaluating elevation data products

Data: elevation data
imagery

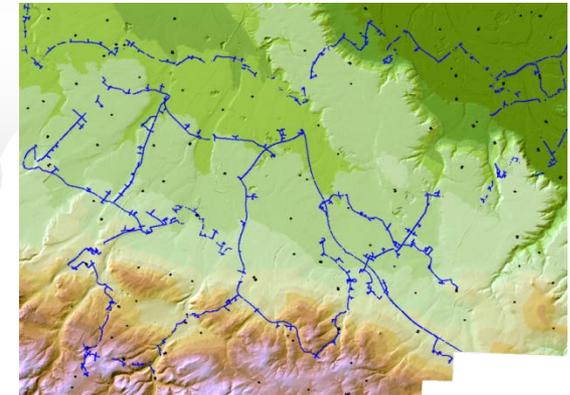
Reference: static and kinematic GPS

Test areas: Euskirchen (~30x40 km²)
Sonthofen



GPS-tracks well suited for:

- identification of features in satellite images
- Comparison with elevation data



Evaluation:

- Accuracy assessments
- Interpretation of results
- Suitability of applications



Product (DLR- RMC Berlin)

- TOM RGB (24Bit) 10cm
- DSM (16 Bit) 10cm

Semi Global Matching



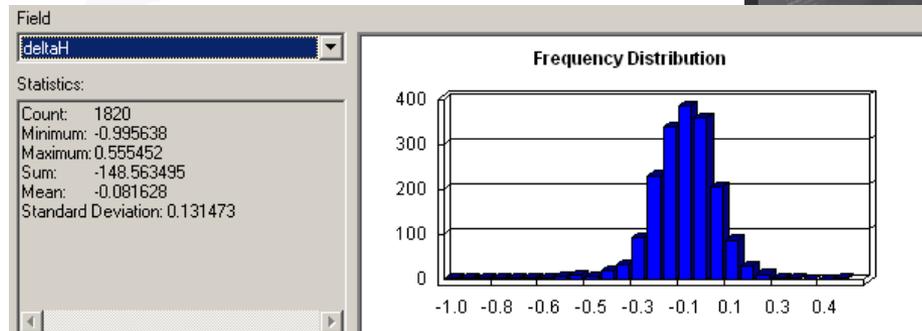
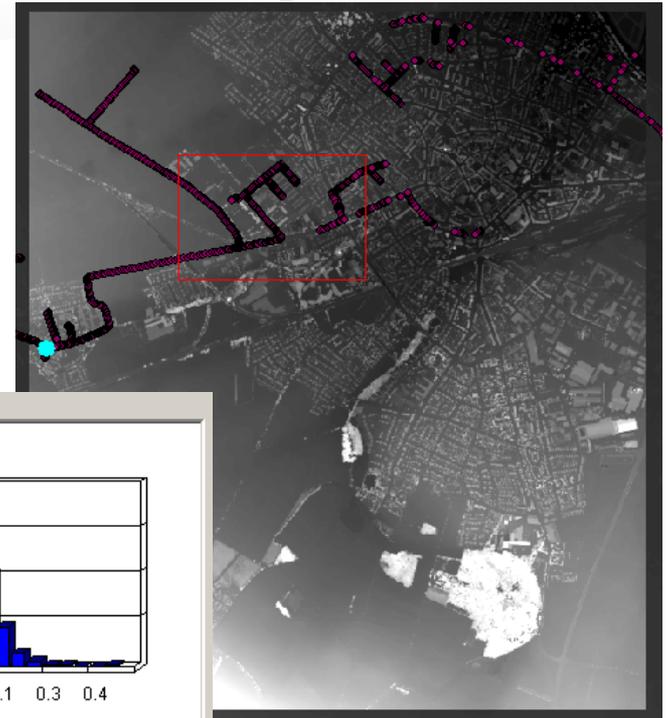


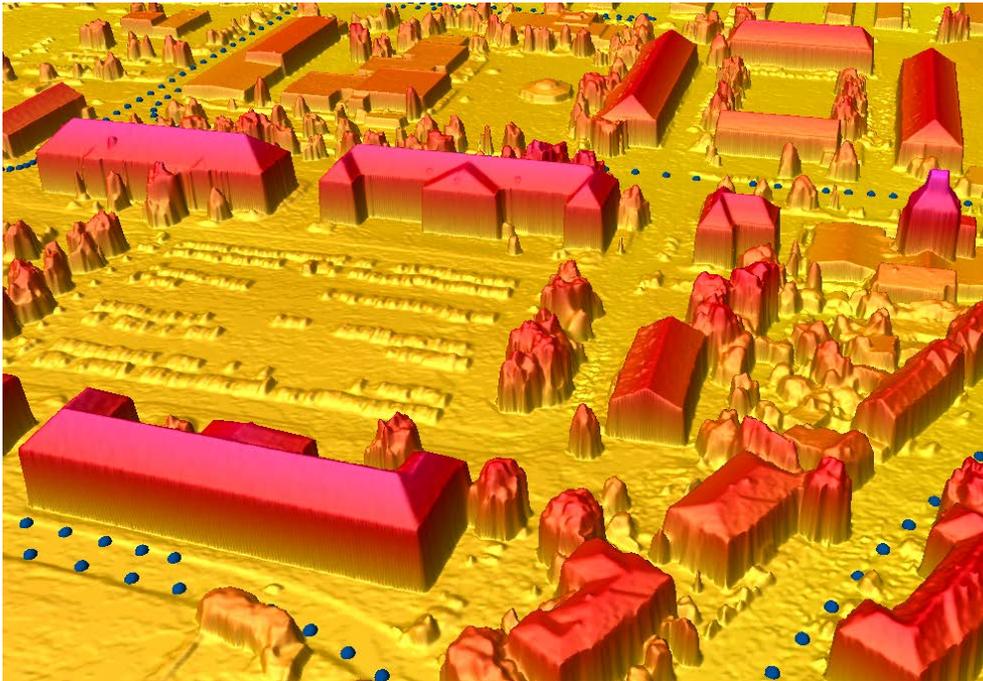
Software: CheckDEMHeight

UC DSM 10 cm tile 2_3

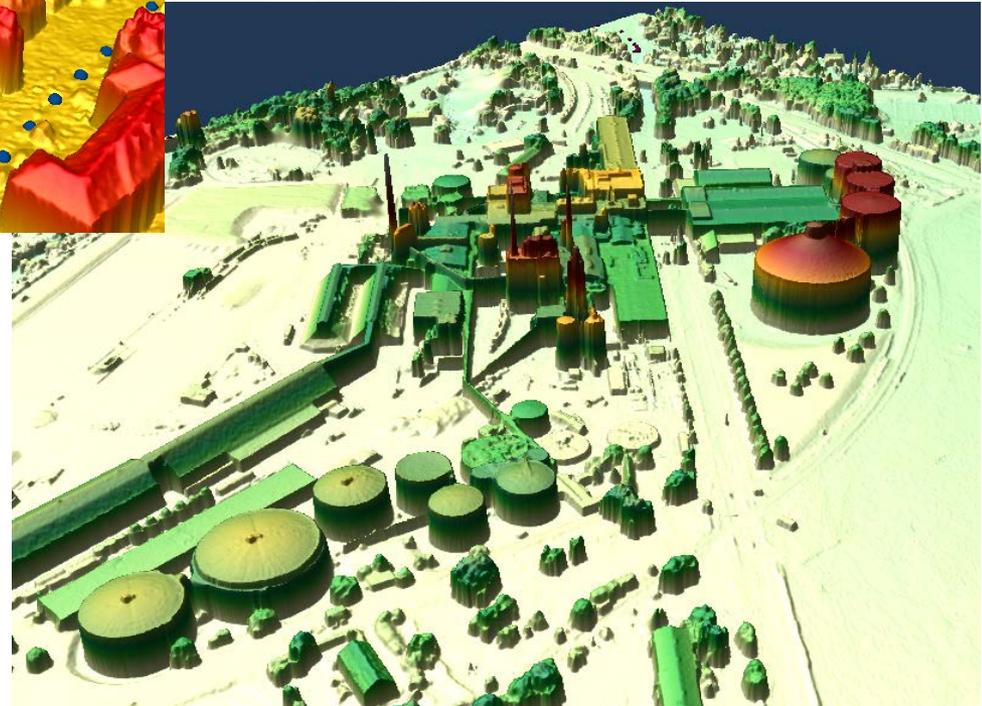
Kinematic GPS

- RMSE: 0.18m
- LE90: 0.29m





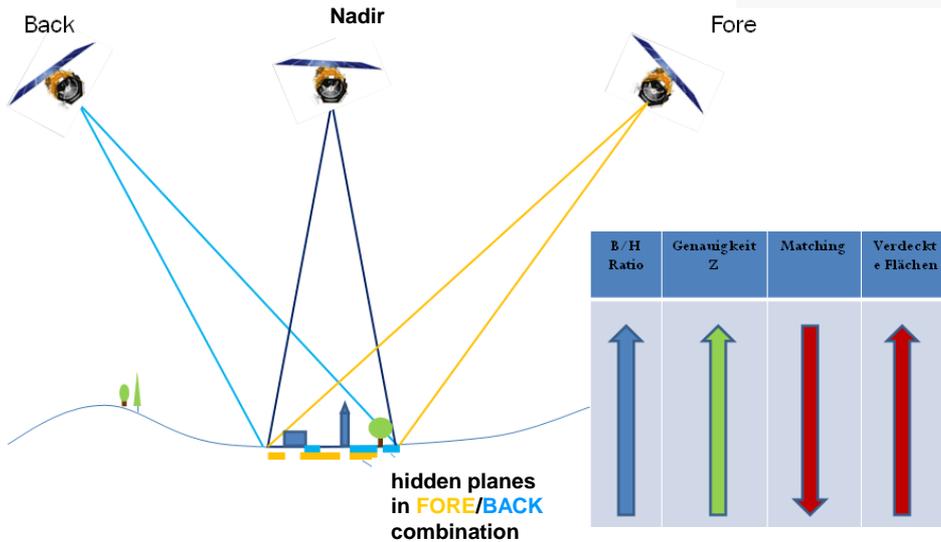
DSM and GPS Tracks



Sugar Refinery



WorldView-1
WorldView-2



Specifications:

Horizontal resolution	0.5m
Vertical resolution	0.1m
Projection	UTM/WGS84
Vertical datum	WGS84/EGM2008
Horizontal (absolute) accuracy	CE90 < 2.5m (without Ground Control)
Vertical (absolute) accuracy	LE90 < 3,5m (without Ground Control)
File format	GeoTIFF (32bit, LZW)
Size	15x15km ²

Cooperation of:



and



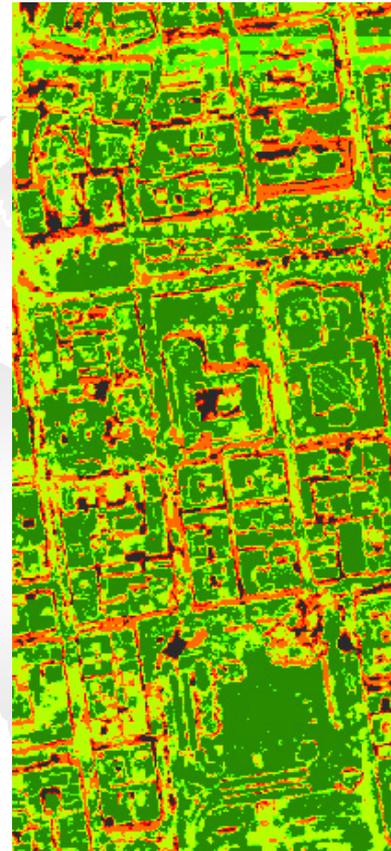
German Aerospace Center



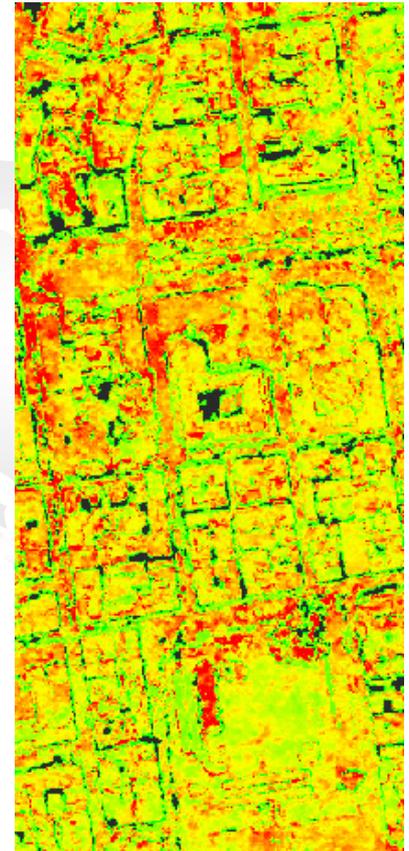
ORTHOimage



DigitalSurfaceModel



NUMBER of Matches



STD of Matches

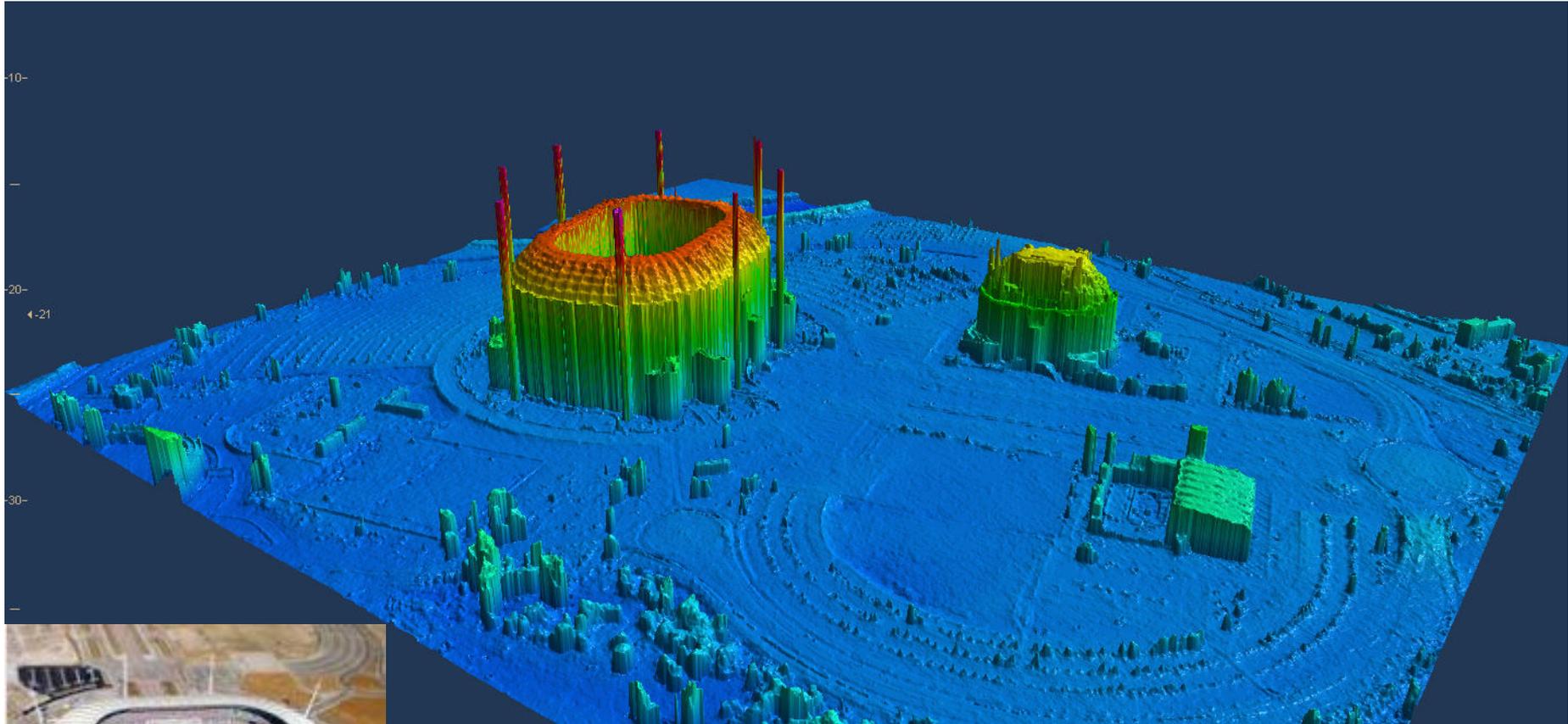
Cooperation of:



and

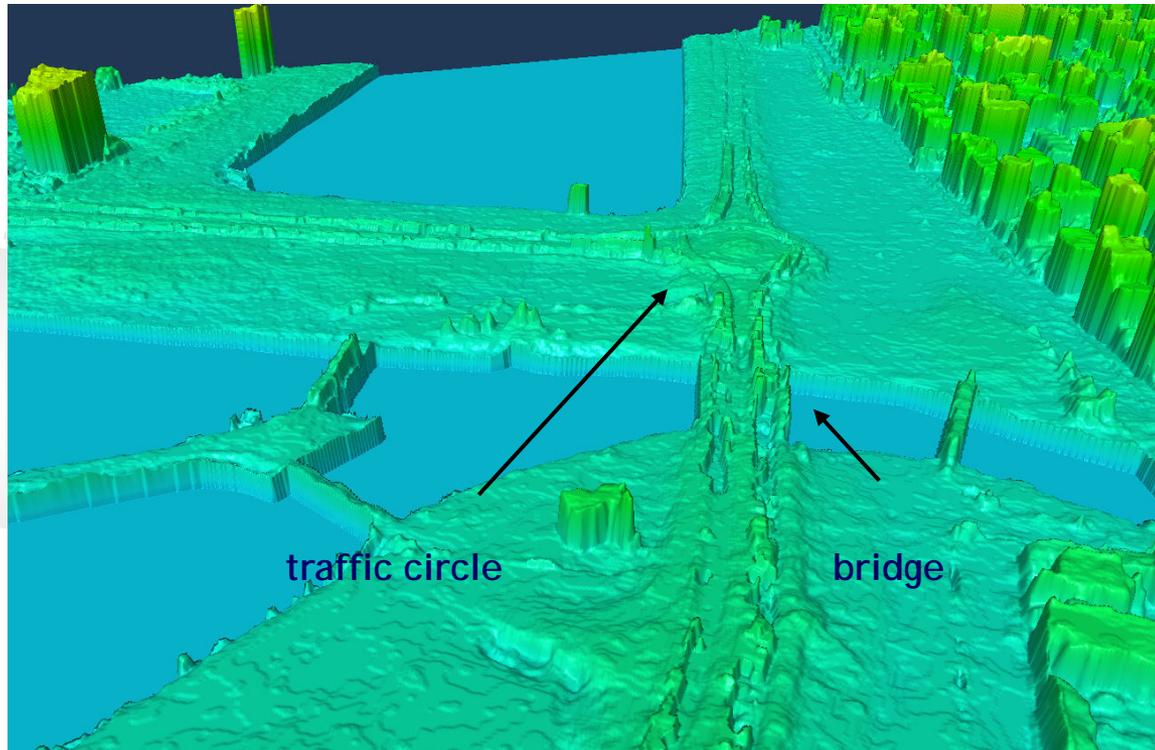


**German
Aerospace Center**



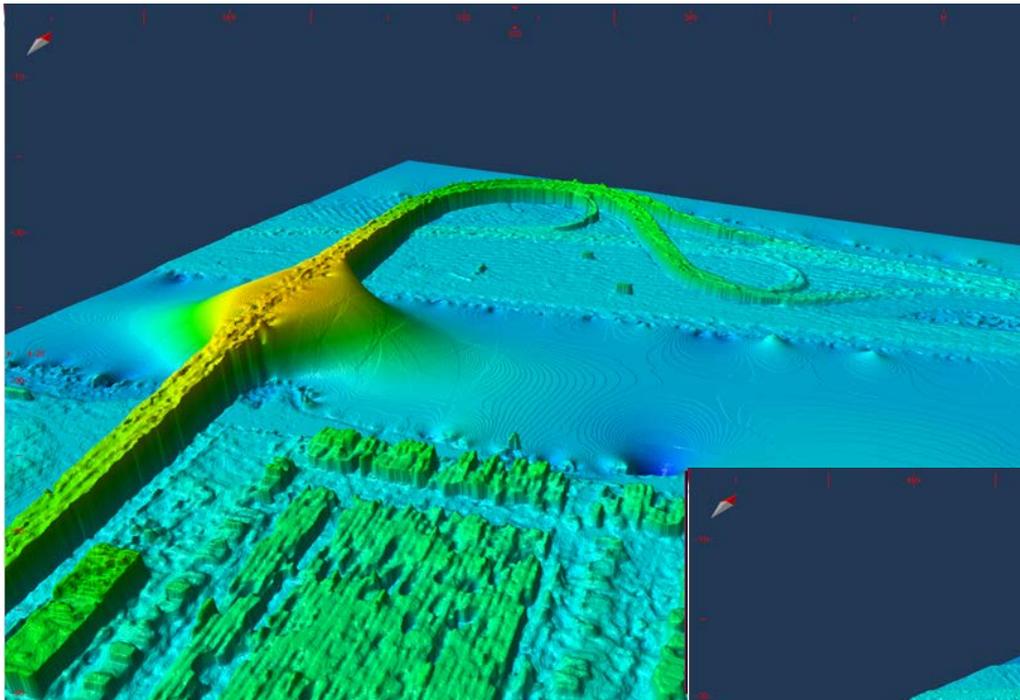
Source: Google

DSM 50 cm WorldView-2



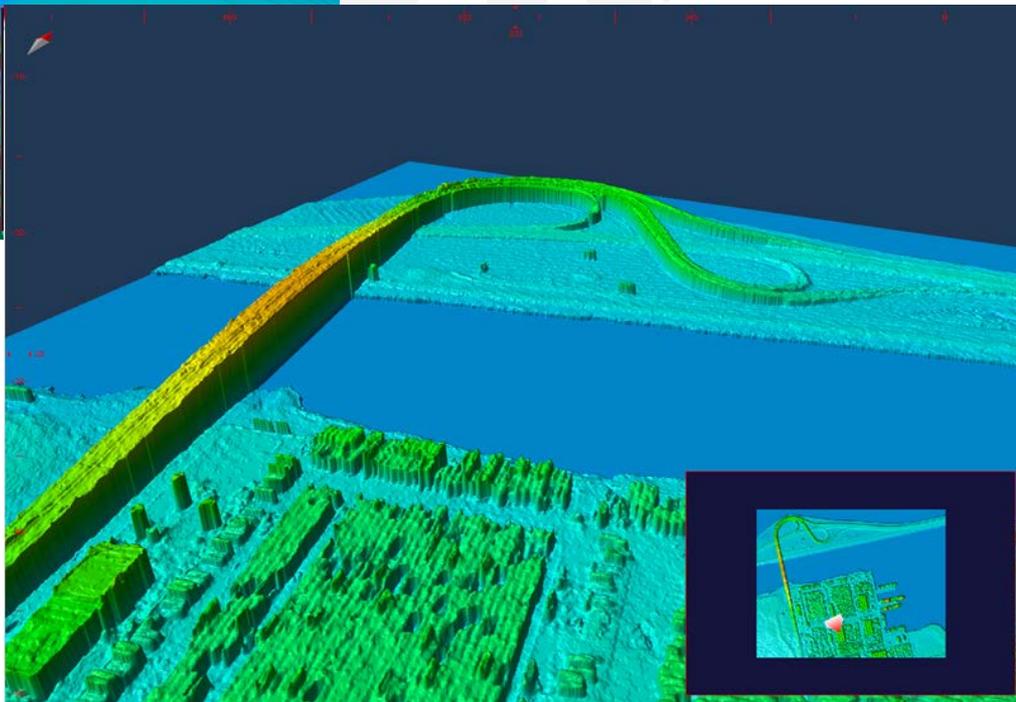
DSM 50 cm WorldView-2

- Cars in the streets are changing position in 3 scenes -> bad matching results



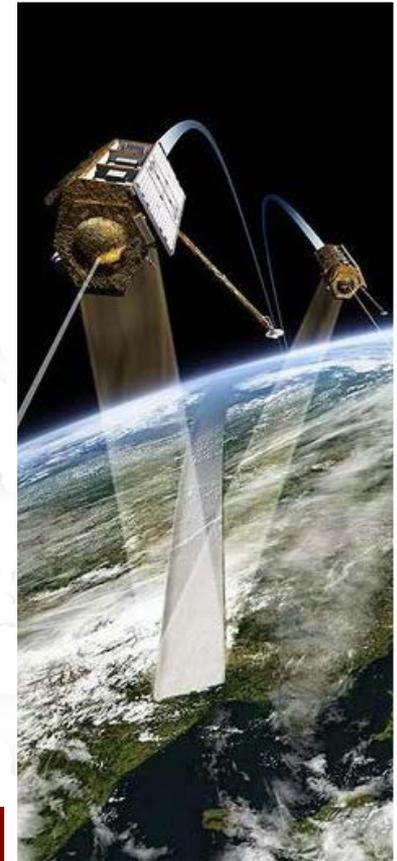
DSM 50 cm WorldView-2

- Water layer manually edited





- TerraSAR-X add-on for Digital Elevation Measurement
- Public Private Partnership (DLR and Infoterra GmbH)
- **Goal**
 - Global Digital Elevation Model
→ Requirement: 90% of landmass until 2014
 - 0.4" ground sampling distance (~12m)
 - 2m / 10m LE90 relative / absolute accuracy
→ TanDEM-X DEM according to HRTE3
- 3rd & 4th coverage over difficult terrain
- Sophisticated acquisition plan
- 3 years of data acquisition



© DLR

	Posting	Absolute Vertical Accuracy (90%)	Relative Vertical Accuracy (point-to-point in 1° cell, 90%)
DTED-1	90 m x 90 m	< 30 m	< 20 m
DTED-2	30 m x 30 m	< 18 m	< 12 m
TanDEM-X	12 m x 12 m	< 10 m	< 2 m
Level-4	6 m x 6 m	< 5 m	< 0.8 m

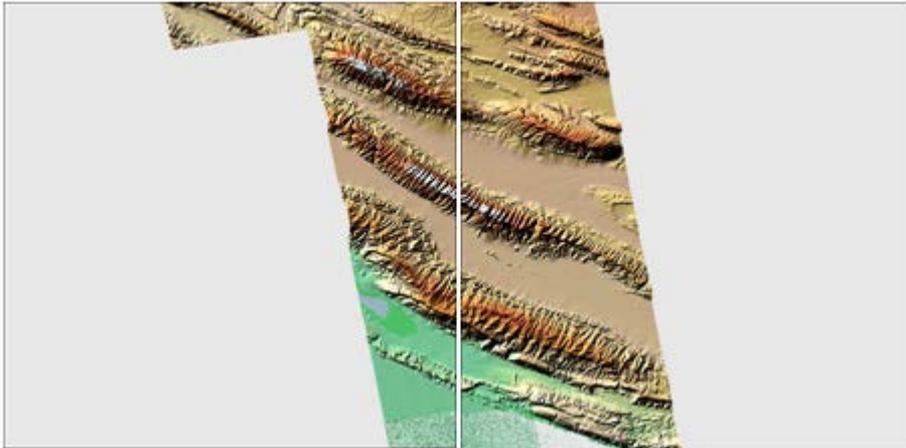
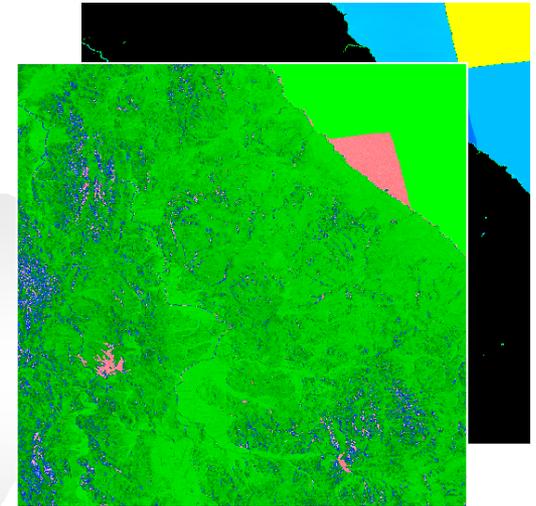


Data: TanDEM-X test data (dual pass)

Comparisons: SRTM

other DEM

Area: arid and hilly



Evaluation

- Accuracy assessment
 - Visual interpretation
 - Statistics of layers
 - Suitability of data for applications
-
- Which areas fulfill requirements?
 - Where will 3rd & 4th acquisitions be necessary?



Area

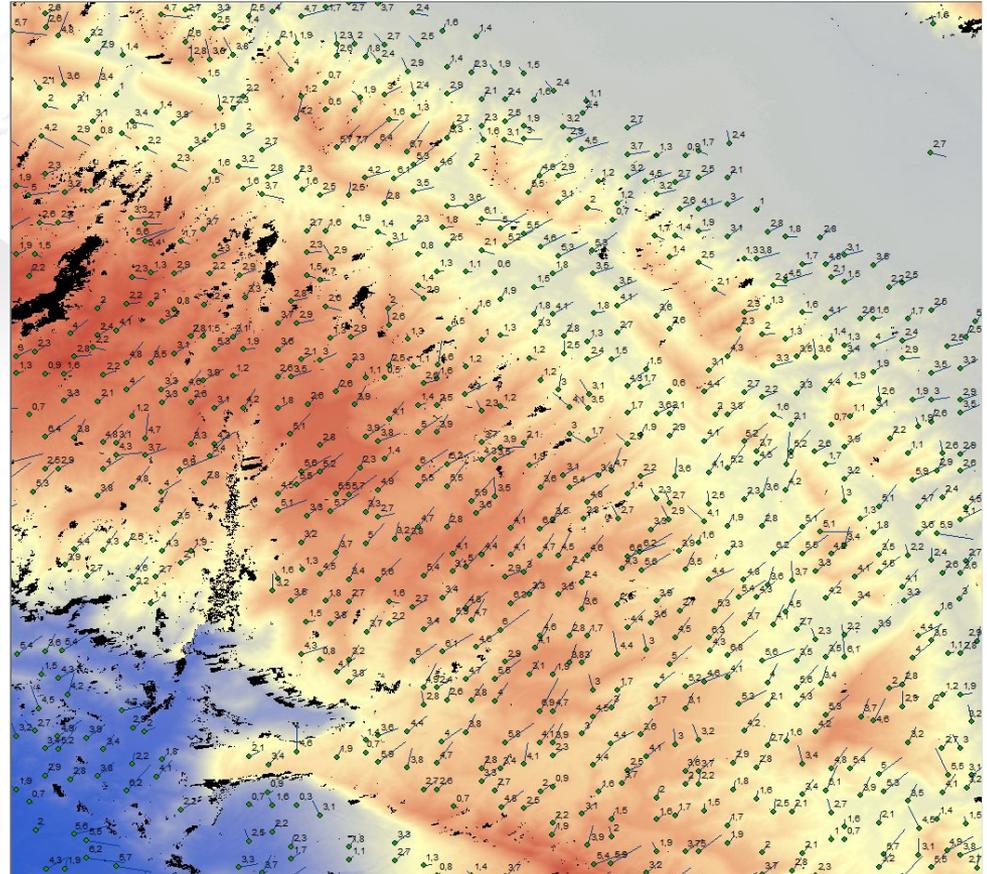
well suited for testing because of its climate and land cover (desert etc.)

Test Data

shows the typical characteristics of interferometric production processes

Comparison of TanDEM-X DEM with Ref-DEM:

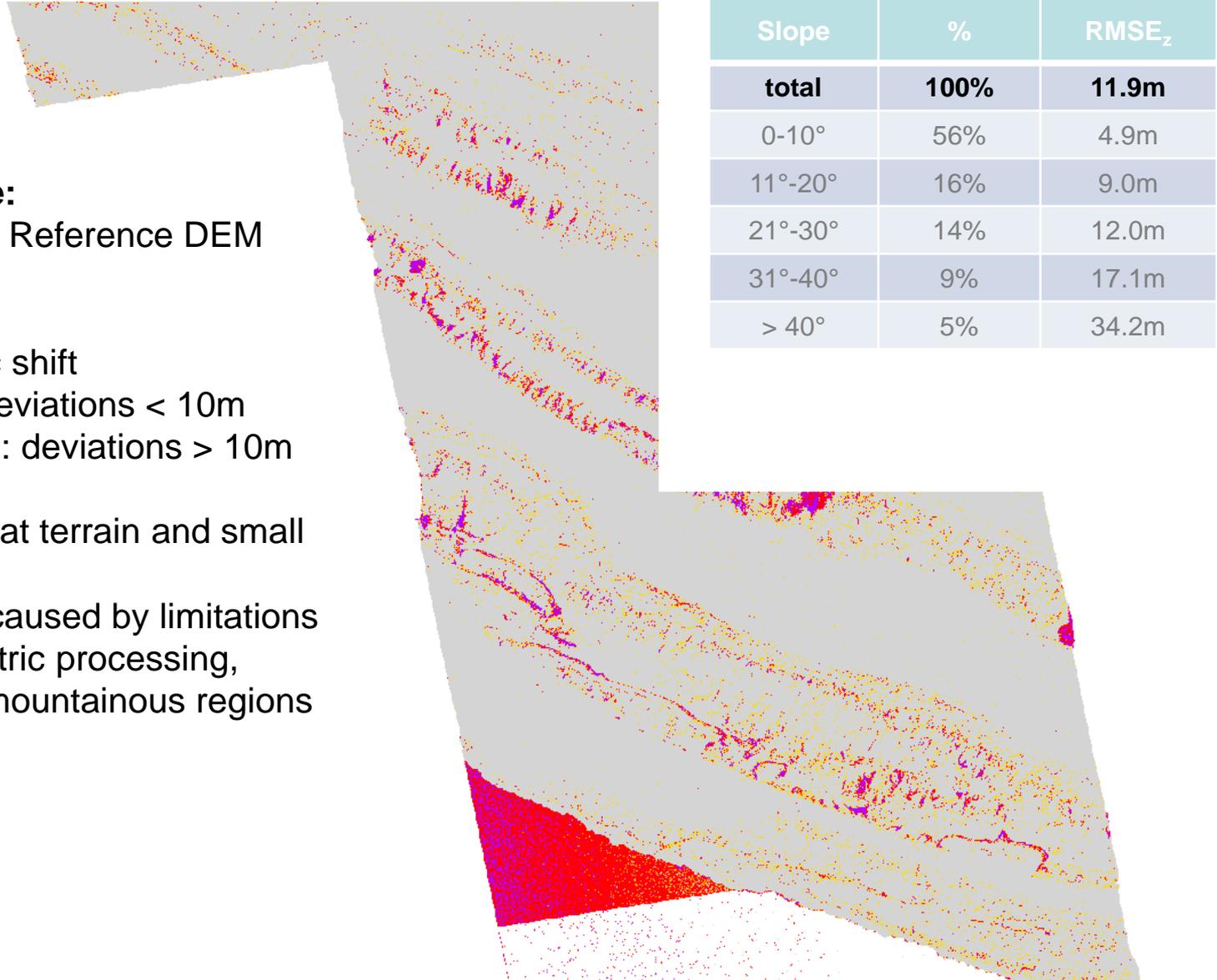
High absolute horizontal accuracy:
< 6m (exceptions!)





Difference image:
TanDEM-X DEM– Reference DEM

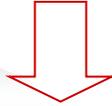
- No systematic shift
 - Grey areas: deviations < 10m
 - Colored areas: deviations > 10m
- very good in flat terrain and small scale features
- lots of errors caused by limitations of interferometric processing, especially in mountainous regions





Feature interpretation in SAR Orthoimage

- Realistic representation of features “fence” and “mining dump”



Data used:

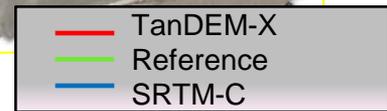
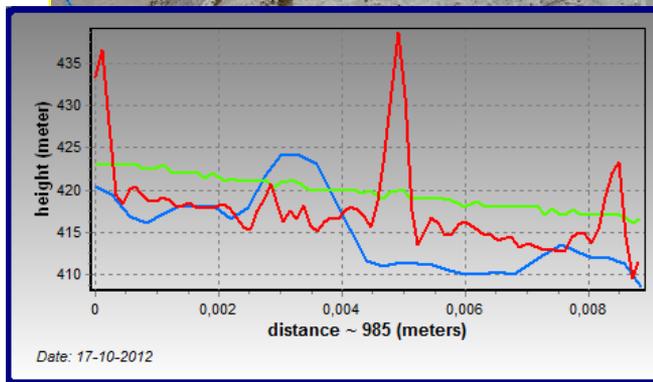
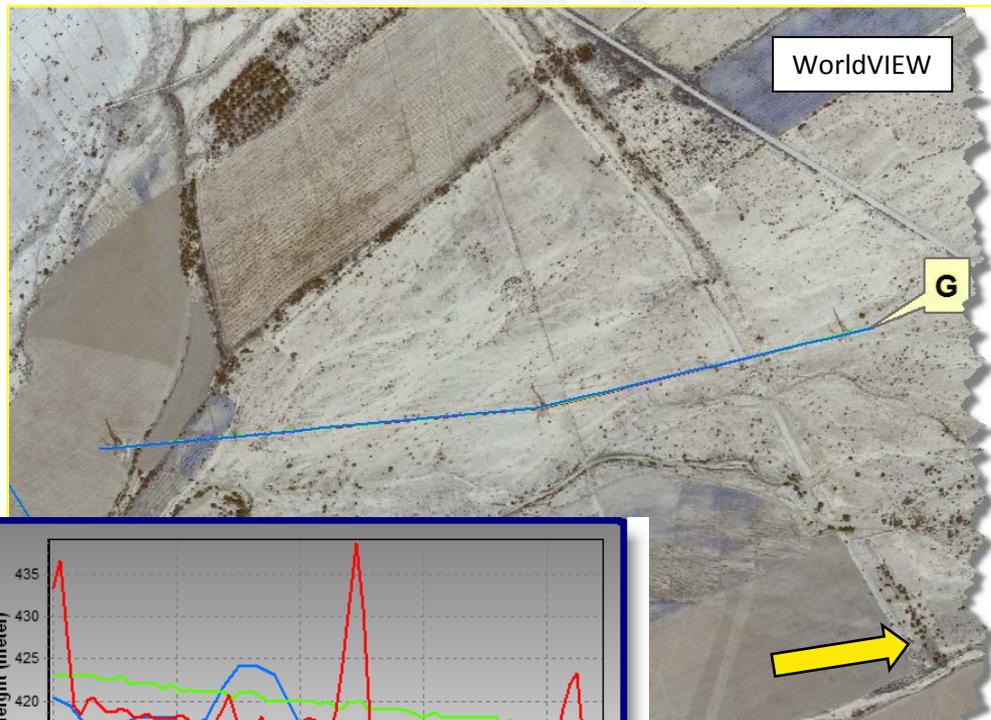
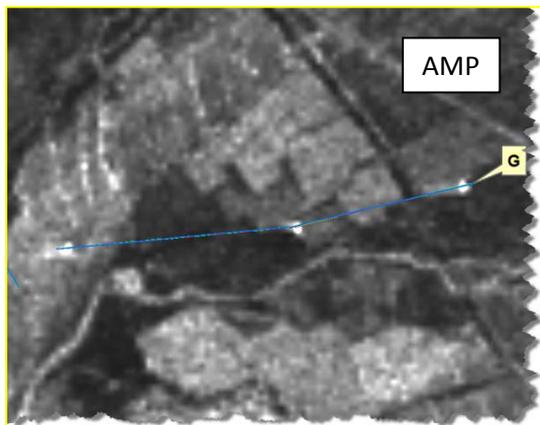
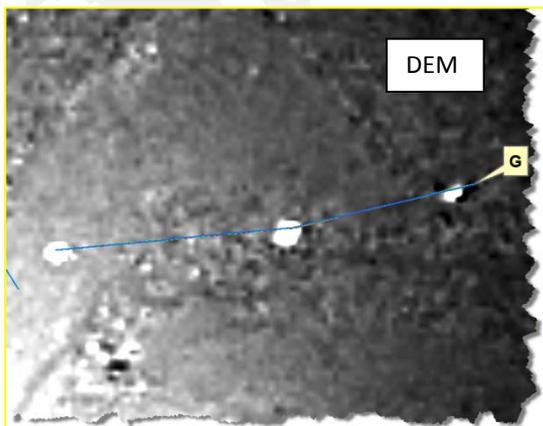
High-resolution TerraSAR-X SAR imagery
SAR Geocoded Terrain Corrected Images

TanDEM-X

SRTM-C



TanDEM-X sample data

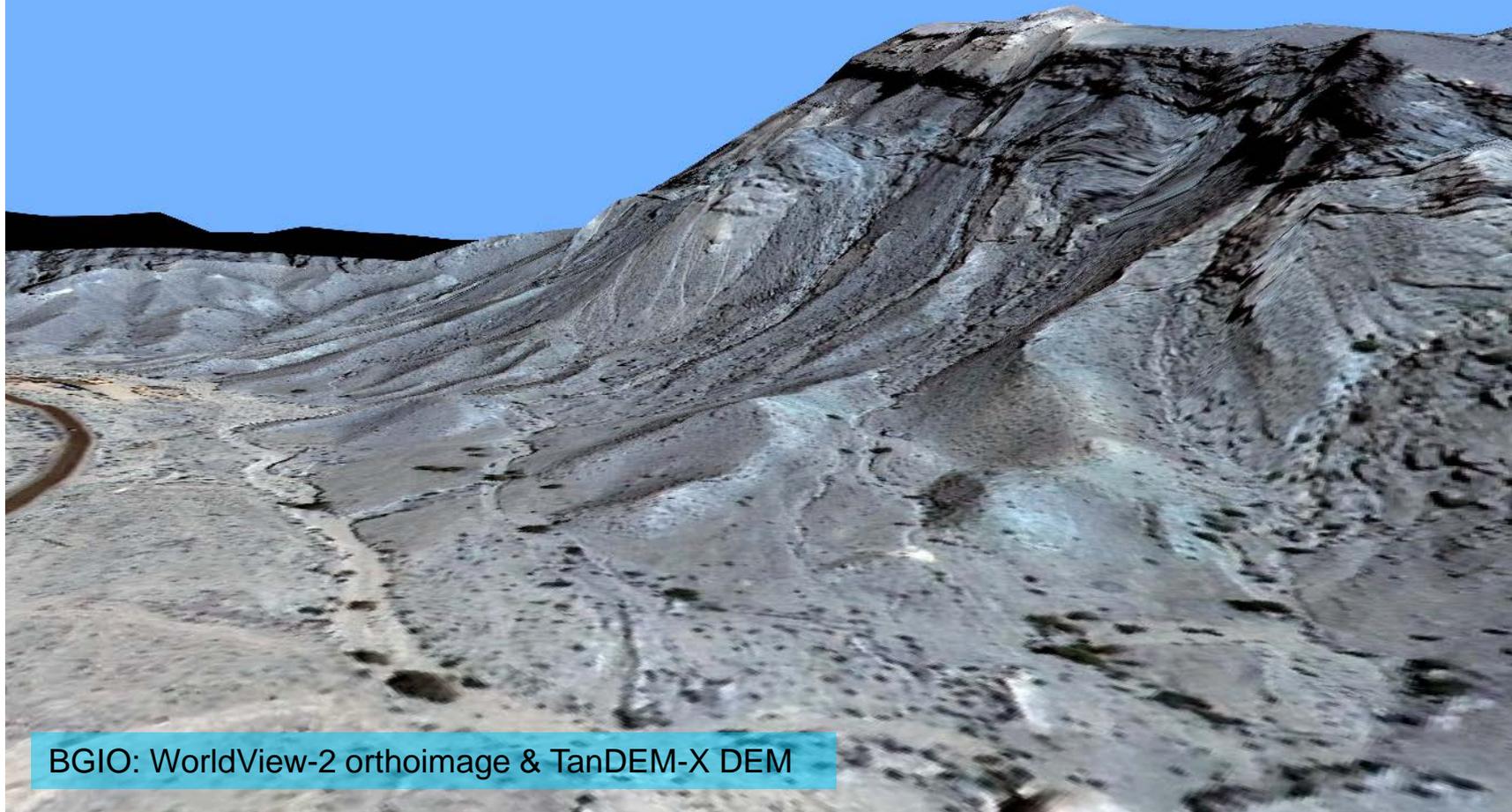




- Basically, existing elevation data products (processing techniques) fulfill requirements of users
- In case of strong requirements => limitations
 - vertical accuracy
 - timeliness of data
 - provision time and costs
 - coverage of data
- Users often are not really aware of quality and reliability of data
- In case elevation data of high resolution is required => knowledge about applications of users is very important



Thank you



BGIO: WorldView-2 orthoimage & TanDEM-X DEM