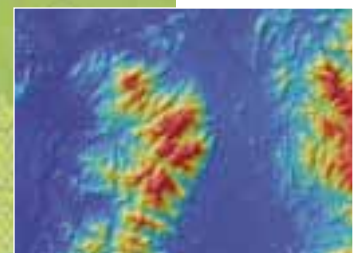


3D Topographic Mapping with TerraSAR-X

Unique Mapping Concepts Using High-Resolution Spaceborne SAR

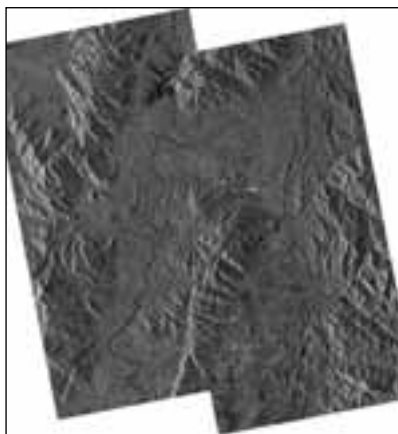




3D Topographic Mapping with TerraSAR-X

Topographic base mapping at scales 1:50,000 and 1:25,000 is a key challenge to authorities/institutions in many regions of the world: Particularly in tropical regions, a reliable acquisition of data using spaceborne or airborne data sources is limited by frequent to even permanent cloud coverage and the fact that often vast areas need to be covered. To date, some remote areas in the Equatorial belt have not been mapped at all; often, available maps date back to the mid of the last century.

Based on data acquired by the high-resolution radar satellite TerraSAR-X, today's geometrically most accurate spaceborne SAR sensor, Infoterra GmbH (Germany) offers a novel approach to topographic mapping projects. The concept ensures a rapid availability of new base maps or map updates in high geometric accuracy and thematic quality: a one-stop approach for SAR data acquisition, elevation model generation and map production.



Basis: StripMap data pairs

Radar satellite data of the area to be mapped is acquired in at least two coverages from two different view angles: these data pairs are recorded in TerraSAR-X's StripMap Mode (3m resolution). If necessary (e.g. in mountainous terrain) an additional pair is acquired from the opposite path direction (ascending/descending) in order to reduce shadow areas and layover effects. The four coverages ensure a complete area-wide survey and guarantee a reliable elevation model extraction.

Radargrammetry: DSM and DTM for contour lines

A precise elevation model is a substantial element for topographic base mapping, as it allows the extraction of precise contour lines and salient height points. Further, it improves the planimetric accuracy of the radar image and the resulting map.

Applying radargrammetry techniques, Infoterra generates a Digital Surface Model (DSM) from the radar data pairs.

Using the results of the stereoscopic interpretation, the DSM is transferred into a Digital Terrain Model (DTM), representing the bare Earth elevation. Contour lines are derived from the finalized DTM.

The very high geometric accuracy of TerraSAR-X and the parallax displacement achieved by the different viewing angle of the data pairs enable the generation of elevation models reaching positional and height accuracies of up to 5m.

This accuracy has been validated by the German Aerospace Center (DLR) during the satellite commissioning phase and has since been confirmed by numerous acknowledged organizations and experts in international publications.



Radargrammetry & stereoscopic interpretation: from StripMap data pairs to DTM



As both orbit and altitude of the satellite are precisely known, TerraSAR-X, unlike any alternative acquisition method (airborne or optical spaceborne) available today, achieves this accuracy without requiring ground control points as references.

3D-Interpretation: topographic objects & features

Object interpretation is performed on a 3D Analytic Workstation (similar to the classical stereoplotter), thus mitigating typical difficulties encountered in 2D radar interpretation. Additional data (e.g. satellite or airborne imagery) is not required, but can be integrated when available to support and verify the interpretation. A reliable Quality Assurance (QA) concept is applied to the entire production process in order to monitor the workflow and to guarantee a constant product quality.

Map scales: 1:50,000 and 1:25,000

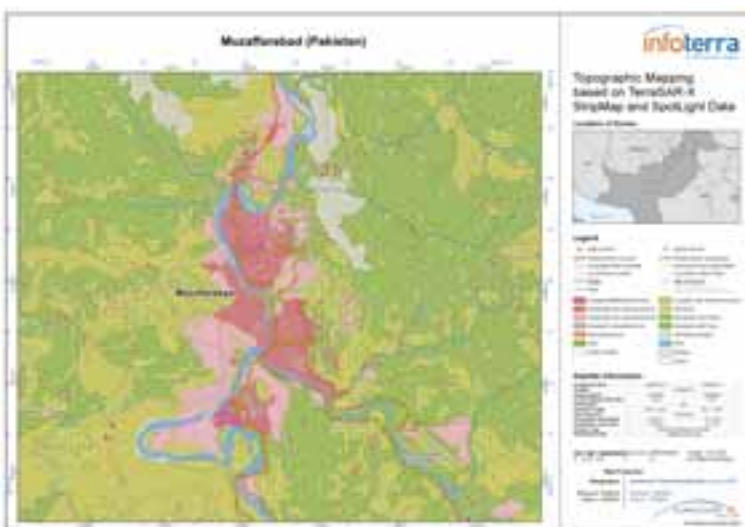
The unique combination of reliable, high-quality data and sophisticated techniques results in high-precision topographic map sheets at a scale 1:50,000, typically suitable as a base map for large areas of interest. More detailed mapping at 1:25,000 scale is possible as well: In case of interpretation difficulties for particular parts of the mapping area, available (outdated) maps or high resolution optical/SAR imagery are integrated.

Map updates: cost-efficient and sustainable

The full concept comprehensiveness is exploited when map updates are generated, typically after 3 to 5 years: TerraSAR-X's consistent imaging geometry and the application of semi-automatic SAR based change detection algorithms enable a rapid and accurate detection of changes in SAR-imagery from different acquisition dates.

- one-stop approach: data, elevation & maps
- rapid, reliable and consistent data acquisition
- high geometric accuracy and thematic quality
- perfect matching: identical data basis for image interpretation and DEM generation
- maximum time- and cost-efficiency for large-scale projects
- sustainable update schemes

Such efficient update processes reduce the cost of up-to-date map generation significantly. The sustainability of these possibilities is ensured beyond the lifetime of TerraSAR-X: future missions (TanDEM-X, TerraSAR-X 2) allow for a consistent mapping and update scheme until at least 2020.



Topographic Map of Muzaffarabad, Pakistan – Scale 1:25,000

In-country production: consulting & support services

If required, Infoterra can support the set-up of a production environment using Infoterra's approved TerraSAR-X Topographic Mapping Processing Chain, which enables the customer to establish an independent map sheet production in-country. This service includes the provision of all know-how (technical consultancy, training of key staff, licensing of the approved processing chain) necessary to establish an operational production facility scheme lasting until at least 2020.



TerraSAR-X data is superiorly suited for topographic mapping applications due to the satellite's high resolution, geometrical accuracy and flexible acquisition modes. In combination with its short access time, this results in an optimal combination of SAR data acquisition parameters.

The proposed approach provides a solution of high quality, speediness in mapping and cost-efficiency: Based on TerraSAR-X, data acquisition for large areas can be achieved in a significantly shorter time frame than by airborne campaigns. Data sets become available successively throughout the project duration, rather than as one large bulk at the end of an airborne campaign, and map sheets can be produced locally while data acquisition is still ongoing.

Technical Specifications

Geometric resolution / scale	1:50,000 (standard), 1:25,000 possible (requires additional data)
Accuracy	up to 5m planimetric and height accuracy (x, y, z)
Minimum object width	customer-specified, up to 3m
Update frequency	customer-specified, typically 3-5 years
Format of delivery	digital datasets, printed map sheets
Type of data delivered	maps: standard vector formats DSM/DTM: raster formats, ASCII
Data sources used	TerraSAR-X data, typically StripMap mode additional data sources as available/ required

Benchmarking

In comparison to today's conventional data acquisition methods, TerraSAR-X Radagrammetry offers several clear advantages for 1:50,000/ 1:25,000 scale topographic mapping.

System	Cloud independence	suitability for		Cost efficiency	DEM	GCP independence	Inter-pretability
		1:50,000	1:25,000				
TerraSAR-X	+++	+++	++	+++	++	+++	++
Airborne InSAR	+++	+++	+++	+	+++	+	++
High-res. opt. satellites	+	+++	+++	++	++	+	+++

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