

# Mountain mapping and DSM generation using high resolution satellite image data



**Mountain Mapping and Visualization**  
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# Overview

Motivation

3D Processing in mountainous areas using HR satellite image data

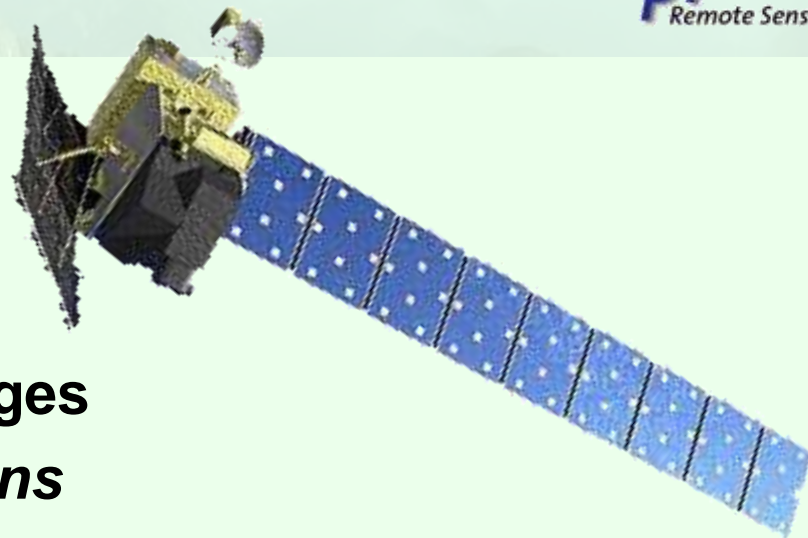
Software packages for DSM generation and mapping

Experiences DSM generation

Experiences Mapping

Summary & Outlook

## Motivation



### High resolution stereo satellite images

- Improved availability by *new missions*
- ***Prices are going down*** (for example ALOS/PRISM)
- 3D processing plays an ever increasing role for many applications
- planned project: generation of a topographic map (1:25 000) of  
Bhutan

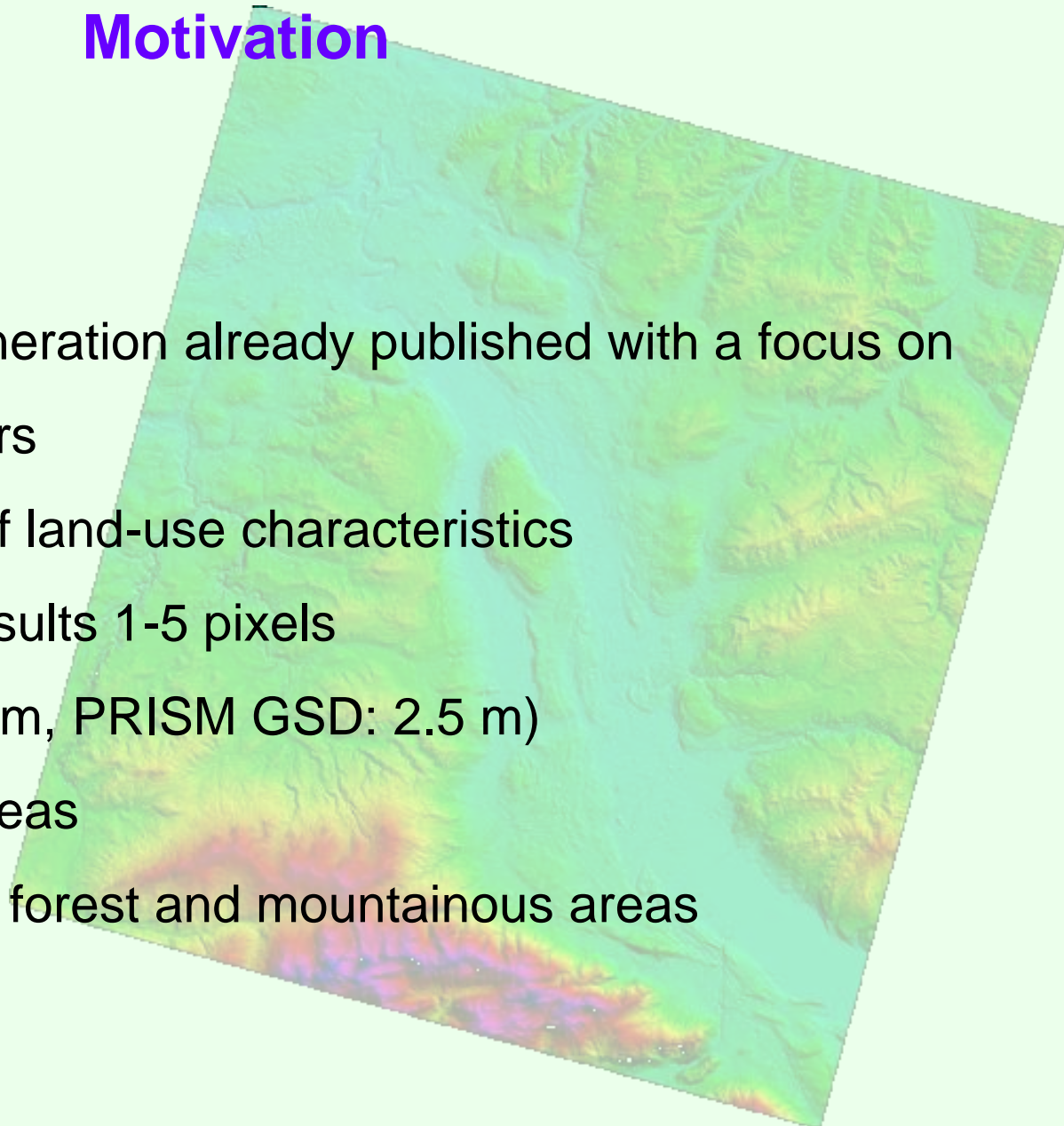
### » ***Evaluation of products is required***

- here:
- DSM generation
  - Feature Mapping

## Motivation

### DSM generation

- evaluation of DSM generation already published with a focus on
  - different sensors
  - different type of land-use characteristics
- in general sufficient results 1-5 pixels  
(e.g. IKONOS GSD: 1 m, PRISM GSD: 2.5 m)
- best results in open areas
- worst (big blunders) in forest and mountainous areas



# Motivation

## Mapping

Gruen & Spiess 1987:

*Point Positioning and Mapping with Large Format Camera (LFC) data*

- LFC image scale: 1:740 000, flying height 225 km
  - ***insufficient interpretation*** for mapping purpose
  - a map 1:100 000 cannot be revised with LFC images without additional external information
- » here : Investigation of potential of HR satellite image data for feature interpretation for a mapping process (1:25 000).

# 3D Processing in mountainous areas using HRS-images

## Topography:

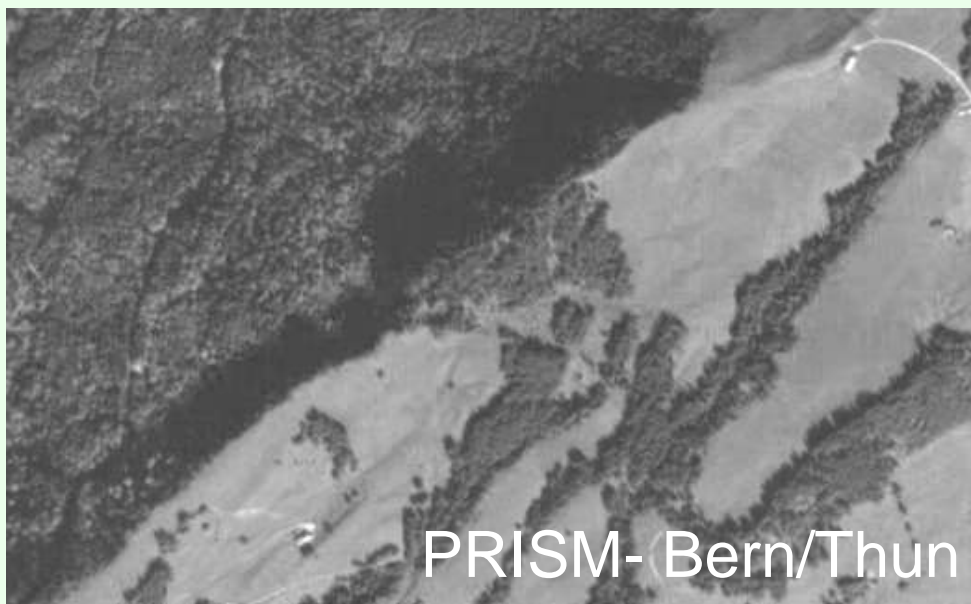
Problematic definition  
and  
measuring of GCPs



## High resolution:

large shadow areas

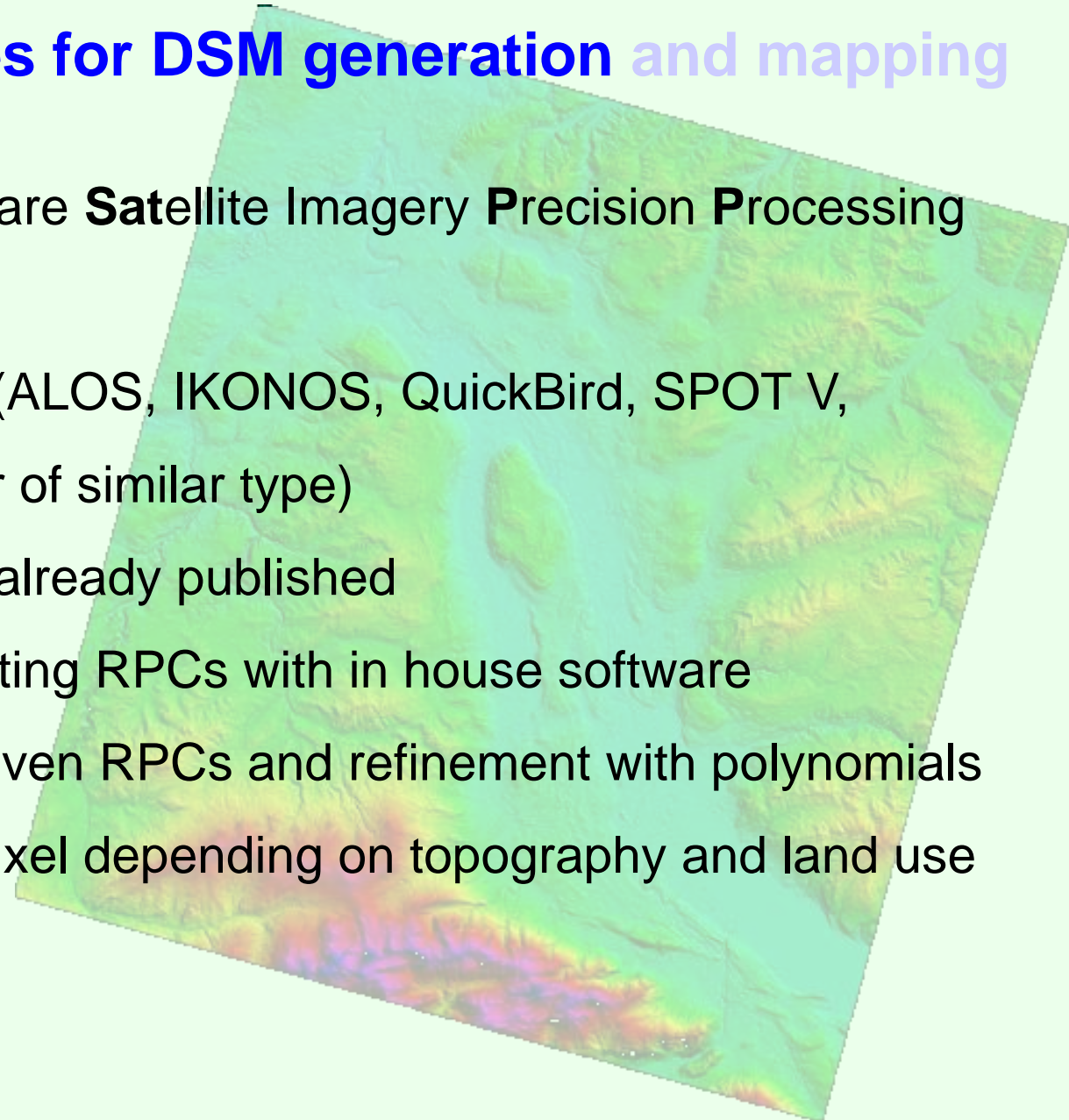
- no useful texture
- Imaging time is fixed



## Software packages for DSM generation and mapping

**SAT-PP:** in-house software **S**atellite **I**magery **P**recision **P**rocessing

- **different image data** (ALOS, IKONOS, QuickBird, SPOT V, Cartosat-1 and sensor of similar type)
- sufficient results were already published
- here: PRISM – generating RPCs with in house software  
IKONOS - with given RPCs and refinement with polynomials
- height accuracy: 1-5 pixel depending on topography and land use



# Software packages for DSM generation and mapping

ERDAS imagine: Leica Photogrammetry Suite (**LPS**)

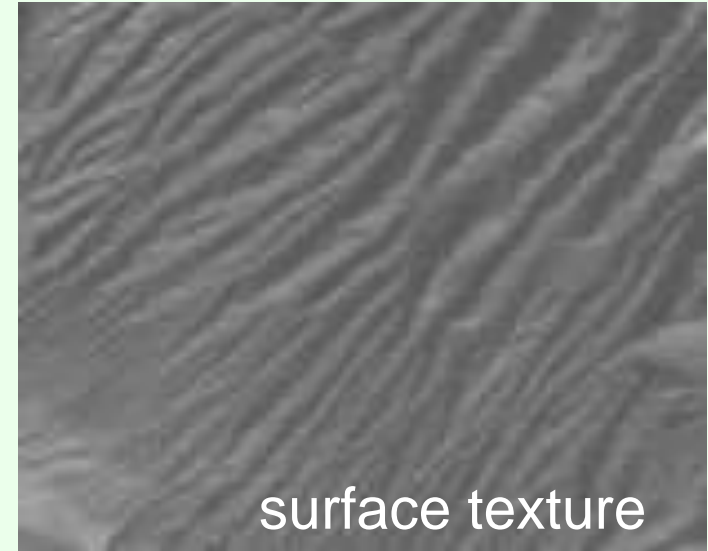
- measurement tool: Leica Stereo Analyst
- direct export of shape files for ArcGIS
- here:

IKONOS with given RPCs and refinement with polynomials (order 1)

## Experiences DSM generation

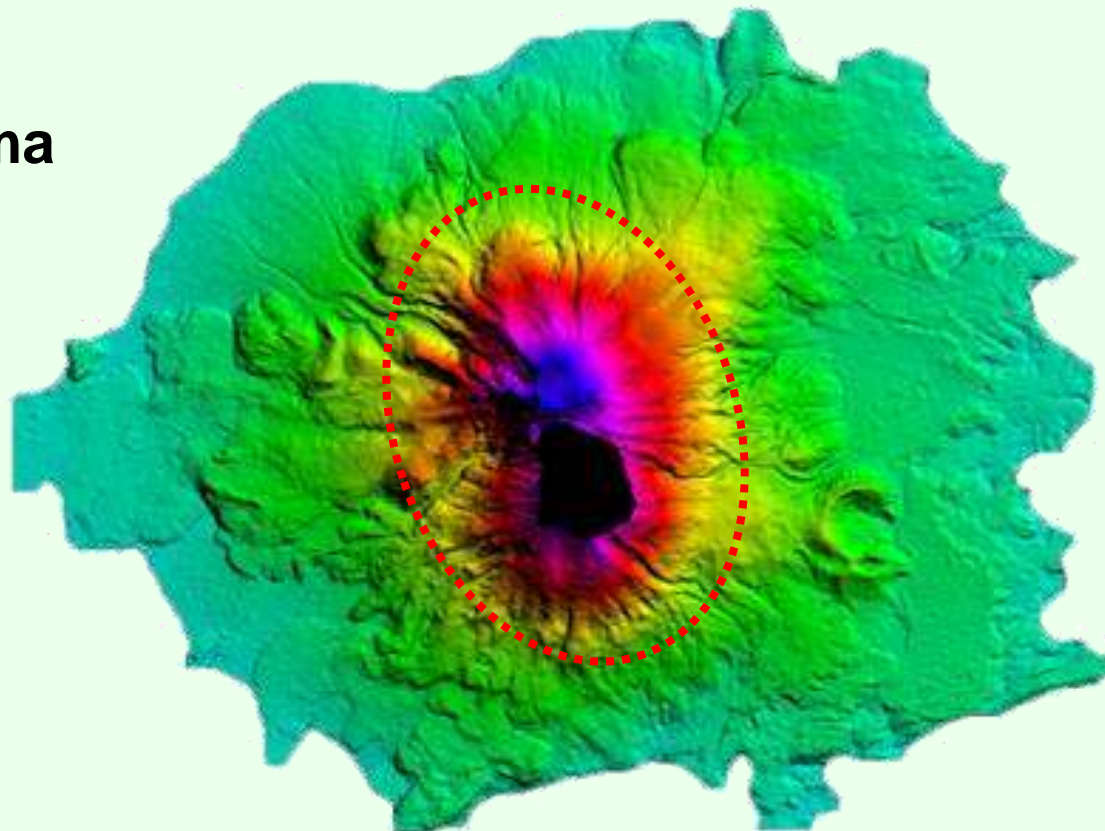
### Testfield Sakurajima

- volcanic area (0 – 1113 m)
- no vegetation
- ALOS/PRISM image data (GSD 2.5 m)
- LaserScanner reference data, 5m (308 m – 1115 m)
- large shadow areas
- large area without useful texture for feature matching
- good texture suitable for image matching only available along the edges of the shadows



## Experiences DSM generation

### Testfield Sakurajima

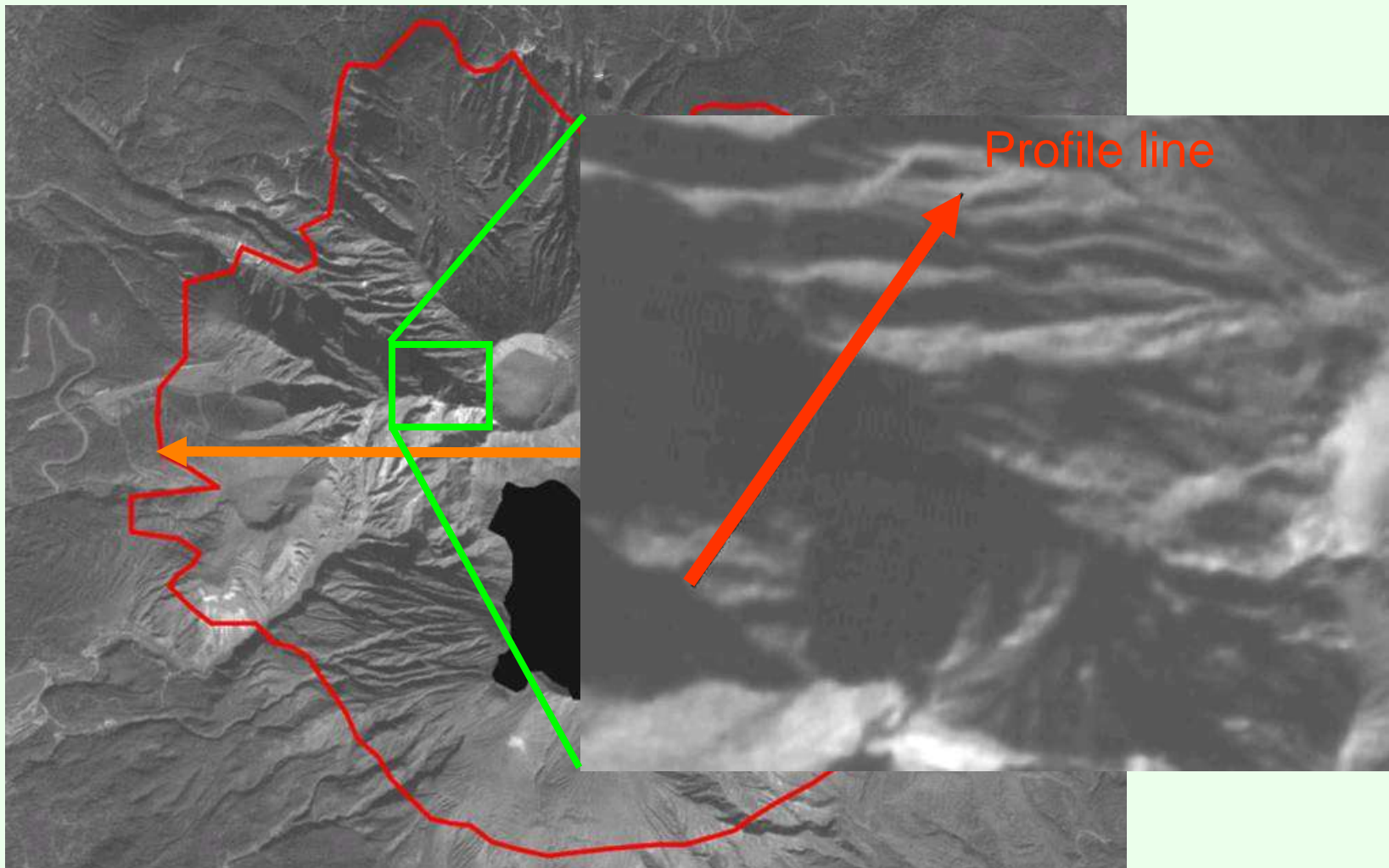


No. of grid points	RMSE <sub>z</sub>	Mean	Min	Max
394828	10.8 m	-0.71 m	-111 m	60 m

*PRISM DSM accuracy evaluation results.*

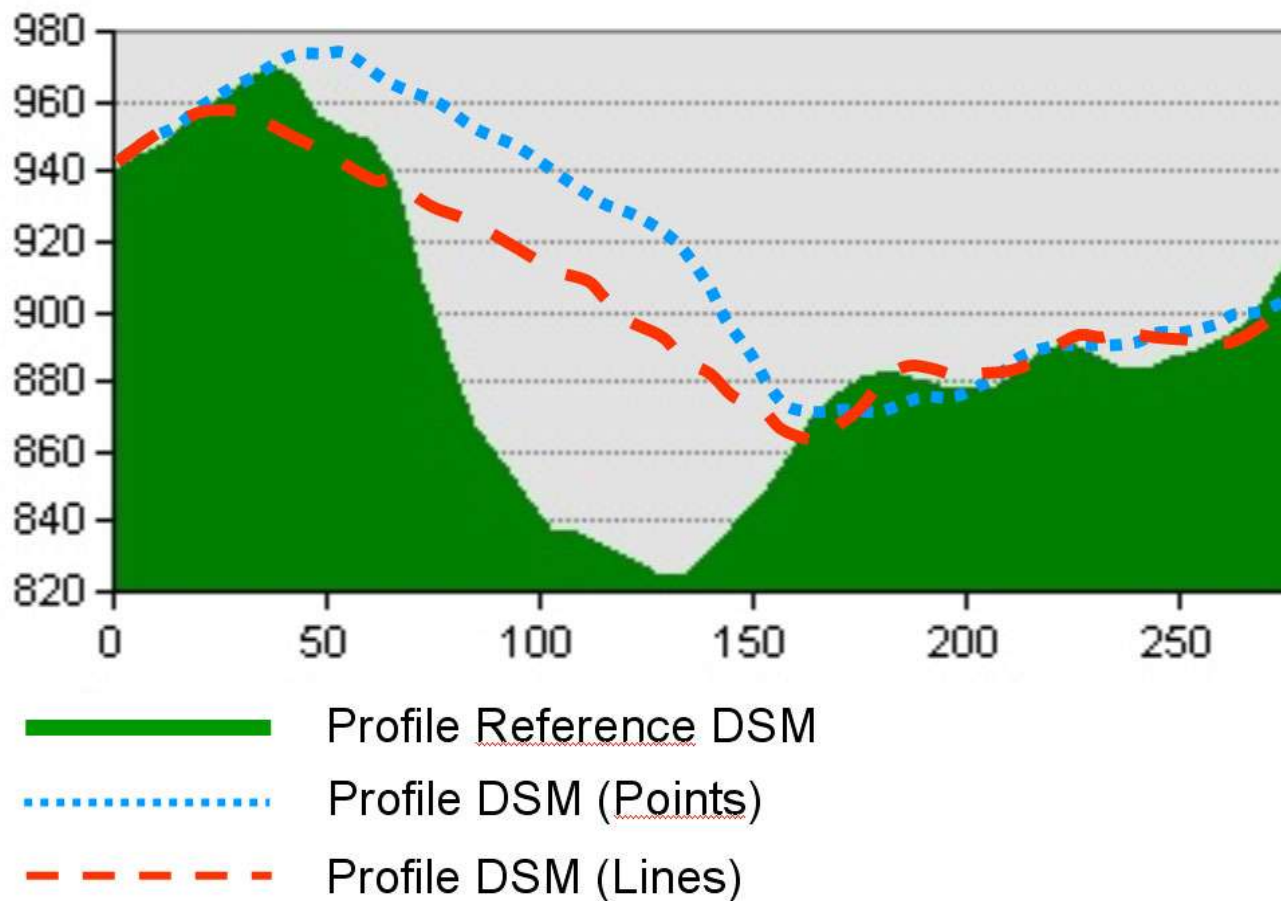
## Experiences DSM generation

### Testfield Sakurajima – investigation of shadow areas



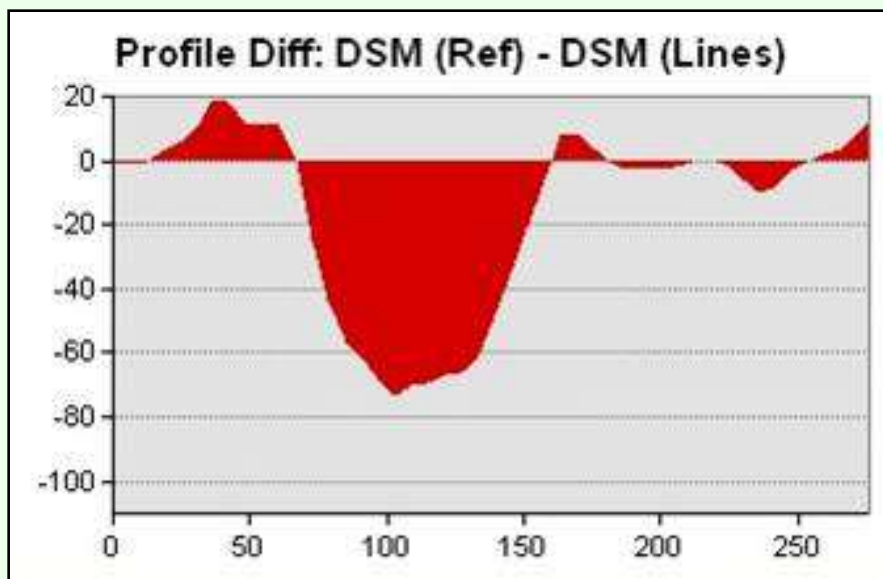
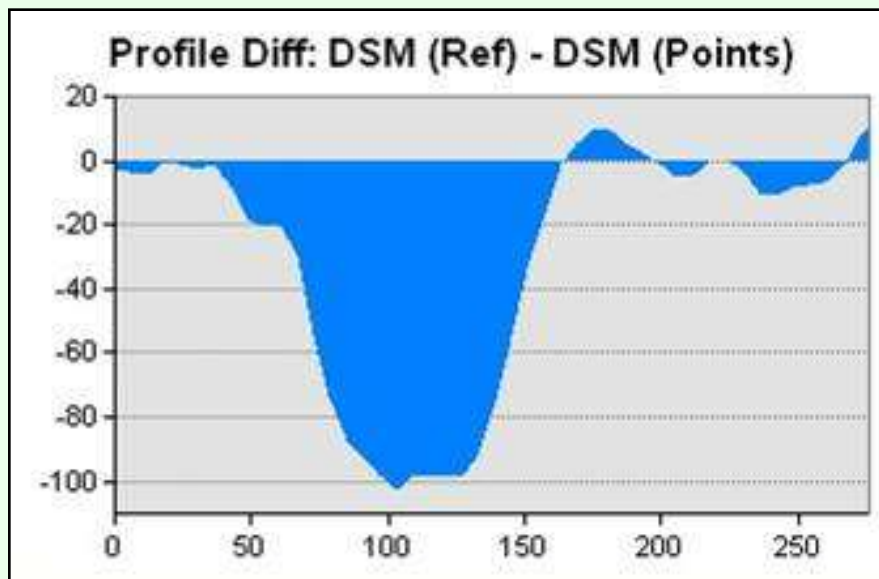
## Experiences DSM generation

### Testfield Sakurajima – investigation of shadow areas



# Experiences DSM generation

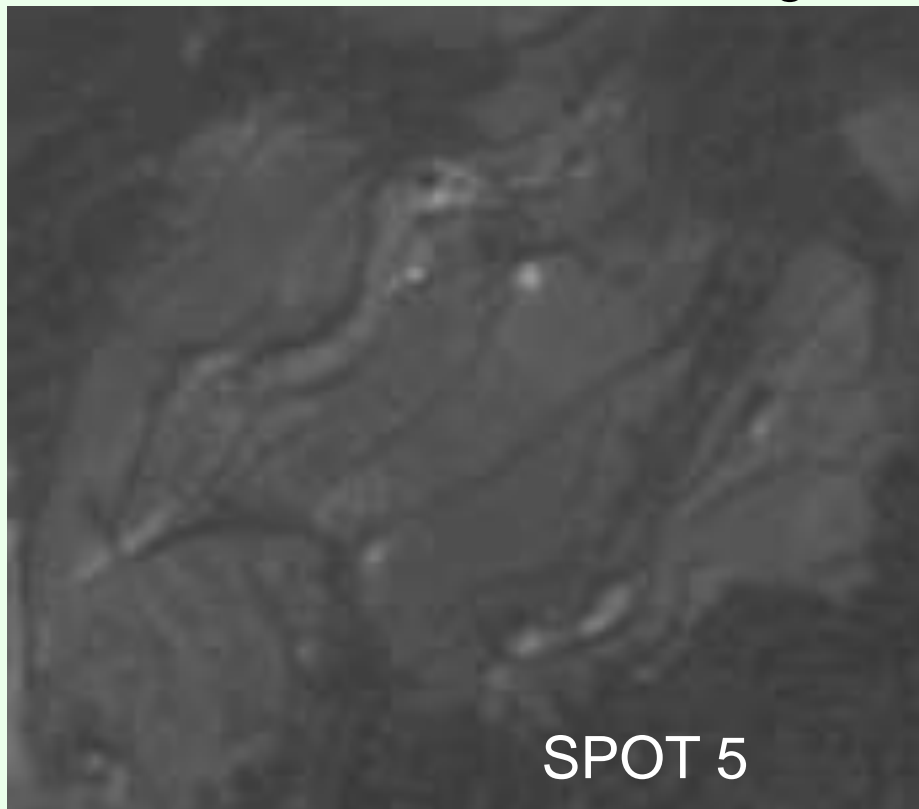
## Testfield Sakurajima – investigation of shadow areas



## Experiences Mapping

### Interpretation of features for mapping

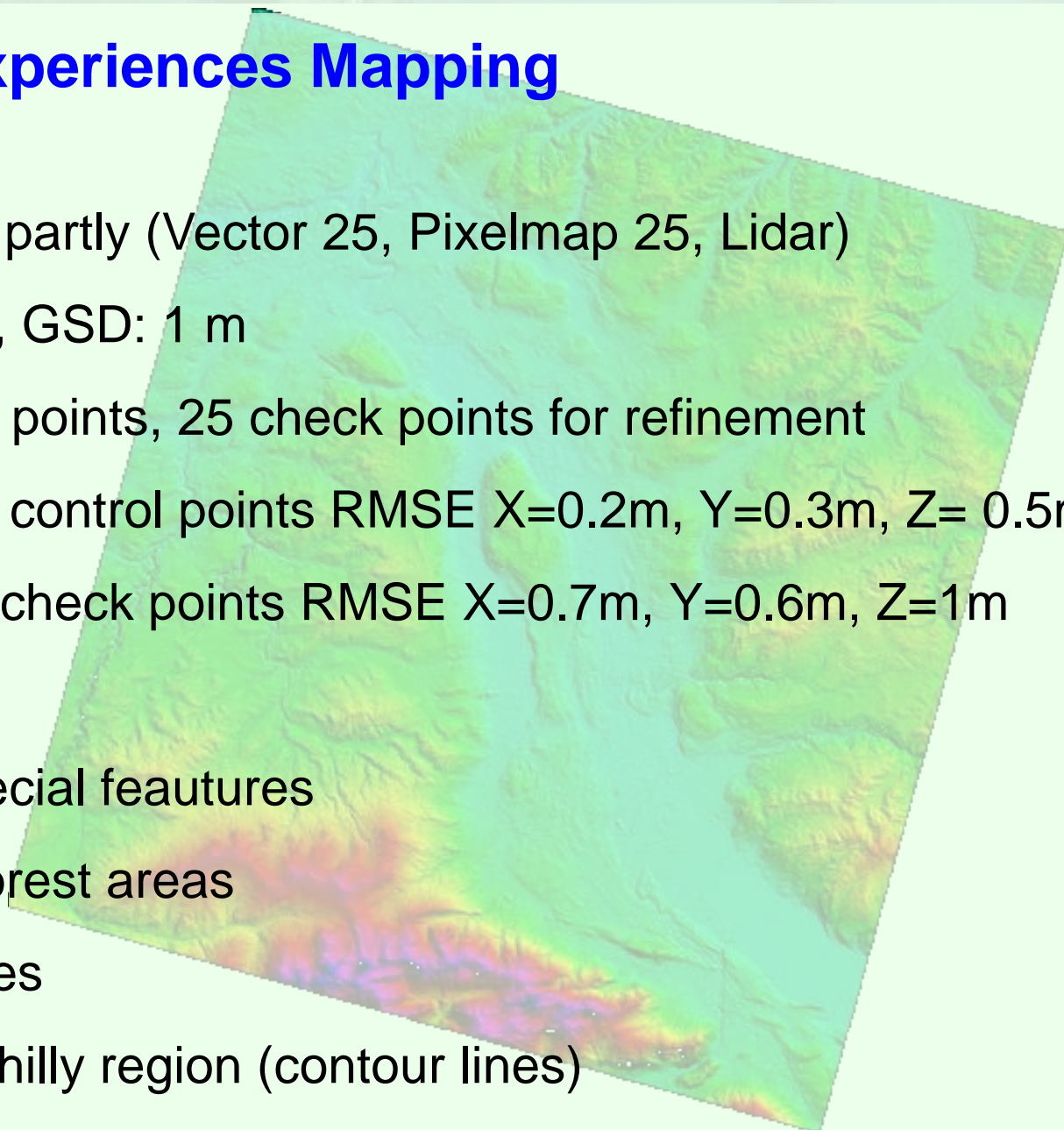
- SPOT 5: GSD 2.5 m
- IKONOS: GSD 1m and image / radiometric quality auspicious



## Experiences Mapping

### Testarea Thun:

- reference data is given partly (Vector 25, Pixelmap 25, Lidar)
- IKONOS panchromatic, GSD: 1 m
- given RPCs + 5 control points, 25 check points for refinement
  - after refinement LPS: control points RMSE X=0.2m, Y=0.3m, Z= 0.5m
  - check points RMSE X=0.7m, Y=0.6m, Z=1m
- measured features:
  - buildings, some special feautres
  - trees (small, big), forest areas
  - streets, contour lines
- flat area (houses etc.), hilly region (contour lines)



## Experiences Mapping

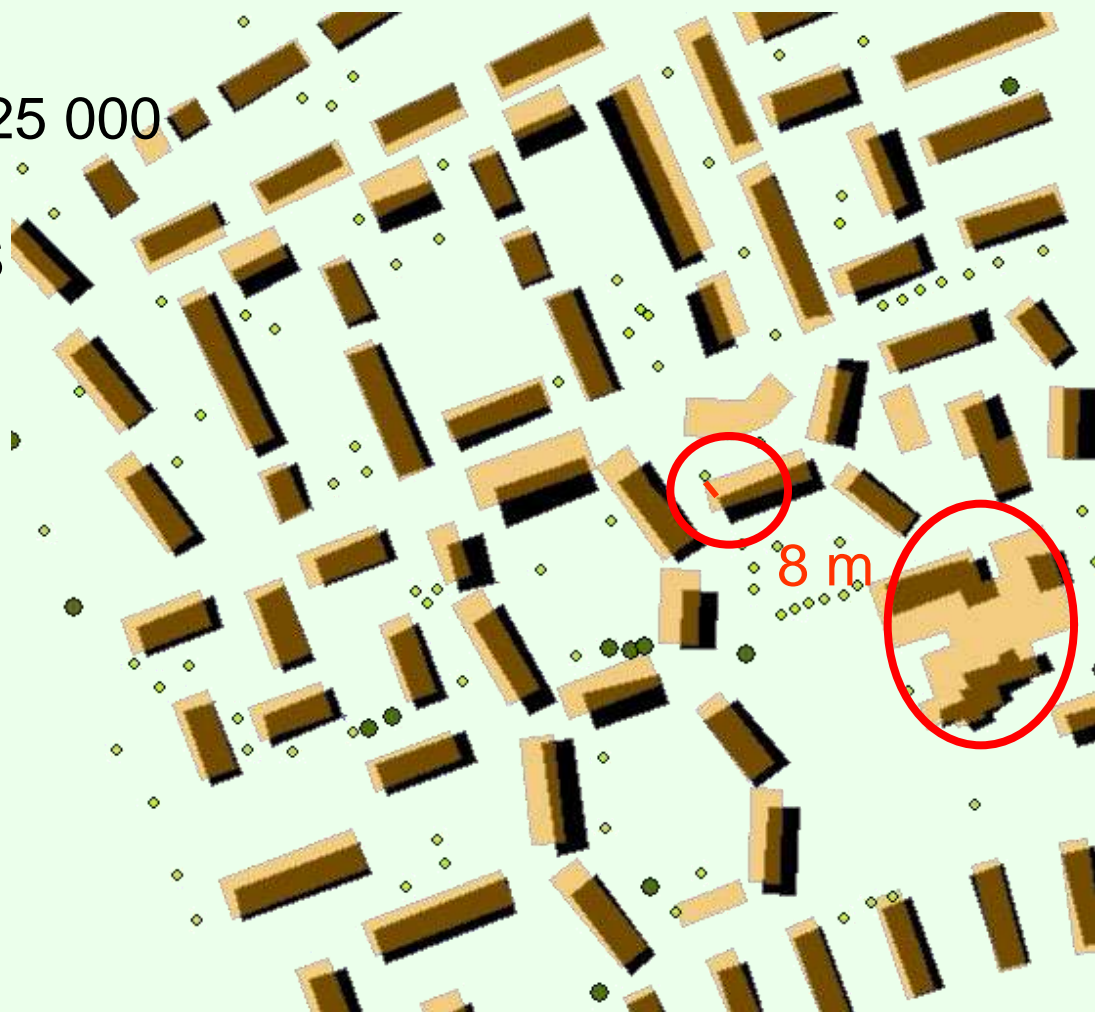
### First results mapping - buildings and single trees



Reference Vector 25, 1:25 000

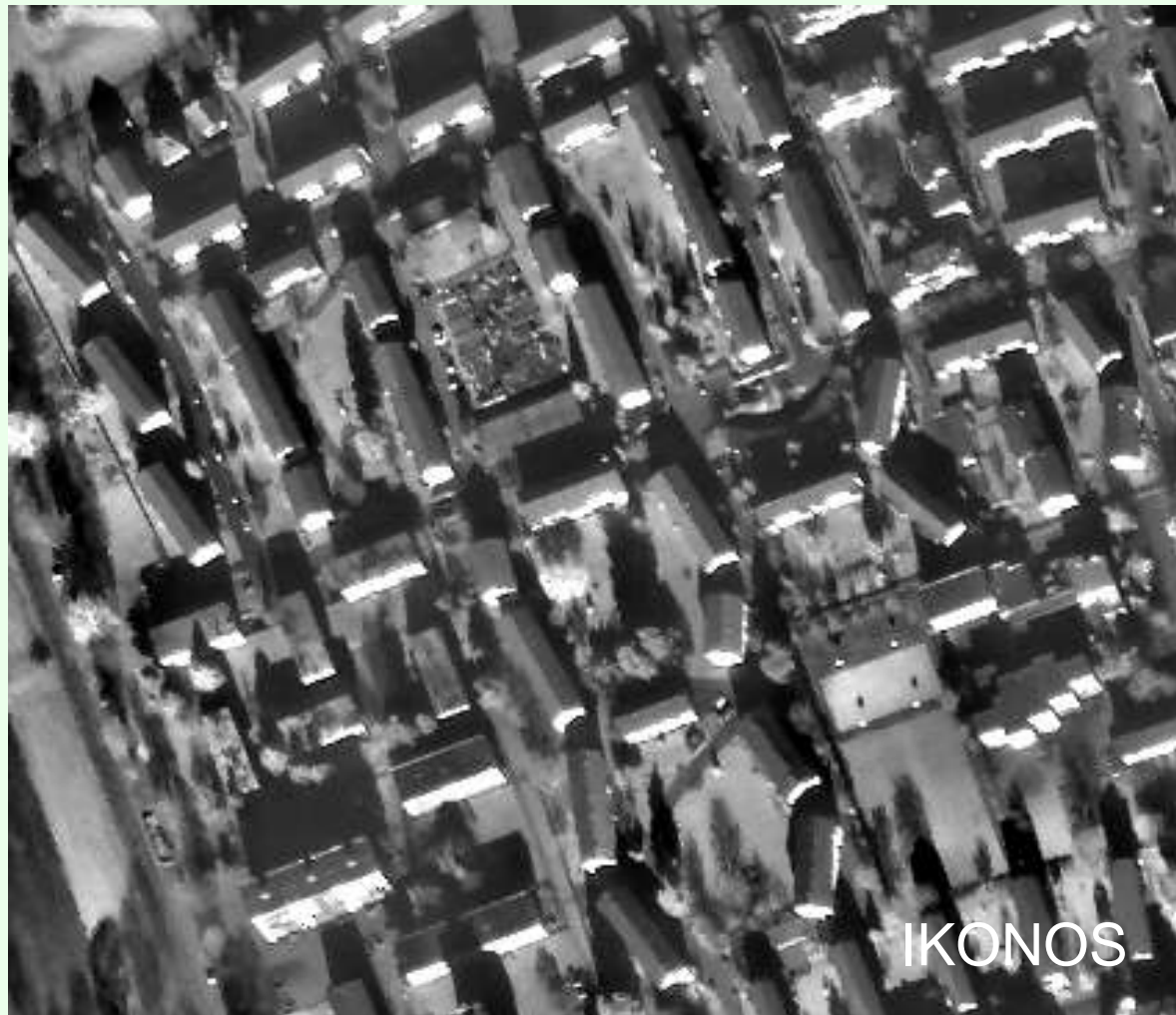


Measurements IKONOS



## Experiences Mapping

First results mapping - buildings and single trees



# Experiences Mapping

## First results mapping – forest



IKONOS



PK 25



Measurements

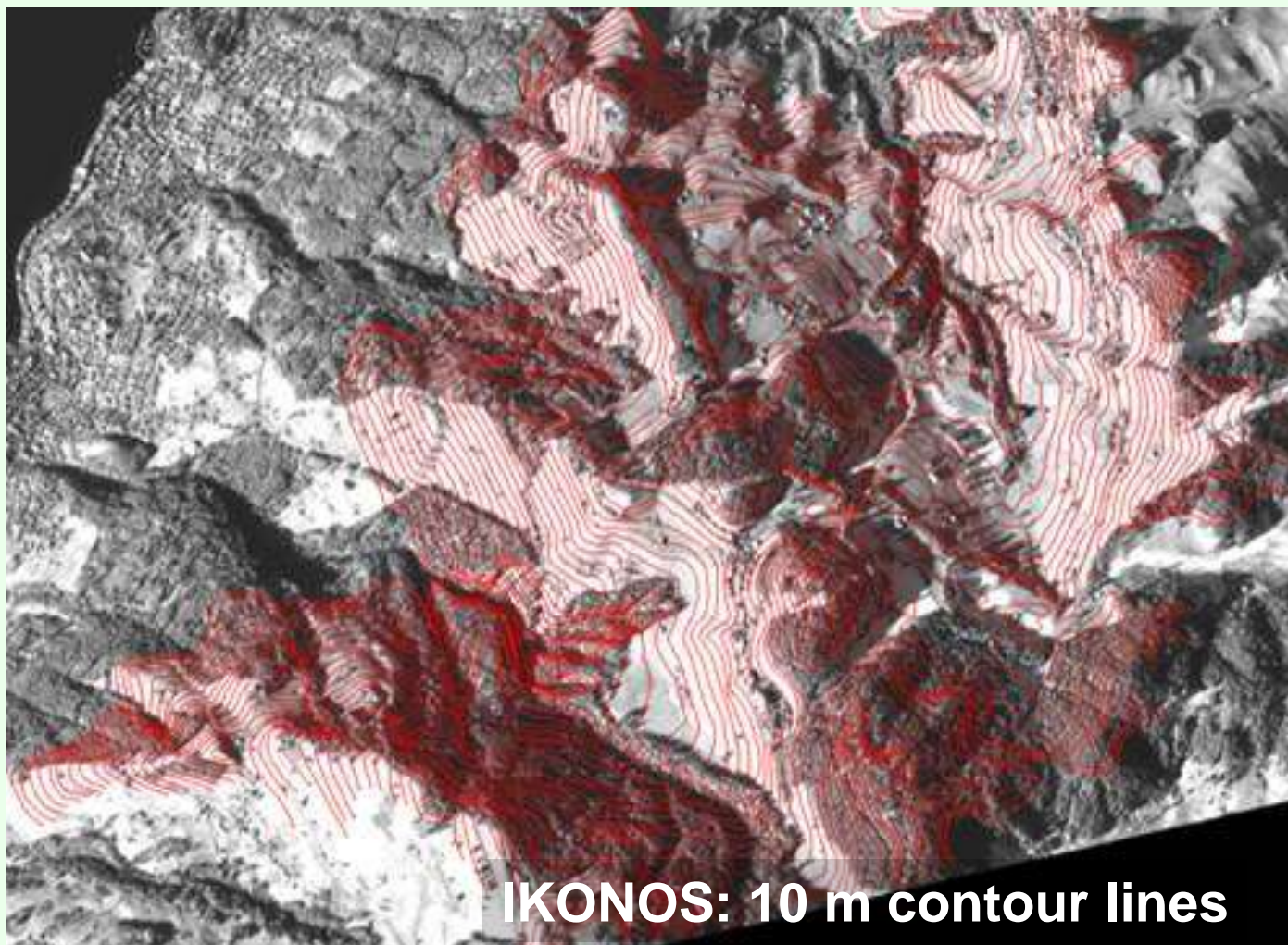
# Experiences Mapping

## First results mapping – streets and roads



# Experiences Mapping

## First results mapping – contour lines

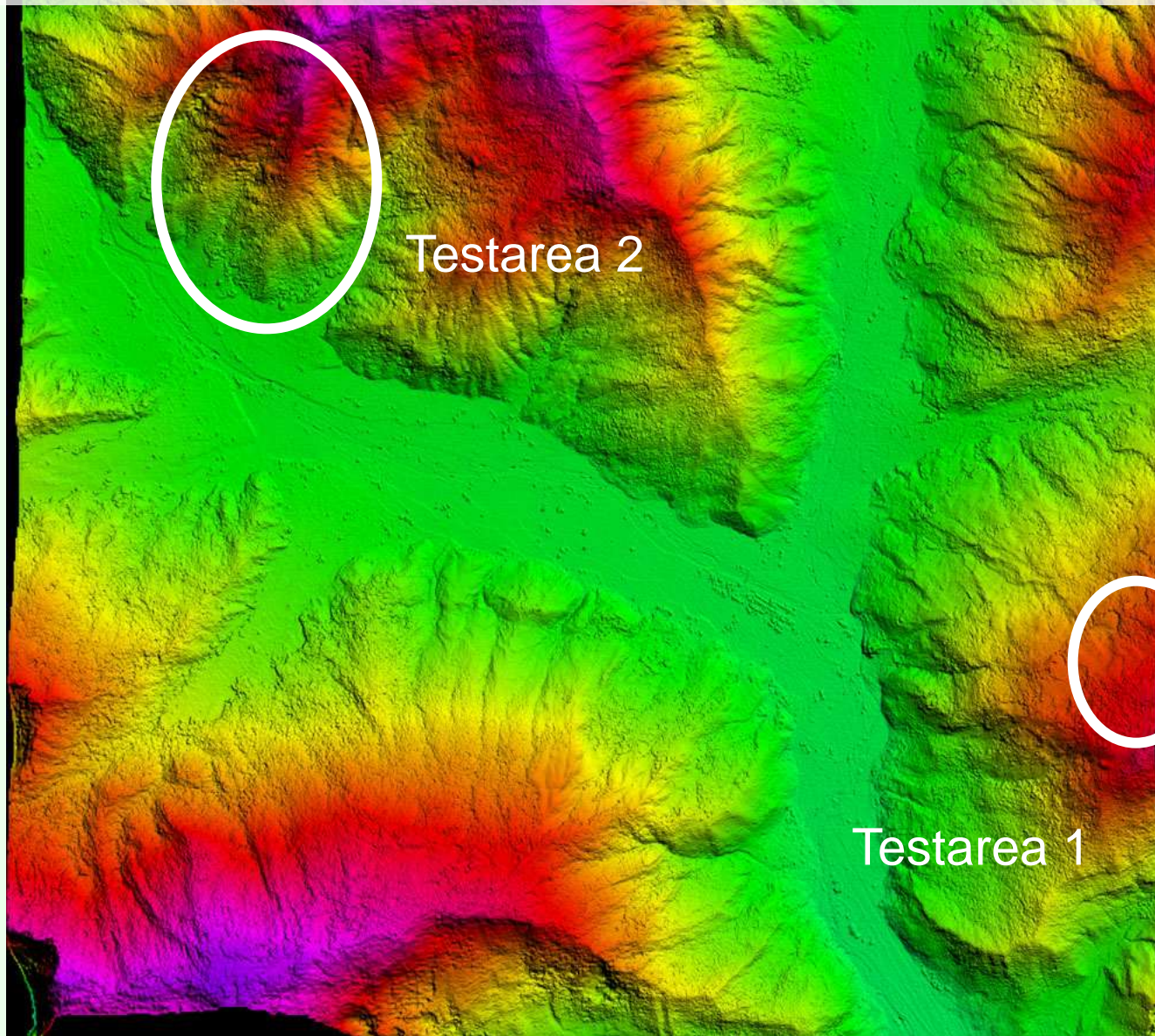


# Experiences Mapping

## Testarea Bhutan

- no reference data is given
  - pansharpend IKONOS, GSD: 1 m, PRISM SPOT 5
    - given RPCs + 4 control points, 2 check points
- after refinement LPS: control points RMSE  $X=0.2\text{m}$ ,  $Y=1.4\text{m}$ ,  $Z=0.7\text{m}$
- check points RMSE  $X=1.2\text{m}$ ,  $Y=1.2\text{m}$ ,  $Z=2.2\text{m}$
- mountainous area (IKONOS: 2225 m – 3462 m)
  - measured features:
    - buildings, trails
    - agriculture areas, forest areas
    - slope lines

# Experiences Mapping



Testarea 2

Testarea 1

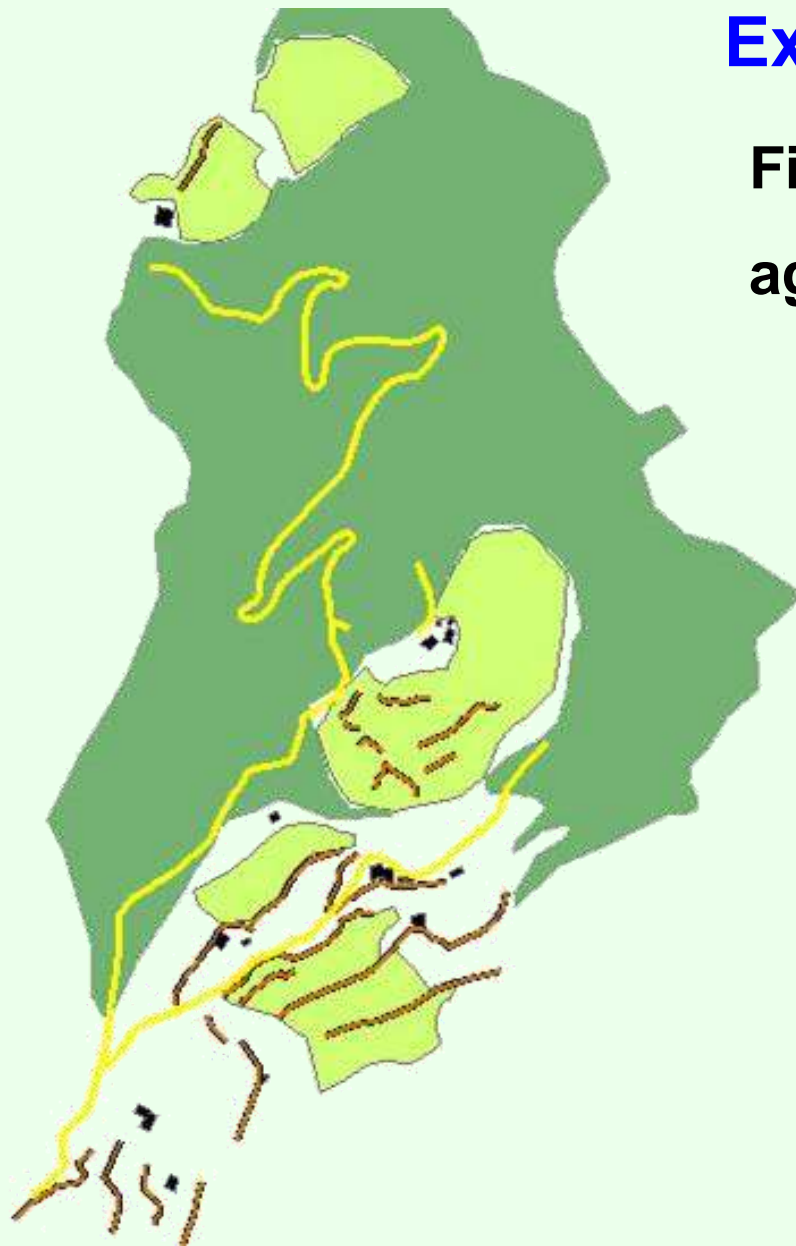
# Experiences Mapping





## Testarea 1 Thimpu, Bhutan - agriculture



## Experiences Mapping

First results mapping –  
agriculture area Thimpu



-  Forest area
-  Agriculture area
-  road
-  Slope lines

# Experiences Mapping

## Testarea Bhutan



## Experiences Mapping

First results mapping – agriculture area Thimpu



- buildings
- trail

## Summary

- **aim:** investigation of potential of high resolution satellite image data for feature interpretation for a mapping process (1:25000)
- here: **accuracy** is not the main question
- **first experiences** were shown
- **GSD 2.5m** sufficient for DSM generation, not for feature mapping
- **GSD 1m** and higher (e.g. IKONOS) sufficient for many features
- interpretation of streets needs special knowledge
- next steps:
  - investigation for all features
  - detailed quality control with reference data
  - future: generation of a map for the mountainous region Bhutan

# Outlook

- next steps DSM:
  - blunder detection
- next steps mapping
  - investigation for all features
  - detailed quality control with reference data
  - future: generation of a map for the mountainous region Bhutan

