# GIM
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**Mapping with OrbView-3 Images**

Error: 0m
Error: 10m (4 pixel)
Error: 25m (10 pixel)

**Creating a Satellite-data Integration System**

**Landslide Hazard Mapping in Austria**

# Features

## THE FRONT COVER

Digital Elevation Model (DEM) of South-Burgenland, Austria, area shown as a shaded 3D representation. The 10-m ground resolution DEM was automatically generated from 1:15,000 airborne imagery captured in 2001 using stereo-matching techniques. Together with other information combined in a GIS, the DEM has been used to analyse the characteristics of landslides and develop a prediction method to support decision-makers in local and regional land-use planning. Read more in the article on page 41.

Information Content of High-resolution Satellite Images

# Mapping with OrbView-3 Images

*The information content of OrbView-3 and Ikonos imagery is compared, using the Zonguldak area in Turkey as test area. Although OrbView-3 images are qualitatively slightly inferior to Ikonos panchromatic scenes, they can be used for the generation of topographic maps at scale 1:10,000. However, they are not suited for 1:5,000 mapping, for which scale Ikonos images also show limitations.*

By Hüseyin Topan, Gürcan Büyüksalik, Zonguldak University, Turkey and Karsten Jacobsen, Leibniz University, Germany

In operation since 2004, OrbView-3 is one of the recent very high-resolution space sensors, offering images of 1m panchromatic and 4m multispectral Ground Sampling Distance (GSD). In mapping terms both geometric accuracy and information content are important, but the required geometric accuracy can be reached without difficulty provided that images are not degraded by atmosphere and sun-elevation effects. As a rule of thumb, the GSD should be at least 0.1mm of the map scale, corresponding to scale 1:10,000 for 1m GSD.

## Visual Comparison

Examination of information content has to be done by visual inspection (Figure 1). OrbView-3 and Ikonos have approximately the same resolution, but comparison shows that edges are sharper in the Ikonos image and that whilst OrbView-3 shows cars only as blobs, structural elements are visible in Ikonos. The GSD of 0.62m offered by QuickBird enables identification of more detail. On the other hand, the 5m GSD of Spot 5 limits the use of these images to the creation of maps of smaller scale. Buildings are still visible but they cannot be mapped in detail, and sometimes back-gardens will be identified as streets. Many of these differences result from sensor configuration, radiometric resolution, recording conditions and terrain characteristics.

## Sensor Configuration

OrbView-3 uses staggered CCD-lines; two CCD-lines are shifted by 0.5 pixels against each other so that the pixel size projected on the ground for nadir view is 2m and adjacent pixels overlap 50% in both directions (Figure 2). The effective GSD of 1m resulting from such over-sampled pixels differs from nominal GSD of 1m. OrbView-3 takes 2,500 double lines per second, but the satellite footprint speed is 7.1km/sec, which requires permanent change of view direction to slow down angular speed. The resulting slowdown factor is 1.4 (Figure 3). The effective GSD as determined by point-spread analysis of sharp edges does not show loss of resolution against the nominal GSD, but it can be manipulated by contrast enhancement.

## Radiometric Resolution

OrbView-3, Ikonos and QuickBird have a radiometric resolution of
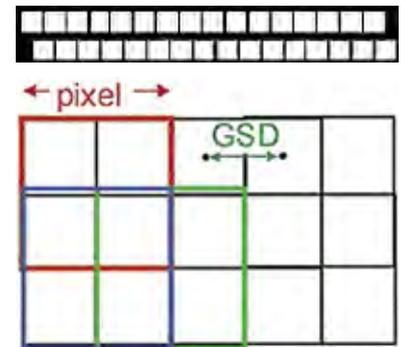


*Figure 2, OrbView-3 sensor characteristics: staggered CCD-lines (top) result in over-sampled pixels (bottom).*



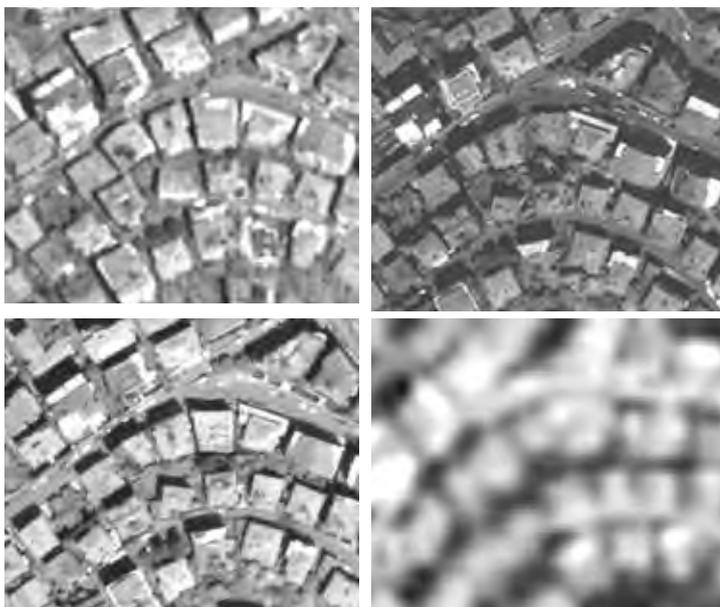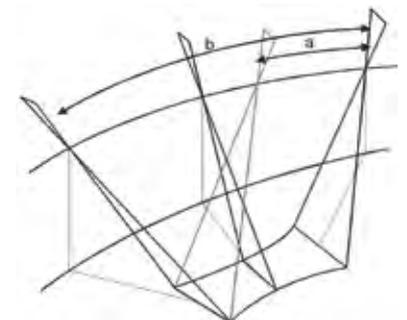*Figure 3, Slowdown imaging by permanent change of view direction: slowdown factor b/a 1.4.*



*Figure 1, Information content of satellite images depends mainly on Ground Sampling Distance (GSD). All images cover the area of Zonguldak, Turkey: (from left to right, from top to bottom) OrbView-3 (GSD: 1.07m), Ikonos (GSD: 1.00 m), QuickBird (GSD: 0.62m) and Spot 5 (GSD 5m).*

*Figure 4, OrbView-3 image represented in original 11bit radiometric resolution (left) and in 8bit radiometric resolution (right).*





*Figure 6, OrbView-3 showing planned built-up areas (dashed ellipse) and unplanned ones (solid ellipse).*
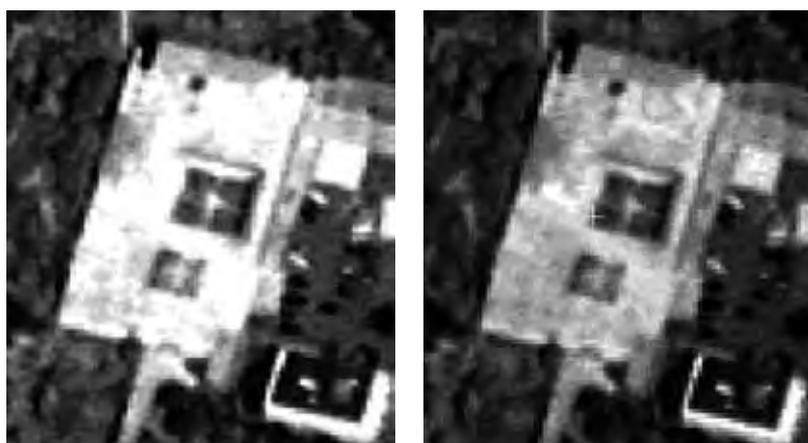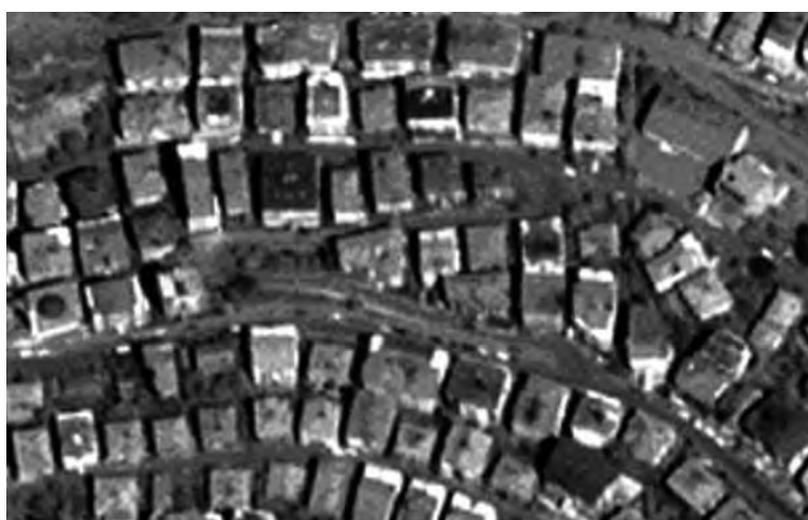


*Figure 5, (Top): OrbView-3 with 63° sun elevation, (bottom): Ikonos with 41° sun elevation.*

8bit grey values. Figure 4 shows more details in the roof in the original 11bit image than in its 8bit counterpart. This may be important for automatic image matching, but for mapping purposes it is unimportant because in both cases the building can be sufficiently well identified in all required detail.

## Recording Conditions

Haze, clouds and smoke may reduce contrast; enhancement is possible but the resulting image quality will not approach that of images taken under optimal conditions. Sun elevation and azi-

### *Shadows hinder identification of details but sometimes support object identification*

muth cause shadows that hinder identification of details (Figure 5). With a sun elevation angle of 63°, shadows in the OrbView-3 image are not so long as in the Ikonos image with a sun elevation angle of 41°. Shadows cause identifi-

11bit, with which 2,048 grey values can be represented. However, the grey values within one scene will not cover the whole range and a qualified change from 11bit to 8bit grey values does not lead to significant loss of information. Only in some crucial areas do differences appear between the original 11bit and the derived
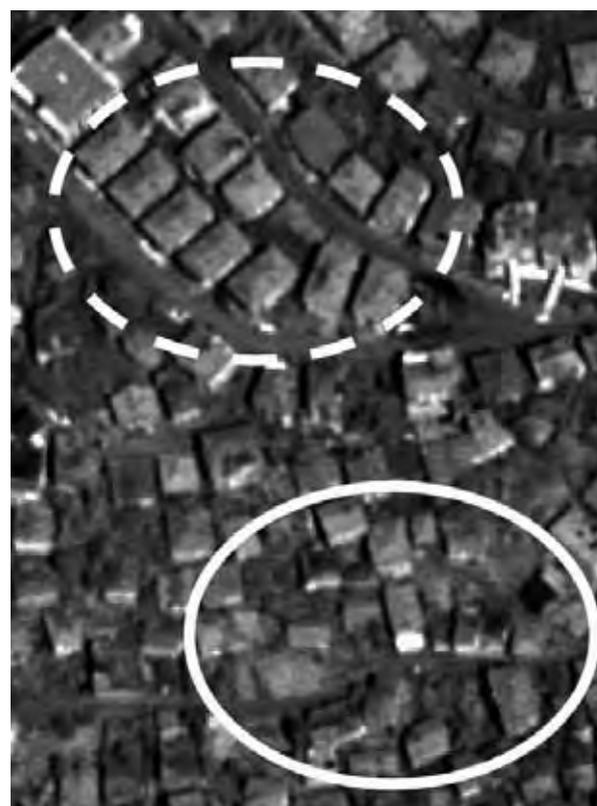
| Object | Image | Det | Rec |
|---|---|---|---|
| Large individual buildings | OV | *** | *** |
| | IKO | *** | *** |
| Small individual buildings | OV | *** | ** |
| | IKO | *** | *** |
| Wide roads | OV | *** | *** |
| | IKO | *** | *** |
| Small roads | OV | *** | ** |
| | IKO | *** | *** |
| Sport grounds | OV | ** | ** |
| | IKO | *** | *** |
| Cemetery area | OV | ** | ** |
| | IKO | *** | *** |
| Coast line | OV | *** | *** |
| | IKO | *** | *** |
| Sideline of roads | OV | ** | ** |
| | IKO | *** | *** |
| Wall | OV | ** | * |
| | IKO | ** | ** |
| Pavement | OV | ** | ** |
| | IKO | *** | *** |
| Footpath | OV | ** | * |
| | IKO | ** | ** |
| Pool | OV | * | * |
| | IKO | *** | *** |
| Grass land | OV | ** | ** |
| | IKO | *** | *** |

*Table 1, Summary of detection (DET) and recognition (REC) possibilities of OrbView-3 (OV) panchromatic and Ikonos (IKO) pan-sharpened images. Good:***, Medium:*, Difficult: ***

cation problems in scenes with narrow streets, high buildings and terrain inclination, as is the case in the north of the Zonguldak area, but sometimes shadows may support object identification. For example, a helicopter landing-pad might at first sight look like a roof, but missing shadow may indicate that it is on the same level as surrounding grassland.

## Terrain Characteristics

Contrast is the dominant component of image interpretation, but identification of objects also depends on their characteristics. Planned areas, with larger, well-arranged buildings can be more easily mapped than unplanned areas with smaller and irregular objects, especially when the latter occur in hilly terrain (Figure 6). Identification of objects in planned areas does not result in significant differences between OrbView-3 and Ikonos panchromatic images, while in unplanned areas the better image quality of Ikonos resulted

in a larger number of identified objects. Not every building has a rectangular shape and, particularly in hilly terrain, walls may not be parallel. Figure 7 shows a building of irregular shape (a), a rectangular building (c) and a low building throwing little shadow (b). The latter has not been identified during the mapping exercise, mainly because of missing shadow. OrbView-3 cannot take panchromatic and colour images simultaneously as do Ikonos and QuickBird, so no direct pan-sharp-
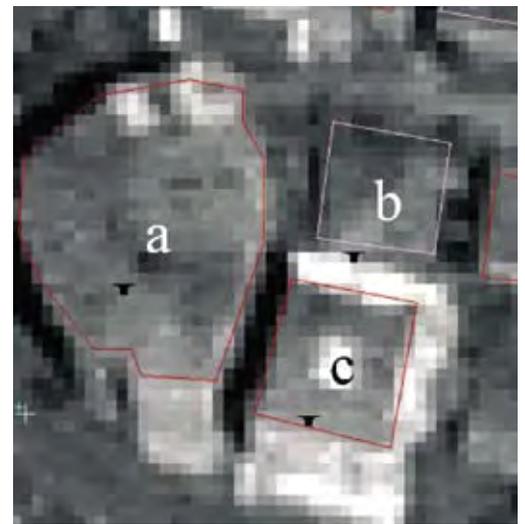


*Figure 7, OrbView-3 image showing building of irregular shape (a), unrecognised building (b) and building of usual shape (c).*
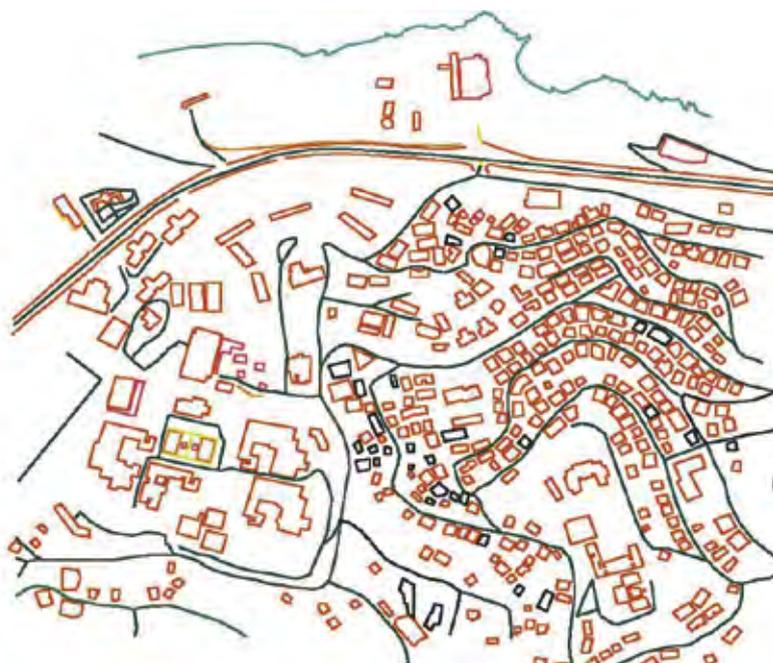


*Figure 8, Mapping based on panchromatic OrbView-3 image (left) and on panchromatic Ikonos image (right).*

ening was possible. Mapping with pan-sharpened Ikonos and Quick-Bird images simplified object identification, but this does not mean that more objects can be identified; the number was insignificant.

## Results

Table 1 summarises the detection (DET) and recognition (REC) possibilities of features and objects in OrbView-3 and Ikonos imagery. Figure 8 shows maps created from panchromatic OrbView-3 and Ikonos images. All buildings and nearly all roads have been recognised in the Ikonos image; a few roads in shadowy areas have not been recognised. In the OrbView-3 mapping 93% of the buildings and 96% of the roads mapped with Ikonos are seen, while only 33% of the pavements could be identified. These results demonstrate that OrbView-3 images are well suited for creation of 1:10,000 topographic maps.◆

### Biographies of the Authors

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**Karsten Jacobsen** received a PhD in Photogrammetry from Leibniz University, Hanover, Germany. He is academic director of the Institute of Photogrammetry and Geo-information at the same university. His main research area is numerical photo-grammetry, especially the use of space imagery.

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