

# DETERMINATION OF THE BUILD UP AREA DEVELOPMENT IN THE GREATER MUNICIPALITY OF ISTANBUL BY SPACE IMAGES

G. Buyuksalih\*, K. Jacobsen\*\*, I. Baz\*

\**BIMTAS, Istanbul, Turkey*

\*\**Leibniz University Hannover, Germany*

Keywords: multi purpose information system Istanbul, map update, IKONOS

## ABSTRACT:

The ongoing urbanisation is a typical situation for countries like Turkey. For planning purposes, for preventing effects to the water catchments areas and other ecologic effects, for planning purposes and earthquake security an information system about available buildings and illegal housing is required. In the Greater Istanbul Municipality, covering an area of 5378 km<sup>2</sup>, the situation of buildings is checked every 3 month by means of IKONOS images. In addition SPOT-5 supermode images with 2.5m ground sampling distance (GSD) are used for topographic mapping. The Municipality area is also influenced by the surroundings, requiring a topographic mapping of the whole Marmara region by means of SPOT-5 images. An overview with rough classification of just forest, agriculture and build up areas is made by means of Landsat imagery.

## 1 INTRODUCTION

The population growth in the Greater Istanbul Municipality area is causing several changes of the build up parts. Often these changes are not legal. Especially in the protected water catchments areas illegal housing is critical and are not accepted by the municipality. Due to the legal situation a close to on-line detection of new buildings is necessary. In addition information for urban planning is required. For these reasons the municipality area of 5378 km<sup>2</sup> is investigated regularly by means of satellite imagery. Because of its influence to the development of the Greater Municipality area, in addition also the surrounding Marmara region is inspected with a lower resolution.

The analysis of the changes is based on a time serious of Landsat images, giving an overview of the land classes, supported by a complete coverage of the Marmara region by SPOT 5 supermode pan-sharpened images and IKONOS scenes covering the municipality area, taken every 3 months.

The Landsat images are available for 5 year time interval; they are used for a rough classification of the main feature classes like forest, agriculture and build up areas. This allows an overview of the urbanisation of the Marmara region, not only limited to Istanbul. In general the build up areas are growing, while forest and agriculture parts are shrinking. The location of the changes is important information for urban planning applications. The changes have to be determined by means of remote sensing because a complete ground inspection is too time consuming. In most cases the changes are not based on allowances by the municipalities.

The complete coverage of the region by pan-sharpened SPOT 5 supermode images, with 2.5m GSD, was used for updating the existing topographic maps as required base for the urban planning. The automatic classification of the SPOT 5 images gave more detailed information about forest and agriculture areas, while a manual update could not be avoided in the build up parts.

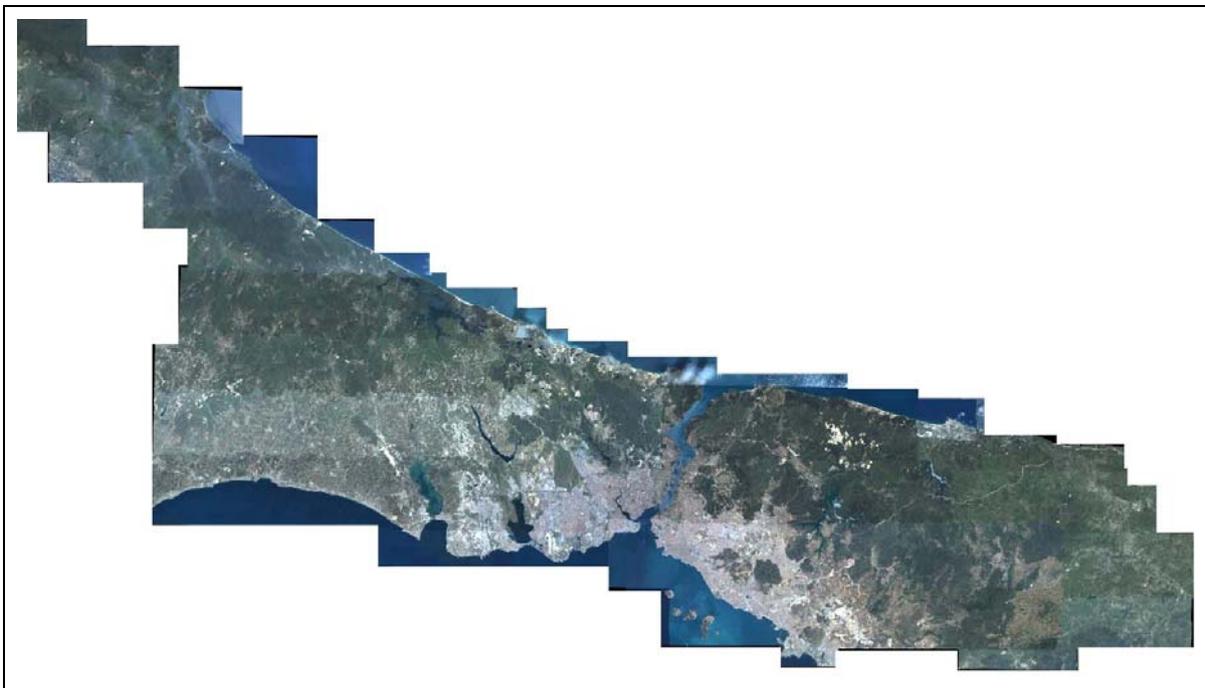


Fig. 1: IKONOS mosaic of Greater Istanbul Municipality and surroundings

Based on pan-sharpened IKONOS images, shape files, including all buildings of the Greater Istanbul Municipality area, have been generated. For controlling illegal housing and as base for urban planning, a time series of IKONOS scenes with 3 months repetition rate has been used, starting in June 2005. With approximately 10 scenes the whole area of Greater Istanbul Municipality is covered. In the case of partial cloud coverage additional images are ordered. The ground resolution of 1m did not allow an automatic identification of new buildings. Often the buildings are too small and partially they are under construction or in preparation. Even not solid buildings, like green houses with plastic covers, have to be mapped. Over 3 month time interval the radiometric changes caused by different sun elevation, changes of the vegetation and the atmosphere are fundamental so that automatic change detection is not possible with very high resolution images.

Especially due to the different length of shadows a reliable result can not be achieved by an automatic method.

As base for the manual detection of building changes IKONOS ortho-image mosaics are used. They are overlaid by shape files of the update period before. Any detectable change is checked against the images of preceding period to be sure about the start of the construction. Important changes are checked also by a second operator. Not only new buildings, also the preparations and obvious changes of the building heights are recorded. In the critical water catchments areas a field check is made for verification. The manual periodical update of the shape files takes approximately 30 operator days for the area of Greater Istanbul Municipality, which is distributed to a group of ten operators. Thus, a fast reaction to not acceptable illegal constructions, especially in the protected areas, can be guaranteed. Around the basins for the drinking water supply in the first zone no buildings are allowed, while in the neighboured zones several restrictions for guaranteeing the water quality exist.

The whole procedure of information acquisition by automatic classification and manual inspection, and periodical update is operational and only possible in using high resolution space images.

## 2 WATER CATCHMENTS

The water catchments are very important for a large city like Istanbul having also longer dry periods. Water pollution and also penetration of acids to surface and ground water has to be avoided. Different restriction classes are specified around the basins.

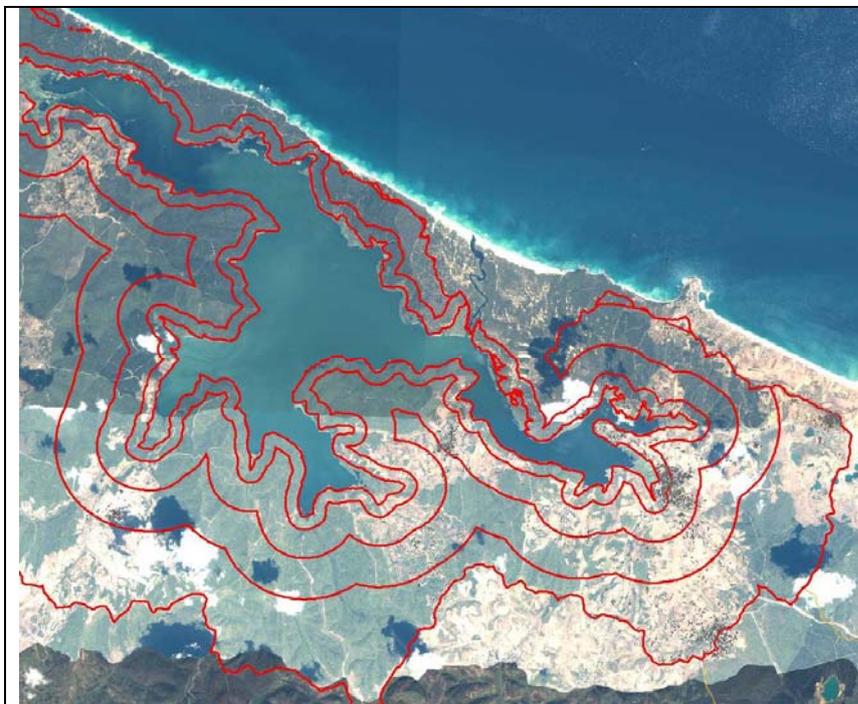


Fig. 2: drinking water basin with different protection zones

The legal situation of illegal housing in Turkey requires a check for new unplanned buildings every three month to avoid a legal status. This requires a building information system for separating between old and new buildings or constructions.

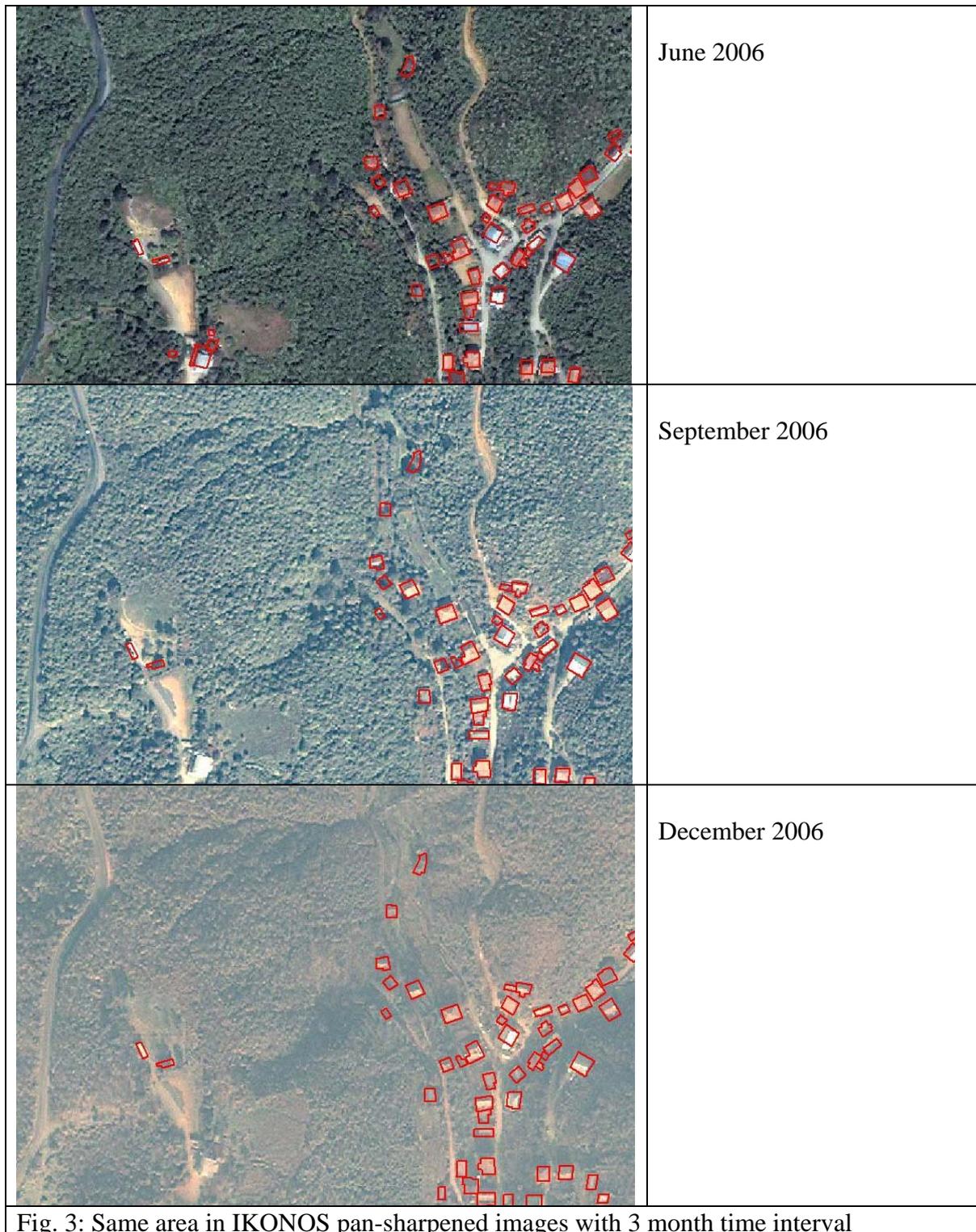


Fig. 3: Same area in IKONOS pan-sharpened images with 3 month time interval

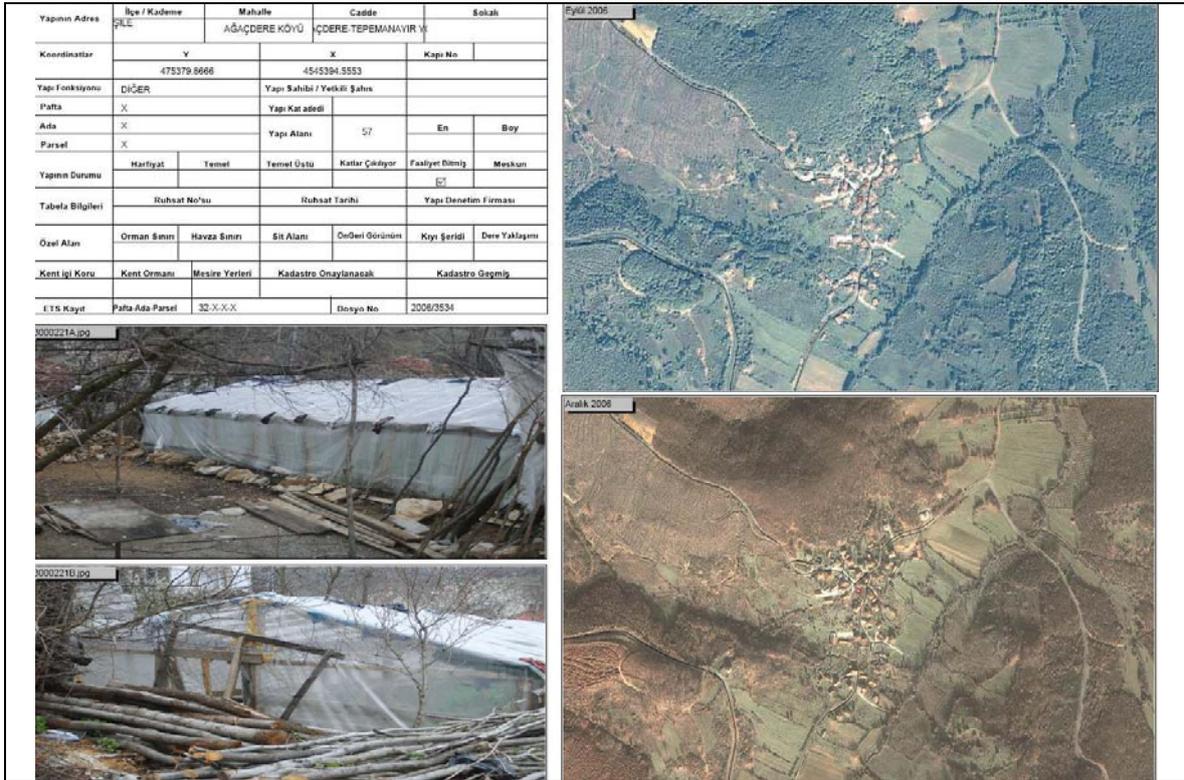


Fig. 4: new not legal construction with actual and 3 month old IKONOS images in the information system IMOS



Fig. 5 : new building with new and 3 month old IKONOS image

Figure 3 demonstrates the changing imaging conditions over the year. The sun elevation is different, causing different shadows, the atmosphere changes like also the vegetation. This avoids the possibility of automatic change detection. Only with a quite better ground resolution this would be possible. In addition often only new constructions and not new buildings are available and sometimes this starts small and becomes later big. So the manual inspection is the only solution. This is supported by an overlay of the used ortho-

images with the building lines of the period before. The new buildings or construction sites are locally checked, photographs are taken like information required for the building GIS. The constructions are not in any case solid, like shown in figure 4, but also such illegal actions have to be avoided in the water catchments area. A typical situation can be seen in figure 5, where the build up area is permanently extended without any allowance.

All the building information is stored in the multi-purpose GIS for the Greater Istanbul Municipality area, named IMOS.

### 3 CITY AREA

In the city the building information is important for planning aspects, but also for avoiding not acceptable constructions. Usually the data acquisition is made based on pan-sharpened IKONOS ortho-images. Only for special purposes true ortho-images are generated.

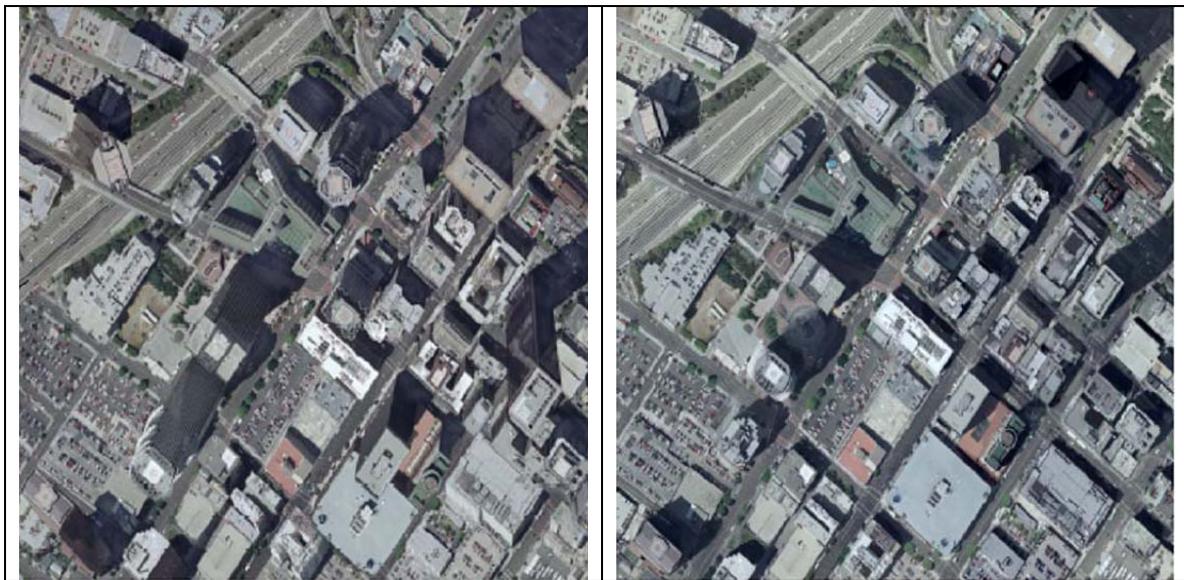


Fig. 6: ortho-image

true ortho-image

The information system IMOS is available in the internet for internal use by the administration (figure 7). Such a tool simplifies every planning process. A large city, having problems with the realisation of the city planning by illegal constructions, needs such a system for several purposes and the access by different offices is absolutely required. Not only the map information, also the details about each building is necessary, included in the description. Important for area endangered by earthquakes is also the building height, because often legal buildings are extended illegal by additional stories, not taking care about the building static and required earthquake stability.

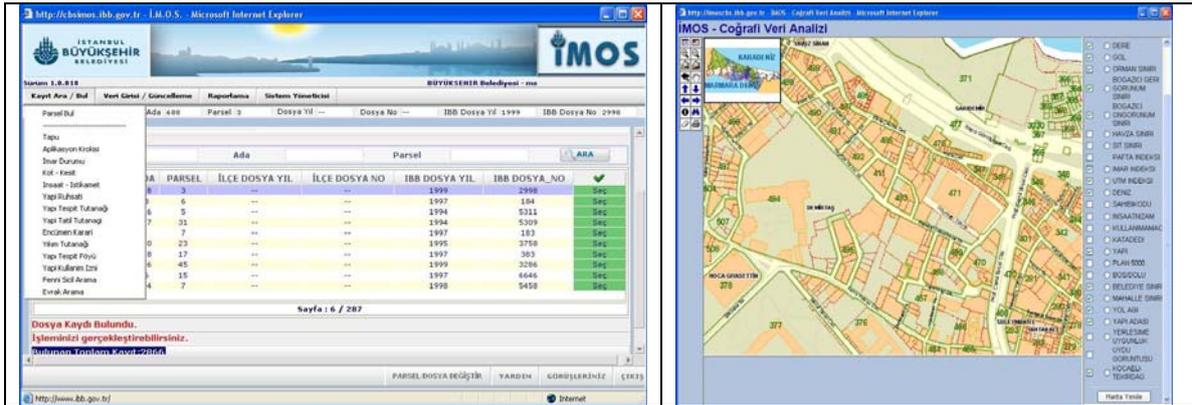


Fig. 7: internet based IMOS information system for Greater Istanbul Municipality

A typical city planning problem is shown in figure 8. In the centre part, up to left lower corner, illegal constructions have to be avoided to keep the required space for planned road constructions.



Fig. 8: IKONOS ortho-image overlaid by map information

critical planning problems in the centre part



Fig. 9: fast development of the outskirts of Istanbul – changes within 1 year

For the fast growing population of Istanbul, speeded up by the emigration to the cities in Turkey, additional housing has to be planned and realised. In an economic and ecologic manner this has to be based on city planning for taking care about the whole infrastructure including school systems, traffic connection and utilities. So a check of the realised situation against the planned (figure 9) is very important.

## CONCLUSION

The check of the building activities in the Greater Istanbul Municipality area is absolutely required for avoiding problems of the infrastructure. Especially the very critical water catchments area have to be checked in at least 3 month time interval to reduce the permanently shrinking of the forest area and to avoid a water pollution. But also in the city itself the building activities have to be controlled for reserving required traffic areas, for saving remaining parks and for checking buildings for earthquake security. In Istanbul the generated information is available in a GIS, which can be used by different offices of the Greater Municipality.