

DETECTION OF CHANGES IN ISTANBUL AREA WITH MEDIUM AND HIGH RESOLUTION SPACE IMAGES

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ABSTRACT:

The population growth in the Greater Istanbul Municipal 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 km² is investigated regularly by means of satellite imagery. In addition also the surrounding Marmara region is inspected because of its influence to the development of the Greater Municipality area.

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 pansharpened images and IKONOS scenes covering the municipality area, taken every 3 months. Based on pansharpened 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 serious 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. Changes of the vegetation and the atmosphere are fundamental so that automatic change detection is not possible with very high resolution space images. Especially, due to the different length of shadows a reliable result can not be achieved by the automatic mode.

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

1. INTRODUCTION

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 and for earthquake security an information system about available buildings and illegal housing is required and has been set up for the Greater Istanbul Municipal area. The data acquisition by aerial images is too time consuming and not so many details are required, leading to the use of very high resolution space images.

A rough overview about urbanisation is made with Landsat images, giving information about land classes. The more detailed information about urbanisation in the whole Marmara region is achieved by SPOT 5 supermode pansharpened images. For the critical check of unplanned buildings a continuing time serious of IKONOS scenes (figure 1), taken every 3 month, is used. This short time interval is required to avoid rights of the illegal constructions based on the Turkish law.

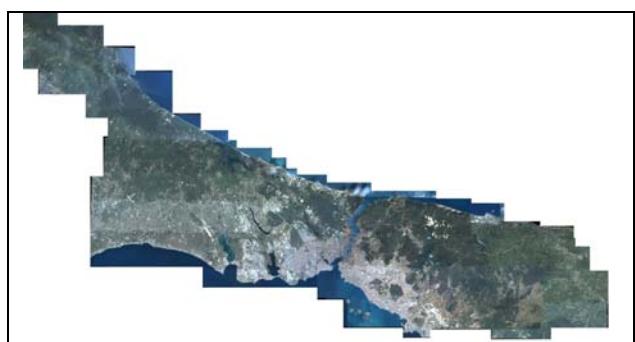


Figure 1. IKONOS mosaic of Greater Istanbul Municipality and surroundings

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 serious 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 population and also penetration of acids to surface and ground water has to be avoided. Different restriction classes are specified around the basins.



Figure 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.



Figure 3. buildings in restricted area



June 2006



September 2006



December 2006

Figure 4. Same area in IKONOS pan-sharpened images with 3 month time interval

Figure 4 demonstrates the change of the 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 big later. So the manual inspection is the only solution. This is done 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 5a, but also such illegal actions have to be avoided in the water catchments area. A typical situation can be seen in figure 6, 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.



Figure 5a. new not legal construction with actual and 3 month

old IKONOS images					
Yapının Adres	İlçe / Kademe		Mahalle		Sokak
	SİLE		AĞAÇDERE KÖYÜ	ÇDERE-TEPEMANAYIR YK	
Koordinatlar	Y		X		Kapı No
	475379.8666		4545394.5553		
Yapı Fonksiyonu	DİĞER		Yapı Sahibi / Yetkili Şahıs		
Pafta	X		Yapı Kat adedi		
Ada	X		Yapı Alanı		57
Parsel	X		En		Boy
Yapının Durumu	Harfiyat	Temel	Temel Üstü	Katlar Çıkıyor	Faaliyet Bitmiş
					Mesken
Tabela Bilgileri	Ruhsat No'su		Ruhsat Tarihi		Yapı Denetim Firması
Ozel Alan	Orman Sınırı	Havza Sınırı	Sit Alanı	ÖnGeri Görünüm	Kuyu Şeridi Dere Yaklaşımı
Kent İgi Koru	Kent Ormanı	Mesire Yerleri	Kadastro Onaylanacak		Kadastro Geçmiş
ETS Kayıt	Pafta-Ada-Parsel	32-X-X-X	Dosya No		2006/3534

Figure 5b., terrestrial photo and information system IMOS



Figure 6a. new building with new IKONOS image



Figure 6b. new building in 3 month old IKONOS image

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.



Figure 7: IMOS building layer over IKONOS image

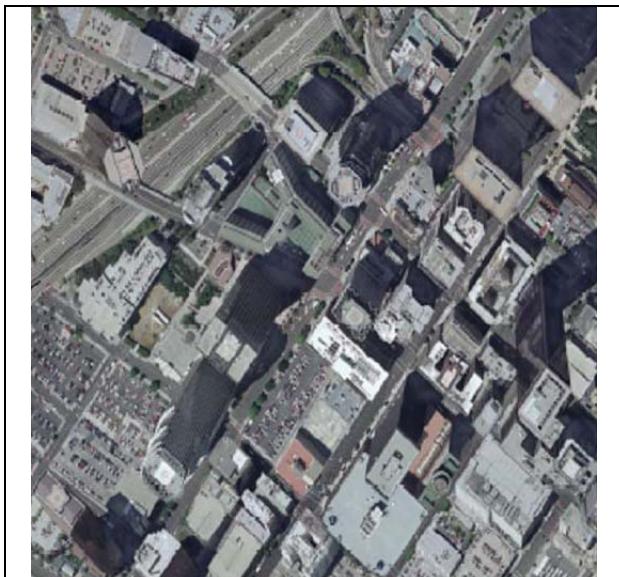


Figure 8: ortho and true ortho image

The information system IMOS is available in the internet for internal use by the administration (figure 9). 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.

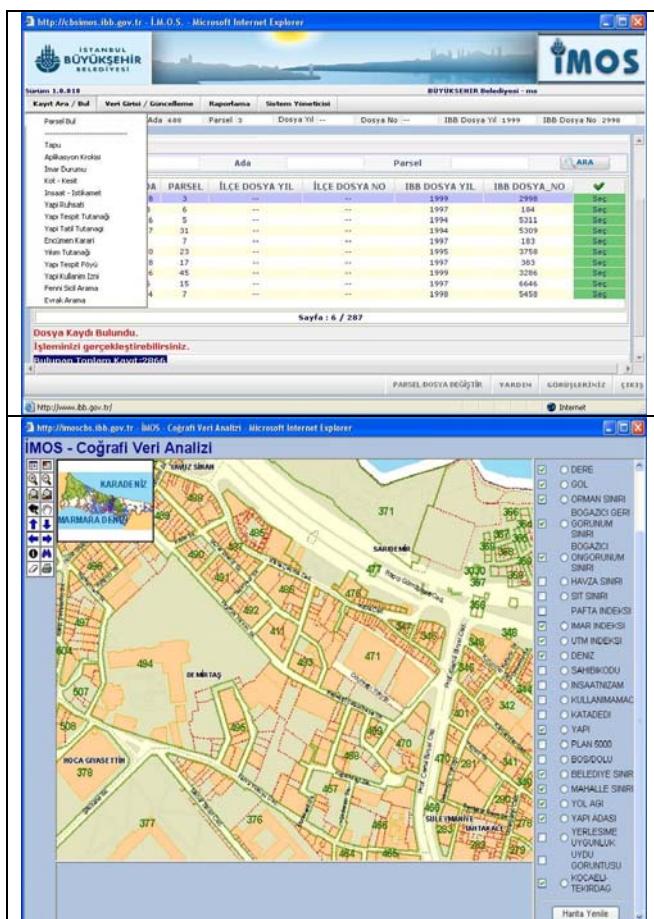


Figure 9. internet based IMOS information system for Greater Istanbul Municipality

A typical city planning problem is shown in figure 10. In the centre part, up to left lower corner, illegal constructions have to be avoided to keep the required space for planned road constructions.



Figure 10. IKONOS ortho-image overlaid by map information critical planning problems in the centre part



Figure 11. fast development of the outskirts of Istanbul – changes within 1 year

4. 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.

