Using Spatial Videos, Google Earth^{tm} and Geographic Information System to Dynamically Monitor Built Environment Changes In a Challenging Environment: Baghdad, Iraq.

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ABSTRACT

Urban expansion and its environmental and safety effects are one of the critical information needed for future development planning, safety considerations and environmental management. This work used two methods to monitor urban expansion and it's environmental and safety effects, the first is based on Google Maps for the years 2002 and 2010, and the second was the usage of spatial videos for the year 2013. Although the usage of satellite images is critical to know and investigate the general situation and the total effects of the expansion on a large piece of area, but the Spatial videos do a very detailed fine scale investigation, site conditions regarding both environmental and safety cannot be easily distinguished from satellite images .Another advantage of spatial videos is new houses can be recognized and separated visually even if they are attached or derived from one house. This article shows that the working conditions for the workers do not comply with the standards especially their health and safety procedures.

Also the municipality services are at the lowest level because of all the debris left in the street , lack of regulation and law enforcement that protect the health of neighborhood residents.

Keywords: GIS, google maps, spatial videos and urban environment.

استخدام الفيديو المكاني، برنامج جوجل ايرث ونظام المعلومات الجغرافية لرصد التغييرات الحيوية للبيئة الحضرية في بيئة مليئة بالتحديات :بغداد، العراق.

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الخلاصة

يعد التوسع العمراني وتأثيراته على البيئة والسلامة من المعلومات المهمة جداً واللازمة لخطط التطوير المستقبلية وأعتبارات السلامة والأدارة البيئية للمدن .في هذا العمل تم استخدام اسلوبين لمتابعة التوسع العمراني وتأثيراته على السلامة والبيئة المدنية ، في الأسلوب الأول تم الأعتماد على خرائط غوغل لسنة 2002 ولسنة 2010 ، اما الأسلوب الثاني فأعتمد على الفيديوات المكانية لسنة 2013 .بالرغم من اهمية استعمال الصور الفضائية لمعرفة وتحديد الوضع العام وكذلك التأثيرات الكلية للتوسع على منطقة كبيرة ، لكن الفديوات المكانية تقوم برصد التغيرات الدقيقة وظروف الموقع بشكل لا يمكن للصور الفضائية تحقيقه . كما ان للفديوات المكانية فائدة اخرى ،هي فرز المنازل الجديدة وتحديدها بالرؤيا حتى لو بنيت بشكل متلاصق أو اشتقت من نفس المنزل . أظهر هذا العمل ان ظروف عمل العمال غير متوافقة مع معايير السلامة المهنية والصحة . ولقد أَظهرت الدراسة ان

الخـــدمات البلديـــة فـــي اوطـــأ مســـتوياتها بســـبب تـــرك الأنقـــاض فـــي الطرقـــات وغيـــاب تطبيـــق القـــوانين والتشـــريعات التـــي تحافظ على صحة سكان المنطقة .

الكلمات الرئيسية : نظم المعلومات الجغرافية ، خرائط غوغل ، الفديوات المكانية والبيئة الحضرية

1. INTRODUCTION

It is estimated that the population growth associated with urban areas in less developed countries will grow from 2.7 Billion in 2011 to 5.1 Billion capita in 2050 **UN, 2012**. The increase in urban population will result in more construction for domiciles and industry, the need for more (and better) roads, and general service provision **,Wong and Jusuf, 2011 and Farooq** and **Ahmed , 2008.** This type of development can have a devastating effect on the urban ecosystem, including increases in solid waste generation, air pollution from a variety of human sources, a higher runoff rate and a general depletion of resources **,Yangfan, et al., 2010.**

In China, **,Yanjun , and Ying, 2011.** found dramatic increases in environmental pollution and an over consumption of resources because of an extremely fast growing urban economy with little planning oversight or general policy guidance. Unfortunately for many environments where these factors combine; dramatic urban development with little planning control resulting in multiple environmental problems, also suffer from a lack of data that can be used to monitor the situation.

A challenge in many of these environments is the lack of data needed to create baselines and assess change. From a spatial perspective, census information is often missing, and often the only source of data is remotly sensed(high resolution aerial photorgaph and satelite data). Although these can provide broader impressions of the change in urban areas, such as where development as a whole is occuring, fine scale data, and espcially dynamic fine scale data are extremely difficult to collect. For exampl**e, ,Erener, et al.,2012.** estimated that there was a 135.72% increase in the built-up area in Göcek Bay in the south western coast of Turkey with an associated 29.38% vegetation loss **,Haregeweyn,et al., 2012.** Using a similar approach found that the horizontal expansion in Bahir dar (North west of Addis Ababa, Ethiopia) increased from 279 ha in 1957 to 4830 ha in 2009, at an average growth rate of about 31% (88 ha year−1). A further challenge for many of these urban environments is the issue of security, which as a result lead to the adoption of new methodologies to collect spatial data **,Cohen, and Arieli, 2011.** One such environment, and the focus of this paper, is Baghdad, Iraq. This is not to say that there is no ground-level geographic information system (GIS) use in the Baghdad area or Iraq in general, for example one study considered the pattern of violence and ethnic segregation in the city **,Weidmann and Salehyan, 2013.** Increasing urbanization in Basra province (southern part of Iraq) was estimated to be approximately 15% from 1990 to 2003 **, Hadeel,et al., 2009.** again using remotely sensed imagery.

This paper will consider the dynamic environment of Baghdad, where the urban landscape is contionually changing, where offical (spatial) data is sparse, and where on-the-ground security issues hamper field data collection. More specicially it will focus on one neighborhood in Baghdad to show how expansion and new construction can be captured using a ubiquitous tool for fine scale data collection, a spatial video. Through this method this paper will explore the environmental impacts and work safety issues in the new construction in a typical dynamically changing neighborhood of the city.

2. STUDY AREA

Baghdad has an estimated population of more than 11 million people **,Salah, and Saleh, 2007.** In the South Western part of Baghdad is the Hitten district, **Fig.1** . The focus of this paper, is section 622 of the Hitten district **Fig.2** , an administrative division smaller than a district. section 622 was built in the late 1960s and initially contained 682 houses. The area is fully serviced including residential connections to piped water, sewer systems, electricty and phone lines. This section (neighborhood) was considered during the period 1970s until the late 1990s to be welathy and full of large houses (an average size of approximately 600 Sq.Meter). The section also had from the full range of education access, from kindergarten to highschools, and generally good infrastructure including roads and commercial areas. However a high demand for urban growth has led to the construction of many new houses in the section, despite the fact that there are few remaining open spaces. Although local "knowledgeis that existing buildings and parcels are being turned into multiple living units, the situation is hard to monitor because of lack of spatial data and assocated cadstral maps, Therefore, there is little offical record of any assessed properties and building footprints, nor is new construction or modifications to existing structures centralized and available for mapping.

This paper presents a proof of concept analysis for this section, showing how spatial video can be used to capture fine scale urban processes, including visual evidence of neighborhood change.

3. METHODOLOGY

Although there are many advantages in using remotely sensed imagery to "map" data-poor urban environments, such studies tend to be cross-sectional and limited to coarse scale mapping. Fine scale mapping challenges from such data sources include building separation where multiple units are adjoined, especially if there is no separation by gardens or corridors, or if the houses share the same roof. Indeed these remotely sensed sources do not capture the dynamic context of the built environment; the look from the curbside, the general condition of the structure, and general human activity such as building activity, building changes, potential safety and environmental problems. To overcome these problems spatial camera and field interviews with owners took place to identify the dynamism of urban morphology, property specific histories, and environmental impact.

Spatial video is a near-scale data collection approach that has been used in multiple situations in the United States, including capturing built environment change after a disaster **,Curtis, et al., 2013. ,Mills, and Curtis ,2008. Curtis, and Fagan, 2013.** The general process of using a spatial video for fine-scale mapping is that fieldwork collects video which is encoded with a coordinate stream. Upon playback, the video image can be identified on a map, and attributes from the video digitized into a spatial package, with a GIS or Google Earth. Although different systems have been used in previous research projects, for this study a Contour + HD video camera was used to record the visual conditions of the construction sites. There are several advantages in choosing this camera including affordability, the wide angle high definition lens which is excellent for capturing street-level built environment data (See **Fig.3** for an example), and the built-in GPS receiver. In addition, as this camera was designed for extreme sports, it is sport which makes it more inconspicuous, rugged and simple to use. The camera is powered by an internal battery boosted by a charger for use in a car's cigarette lighter. Data is stored onto an internal micro SD card (32GB). Both battery life and disk storage allow for up to 5 to 6 hours of data collection.

For this proof of concept study one Contour + camera was attached to the driver's window. In other locations multiple cameras would collect different angles around the car, but as only one camera was used here each road had to be driven twice. Pre-data collection experimentation were important to determine the right angle for the camera, optimum car velocity and the GPS accuracy data collection included approximately 15 hours of recording and interviews over three days. The only streets omitted in the analysis were those that were closed to traffic.

Once captured the video data were downloaded into the associated free-software (Storyteller) which is a user friendly system that allows for both the video and data collection path to be viewed simultaneously. Storyteller can be downloaded by anyone even without a camera purchase which facilitates the easy dissemination of video data. The software has basic functionality including the ability to zoom in and out of the data collection path (displayed on Google Maps), some speed controls, and a GPS extraction function.

Fig.3 Shows the Interface window of the camera software. The red box represents the normal viewer for the video including a time counter with play/pause button. The Blue box shows the GPS part for this Camera. The video collection path is displayed as a yellow line with the exact location of the image displayed represented as a yellow circle, with associated speed, elevation and length of path to that point. The image can be progressed by clicking onto the map path, or by sliding the bottom progress bar.
After data collection, the part of the Google Earth™ started.
Although digitizing can occur directly into ArcGIS 10.1, there are benefits for using Google Earth as an intermediate platform. Firstly, it is free meaning that digitizing can occur irrespective of any GIS license, or GIS skillset. Secondly, the imagery used in Contour Storyteller is the same as Google Earth making digitizing easier. Thirdly, the digitizing framework in Google Earth allows for points, lines and polygons to be digitized, with additional notes added, in an uncoffining format. Digitizing in ArcGIS 10.1 has more restrictions in terms of data structure, and database attribute structure.
A two screen system was utilized whereby the spatial video played on one, and attribute information was digitized into the other. Example data extractions included the locations of debris and changed houses each represented as a separate point, with additional written context added into the dialogue box. After completion, both the spatial video collection path and the digitized points were exported to the ArcGIS as KMZ file.

Google Earth also provided the source for a historical comparison of structures. In addition to the quantity and size of the houses in 2013 was extracted from the spatial video, the historic imagery function in Google Earth™ was used to add two further time periods; 2002 and 2010. After the digitized data were imported into ArcGIS 10.1 data were separated into two categories; debris, new houses construction sites. New columns have been added to the attribute table like the time window of construction for the new houses, this time window was found through the comparison of the 2002 and 2010 images and the 2013 spatial videos.

4. RESULTS AND DISCUSSION

1- Urban Expansion:

The debris location and the current new houses construction sites in 2013 were displayed in **Fig .4** .

By comparing the historical imagery in Google Earth between 2002 and 2010, thirty four new buildings were constructed, eight on empty land and the others either in the grounds of an existing house, or as multiple rebuilds on the site of a demolished house. By comparing the imagery in 2010 with the spatial video in 2013, eighty new houses had been constructed, 13 of them are built in empty lands. In total there were 114 new units built between 2013 and 2002.In order to visualize the urban expansion, numbers were assigned to each parcel condition: if only one house were built the digit 1 will be assigned, if there was two houses built the digit 2 will be assigned and so on.

Then subtracting the number of houses we have in 2010 and 2013 from the baseline in 2002. **Fig.5** Shows the Urban expansion in 2010. The map shows that few houses was expanded to 3 houses (7 only) and 2 lands become 4 houses, others are increased by 1 house only .

While in 2013, **Fig.6** shows that one parcel increased to six houses, two parcels increased from one house to five houses, seven parcels increased from one house to four houses. Six land parcels built to be 14 houses in total.

The period from 2002 till 2010 showed a limited expansion in this area due to the war in 2003, and the security situation in the years from 2007 till 2009. During this period most of the new houses were for the same family expanding their living arrangements within the bounds of their existing property. More rapid expansion occurred between 2010 to 2013 because of the better security situation, and the fact that the neighborhood was fully serviced while many other areas of Baghdad had little or no service provision. A further reason for the expansion was that the government had started to give loans for building new houses; also some real estate companies bought old houses and divided them into sections on demand.

As a result of the urban expansion, new governmental buildings were also constructed in the neighborhood; Police station, clinic, new School and municipality building.

2- Environment and safety

A- In some cases, the new houses areas were less than 50 Sq. Meter, that will cause very poor ventilation which will lead to serious respiratory diseases and allergies especially for children **,Zuraimi,et al., 2007.** also poor Indoor air quality could lead to 6-9% less performance and productivity **,Wyon, 2004.**

B- Lack of safety; the safety in the construction sites are in the lowest level ,**Fig.7** and **Fig.8** shows that the site has no warning signs of any type, non-secured scaffold and large heavy materials (large white marble boards) .

Fig.9 and **Fig.10** shows that the workers are not wearing PPE (Personal Protection equipment).

In Australia, 138 works related death occurred, 120 workers and 18 bystanders two of them were children **,Australia, 2012.** In the United States 4,609 work related deaths **,BLS, 2012.**

Environmental problems with the construction site is the debris of old houses, the debris may contain asbestos, sharp metals and leaded paint. **Fig.11** shows the regular debris of the demolished houses left on the curb side without any covering or securing for long time. Asbestos can cause several severe diseases such as lung cancer, malignant mesothelioma and pleural effusion **,Jamrozik, 2011. ,Farfels, et al., 2003.** Stated that lead paint from old demolished houses increase the concentration of lead by 81 fold. Lead poisoning can cause serious neural disability. Also having all these debris and new construction materials can contribute to higher suspended material concentration in the ambient air.

5. CONCLUSION

There are several factors affecting the urban expansion, the security situation, the services in the area, location and the prices of land. Although the use of satellite images is critical in investigating and evaluating the general situation and total effects of the expansion on a large piece of area; the Spatial videos do a very detailed fine scale investigation, site conditions regarding both environmental and safety which cannot be easily distinguished from satellite images .

Another advantage of spatial videos is, new houses can be recognized and separated visually even if they are attached or they derived from one house.

This article shows that the working conditions for the workers do not comply with the standards especially their health and safety procedures.

Also the municipality services are at the lower levels because of all the debris left in the street and lack of regulation and law enforcement to protect the health of neighborhood residents.

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Table 1. Summarizes the urban expansion details.

Details	Urban Expansion differences between	
	2010 and 2002	2013 and 2013
New houses built	34 (8 on empty lands)	80 (13 on empty lands)
Houses demolished	5	2
Houses expanded to 6 houses	nil	1
Houses expanded to 5 houses	nil	2
Houses expanded to 4 houses	2	7
Houses expanded to 3 houses	7	2

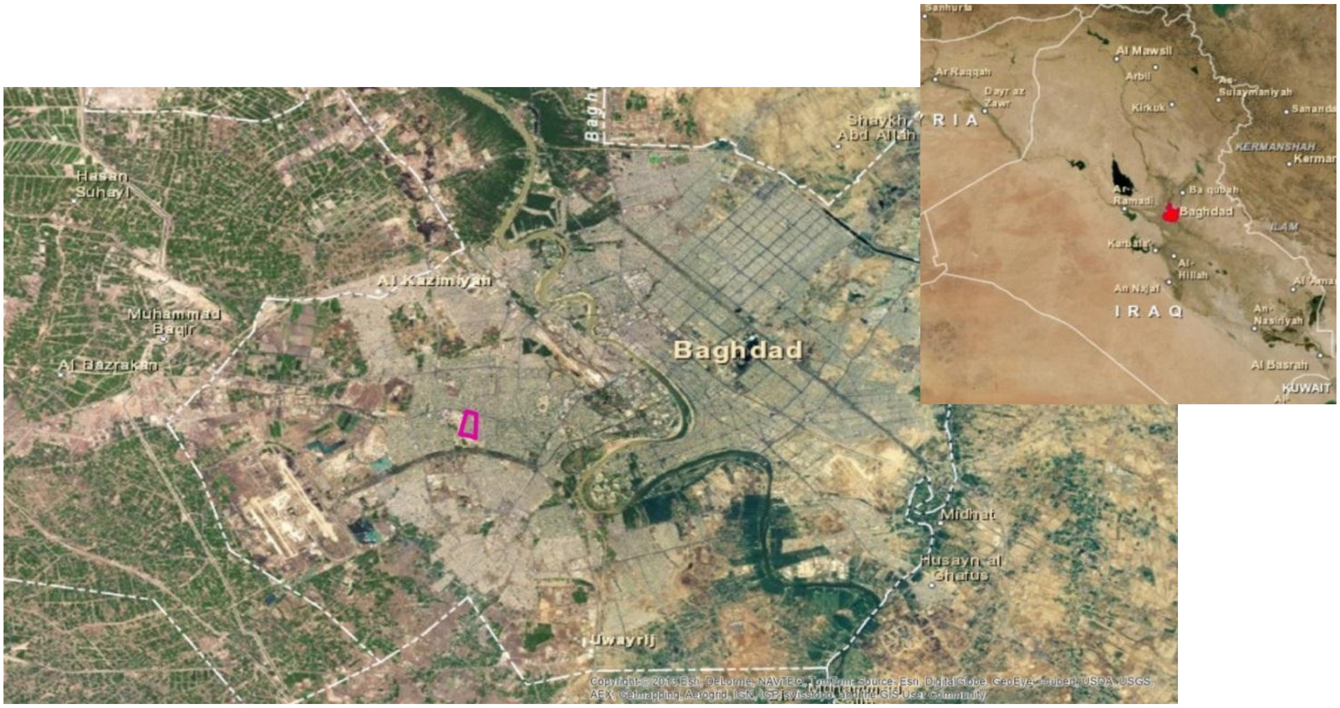

Figure 1. Satellite images locates the district within Baghdad Governorate **.**

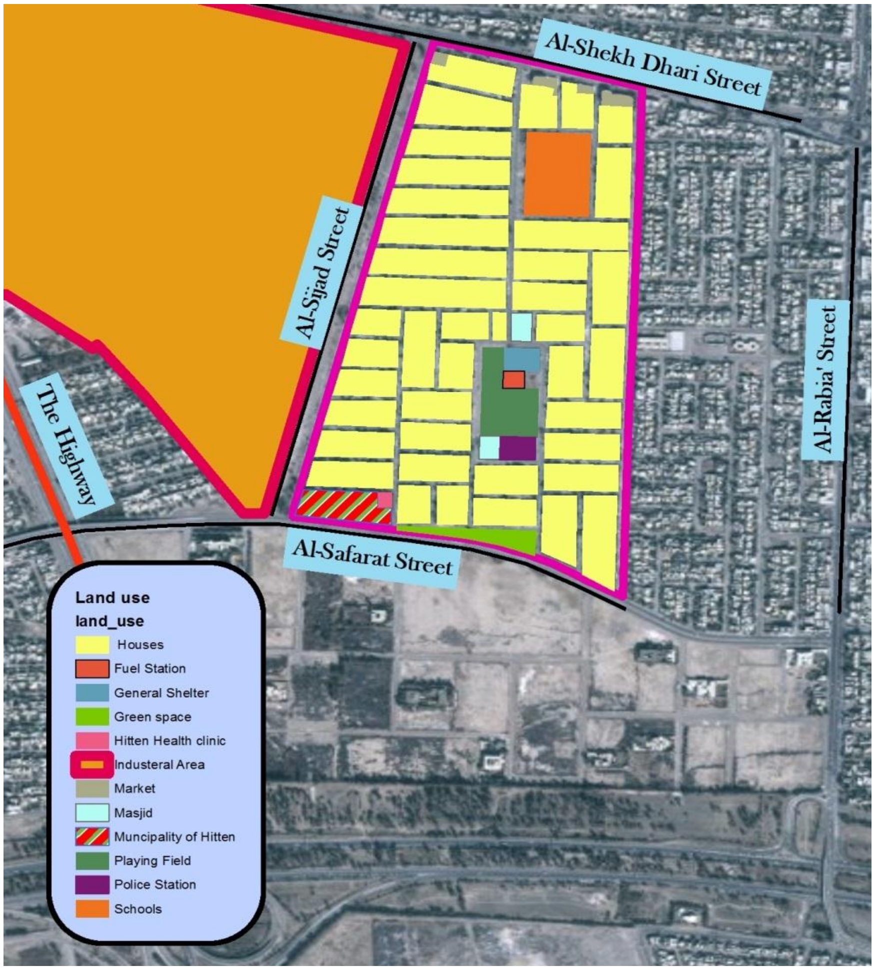

Figure 2. Land use of the study area.

Figure 3. The interface window of the spatial video camera.

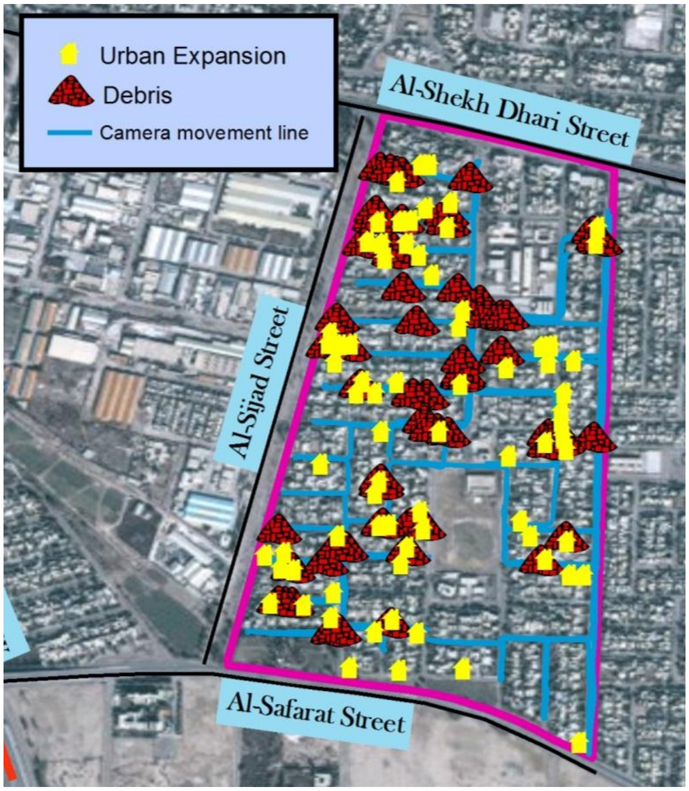

Figure 4. The debris and location of new houses in 2013.

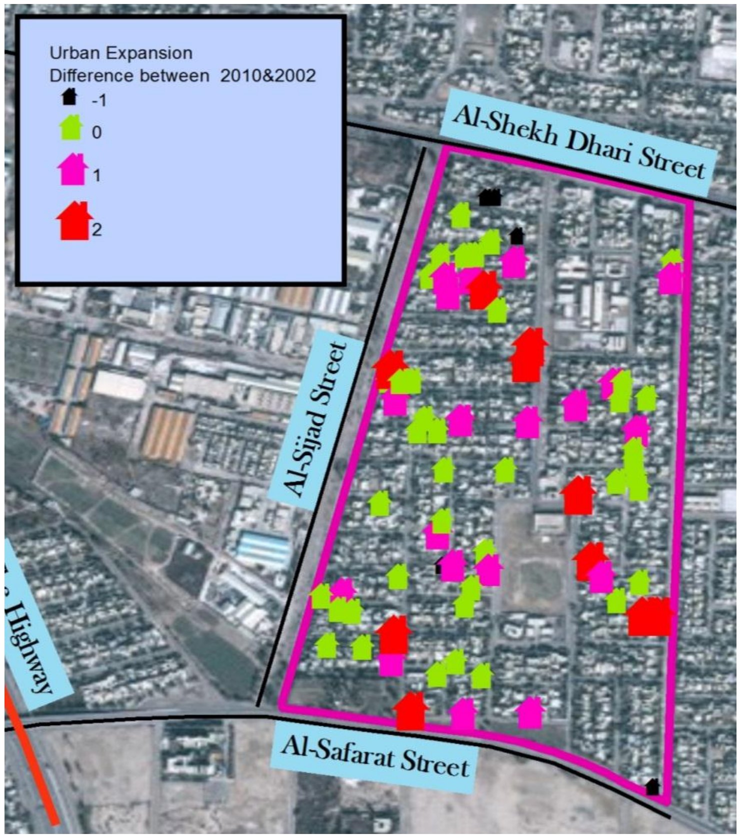

Figure 5. The urban expansion in 2010.

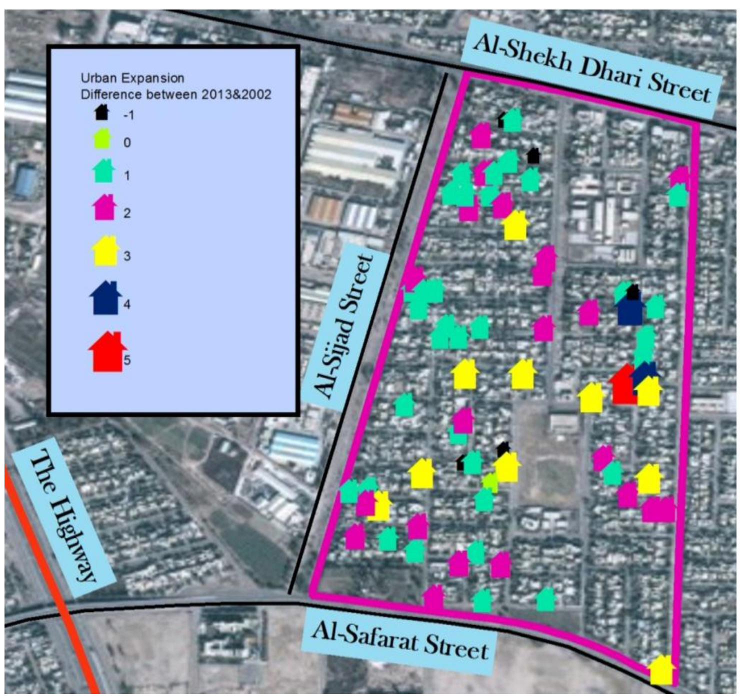

Figure 6. Urban expansions in 2013.

Figure 7. Non secure site with large heavy marble boards and unattended scaffold.

Figure 8. Non secured site, no warranty signs and potential falling objects.

Figure 9. Workers without hard hats, gloves or any other personal protection equipment.

Figure 10. Workers without hard hats, boots, gloves, and respirator.

Figure 11. Debris from demolished houses; contain Brick, sharp metal and other building materials.