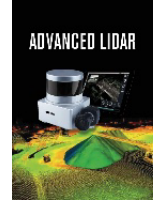


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**Detection of Informal Housing and Non-Compliance with Planning Regulations from Maps Produced by Mobile Lidar Technique**Serhat Güneş\*<sup>1</sup>, İsmail Şanlıoğlu\*<sup>2</sup><sup>1</sup>Mersin University, Institute of Science and Technology, Remote Sensing and Geographic Information Systems, Mersin, Turkey<sup>2</sup>Mersin University, Faculty of Engineering, Department of Geomatics Engineering, Çiftlikköy Campus, 33343, Mersin, Turkey**Keywords**

Remote sensing,  
Mobile Lidar,  
Satellite Images,  
Informal housing,  
GIS,  
Building Determination,  
Squatter housing.

**ABSTRACT**

With the increasing population, cities are constantly changing and developing. Therefore, it is difficult to monitor and control rapid changes in cities. Therefore, planning is very important in terms of controlling these dynamic cities and ensuring regular and planned settlements. However, buildings may not always be built in accordance with the plan and may be built against the zoning law. These structures, which are built against the plan, can distort the city's silhouette, cause unplanned construction and restrict people's access to some services. It is also important that the building detection process, which is needed in many areas from population movements to city development, from illegal building surveillance to casting extraction, is accurate and automatic. With the development of Remote Sensing and Geographic Information Systems (GIS), new methods have been used to detect such structures. One of these methods used is the detection of these structures with high resolution data. In this research, the building detection by using point clouds data obtained from Light Detection and Ranging (LiDAR) system with satellite images.

**1. INTRODUCTION**

Since the first settled life, people have given importance to city planning due to many different factors. In the first city life, due to both under population and wars with other communities, city plans were made in such a way that people were together as much as possible. However, when we come to the present day, people have changed their city plans due to the increasing population, the wars are almost over and the needs of people have changed. For all these reasons, cities are planned by considering factors such as people's comfort and safety against natural disasters.

However, although it is prohibited, the number of buildings that do not comply with the areas outside the city planning or the rules specified in the plan is increasing rapidly with the increasing population. The detection, inspection and control of these structures is

very difficult and costly due to the lack of authorized personnel and supervision, in addition, it causes a loss of time.

However, with the high resolution data obtained by remote sensing methods, it is possible to map very large areas in a much shorter time. These created maps provide the opportunity to analyze in GIS environment with the help of satellite images produced with the help of remote sensing methods or orthophoto images created with aerial photographs.

In this study, it is aimed to monitor the urban development of the building data obtained with the help of mobile Lidar data of Konya province of Turkey, with the help of high resolution satellite data, and to determine the illegal structures and the buildings and areas.

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## 1.1. Terminology

Informal housing refers to urban settlement that does not conform.

## 2. INFORMAL HOUSING IN TURKEY

### 2.1. What is Informal Housing?

Informal housing: Includes informal housing built on government or private land that is used illegally. In such a case, there is no legal claim on the land or the structure built on the land. (Iban, 2020)

Non-compliance with planning regulations: In such a case, most of the owners have a legal claim to the land/structure they built; however, their structures are non-compliant with planning and building laws. This implies that the owners build without, or in excess of, a planning, building, occupancy or functional permit. (Iban, 2020)

When viewed in this way; It will be seen that many buildings in our country can be considered as illegal structures. In addition, in many buildings constructed in accordance with the provisions of the zoning plans, occupancy permits cannot be obtained because of the construction contrary to the project and its annexes, and residences with a construction permit emerge. In this case, it can be said that a significant part of the buildings in the country are unhealthy, illegal, unlicensed or only have construction permits and have illegal elements other than the project requirements required for a residence permit. Buildings of this nature are one of the biggest reasons why natural disasters such as floods and landslides that have occurred in our country recently are so destructive.

### 2.2. Historical framework of informal urbanisation policies in Turkey

Turkey, after 2. world war, experienced the liberalisation of trade and introduction of gasoline-powered agricultural machines. Government at that time made highly leveraged commercial and industrial investments in major Turkish cities; as a consequence, the Turkish urbanisation began to grow rapidly through that decade. The urban population continuously increased until the 1980s due to massive rural-to-urban migration. Nevertheless, neither housing supplies nor technical infrastructure in the cities were adequate in terms of quality and quantity. As a result, low-income migrating groups were obliged to build squatter houses (mainly on public lands) to meet their housing needs. (Iban, 2020)

“Informal housing, which started for shelter purposes, changed its quality especially after 1980 and became an alternative sector with the motive of grabbing a share from urban rents.” (Iban, 2020)

Informal housing has become a social problem and has become widespread in all sectors in a situation that has diversified from luxury housing, shopping mall, industry, agriculture and tourism structures over time. (Iban, 2020)

## 2.3. Consequences of Informal Housing

- Unhealthy residential areas and cities are formed.
- It makes it necessary to make a plan.
- It causes the unjustified seizure of state lands.
- It provides resources to the informal economy.
- It negatively affects security.
- Infrastructure, education and health care problems arise.

In summary, the result of this situation: zoning amnesties for unhealthy, unqualified and unsafe buildings have been developed, resulting in intensive structuring with improvement zoning plans.

## 3. ZONING LAW NO. 3194 (09.05.1985)

Zoning literally means to improve, develop and beautify. A general definition; It is the determination of supply within the framework of certain scales.

It does this by dividing the land that constitutes the legal domain of municipalities, allowing certain land uses to shape the settlement of provinces and districts in certain areas and enable various development plans. (The World Bank)

## 4. Why is zoning necessary?

The purpose of zoning is to allow states to regulate and control the land and real estate markets. Zoning can also provide an opportunity to stimulate or slow development in certain areas. (The World Bank)

City planning is important for people to live in a more comfortable, safer and more socially developed city. While planning, how and how much a city will grow in the long run are also taken into account, thus paving the way for business opportunities for people.

### 4.1. Aim & Extent

This Law covers the constructions in the settlements; The plan has been arranged in order to ensure its formation in accordance with science, health and environmental conditions.

Plans to be made and all official and private structures to be built in places within and outside the borders of the municipality and adjacent areas are subject to the provisions of this Law.

## 5. METHOD

### 5.1. Informal Housing or Building Contrary to Zoning Legislation

Informal housing or a building in violation of the zoning legislation means a structure that is built without the knowledge of the competent authorities (without a license) or that is built in violation of the license and its annexes by not complying with the obligatory rules in the zoning legislation.(Fig.1) According to the definition in the law; Buildings in violation of zoning legislation, unlicensed buildings, license and its annexes, rules of science and health, floor order, floor area, neighbor

distances, zoning road, front line, building depth, zoning principles, and roads in neighboring parcels or zoning plans, It is defined as structures that encroach on areas reserved for public services and facilities such as green areas, parking lots, and are built in places with a definite construction ban.

“It is a common situation that buildings are built contrary to the legislation regulating zoning and construction works by ignoring the rules set by the administration during zoning activities. On the occasion of October 6, World HABITAT Day, the UN announced that one out of every six people in the world lives in slums with unhealthy, inadequate infrastructure and poor property rights.” (Gök H, 2010)

This study aims to detect the structures that are contrary to zoning with the help of high resolution data. The study consists of 3 main stages. In the first stage, the numerical data to be used for the determination of the buildings belonging to the region were obtained with the help of mobile lidar. These data were then transferred to Netcad 8.5 GIS program. The building data obtained in the second stage were matched with the current zoning plan of the province of Konya. In the last step, as seen in figure 1 the resulting data was superimposed on the high-resolution current google satellite image, then this dataset was analyzed and the structures against the zoning were detected.



Figure 1. Example illegal structures on the zoning roads

**5.2. Building Data Generated with the Help of Mobile Lidar**

Various detection systems have been developed in order to meet the rapidly increasing need for geographic information today. One of them is the Lidar (Light detection and ranging) system, which has become popular especially in the last ten years. (Ekercin & Üstün, 2004) Lidar is a popular remote sensing method used to measure the exact distance of an object on the earth's surface. According to the American Geological Institute, LiDAR uses a pulsed laser to calculate an object's variable distances to the earth's surface. These light pulses produce precise 3D information about the earth's surface and the target object. A Lidar device has three main components; scanner, laser and GPS receiver. Other

elements that play a vital role in data collection and analysis are the photodetector and optics. Helicopters, UAVs and airplanes are mostly used to obtain lidar data. In this study, building data obtained from mobile lidar data were obtained from necessary persons and institutions. (Fig.2)



Figure 2. High Speed, High Performance & Dual Browser Mobile Mapping System RIEGL VMX-450 (courtesy Koyuncu Lidar)

We generate the building data with the help of the point data in Figure 3-4. After structure data has been generated and boundaries had been plotted and connected by using the CAD software (Fig. 5).

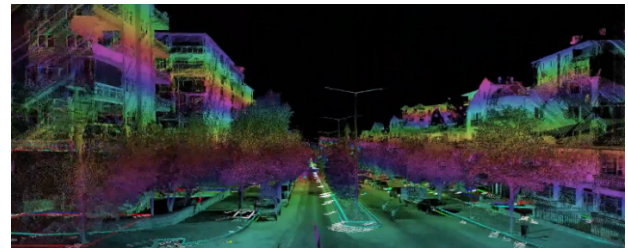


Figure 3. Mobile lidar point cloud data.

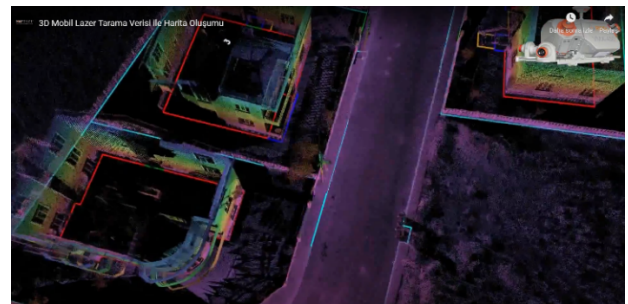


Figure 4. Building data and ownership boundary generated with the help of point cloud data.

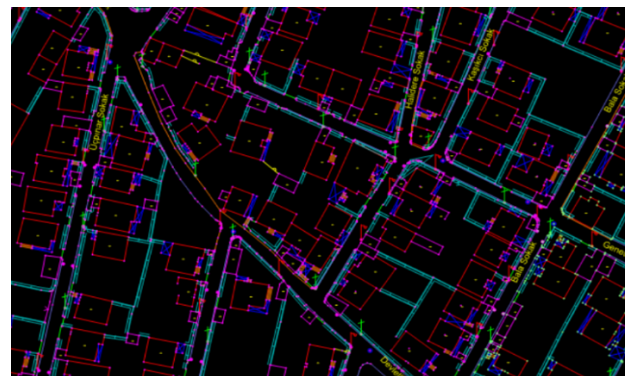


Figure 5. Structure data generated after the drawing step shown in Figure 4.



### 5.3. Zoning Plan Data

The documents containing the detailed plans and maps of the areas open to development are called zoning. The zoning status gives detailed information about how many buildings can be built on a plot and for what purpose. It's 1/1000 scale plans. (Fig.6). The zoning plan of our study area was taken and the necessary projection definition was made in order to be compatible with other data.

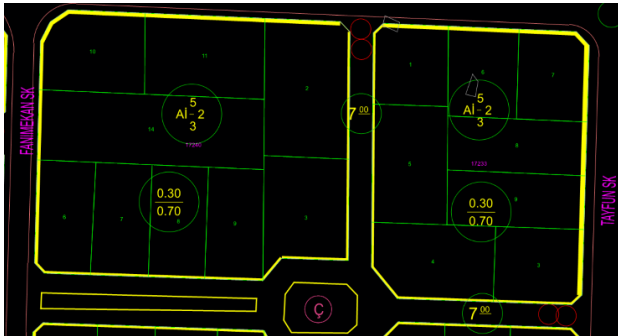


Figure 6. Parceled zoning islands.

### 5.4. Building Data and Zoning Plan Merging Process

At this stage, the building data created with the help of mobile lidar was combined with the zoning plan layer after the necessary coordinate transformation was made in the Netcad 8.5 GIS program. (Fig.7)



Figure 7. Merging of building data and zoning plan data.

### 5.5. Leakage build Detection with High Resolution Satellite Imagery

High resolution current google satellite image was added on the data seen in Figure 7 and the data were analyzed. (Fig.8-12)



Figure 8. Illegal structures on the zoning road.



Figure 9. Buildings contrary to zoning in the school area.



Figure 10. Illegal structures in roads and parking areas.

## 6. CONCLUSIONS

In this study, as seen in Figure 8, Figure 9 and Figure 10, using lidar data and satellite images, it was revealed that some buildings in the Ladikli, Hacı İsa Efendi, Arifbilge and Batı Hadimi neighborhoods of Meram district of Konya were built against the zoning plan. However, as can be seen in figures 11 and 12, it was revealed that some of the buildings identified with the help of current satellite images used in the study were demolished by the necessary authorities and suitable structures were built in their places.



Figure 11. Demolition of illegal structures.

NOTE: Red areas represent pre-existing buildings.



**Figure 12.** Buildings built in accordance with zoning instead of buildings constructed in violation of zoning.  
**NOTE:** Red areas represent pre-existing buildings.

## 7. DISCUSSION

These detected structures only ensured the detection of structures that encroached on areas reserved for public services and facilities such as roads, green areas, parking lots in the zoning plans, and were built in places with a definite construction ban. Apart from this, conditions such as license status, floor and order, floor area and neighbor distances should be examined separately.

The detection of these structures and the measures to be taken afterwards are extremely important for human life. Because the recent flood events, natural disasters such as landslides generally affect the structures built against the zoning law very seriously and can cost human life. In addition, since the identified buildings distort the silhouette of the city and cause distorted settlement, such studies should be accelerated and necessary steps should be taken as soon as possible so that the people of the city can live in a more prosperous environment.

In addition, the building data produced with the help of mobile lidar technology used in this study can be used in 3D cadastre and 3D zoning projects in the coming years.

## THANKS

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## Author contributions

The authors contributed equally.

## Conflicts of interest

There is no conflict of interest between the authors.

## Statement of Research and Publication Ethics

The authors declare that this study complies with Research and Publication Ethics

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## INTERNET ADDRESS

The World Bank Zoning and Land Use Planning (<https://urban-regeneration.worldbank.org/node/39>)