



# *The Impact of Expansion of Urban Area on the Agricultural Development*

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## Abstract :

The study aimed to monitor agricultural lands due to urbanization and to know the role of agricultural lands reduction on the developmental side in the study area, through the production of digital maps representing the urban expansion, agricultural lands, and wastelands during the time period from 1984 AD to 2017 AD in the study area, which surface is 361 km<sup>2</sup>. Several methods were used in the study, in addition to the questionnaire, satellite images, topographic maps, and statistical and spatial download, with the aim of coming up with a number of maps showing the reduction of agricultural land during various stages. The study reached a number of important results where it found that the surface of urban area increased from 3,80 km<sup>2</sup> in 1984 AD to 115,5km<sup>2</sup> in 2017 AD, which was accompanied by the reduction of the agricultural lands from 238,2km<sup>2</sup> to 92,15 km<sup>2</sup> during the same period while the wasteland area increased from 119 km<sup>2</sup> to 153,6 km<sup>2</sup>.

The study revealed that the reduction of agricultural lands affected the developmental aspects, including agricultural development in terms of lack of agricultural production and agricultural areas reduction. It also affected the environmental development represented by a reduction in green spaces, distorting the aesthetic view of mountains, and its effect on the local climate as a result of green spaces reduction and the expansion that affected the temperature and relative humidity, and in the movement of winds. This change varies from one region to another, as the local climate is more stable in the outskirts and more extreme in the center, where urbanization and areas of high population density are located.

The study found that the change that occurred in the mountain areas and distorted the aesthetic view has affected tourism development, and it showed that the most important factors that caused the deterioration of agricultural lands are roads and the increase in population size. The most prominent recommendation of the study was to establish laws that would prevent building on agricultural land as well as direct urban development towards non-agricultural wasteland, enacting laws and legislations, and continuing to modernize them whenever the need arises in order to preserve agricultural lands, which represent the most important pillars of agricultural, environmental and tourism development.

## Introduction:

The urbanization of agricultural lands is one of the most important modern and applied studies that has been the focus of much research and studies at the global, regional and local levels, because of its great role in achieving and improving development, especially since urban expansion is the result of misuse of the land, and this led to a decrease in vegetation cover, and a change in the ecosystem of the earth and the environment. This is evident in cities and various population groups that currently occupy more than 2% of the earth's surface (Lester R. Brown et al., 1985 AD, p. 220).

In addition, the various human activities that have contributed to meeting the continuous and urgent human need, to create the greatest possible luxury on the surface of the earth, have led to a growing demand for land ownership in an ill-considered and random manner far from developmental plans, which led to serious changes in agricultural land fertile. And these human activities have directly affected the developmental aspects that aim to achieve the well-being and social progress of many countries that suffer from the phenomenon of urban expansion on agricultural lands, without serious monitoring, causing many losses and developmental obstacles, including the deterioration of the agricultural sector, food security, in addition to the presence of natural disasters that led to droughts and floods, which caused an increase in the proportion of malnutrition in countries characterized by high population density dependent on agriculture, rain or irrigation as a result of periodic droughts, which took the lives of more than 3 and a half million people annually, and consequently causing ecosystem fluctuation, loss of moisture, desertification and soil drought.

The study of (El-Hafiane, 2001 AD, p. 18) indicated that developing countries suffer from an increase in the size of the population that has worked on the deterioration of agricultural lands, the destruction of the environmental milieu of a number of living creatures, the change of their natural habitat, and forcing them to leave it and move to a new environment, and then the death of these living creatures and not only that, but the emergence of pollution, and the spread of toxic substances, which led to a deterioration in environmental development.

The Republic of Yemen, like other countries in the world, suffers from urbanization on agricultural lands in most urban cities, which coincided with the entry of Yemen into the stage of renaissance and development since the beginning of the eighties and accelerated with the achievement of unity between the two parts. It contributed to the speed of linking the governorates together through road construction and cities expansion associated with urban and economic development, which resulted in high and irregular internal migration to urban areas, and the rapid and indiscriminate construction of cities, leaving environmental impacts as a result of urban expansion for residential, commercial and industrial purposes at the expense of fertile lands.

This has had a negative impact on the developmental side, including the reduction of agricultural areas, especially on valleys, and urban expansion on the outskirts of roads has produced environmental problems with far-reaching effects on the developmental side as well, including reducing agricultural productivity, destroying vegetation and soil erosion, and diverting watercourses and rock slides.

Hence, the topic of urban expansion on agricultural lands and its impact on the developmental aspect in Ibb city was chosen as a subject of study, especially since such a study is considered one of the modern applied geographic studies that has a role in supporting the developmental aspects, whether in economic or environmental development.

Remote sensing techniques, geographic information systems, data use, statistics and satellite images for the 7-TM-ETM + Landsat satellite have been used in order to monitor the ground changes during different time periods, draw the boundaries of that change and calculate the difference in areas shown to the extent of the deterioration that the study showed during the field landing and its matching with the satellite visuals, then come up with results, recommendations and future expectations that help planners in decision-making aimed at solving problems and preserving what remains of agricultural lands and achieving sustainable development.

### **The problem of the study:**

The urban expansion has led to a reduction of agricultural lands, which has affected the developmental side in its various fields, whether in the agricultural, tourist or environmental side, and the study came to answer the following questions:

- Is there an urban expansion on agricultural lands during the time period from 1984 AD to 2017 AD?
- What are the factors that have contributed to the increase of urban expansion?
- How has urban expansion affected agricultural lands in terms of development?
- What is the role of geographic information systems and remote sensing in achieving development?

### **The objectives of the study:**

The main objectives of this study can be summarized as follows:

- Production of digital maps showing urban expansion on agricultural lands during the time period from 1984 AD to 2017 AD using geographic information systems and remote sensing.
- Knowing the factors that contributed to the reduction of agricultural lands.

## Study Area:

### Spatial Boundaries

The study area is located in the governorate of Ibb in the south-central region of the Republic of Yemen, as shown in map (1) between two latitudes of 13° 55' and 14° 50' and two longitudes of 15° 44' and 44° 50' E, and it is bounded to the north by the two districts of Al-Makhadir and Hubaysh, and from the south the districts of As-Sabra and Dhi As-Sufal, Al-Siyani, and from the east are the districts of Ba'dan and As-Sabrah, and from the west are the districts of Al-Udayn and Al-Mudhaykhirah. The study area is characterized by being the most prolific region in Yemen in terms of the amount of rain that reaches about 1200 mm annually (Central Statistical Organization, 2004, p.23). The study area is also distinguished by the presence of fertile agricultural lands that are subject to deterioration and need serious attention to preserve them, in addition to what is characterized by its study area, from a relatively warm climate, and the source of a number of valleys, where the area of the study area is 361 km<sup>2</sup>, and is also characterized by the diversity of its topography and heights ranging from 600m to 3350m.

### Time Frame

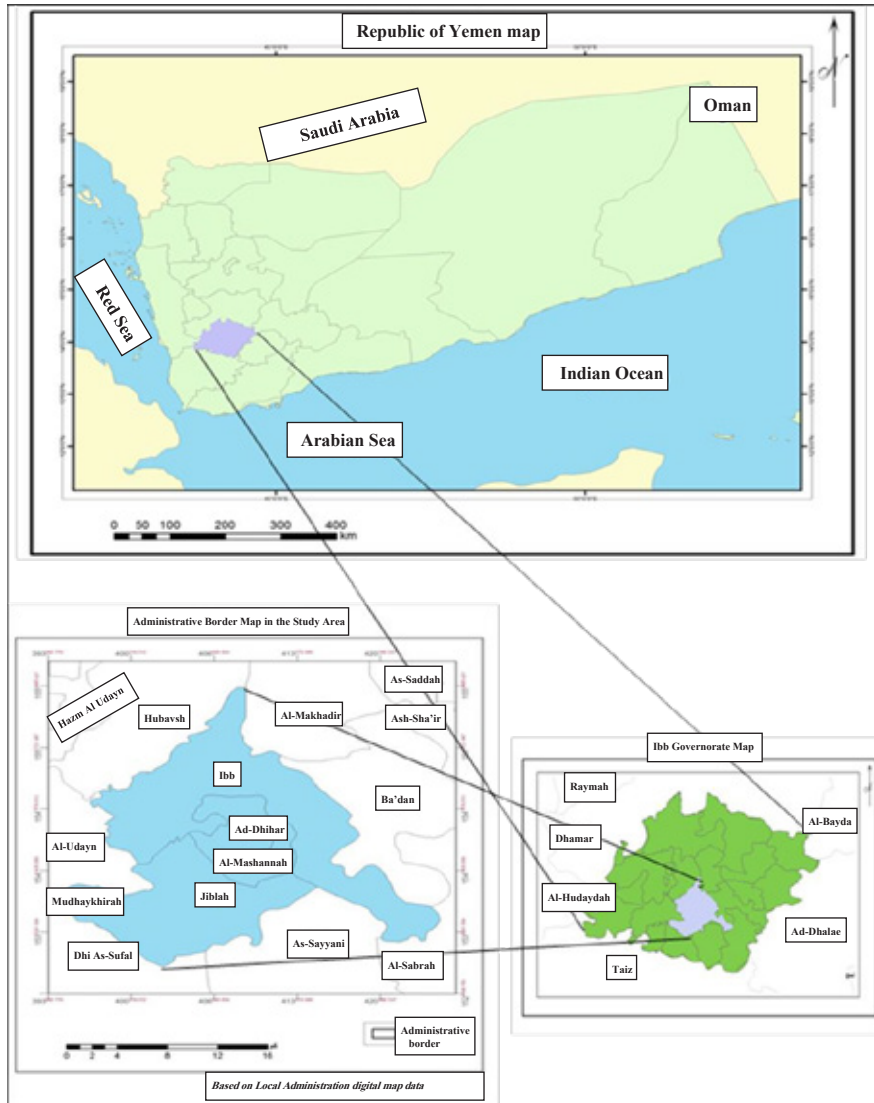
The study examines the urbanization of agricultural lands and its impact on the accompanying developmental aspect during the time period from 1984 AD to 2017 AD.

### Methodology:

This study is based on the analytical method by studying the change that occurred in the agricultural lands due to the urban expansion in the study area and by following the following steps:

- Studying the temporal change in agricultural lands through a practical comparison of time for urban expansion.
- Using a Geographic Information System (GIS) program to create layers, add information, correct images, number information, calculate areas for land cover types, and classify land cover using the Gustilo Anderson classification.





### **Data Used:**

This is represented in collecting and uploading data in this research through two steps, namely office work and field work.

### **Office work:**

- A- Data collection and input
- Non-spatial data by taking references and reports on the subject in particular or in general.
  - Spatial data represented by relying on the following satellite maps and visuals:
    - Topographic map
    - Ibb City map, scale of 1:50,000, for the year 1973 AD, and plate No 1544, issued by the Survey Authority and Land Registry.
    - Satellite visuals to study the phases of land cover change, and it was relied on the following images as in table (1):



**Table (1): The Satellite Visuals that were relied upon in the Land Cover Study**

Objectives	Procedures for Data Extraction	Number of Bands	Date Data	Spatial Data Accuracy	Type of Artificial Satellite	Type of Sensor	Years	M
Determine the types and surface of land cover represented by agricultural lands, wastelands and urban expansion	Using Supervised Classifications to classify land cover using <b>Erdas Imagine Software</b>	7	30/9/1984 AD	30	Landsat 5	Tm	1984	1
Determine the types and surface of land cover represented by agricultural lands, wastelands and urban expansion	Using Supervised Classifications to classify land cover using <b>Erdas Imagine Software</b>	7	30/9/1990 AD	30	Landsat 5	Tm	1990	2
Determine the types and surface of land cover represented by agricultural lands, wastelands and urban expansion	Using Supervised Classifications to classify land cover using <b>Erdas Imagine Software</b>	7	5/5/1995 AD	30	Landsat 5	Tm	1995	3
Determine the types and surface of land cover represented by agricultural lands, wastelands and urban expansion	Using Supervised Classifications to classify land cover using <b>Erdas Imagine Software</b>	7	23/12/2000 AD	30	Landsat 5	Tm	2000	4
Determine the types and surface of land cover represented by agricultural lands, wastelands and urban expansion	Using Supervised Classifications to classify land cover using <b>Erdas Imagine Software</b>	11	26/10/2010 AD	30	Landsat 8	Etm	2010	5
Determine the types and surface of land cover represented by agricultural lands, wastelands and urban expansion	Using Supervised Classifications to classify land cover using <b>Erdas Imagine Software</b>	11	24/10/2017 AD	30	Landsat 8	Etm	2017	6

Source: [www.usgs.earth.explore](http://www.usgs.earth.explore)

## **B- Satellite Image Processing**

The process of satellite visuals processing is important in order to build a high-resolution information base to study the urban expansion on agricultural lands, especially that the image is usually in its raw form and is not suitable for studying, in addition to the fact that it precedes the download and classification process.

Several programs were used, most notably the ERDAS Imagine 2014 program in processing, and the information processing went through the following stages:

- Radiometric correction
- Geometric correction
- Special processing

C- Determining the Study Area

D- Creating Data Base

## **Land Cover Classification:**

The study was prepared by following the other classification, which is the supervised classification, which is the selection of prior models by the researcher based on experience through prior knowledge of the study area, or the researcher's experience of the types of land cover. This study was identical to the study of (Al-Ani et al. 2011AD).

The following steps were relied upon in supervised classification, such as combining supervised and unsupervised classification in order to come out with the first-level land cover map for classification at first, then relying on the unsupervised classification in order to come up with the second level map for land cover classification and clarifying the area of each class with its spatial distribution and where it is concentrated in the study area.

## **E- Data Modeling and Analysis**

It is monitoring the changes in agricultural lands due to the urban expansion of the study area, making comparisons and creating several layers in order to know the changes and determine its quality negative whether negative or positive.

### Field Work:

It represents the most important measures followed in the course of the study, on an ongoing basis with the aim of observing and monitoring changes in the study area, the extent of its approval in the satellite visuals and maps, and noting the direction of urban expansion, and its impact on the change of agricultural land areas, valleys and mountainous regions. In addition to that, the field visit to the study area is of great importance in obtaining new and updated information.

#### **During the field study, the following methods were used:**

- **Topographic maps on the scale of 1.50000:** The purpose of this is to establish the topographic areas such as the plain areas, and specify their exact names, mountainous areas, and their locations, as well as the degree of slope of the urban expansion areas on agricultural lands.
- **An old and new satellite hardcopy image:** its purpose is to determine what is in the image and match it on the ground, especially agricultural lands with a large and clear area, while the transitional and small areas are difficult to distinguish, so an image will be taken from the Google Earth program and its purpose is to know the transitional areas, in the types of cover land, which is a small, indistinguishable transitional area, that is confirmed and identified.
- **Digital Camera:** To take pictures which show the extent of urban expansion on agricultural lands in the study area.
- **GPS (Global Positioning System):** To determine the latitude and longitude of agricultural lands, mountainous areas, and the extension of urban expansion.
- **Defining training areas:** The preparation of training areas represents a good prior knowledge of the study area, so that the satellite image is completely compatible on the ground, especially since field work represents the most important practical steps to

know and describe the types and varieties of land cover. And in order to determine the accuracy of the classification, the data and prior reference information must be provided to define the training areas, through the work of GPS points to determine the training areas, and the types of land cover for the study area. Then the correspondence between the supervised classification in the satellite imagery visuals, with the reality on the ground in the study area, making an inventory of the studied items, uploading the visuals taken, and determining the land cover patterns and areas that really need field descent, as the items are visible through the satellite imagery, especially fixed use, such as urban expansion, agricultural lands, mountainous areas, thus some varieties are unclear so, they are ascertained during field visits.

According to the research objectives set for this training, areas were defined, in order to provide more accurate details, which are to select small sites and make more than thirty ground control points to represent the different areas in the ground cover, and then study the relationship between the numerical values and the studied varieties. Hence, the method of studying during field visits was consistent with the study of (Al-Sheikh, 2012 AD, p. 321) in selecting the number of points during field visits. Then the stage of identifying and monitoring the change in agricultural lands arises, especially since agricultural lands are characterized by continuous change, so the researcher must be fully aware of the type of change that occurred and it can only happen by investigation, and field enquiry.

#### **- Conducting interviews**

By conducting an interview with farmers and individuals of the study area through the questionnaires that were used and obtaining a statistical download in the study of urban expansion on the agricultural lands of the study area, in addition to allowing questions to officials in the offices of the study area, and knowing the extent of the environmental deterioration resulting from this change, in addition to allow questions to officials in the offices of the study area and to know the extent of the environmental degradation resulting from this change, adding the

researcher's observation of the study area which has two phases; the first phase at the time of drought and the other at the time of rain, in order to know the cultivated agricultural lands and the uncultivated lands.

#### **- Data output extract**

through several maps, including:

1. Creating surprised classification based on the field study of each satellite imagery visual of the land cover in the study area.
2. Changing detection, which is a comparative work to detect change during the time period of 1984 AD – 2017 AD, based on the results of the supervised classification.
3. Building a model to detect land cover change and integrating digital maps.
4. Converting data from Raster to vector, then moving to ARC MAP program, in order to calculate the areas of land cover varieties for several stages and then come up with several maps to compare and know the extent of change and the impact of that change on the developmental side of the study area, and accordingly the following maps were made:
  - Maps of the types of land cover at the level of the study area during the time period from 1984 AD to 2017 AD

#### **First: Exposing the urban expansion on agricultural lands using the means of geographic information systems and remote sensing during the time period from 1984 AD to 2017 AD:**

##### **1. Urban expansion on the agricultural lands of the study area prior to the 1984 AD period**

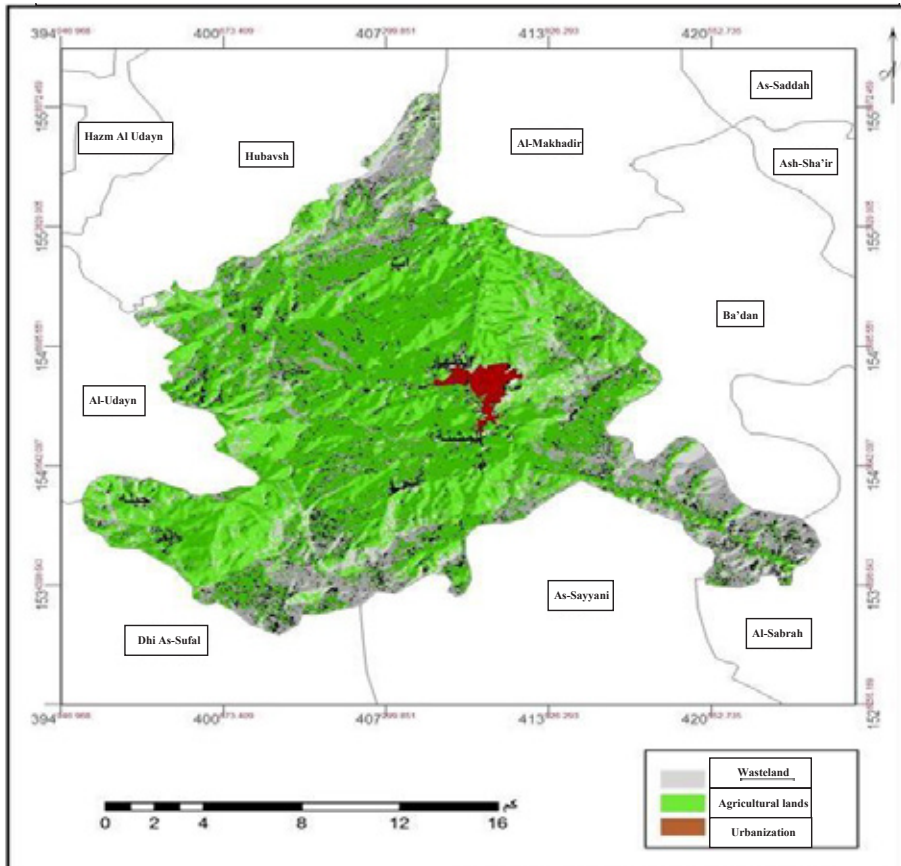
As a result of downloading the Landsat satellite image for the year 1984 AD, Map (2) shows that the urban expansion was not in a great way, as it still represents the least area in the land cover by about 3.80 km<sup>2</sup> at a rate of 1.05% Table (2) of the total area of the study area, as shown in Figure (1), and the urban expansion extended on the side of

the Taiz-Sana'a road towards the south of the study area, and Al-Udayn road towards the west.

In addition to that, there are many uses that were beneficial to the study area, but they changed due to urban expansion, including the surfaces of space. At this stage, the uses of the land entered and mixed, along the roads, including industrial uses, where the mixed side is concentrated, which consists of one building with different uses including commercial, residential, and industrial land. As for agricultural lands, they lost 1.4% of its area in favor of urban expansion, with an area of 238.2 km<sup>2</sup>, or 65.98% of the total area of the study area.

Consequently, agricultural lands have not noticed significant changes in them, as there is still attention to the land, and therefore the agricultural development process based on preserving agricultural lands still exists, and has an impact on the presence of a balance in the environmental and natural aspects, as no change has occurred in the wastelands. , which are mountainous areas characterized by the presence of forests and grass, which occupy an area estimated at 119 km<sup>2</sup>, or 32.97% of the total area of the study area.

**Map (2): Land Cover Classification for the Study Area during the time period from 1974 AD to 1984 AD**



*Source: The researcher based on the land-sat satellite visuals for the year 1984 issued by the United States Geological Survey*



## **1. Urban expansion on the agricultural lands of the study area during the time period from 2011 AD to 2017 AD**

The interest in studying the current urban expansion on the agricultural lands of the study area represents one of the most important pillars that have been researched in knowing and detecting changes in the study area on the one hand, and knowing the extent of their impact on the developmental aspects associated with this urban expansion on the other hand, especially since the previous stages had determined what it was in its natural state, but this stage confirmed the occurrence of continuous change due to various human activities, most notably urban expansion, as we find that its area reached 115.15 km<sup>2</sup>, with a percentage of 32% of the total area of the study area as shown in Figure (2). This means that the expansion increased by a difference of 35.1 km<sup>2</sup>, during seven years, and this expansion was on the western side, on the Al-Udayn road, with a distance of 9.96 km<sup>2</sup> to reach the last border in the Dar Al-Marjum area in Bani Madsam in the north of the Jiblah district and the far southwest of the city of Ibb. As on the southern side, the urban expansion was on the road to Taiz and Sana'a, and to a lesser extent than Al-Udayn Road in the west, and this is due to the presence of the treatment plant, which affected the limited expansion in this region, so we find that the urban expansion on it is 8.6 km<sup>2</sup>, while the southwestern side has reached building and reconstruction to the Al-Awtalia area in the Jiblah district, as the expansion was not limited to the main streets only, but extended greatly between Al-Udayn Street and Taiz Street. And this great expansion in this area is mainly due to the absence of prominent natural determinants that prevent the expansion in this area, but we also find that the urban expansion in the study area was initially planned, but the current expansion of the buildings is noticeable in a very random manner, especially in the southwestern part of the Akma Al-Saafani area, and this is what was found during the study from a map (3).

As for the level of the districts, it was noticed that there is a weakness in the agricultural development side, including the Ibb district, where the area of urban expansion increased from 7.6% to 27% in 1990 AD and 2017 AD respectively, which affected Agricultural Wadi Suhul, as the

area of fallow land in Ibb district increased from 33% to 42% during the time period from 1990 till 2017. This has affected the weakness of the agricultural development process. In addition to that, there is a weakness in the developmental aspect in the Jiblah district, as the urban expansion increased from 7.4% to 30.3% during the period of 1990 AD to 2017 AD respectively, and the area of agricultural land from has reduced from 68.6% to 25.76% in 1990 AD and 2017 AD respectively, while the area of fallow land increased from 23.9% in 1990 AD to 43.94% in 2017 AD.

As for Ad-Dhihar district, the weakness of environmental development is more evident than other directorates of the study area, as it is located in the center of the study area, where the area of urban expansion increased from 10.7% in 1990 AD to 52% in 2017AD , and this led to the deterioration of agricultural land and its shrinkage from 83% in 1990 AD to 3% in 2017 AD, and this shows that the Directorate of Ad-Dhihar represented the most directorates in the deterioration of agricultural lands at the level of the district of Al-Dhahar, and as Wadi Ad-Dhihar, which was famous for the agriculture during that period, almost completely disappeared, while the area of fallow land increased from 6.3% in 1990 AD to 45% in 2017 AD.

As for the Al-Mashannah district located in the center of Ibb city, it suffers from a severe weakness in the noticeable environmental development aspect due to the change of the land cover, as it is evident that the area of urban expansion increased from 13.51% to 50% in 1990 AD and 2017 AD, respectively, and this led to the deterioration of agricultural lands in the Al-Mashannah district, where it was 72.98% in 1990 AD, which decreased in 2017 AD to 14%, due to the large population concentration and the fact that it represents the center of the study area.

Hence, what accelerated the pace of urban expansion on agricultural land was the construction of roads without an environmental planning study and without concern for preserving the environment, and a very large population increase, especially during the war on Yemen due to the increase in the number of refugees to the study area being one of the safe and remote areas of armed conflict (Ash-Sharafi, 2019 AD, p. 132-152).

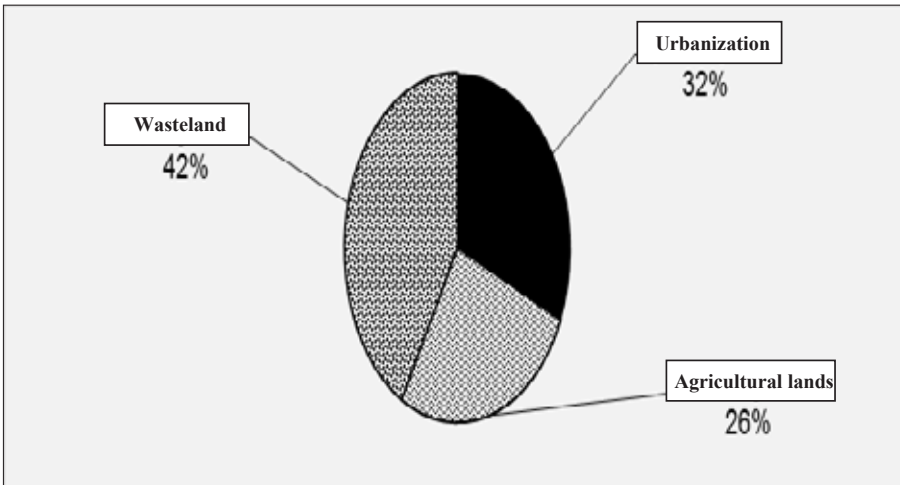


Figure (1): Land Cover for the Study Area during the time period before 1984 AD.

Source: The researcher based on Table (2)

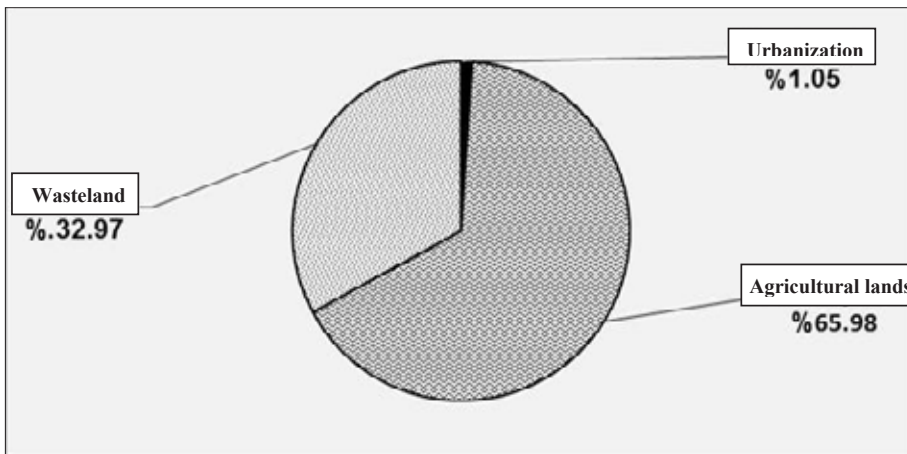
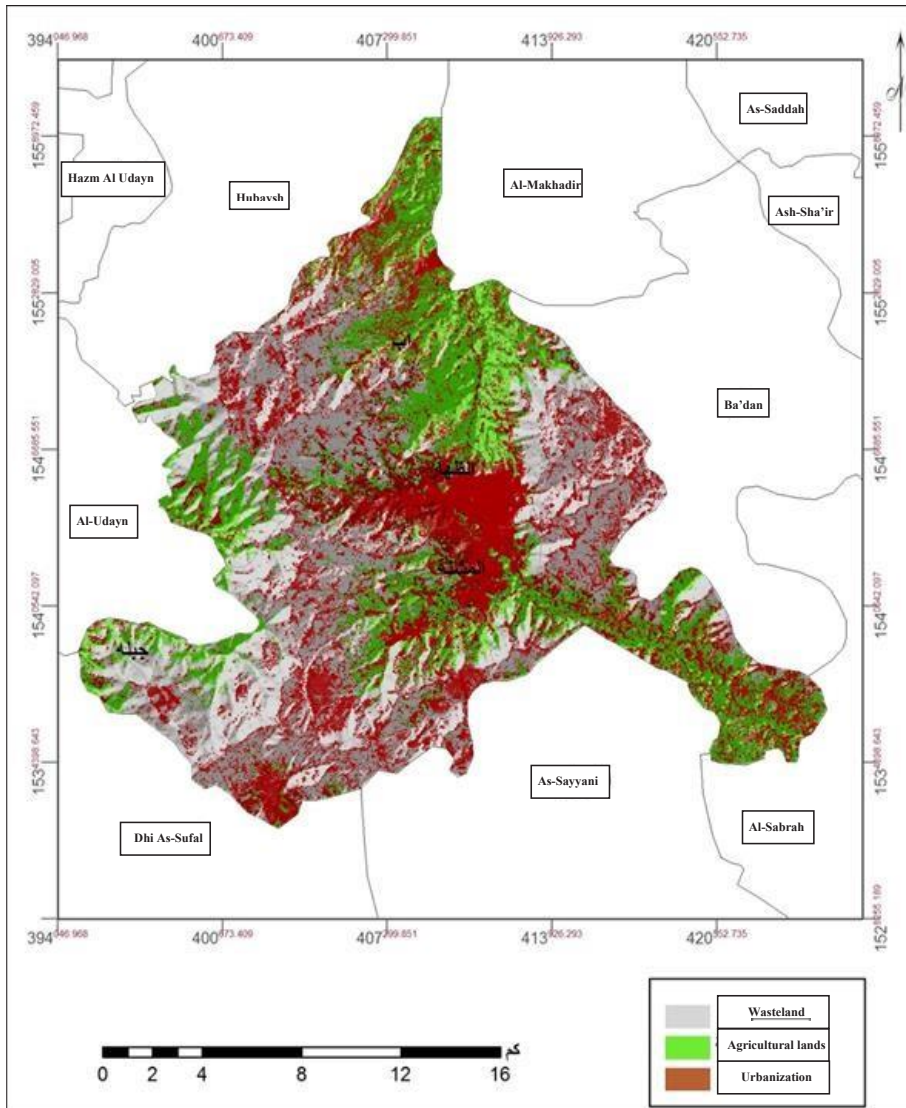


Figure (2): Land Cover for the Study Area during the time period from 2011 to 2017.

Source: The researcher based on Table (2)

Map (3): Land Cover Classification for the Study Area during the time period from 2011 AD to 2017 AD



*Source: The researcher based on the land-sat satellite visuals  
for the year 2017*

*issued by the United States Geological Survey*

The modern houses in the study area are random areas that lack planning, and this was at the expense of agricultural lands, as well as in the Jiblah region, which was a village surrounded by agricultural

lands in the seventies and eighties. In addition to that, the area includes a passage of valleys such as Wadi As-Sabt, which used to nourish the agricultural lands to a very large extent, and thus the agricultural lands area amounted to 92.15 km<sup>2</sup>, representing 26% of the total area of the study area. So, the difference in the change and loss of agricultural lands is 224.22 km<sup>2</sup> during the time period from 2011 AD to 2017 AD, due to the urban expansion.

All of the above-mentioned had a negative impact on the developmental side, especially the destruction of soil, its deterioration and removal due to many changes and modifications for the sake of building and reconstruction, in addition to the increase in the amount of garbage and solid waste polluting the environment, which affects the environmental development, as wastes spread in all lanes and neighborhoods of the study region, and the spread of sanitation near residential areas, which affected the environmental development side. This has emerged greatly at this stage, which is due to many factors, most notably the dense population growth in the study area, in addition to the political factor, and the conditions of war that the country went through, which had the greatest impact on the occurrence of drastic changes in terms of population movement and stability, as well as the suspension of the competent official and protected authorities from carrying out their duties.

Consequently, we find remarkable clarity in the urban expansion and the change of agricultural lands that have completely disappeared where only areas beyond the population concentration remain. In addition to that, we see the presence of many changes in mountainous areas and hills and even removed them completely, as in the Al-Jawazat area, where we find that there is clearance of soil which is characterized by the study area, which is very fertile agricultural soil, and a natural resource that is difficult to regenerate, as it took thousands of years to form, and it was changed, removed and replaced by urban expansion as we find that in Ring Road.

Consequently, this tremendous sweep of buildings during the period from 2011 AD to 2017 AD map (3) in a striking and noticeable way was not limited to changing agricultural lands, but extended to the natural vegetation cover. As for the northern side of the study area, we notice that there is an increase of urban expansion in an accelerated and frightening manner, and this is due to the limited land space, and the search for other lands, obviously with large areas, such as Kaa Sahul now, which represents a new model in the direction of unplanned construction towards it, which is famous for its fertility agricultural land and abundant water, which was the true aspect of agricultural development on the one hand, and a great example of the natural environmental aspect and a permanent outlet that the study area was famous for on the other hand. This is due to many factors, the most prominent of which is the war, as large numbers of displaced people began to live in it, in addition to the difficult economic conditions that the country is going through, and this led to the lack of control and strict laws that tend to the sale of land, according to well-thought-out plans and determining the path of building and reconstruction, so the role of planning was weak, rather it is clearly absent from the developmental side, which no longer has any interest either from the government side or by individuals who contributed to the excessive buying and selling of agricultural lands to achieve quick profits at the expense of a rare natural resource in which the loss was from the vast areas clearly, which was supposed to be preserved to achieve part of self-sufficiency and food security for a number of agricultural crops, at least at the individual level.

### **3. The role of geographic information systems and remote sensing in achieving development**

Geographic information systems and remote sensing play a major role in achieving development and even stabilizing development in all economic fields, because of their role in guiding decision-makers and choosing the most appropriate places for urban expansion, or for economic projects so that their location is appropriate and economically feasible for a long period of time in addition to the fact that monitoring ground changes directly contributes to reducing the size of economic

losses to achieve development. By monitoring agricultural lands that are subject to deterioration, it is possible to make recommendations to prevent construction in it and to identify other suitable places for construction as well as flood line areas. So, we can by satellite imagery prevent the construction in these places, because they constitute a major disaster and thus increase the losses which affect the developmental side. Therefore, it is necessary to take advantage of previous studies as well as modern means such as geographic information systems and remote sensing to reduce or at least mitigate the risks and impacts of natural disasters.

Table (2): Urban expansion on agricultural lands in the study area during the time period from 1973 AD to 2017 AD

%	2011 - 2017	%	2001- 2010	%	1996- 2000	%	1991- 1995	%	1985- 1990	%	1974- 1984	%	1973	Land cover varieties
32	115.15	22.2	80.05	19	68	9.4	34	8.3	29.8	1.05	3.80	0.4	1.27	Urban Expansion
26	92.15	31.7	114.39	40	146.14	49.6	179	65.8	237.7	65.98	238.2	3	240	Agricultural lands
42	153.6	46.1	166.56	41	146.86	41	148	25.9	93.5	32.97	119	33.2	119.73	Fallow grounds
100	361	100	361	100	361	100	361	100	361	100	361	100	361	Total

Source: - Researcher measurements based on Land-sat satellite visuals for the year 1973, 1984, 1990, 1995, 2000, 2010, 2017 using ARC MAP 10.5

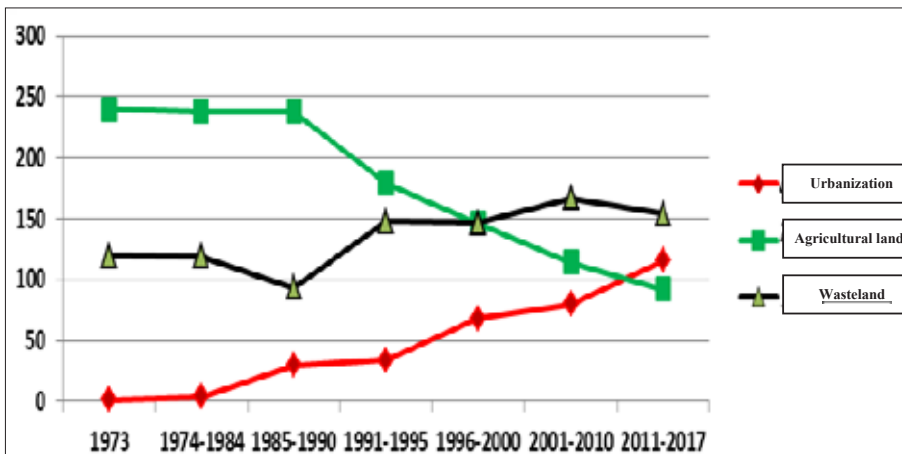


Figure (3): Land cover area (km<sup>2</sup>) in the study area during the time period from 1973 AD to 2017 AD  
 Source: Table (2)



### Second - Factors that Affect the Agricultural Lands reduction:

Table 3 and figure 3 illustrate the results of the questionnaire for the factors that affect the agricultural lands reduction, where we find that roads represent the first important factor affecting agricultural land with an average of 3.35, this means that the sample confirms with a high degree that the roads factor participated in the destruction of agricultural land that represent the most important ground coverings in the study area. This goes back to poor environmental planning in preserving agricultural land which had a negative impact on environmental development, in addition to factors like population size and rising land prices that affect agricultural land with an average of 3.15 , 3.01 respectively, while expatriate revenues occupied the last factor in affecting agricultural land with an average of 2.1, and this means that the study sample confirms that expatriate revenues contribute to the decrease in agricultural land indirectly via urbanization at the cost of agricultural land in the study area. While the overall average for the factors that affect the agricultural land is 2.91 and this indicates that the study sample agrees on average on the factors that play a role in the deterioration of agricultural land.

Table (3): Factors Affecting the Reduction of Agricultural Lands in the Study Area

Factors affecting the change of agricultural lands	Simple Moving (Average (SMA	Degree	Rank
Roads	3.35	Strongly	1
Population size	3.15	Moderate	2
Land prices increase	3.01	Moderate	3
Urban planning	2.97	Moderate	4
Climatic factors	2.96	Moderate	5
Endowment lands	2.90	Moderate	6
Individual Private Property	2.86	Moderate	7
Land uses	2.85	Moderate	8
Economic investments	2.68	Moderate	9
Expatriate revenues	2.10	Weak	10
Average	<b>2.91</b>	-	-

Source: the researcher's work based on the field survey questionnaire

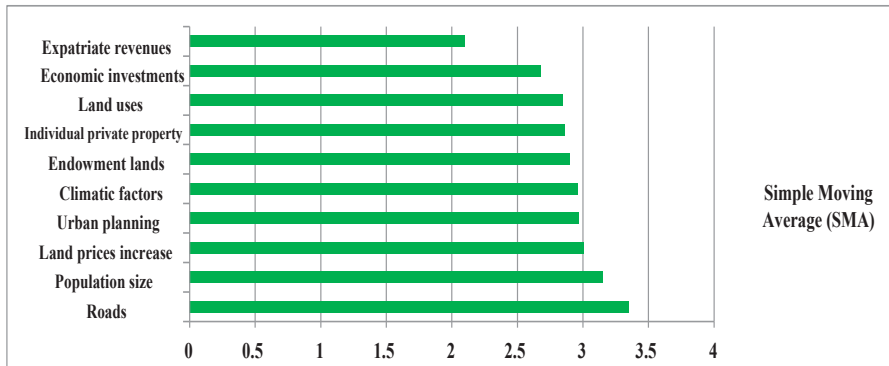


Figure (3): Factors affecting the reduction of agricultural lands in the study area  
 Source: the researcher, based on Table (3)

### Third: - Reduction of Agricultural Lands and their Impact on Development:

The development is the upgrading of society, and its transition from a situation to a better one, not in economic conditions, but in various aspects of life, in order to achieve the goals and improve the standard of living, which represents one of the most important stages of stability and development in the field of development (Medhat et al. p. 65, 2017 AD)

However, the reduction of agricultural lands in the study area as a result of urban expansion has hindered the development process and played a fundamental role in reducing agricultural areas that had an important role in improving the various developmental aspects due to mismanagement and failure of development plans, and this certainly has affected the various developmental aspects as follows:

#### First: Agricultural Development:

Preserving agricultural land is one of the most important aspects of contribution to the development, but the increase in the unexamined urban expansion on the most fertile agricultural lands has reduced the

agricultural areas that the study area had, so by monitoring the land cover for different years, it was found that there is a severe reduction in agricultural lands which was in 1984 AD at an estimated rate of 65.98% of the total of the study area, which is now only about 26% of the total of the study area and thus played a big role in increasing the food gap and decreasing the agricultural crops that the study area had in terms of grains of all kinds and fruits which affected the agricultural development in the study area.

This was demonstrated by field studies, where the results of the field questionnaire showed that the reduction of agricultural lands affected the developmental side that appears in table (4) and figure (4) and that the agricultural development has been affected by the lack of agricultural production which has taken first place as the largest result on SMA 3.63. This means that the study sample highly agrees on the fact that the lack of agricultural production is the result of the degradation and erosion of agricultural lands, owing to the fact that these lands in the study area contributed to the self-efficiency of the inhabitants of the study area, for it was known for growing different types of crops such as Kaa Sahul region and the vast agricultural Wadi Al-Dhihar.

### **Second: Environmental Development:**

Environmental development means preserving natural resources and protecting them from pollution and working to achieve balance and continuity and satisfy the needs of current generations while preserving the needs of future generations (Medhat et al. pp. 96, 2017 AD). However, the existence of the phenomenon of urban expansion has directly affected the environment and hindered the process of environmental development in the study area, due to the great sweep of many natural areas and the natural plants for which they were famous, such as the spread of some natural trees like teak and Cordia Africana, which used to cover large areas, especially some of the hills scattered in the city of Ibb, in addition to the increase in buildings and road construction, which increased the temperature and pollution, which can be noticed in the early morning times by observing the spread of polluted air accumulation over the city, in addition to the increase in

traffic congestion, which increased with the expansion of urbanization and population growth.

And through the questionnaire, it was found that there is a weakness in environmental development resulting from a reduction of agricultural lands, which received a high score in results, including reduction of green areas, distortion of the aesthetic view of the mountains and destruction of agricultural terraces.

While the section on the result of the high temperature in the study area was ranked last with an average of 2.89, this means that the sample moderately agrees that the high temperature is one of the effects resulting from the deterioration of agricultural lands and this is due to the presence of other reasons that contribute to the rise in temperature, such as global climate change, the fluctuation of the annual rainfall and the deterioration of land cover. In general, the average year for the results of the deterioration of agricultural lands reached 3.26, and this indicates that the study sample highly agrees with regard to the effects resulting from the deterioration of agricultural lands, and this indicates the size of the deterioration that resulted from the reduction of agricultural lands, which were identified through field visits.

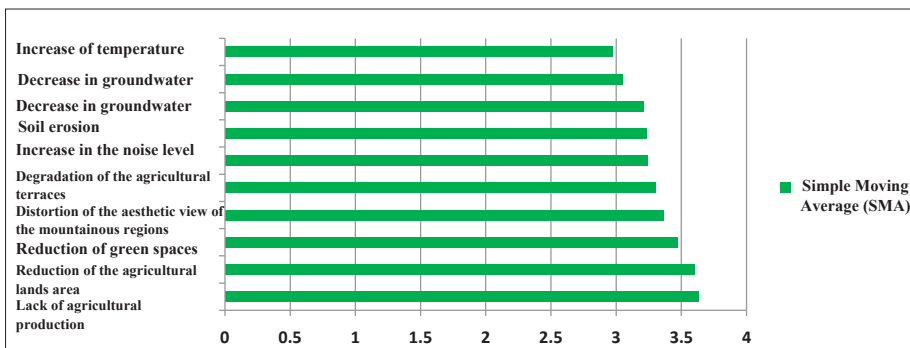
### **Third: Tourist Development:**

The reduction of the agricultural areas in which the study area was popular of, and observed by the satellite images for different years, has shown that there is an increase in concrete blocks, especially in the areas that were famous for tourist attractions such as Rabi Mountain, which in turn represents a tourist development aspect that must be preserved. However, this tourist attraction has been subjected to distortions due to random urban expansion, especially since the city suffers from very few green spaces due to the narrow area of the city on the one hand and the weakness of the planning factor on the other hand. Therefore, most of those who come for tourism go to the neighboring tourist areas, such as Al-Udayn region famous for Wadi Anah, Ba'dan District, Wadi Bena and other areas that have not been spared from environmental degradation as a result of urban expansion on agricultural lands, which affected the tourist development.

**Table (4): The Reduction of Agricultural Lands in the Study Area and its Impact on the Developmental Side**

Environmental degradation resulting from agricultural lands change	Simple Moving Average (SMA)	Degree	Rank
Lack of agricultural production	3.63	Strongly	1
Reduction of the agricultural lands area	3.60	Strongly	2
Reduction of green spaces	3.47	Strongly	3
Distortion of the aesthetic view of the mountainous regions	3.36	Strongly	4
Degradation of the agricultural terraces	3.30	Strongly	5
Increase in the noise level	3.24	Moderate	6
Soil erosion	3.23	Moderate	7
Increase in air pollutants	.37	Moderate	8
Decrease in groundwater	3.05	Moderate	9
Increase of temperature level	2.97	Moderate	10
Average	3.26		

*Source: the researcher's work based on the field survey questionnaire*



**Figure (4): The Reduction of Agricultural Lands in the Study Area and its Impact on the Developmental Side**

*The researcher's work based on Table (5-7)*

## Results and Discussion:

The results of the study showed that there is a reduction in agricultural lands due to the random urban expansion observed in the study area. The area of urban expansion in the study area increased from 3.80 km<sup>2</sup> by 1.05% in 1984 AD to 115.15 km<sup>2</sup>, which is 32% of the study area.

- The study revealed that the reduction of agricultural lands has mainly affected the agricultural development represented by the lack of agricultural production and the reduction of agricultural areas, and it has also affected the environmental development such as the reduction of green spaces and the distortion of the aesthetic view of the mountains through the random expansion of urbanization.
- The agricultural lands area decreased from 238.2 km<sup>2</sup> by 65.98% in 1984 AD to 92.15 km<sup>2</sup> by 26% of the total area of the study area, due to the increase and rise in the area of urban expansion.
- The study revealed that wastelands increased in size, as in 1984 AD they represented about 119 km<sup>2</sup>, or 32.97%, so the area increased in 2017 AD to 153.7 km<sup>2</sup>, by 42%, which means a neglect of agricultural lands.
- The means of geographic information systems and remote sensing have played an effective role in monitoring agricultural land areas during different years and indicated that there is a decrease in agricultural areas.
- The study revealed that there is a weakness in the agricultural development side at the level of the study area directorates, including the Ibb district, as the area of urban expansion increased from 7.6% to 27% in 1990 AD and 2017 AD respectively, which affected the agricultural Wadi Suhul, as the area of wastelands increased in size in Ibb district from 33% to 42% for the year 1990 AD and 2017 AD respectively.

- The study also revealed that there is a weakness in the developmental aspect in Jiblah district, as urban expansion increased from 7.4% to 30.3% during the time period from 1990 AD to 2017 AD respectively, and the area of agricultural lands decreased from 68.6% to 25.76% in 1990 AD and 2017 AD respectively, and the area of wastelands has also increased from 23.9% in 1990 AD to 43.94% in 2017 AD.
- As for Al-Dhihar district, the weakness of environmental development is more evident than other districts of the study area, as it is located in the center of the study area, where the area of urban expansion increased from 10.7% in 1990 AD to 52% in 2017 AD. This led to the deterioration of agricultural lands and their reduction from 83% in 1990 AD to 3% in 2017 AD which shows that Al-Dhihar district represented the most districts of which agricultural lands were deteriorated at the level of Al-Dhihar district, the disappearance of Wadi Dhihar (a large agricultural valley), which was famous during that period with agriculture, as well as the increase of the wastelands area from 6.3% in 1990 to 45% in 2017 AD.
- The results of the study showed that Al-Mashannah district suffers from a marked environmental weakness due to the change of land cover, as it is evident that the area of urban expansion increased from 13.51% to 50% in 1990 AD and 2017 AD respectively, and this led to the deterioration of agricultural lands in Al-Mashannah district, where it was 72.98% in 1990 and decreased in 2017 AD to 14%, due to the large population concentration and the fact that it represents the center of the study area.
- The study revealed that the most prominent factors that helped the urbanization increase on agricultural lands are roads and the population growth.



## Recommendations

- 1- Working on the development and enactment of the following legislation:
  - A. Preventing construction on agricultural lands, and directing urban development towards non-agricultural lands.
  - B. Modernizing laws in order to preserve agricultural lands, which represent the most important pillars of agricultural, environmental and tourist development.
  - C. Amending environmental management systems and establishing natural reserves for the purpose of preserving the environment and plant species from extinction and increasing financial funds for the environmental preservation and development work.
  - D. Organizing housing construction in cities and urban centers and reducing the flow of migration from the countryside to the city through the continuous development of integrated development programs for rural areas.
- 2- Involving governmental and supervisory agencies, civil society organizations, parties and political forces in working on afforestation around the city to reduce pollution and preserve the city's borders.
- 3- Adopting a comprehensive national plan aiming at preserving vegetation cover, especially around urban centers, and it is called the Comprehensive National Development Plan to protect the environment in areas of environmental sensitivity.
- 4- Introducing geographic information systems and remote sensing methods in all state agencies and the private sector because of their effective role in supporting and developing the development process and reducing time and effort for the process of inventorying natural resources in the smallest details.

### Suggestions:

- Conducting similar studies to find out the level of agricultural land decline versus urban expansion in the various Yemeni governorates and their impact on the developmental side.
- Working on classifying the cultivated and non-cultivable agricultural lands in order to develop solutions for them, organizing and exploiting them for other uses in order to preserve them or rehabilitate them in ecotourism.
- Encouraging the provision of agricultural loans so that the individual's income increases and helps to preserve agricultural lands so that he does not tend to sell lands and exploit them in the real estate side, which contributes to agricultural development.
- Extrapolating the experiences of countries that were suffering from the same problem, to benefit from it and extract practical solutions.

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