جامعة محمد خيضر بسكرة

كلية العلوم الدقيقة وعلوم الطبيعة والحياة

قسم علوم الأرض والكون

UNIVERSITÉ DE BISKRA

مذكرة ماستر

ميدان: هندسة معمارية، عمران ومهن المدينة

شعبة: تسيير التقنيات الحضرية

تخصص: تسيير المدن

رقم: ....

إعداد الطالب:

عبد الرحمان لهشمي

يوم: 2023/06/19

Contribution of spatial remote sensing and geographic information systems to the preparation of a multipurpose cadastre

---

لجنة المناقشة:

سومية عرامي	أ. مس أ	جامعة بسكرة	مقرر
صالح صيد	أ. مس أ	جامعة بسكرة	رئيس
نوال هبهوب	أ. مس أ	جامعة بسكرة	مناقش

السنة الجامعية: 2022 – 2023

اهداء :

إلى من أُفضِّلها على نفسي، ولِمَ لا؛ فلقد ضحَّت من أجلي ولم تدَّخر جُهدًا في سبيل إسعادي على الدَّوام (أُمِّي الحبيبة). نسير في دروب الحياة، ويبقى من يُسيطر على أذهاننا في كل مسلك نسلكه صاحب الوجه الطيب، والأفعال الحسنة. فلم يبخل عليَّ طيلة حياته (والدي العزيز). إلى اخوتي واخواتي واخوالي الأعزاء كل باسمه الى أصدقائي، وجميع من وقفوا بجواري وساعدوني بكل ما يملكون، وفي أصعدة كثيرة أُقدِّم لكم هذا البحث أقدم وأتمنى ان يحوز رضاكم.

Acknowledgments

First of all, we have to thank **ALLAH** for his assistance and guidance.

I acknowledge with deeply gratitude my supervisor, **ARAMI SOMIA**, I am Thankful for your valuable time, experience and useful comments.

Very special thanks to all STU teachers.

Last, I would like to thank everyone who shows me his or her support

Table of contents

list of Figure:

list of tables

Abbreviations:

DASE: Diachronic Analysis of Spatiotemporal Evolution.

ESRI: Environmental Systems Research Institute.

ETM+: The Enhanced Thematic Mapper Plus

GIS: Geographic Information Systems.

Landsat: Land Satellite.

LWIR: Long Wavelength Infrared.

NASA: National Aeronautics and Space Administration. NIR: Near Infrared.

OLI: Operational Land Imager.

SWIR: Short Wavelength Infrared.

TIRS: Thermal Infrared

Sensor. TM: Thematic Mapper.

USGS: United States Geological Survey. VNIR: Visible and Near Infrared

MPC: Multi-Purpose Cadaster

I. Introduction:

For centuries, humans have relied on land as a fundamental source of livelihood and development. With advancements in technology and scientific innovations, especially those that help them understand their vast and expansive surroundings with minimal effort and cost, high accuracy, and in a short period, it has become possible to use technology to improve land management and organization. One of the innovative technologies that has proven its worth in this field is the use of remote sensing and geographic information systems (GIS).

Remote sensing, in all its forms, including aerial imagery, satellite imagery, and other cutting-edge technologies, enables continuous monitoring of the Earth and its resources. It provides rich information about the Earth, revealing its hidden secrets from the vastness of space. This approach relies on measuring the reflected electromagnetic radiation from various natural resources to analyze and interpret it, highlighting their characteristics, features, and integrity. Each object on the Earth's surface has its spectral signature that distinguishes it from others and represents its condition. Thus, researchers can continuously monitor these natural resources and observe their changes, especially considering that the Earth's surface is subject to constant dynamics and vitality.

Geographic information systems (GIS) are computer systems that specialize in the storage, analysis, and management of geographic information. They serve as powerful tools for creating and updating a multi-purpose cadaster that contains accurate and comprehensive information about land parcels and related attributes. By integrating remote sensing data and other geospatial information, GIS enables efficient land administration, transparent property transactions, and informed decision-making.

The utilization of remote sensing and GIS in the development of a multi-purpose cadaster has revolutionized land management practices. It enhances the accuracy, comprehensiveness, and efficiency of land administration processes, leading to improved land governance, sustainable development, and equitable utilization of land resources. The multi-purpose cadaster serves as a valuable tool for land administrators, planners, and policymakers, enabling them to make informed decisions and promote effective land management for the benefit of society.

1. Problem Statement

Over the years, the notion of cadaster has developed to meet new demands or apply new methodologies. The cadaster's objective is to produce large-scale parcel maps that are more or less properly connected to property. However, regardless of the type of cadaster studied, a generic definition may be derived. A cadaster, in its broadest definition, is an inventory of land ownership that provides a more or less complete description designed to suit individual or communal requirements, notably in tax, land, legal, and economic problems.

The objective of the multi-purpose cadaster has thus been defined by the International Federation of Surveyors Congress in Ankara: the purpose of the multi-purpose cadaster is to provide the community with documents that can meet the needs of land administration, civil and rural engineering, land planning and urbanism, land use, public services economy, statistics, science, and research.

The problem lies in the outdated and inefficient methods of maintaining and updating cadastral records. These methods are time-consuming, resource-intensive, and prone to errors. Additionally, the lack of integration between different data sources and the inability to effectively capture spatial and non-spatial information hinder the comprehensive management and utilization of land resources.

Remote sensing and geographic information systems, for example, lead to a more efficient and adaptable multi-purpose cadaster. Remote sensing, such as satellite imagery and aerial photography, may provide multi-source and level data about the land, and geographic information systems (GIS) provide the framework for storing and managing geographic data, such as cadastral data.

2. Research questions:

-What data and information can be collected in a multi-purpose cadaster using remote sensing and GIS applications ?

- Landsat MSS digital imaging can be used as a support in terms of agrarian systems; the criterion used is the configuration of the fields?

- whereas this compartmentalization of space constitutes an adequate basis for agricultural statistical investigations?

- It provides an effective framework for developing a regional agricultural development policy?

3. Hypotheses

- Using a geomatic approach, it is possible to reconstruct a basic map of the study area and track its land use.

- The integration of spatial remote sensing and GIS technology in a multipurpose cadaster can enhance the overall effectiveness and reliability of land information. systems, leading to better land resource management and sustainable development outcomes.

- That it is possible, using LANDSAT data, to diagnose the effects of ecological imbalances and risks affecting agrarian systems on environmental facies problem

4. Research Objective:

- To improve transparency, accountability, and governance in land resource management by incorporating spatial remote sensing and GIS technology into the multipurpose cadaster.

- optimizes decision-making processes related to land resource management and sustainable development by utilizing the capabilities of spatial remote sensing and GIS in the multipurpose cadaster.

- To apply advanced spatial analysis techniques, such as change detection, spatial modeling, and geostatistics, to derive valuable insights and patterns from remote sensing and GIS data within the multipurpose cadaster.

II. # Chapter 01:

Fundamentals and Preliminary Concepts

Chapter 01: Fundamentals and Preliminary Concepts

1. Part 1: Terms and Definitions of Multipurpose Cadastral

1.1. The origins of the cadastre:

“From the very origin of societies, land has formed the essential basis of individual wealth. To meet their needs, the new communities created a levy on the products of this natural wealth, thereby creating property tax.

It very soon proved necessary to know about the area and the nature of the property of each and every one and to assess it, in order to spread this tax fairly.

This gave rise to the cadaster, an institution which goes back to the most ancient times.

A clay tablet dating back to 2300 years B.C. and giving the dimensioned drawing, the area and the description of a group of parcels was found at Telloh in the Arabian desert.

Le cadaster... 3 Juillet 1920: The Chaldean cadaster circa 2300 B.C. (According to "La Nature" of 3 July 1920).

The Egyptians, Greeks and Romans all had cadasters (the census was used as the basis of assessment for the tax and the related books were called capitastra).

In the Middle Ages, the cadastre served to establish tallage in the provinces where there was property tax.

Descriptive and evaluative registers of property called polyptychs and terriers... sometimes accompanied by plans of a highly variable value depending on regions, give a rough presentation of the parcels in areas.

Until the revolution of 1789, the cadastre kept an essentially local nature in France despite various attempts at the contrary. The kings Charles VII. Louis XIV and Louis XV envisaged in turn the project of a regular cadastre; the basis of a coherent tax system applicable to all the country.

The lack of finances, the shortage of sophisticated instruments and methods, the resistance of the great vassals, and the disparity of the provinces (customs, languages, measures...) made these attempts fail.

Only a few provinces provided themselves with an institution whose advantages are quite clear.

On the eve of the revolution, the basis of assessment of the tax relied on the same method as that laid down by Roman" (Oicrf).

1.1.1. THE NAPOLEONIC PERIOD

"The law of 15 September 1807 was at the origin of the French parcel cadastre.

Commenced in 1808, the works progressed rapidly until 1814 and then more slowly from 1814 to 1821. After 1822 they took place at a swifter pace and were completed in 1850 in continental France. They continued after this date in Corsica and in the annexed territories (Earldom of Nice and Savoy).

The parcel cadastre, called the "old cadastre", remained unaltered however as no updating was provided for.

Un plan... Ardennes A Napoleonic cadastral plan (1842 Remilly-les-Pothées Ardennes.

The parcel situation was to be transformed with the general evolution of the rural economy, and the development of towns, roads and railways, etc. It became essential to update the plan (keeping the cadastre up-to-date).

An extra-parliamentary commission in charge of studying the questions raised by the reform of the cadastre was created in 1891. Its works were completed in 1905 without having received legislative sanction.

Nevertheless, their usefulness cannot be denied as they inspired the works which finally led in 1955 to the reform of real estate registration and to the new rules applying to the renewal of the cadastre and keeping it up-to-date.

Cartouche... (1832) Cartouche of the cadastral plan of Bouligneux, in the Ain (1832).

Finally, the law of 16 April 1930 laid down an exceptional revision of the evaluations serving as the basis for the property tax of undeveloped properties. It set out the prerequisite of a general renewal of the old cadastral plans. chargeable to the State, and keeping them up-to-date on permanent basis" (Oicrf).

1.1.2. THE RENEWAL OF THE CADASTRE

"The law of 1930 limited the complete redrawing of the cadastre to the sole communes where it proved necessary for the basis of assessment of property tax.

A simple updating of the plan was laid down in the other communes when the value of the framework of the old cadastral plan was acknowledged as sufficient and when the parcels had not undergone too many modifications since the beginning. The renewal laid down by this law is today completed. This is still not the case in the departments of Alsace and Moselle where the renewal of the Napoleonic cadastre has been undertaken pursuant to a German law of 31 March 1884.

The principle of renewal was reintroduced within the framework of the reform of real estate registration of 1 January 1956 making it compulsory for properties to be designated by their cadastral identifiers in any act subject to real estate registration formalities (this is the case in particular of notarial acts).

There are now close relations between the cadastre and the real estate file held at the mortgage registries, recounting the legal events of property (in Alsace-Moselle, the system in force is that of the property book held by a magistrate, inherited from German law).

Finally, a law of 1974 authorizes a further renewal of the cadastre, called a "revision", whenever required by the lack of adaptation between the plan and the evolution of the parcel fabric" (Oicrf).

1.1.3. THE CADASTRE TODAY:

"Geometry... magnifique: A cadastre surveyor surveying with a theodolite equipped with an electromagnetic range finder.

An EXHAUSTIVE. PERMANENT. DESCRIPTIVE and EVALUATIVE inventory of landed property, the cadastre reflects the civil status of built and undeveloped property.

Its main missions are:

- fiscal (evaluation of real estate, determination of the bases for property taxes, identification of the taxable owners):

- legal and property related (identification and physical description of properties):

- technical (establishment of the cadastral plan and keeping it up-to- date, topographical pictures essential for the identification and physical description of the property in question).

Part 1: Terms and Definitions of Multipurpose Cadastral" (Oicrf).

1.2. the Cadastral Concept:

> "It is impossible to give a definition of a cadaster which is both terse and comprehensive, no two cadasters are the same. The form of the cadaster in each state or country is usually a consequence of the jurisdiction's historical development, its laws and custom and, to a large extent, its form of conveyancing and method of introduction of land registration" (Williamson, 1983, p 01).

Most authors writing on the subject attempt to define a cadaster. A definition which would have general acceptance is as follows:

> "A cadaster is a complete and up-to-date official register or inventory of land parcels in any state or jurisdiction containing information about the parcels regarding ownership, valuation, location, area, land use and any buildings or structures thereon" (Williamson, 1983, p 01).

> "The land parcel is usually the smallest individual ownership - in other words, the legal parcel is the basic building block of the cadaster. parcel parcel. having This There are some cases, however, when this parcel is not suitable and it must be divided into smaller units. This is usually for valuation or rating (fiscal) purposes or for land use classification. In a considerable number of cases the legal parcels must be aggregated to form. the larger ratable/land use parcel" (Williamson, 1983, p 01).

> "Even though a precise definition of cadaster is difficult, Dowson and Sheppard point out that the distinctive character of any cadaster is readily recognized and may be expressed as the marriage of" (Williamson, 1983, p 02,03,04):

1- A technical record of the parcellation of the land through any given territory, usually represented on plans of suitable scale; and
2- An authoritative documentary record, whether of a fiscal or proprietary nature or of the two combined, usually embodied in appropriate associated registers.

"In order to better understand the concept of cadasters, it is beneficial to examine the essential elements of a modern cadaster. These have been described numerous times by such authorities as Dale, Blachut, McLaughlin, Larsson, Henssen and Ziemann, and may be summarized as follows" (Williamson, 1983, p 02):

1- A series of large-scale maps showing property boundaries, all buildings and structures on the land and the major natural features.

In urban areas scales of 1:1000, 1:500 or greater are used, decreasing to about 1:2500, or less, in rural areas.

2- A register or number of registers containing information on ownership, valuation, land use and any other matters dealt with by the cadaster, for every land parcel. Of prime importance is that the basis of the cadaster is land parcels - not buildings, people or any other criteria. Even though many modern cadasters maintain information on fiscal matters within the cadastral registers, it is the legal component of the cadaster which has prime importance. The majority of the registers in the cadaster relate to legal matters, particularly concerning ownership and other legal interests in land, and conveyancing matters.
3- The cadaster must be complete, that is, every parcel of land in the state or jurisdiction must be displayed on the maps and included in the respective registers. Ideally, this would include all state-owned parcels including reserves, parks, roads and unalienated land, if applicable.
4- Each parcel in the cadaster must have a unique common identifier to be used by all authorities dealing with parcel-based information.

Ideally, the use of this identifier by all authorities should be enforceable at law. Common identifiers include:

a- volume number and folio number derived from title registration;

b- recorded survey plan number and parcel number;

c- rectangular land survey system descriptions (as found in the United States and Canadian rectangular survey systems);

d- municipal, village or regional unit and parcel number;

e- map number and parcel number;

f- municipality, suburb or region and street address; and

g- geographic coordinates.

5- The cadaster must be dynamic, that is, it must be continually updated. There must be legally enforceable procedures which require that all changes to the information in the cadaster must automatically and immediately update the registers.

6- The information in the registers must be correct and preferably have legal status and be guaranteed by the state. This aspect particularly applies to title registration but equally could apply to all encumbrances or matters affecting title.

7- The contents of the registers should be public, within ' reasonable limits.

8- The large-scale mapping system must be supported by a permanently marked and well maintained, coordinated survey system. Such a system is mandatory so as to be able to integrate all forms of spatial information.

9- The cadaster must include an unambiguous definition of parcel boundaries both in map form and on the ground - this is usually as a result of cadastral surveys, The most common method of carrying this out is to permanently monument the parcel boundaries. These monuments are then surveyed by ground methods with the corresponding measurements being displayed on technical maps. In such a system, the boundaries of each parcel can be precisely defined and located on the ground even if the boundary monuments are missing or disturbed.

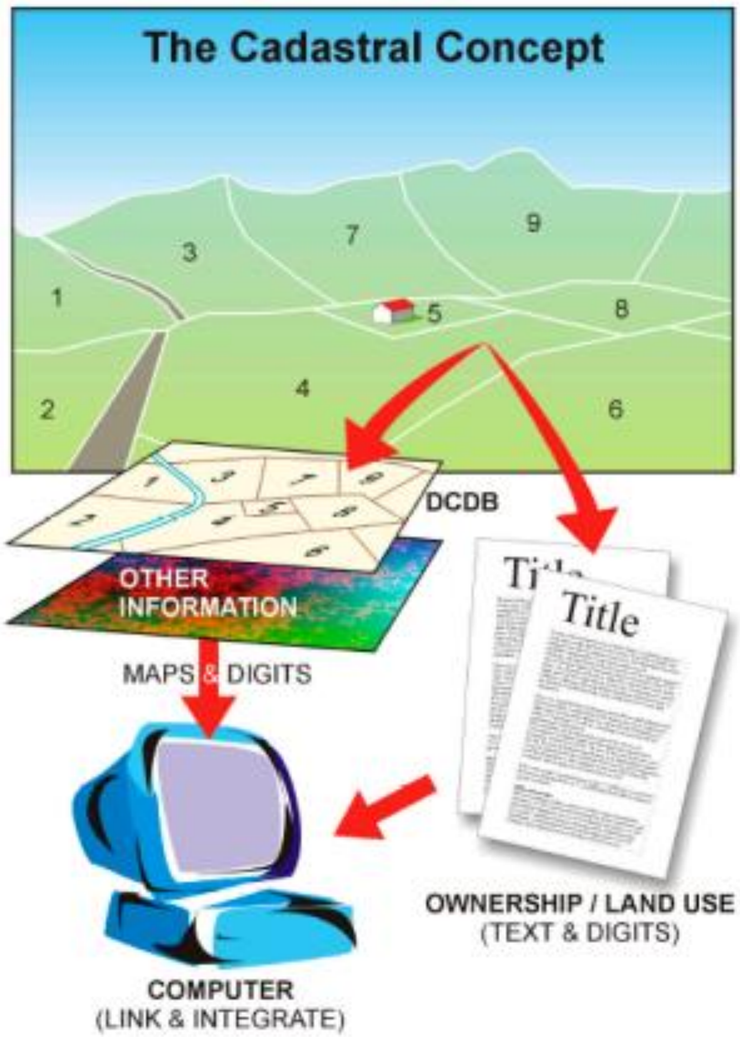


Figure 1 The Cadastral Concept (Williamson)

1.3. Classification of Cadastral System:

They can be grouped under three general heads (Abdeta Daba, 2022, p.138):

1- Tax Cadaster.

2- Real Cadaster.

3- Legal Cadaster.

4- Fiscal cadaster.

5- Multipurpose cadaster.

1.3.1. The Tax Cadaster:

It is a system of survey where information is collected for land taxation. The tax may be assessed based on area of land, type of land, value of land and produce of the land. The physical survey may be represented by sketch. Usually, accuracy of the survey is low since main objective is tax collection. The determination of rightful ownership is not done since main objective is tax collection. As long as someone agrees to pay taxes, it does not matter to the government who the rightful owners are. (Abdeta Daba, 2022, p.138).

1.3.2. Real Cadaster:

In contrast, the real property Cadaster is executed mainly for the physical mapping of land holding boundaries and locating real other properties for land inventory. Real property includes not only land, but also buildings, trees etc., which are permanently fixed to it. Minerals below the surface are also integral part. However, in the legal courts of many countries; private ownership of mineral deposits does not necessarily follow from the ownership of the land. (Abdeta Daba, 2022, p.138).

1.3.3. Legal Cadaster:

Surveys are which furnishes information for the registration of the land. Determination of legal Ownership and Registration of legal transactions is called as legal cadaster. The requirements of physical survey of land boundaries preceding registration may not be necessary since registration can be based on old documents. Thus, in general, the legal cadaster is a complement to both property cadaster and tax cadaster. Hence, the most efficient approach is to take all three objectives together and integrate the three types of cadasters in one system. This, in essence is Land Information System or LIS. (Abdeta Daba, 2022, p.138.139).

1.3.4. Fiscal cadaster:

Fiscal cadaster is a record of information necessary for levying property taxes, which includes location and value of parcel. Frequently, the occupant of the parcel is identified for tax purpose, and no effort is made to determine the legal owner. Governments need income, which generally is generated through some sort of taxes. One major resource in country that can be taxed is land and land related properties. Thus, a fiscal cadaster must include enough information to calculate a value using certain valuation. (Abdeta Daba, 2022, p.139).

1.3.5. Multipurpose cadaster:

An integrated land information system containing legal (e.g., property ownership or cadaster), physical (e.g., topography, man-made features), and cultural (e.g., land use, demographics) information in a common and accurate reference framework. The reference framework typically is established with rigorous geodetic and survey control standards, such as the state plane and latitude/longitude coordinate systems. The Cadaster is made up of multiple independent, interrelated layers commonly used to describe the graphic component of a GIS database. Each layer contains a set of homogeneous map features registered position ally to other database layers through a common coordinate system. Data are separated into layers based on logical relationships and the graphic portrayal of sets of features. A relatively new development that incorporates, at one source, the data concerning the legal and fiscal cadaster along with information on land use, infrastructure, buildings, soil and other factors. (Abdeta Daba, 2022, p.139).

1.4. The need for an MPC:

"The findings of the Panel on a Multipurpose Cadaster Committee on Geodesy in 1983 that problems inherent in the present land information system be categorized as follows" (Shamsul Abdul, 2000.p24):

1- Accessibility;

2- Duplication;

3- Aggregation;

4- Confidentiality and

5- Institutional structure.

"The Panel suggested the MPC concept forms the basis for action to remedy these problems that exist in current systems. The committee had also constituted the essential requirements for the development of a MPC. These are as follow" (Shamsul Abdul, 2000.p24.25):

1. The development of technical standards and specifications and the means to enforce these;
2. The development of linkage mechanisms in order to relate other geo-spatial data to the basic components;
3. An emphasis on gradual, phased re-organization and quality control of existing government functions, rather than the creation of new functions and agencies;
4. A focus on the municipality level as the place where much of the work in developing and maintaining a MPC will occur, with appropriate support by state and federal government; and
5. The development of qualified personnel through encouragement and support of university research and education.

"The MPC should be designed to record, store and provide not only land-tenure and land valuation information but also a wide variety of land-related facts. The Panel further supported that if a MPC is truly multipurpose, it does not only receive information and data from many sources, but it also provides services and products for many purposes and to many users" (Shamsul Abdul, 2000. p25).

"Therefore, in many ways, the MPC is designed to address the inherent problems in the geo-spatial industry by (Shamsul Abdul, 2000.p25)":

A. Providing comprehensive records of land-related information and;
B. Presenting this information at the parcel level.

1.5. Fundamental Components of an MPC:

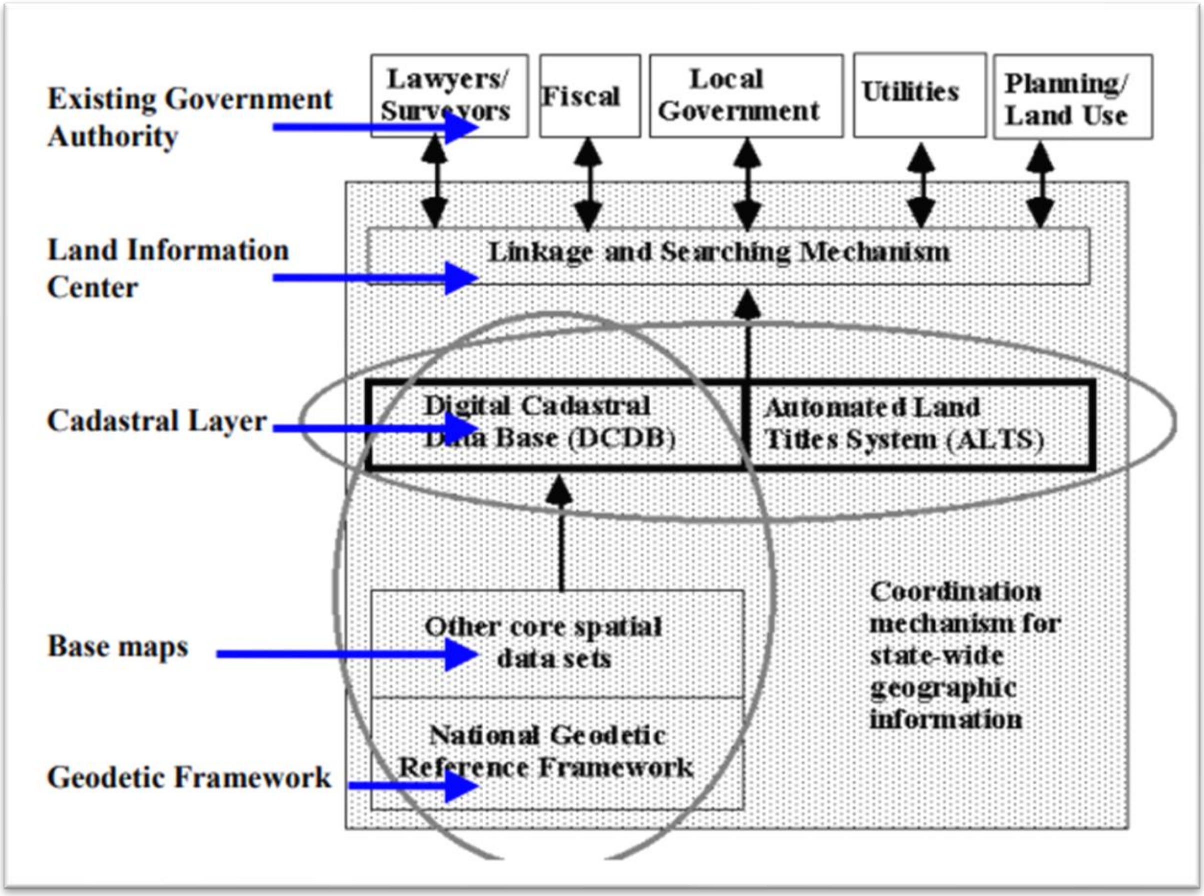


Figure 2 Fundamental Components of a MPC (Shamsul Abdul, 2000)

"A MPC consists of public inventories that support and overcome the difficulties associated with traditional and in some aspects, limited capabilities of the modern cadaster. The Panel on a Multipurpose Cadaster in 1983 proposed that the fundamental components of a MPC should include the geodetic framework, the base map and the cadastral layer" (Shamsul Abdul, 2000. P26).

1.6. BENEFITS OF THE MULTI-PURPOSE CADASTRE:

"With the FIG and many government agencies expressing their interest to release their registers, map series and databases to the greatest extent possible, the creation of an MPC will be a welcoming effort by many. With most land information being produced by government authorities, the development of the MPC will be largely dependent on the commitment and contribution from these authorities. The MPC is envisaged to benefit a range of potential users such as federal, state and local governments, private firms, individual, academia and regional bodies”. (Abdul Majid, 2000.p23)

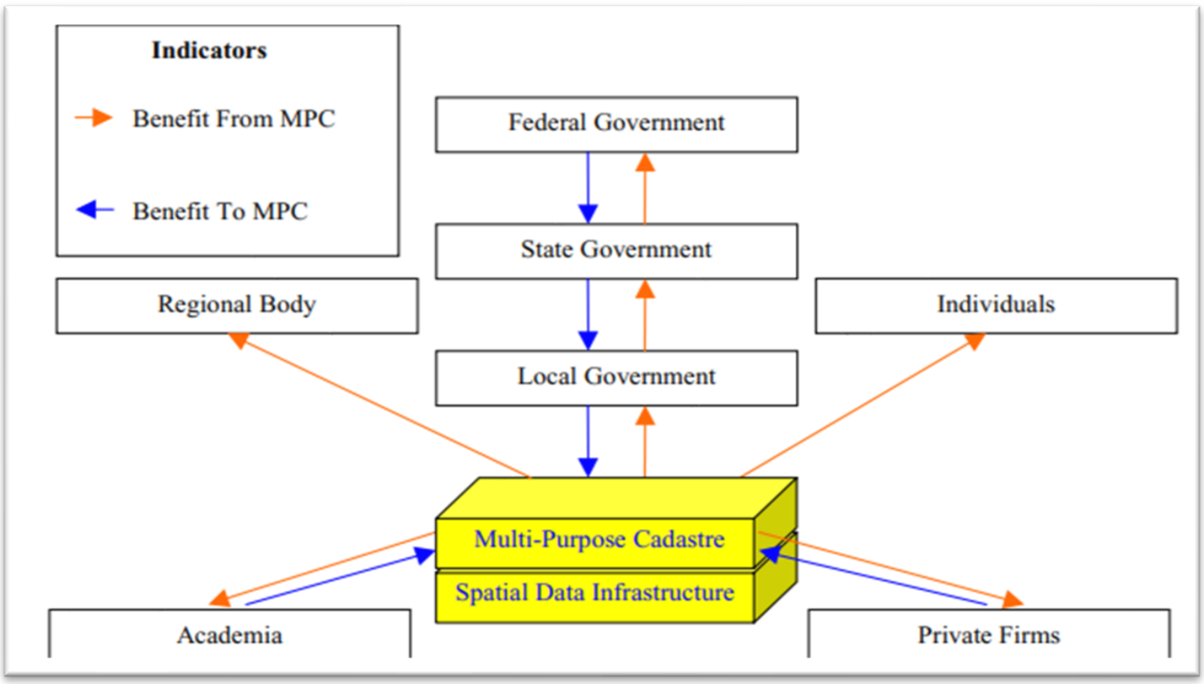


Figure 3 Benefits of the Multi-Purpose Cadaster (Abdul Majid, 2000.p23)

“Federal governments are the roots of any national administration of land and other resources. Through an MPC, a flow of standardized data for updating federal maps and statistics for use in national-wide census to efficiently manage federal assistance to local programs such as community housing and developments can be achieved. Small-scale national maps and themes can be linked to more accurate databases from state and local governments”. (Abdul Majid, 2000.p23).

“State governments are the mechanisms for the administration of state affairs, regulations and interests. State maps could be related with other detailed maps and databases available from private firms and local governments. State governments could also easily share information between themselves and local governments". (Abdul Majid, 2000.p23).

"The Panel on Multi-Purpose Cadaster Committee suggested that one of the biggest users of MPC would be local governments (Panel on a Multipurpose Cadaster 1983). This is because an MPC allows for better data to be used in any public transactions with the local governments. Local governments in turn have access to other related geo-information using an MPC. Higher accuracy data when needed, is available through existing connectivity with other geo-information repositories. The production of new themes or datasets may not be necessary because local governments and government authorities may collectively agree to share land related resources through the MPC. As a result, a MPC will dramatically reduce costs of maintaining separate map systems and land information". (Abdul Majid, 2000.p23)

"Private sectors will also benefit from the MPC through efforts such as the production of standard and regulations, sharing of themes and datasets and large-scale maps, amongst others. Most importantly, the private sector will benefit from the manner in which the MPC will speed up administrative actions and reduced costs in dealing with government authorities". (Abdul Majid, 2000.p24)

"Academic institutions will play a vital role in ensuring that the purpose and creation of the MPC serves the whole of community. Academic institutions will continue to contribute through extensive research and education into areas such as human interaction with the MPC, feasibility studies and the data transfer formats". (Abdul Majid, 2000.p24)

"Individuals as the end-users would greatly benefit from efficient delivery of geo-information. The MPC will allow members of the public better access to geo-information than ever before. Faster access to records affecting individual rights, such as planning control, native title and land title issues could be achieved. The MPC is also expected to clarify minor boundary disputes through simultaneous access to planning, cadastral, title and customary land title databases. Ultimately, the public's attitude towards the administration of local governments programs may improve". (Abdul Majid, 2000.p24)

“The MPC could also benefit regional institutions such as European Umbrella Organization for Geographic Information (EUROGI) and Permanent Committee on GIS Infrastructure for Asia and the Pacific (PCGIAP). Regional institutions strive on the collaboration of their member nations on matters that extend beyond their respective national boundaries (European Umbrella Organization for Geographic Information 2000), (Holland 1998). Regional disasters such as the forest fires and oil spills would greatly benefit from a MPC as countries require greater use of national data. Furthermore, the implementation of SDI will be particularly evident when member nations could share themes, datasets and information through an MPC”. (Abdul Majid, 2000.p24).

1.7. The legal framework:

Article 02 of Order 74-75 dated November 12, 1975, which involves the preparation of a general land survey and the establishment of the land registry, states: "The general land survey determines and defines the natural boundaries of properties and serves as the material basis for the land registry."(The Official Gazette, issue number 97, dated [year1997].)

Referring to the text of Article 04 of Decree number -76 62 dated March 25, 1976, concerning the preparation of the general land survey, as amended and supplemented by Decree number 400-84 dated December 24, 1984, we find that the land survey operations provide us with the physical structure and nature of the land. This is necessary in rural areas to determine the physical structure and nature of land occupation or allocation, as well as the pattern of use for buildings erected on it or its exploitation. It also describes each floor in relation to urban properties."(The Official Gazette, issue number 97, dated [year1997].)

On the other hand, the purpose of the survey is to identify the owner and apparent property rights, as well as the method of exploitation. This is achieved by determining public and private properties, ensuring that the boundaries between properties, in their various forms, are permanently established through the use of landmarks such as stones or other symbols."(The Official Gazette, issue number 97, dated [year1997].)

It is evident from the previous texts that the process of land surveying is a dual process with two aspects, a technical aspect. It involves the work carried out by surveyors affiliated with the responsible authorities."(The Official Gazette, issue number 97, dated [year1997].)

In the process of land surveying, surveyors work to determine property ownership and accurately measure the area of each parcel for the purpose of preparing an organized cadastral map for each municipality. This map helps in organizing the territory of the state and identifying the locations, boundaries, and structures of properties, as well as determining the adjacent properties. It serves both technical and legal aspects."(The Official Gazette, issue number 97, dated [year1997].)

"The technical aspect involves defining the properties and indicating their legal status by creating an identification card for each property. This card includes the names of the owners, the reasons for ownership, and the corresponding property rights.

It is also evident that the Algerian legislator did not provide a clear and precise definition of the land surveying process but focused on the objectives, which include defining the natural boundaries of various types of properties and identifying their owners.

The legal basis for land surveying in Algeria is derived from Order 73-71 dated November 8, 1971, which is related to the agricultural revolution, particularly Article 25. This article states that upon completion of the agricultural revolution-related projects in a municipality, the surveying documents for that municipality should be prepared based on the collective property card(" The Official Gazette, issue number 97, dated [year1997].)

2. Part 2: Remote Sensing and Geographic Information Systems

2.1. What is Remote Sensing?

“Remote sensing is the science of obtaining the physical properties of an area without being there. It allows users to capture, visualize, and analyze objects and features on the Earth’s surface. By collecting imagery, we can classify it into land cover and other types of analyses”. (GISGigography).

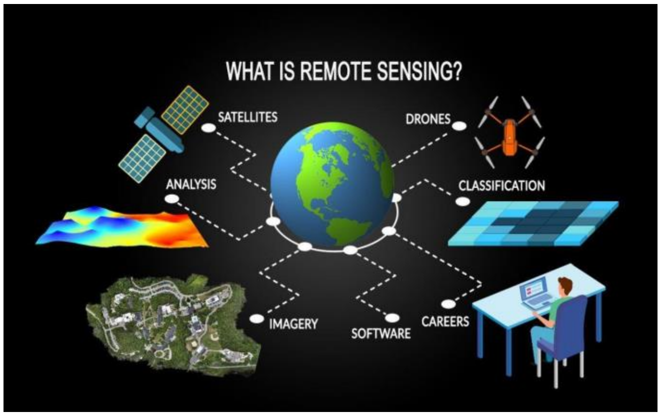


Figure 4 : What is Remote Sensing (GISGigography)

2.1.1. SPATIAL RESOLUTION:

“Is the detail in pixels of an image. High spatial resolution means more detail and smaller pixel size. Whereas, lower spatial resolution means less detail and larger pixel size.

Typically, drones like DJI capture images with one of the highest spatial resolutions. Even though satellites are highest in the atmosphere, they are capable of 50cm pixel size or greater.” (GISGigography).

Figure 5 SPATIAL RESOLUTION (GISGigography)

2.1.2. SPECTRAL RESOLUTION:

Is the amount of spectral detail in a band. High spectral resolution means its bands are narrower. Whereas low spectral resolution has broader bands covering more of the spectrum. (GISGigography).

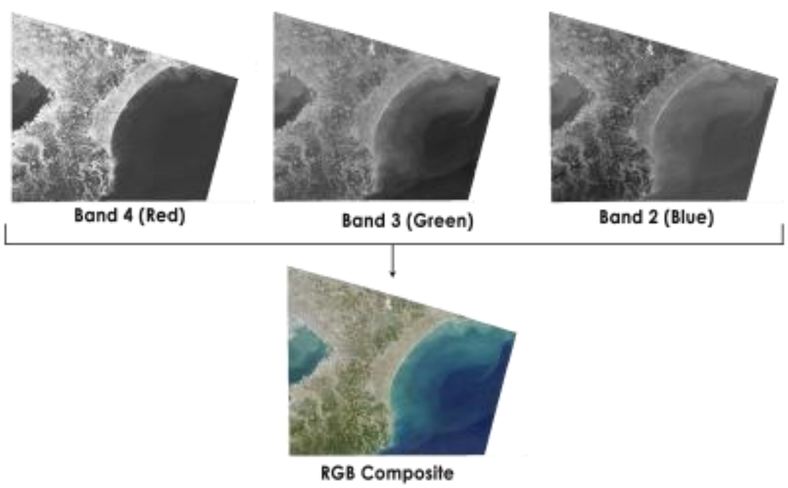


Figure 6: SPECTRAL RESOLUTION (GISGigography)

2.1.3. TEMPORAL RESOLUTION:

Is the time it takes for a satellite to complete a full orbit. UAVs, airplanes, and helicopters are completely flexible. But satellites orbit the Earth in set paths.

Global position system satellites are in medium Earth orbit (MEO). Because they follow a continuous orbital path, revisit times are consistent. This means our GPS receiver can *almost* always achieve 3 satellites or greater for high accuracy. (GISGigography)

2.1.4. ELECTROMAGNETIC SPECTRUM:

"Our eyes are sensitive to the visible spectrum (390-700 nm). But engineers design sensors to capture beyond these wavelengths in the atmospheric window.

For example, near-infrared (NIR) is in the 700-1400 nm range. Vegetation reflects more green light because that's how our eyes see it. But it's even more sensitive to near-infrared. That's why we use indexes like NDVI to classify vegetation" ***(***GISGigography***).***

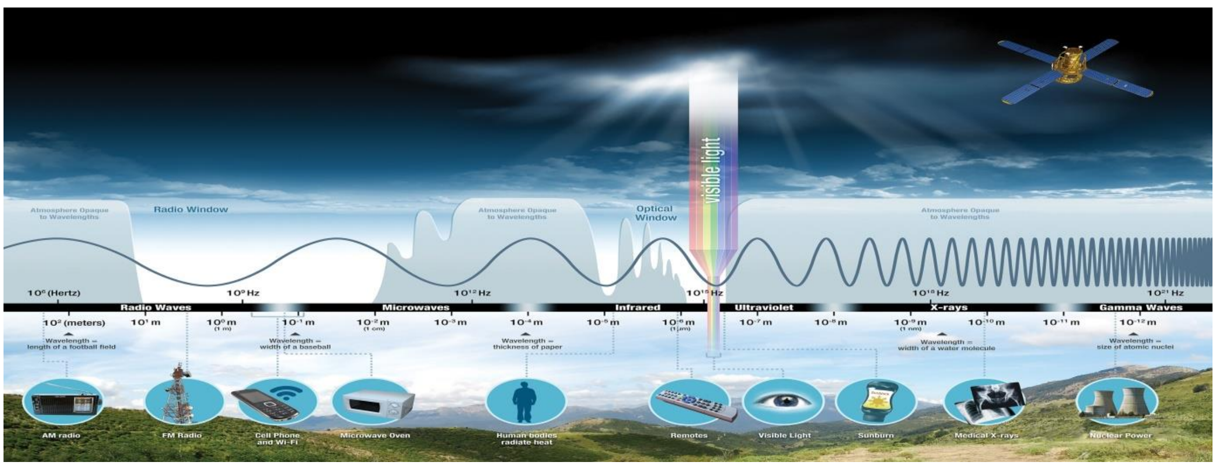


Figure 7 ELECTROMAGNETIC SPECTRUM (GISGigography).

2.1.5. SPECTRAL BANDS:

"Spectral bands are groups of wavelengths. For example, ultraviolet, visible, near-infrared, thermal infrared, and microwave are spectral bands.

We categorize each spectral region based on its frequency (v) or wavelength. There are two types of imagery for passive sensors: Multispectral imagery and Hyperspectral imagery

The main difference between multispectral and hyperspectral is the number of bands and how narrow the bands are. Hyperspectral images have hundreds of narrow bands; multispectral images consist of 3-10 wider bands.

MULTISPECTRAL IMAGERY: generally, refers to 3 to 10 bands. For example, Landsat-8 produces 11 separate images for each scene.

HYPERSPECTRAL IMAGERY: has much narrower bands (10-20 nm). A hyperspectral image has hundreds of thousands of bands.

For example, Hyperion (part of the EO-1 satellite) produces 220 spectral bands (0.4-2.5 um)." ***(***GISGigography***).***

2.1.6. Image Classification

"When you examine a photo and you try to pull out features and characteristics from it, this is the act of using image interpretation. We use image interpretation in forestry, military, and urban environments.

We can interpret features because all objects have their own unique chemical composition. In remote sensing, we distinguish these differences by obtaining their spectral signature." ***(***GISGigography***).***

2.1.7. SPECTRAL SIGNATURES:

"In the mining industry, there are over 4000 natural minerals on Earth. Each mineral has its own chemical composition that makes it different from others.

It's the object's chemical composition that drives its spectral signature. You can classify each mineral because it has its own unique spectral signature. When you have more spectral bands, this gives greater potential in image classification.

A spectral signature is the amount of energy reflected in a particular wavelength. Differences in spectral signatures are how we tell objects apart." ***(***GISGigography***).***

2.1.8. IMAGE CLASSIFICATION:

When you assign classes to features on the ground, this is the process of image classification.

The three main methods to classify images are:

- Supervised classification
- Unsupervised classification
- Object-based image analysis

The goal of image classification is to produce land use/land cover. By using remote sensing software, this is how we classify water, wetlands, trees, and urban areas in land cover. ***(***GISGigography***).***

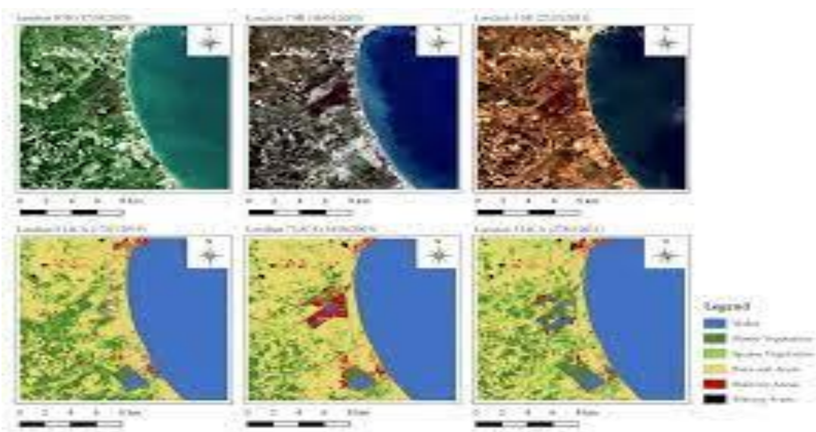


Figure 8: Landsat Images Classification Algorithm (LICA) classification(mdpi).

2.1.9. Applications and Uses:

There are hundreds of applications of remote sensing. From weather forecasting to GPS, it's satellites in space that monitor, protect, and guide us in our daily lives. ***(***GISGigography***).***

2.1.10. LOCAL ISSUES:

Commonly, we use UAVs, helicopters, and airplanes for local issues. But satellites can also be useful for local study areas as well. ***(***GISGigography***).***

Here are some of the common sensor technologies:

- Light Detection and Ranging (LiDAR)
- Sound navigation ranging (Sonar)

- Radiometers and spectrometers

We use Light Detection and Ranging (LiDAR) and Sonar are ideal for building topographic models. But the main difference between the two is "“where”". While LiDAR is best suited for the ground, Sonar works better underwater. ***(***GISGigography***).***

By using these technologies, we build digital elevation models. Using these topographic models, we can predict flooding risk, archaeological sites, and delineating watersheds (to name a few). ***(***GISGigography***).***

2.1.11. GLOBAL ISSUES:

As the world becomes more globalized, we are just starting to see the proliferation of remote sensing. For example, satellites tackle issues including ***(***GISGigography***)***:

- Navigating with global positioning systems
- Climate change monitoring
- Arctic surveillance

Satellite information is fundamentally important if we are going to solve some of the major challenges of our time. All things considered, it's an expanding field reaching new heights.

For issues like climate change, natural resources, disaster management, and the environment, remote sensing provides a wealth of information on a global scale.

2.1.12. Gps Trilateration:

2.1.13. GPS Receivers Use Trilateration:

Have you ever wondered how your GPS receiver works? They use a technique called trilateration.

Despite how GPS receivers are often confused with triangulation (which measures angles), they really don't use angles at all.

Trilateration involves measuring distances. Let’s take a look into this with a bit more detail.

Trilateration Measures Distance, Not Angles

How does the GPS system pinpoint your location using trilateration?

Using a simple two-dimensional example, let’s imagine we have three GPS satellites each with a known position in space.

2.1.14. Trilateration Gps Satellites:

Really, all that satellites do is broadcast a signal for your GPS receiver to pick up with a specific time and distance.

For example, the first satellite broadcasts a signal that eventually hits your GPS receiver. We don’t know the angle, but we do know the distance. That’s why this distance forms a circle equal in all directions.

This means that your GPS position could be anywhere on this circle at this specific radius.

trilateration satellite broadcast

Using three distances, trilateration can pinpoint a precise location. Each satellite is at the center of a sphere and where they all intersect is the position of the GPS receiver.

As the position of the GPS receiver moves, the radius of each circle (distance) will also change.

2.2. Geographic Information Systems (GIS):

“Geographic Information Systems is a vast field in Information Technology and, like any other booming technology, also has various applications in multiple domains. A GIS is a system that creates, manages, analyzes, and maps all types of data. GIS connects data to a map, integrating location data (where things are) with all types of descriptive information (what things are like there). This provides a foundation for mapping and analysis that is used in science and almost every industry. GIS helps users understand patterns, relationships, and geographic context. The benefits include improved communication and efficiency as well as better management and decision making". (EDUCBA).

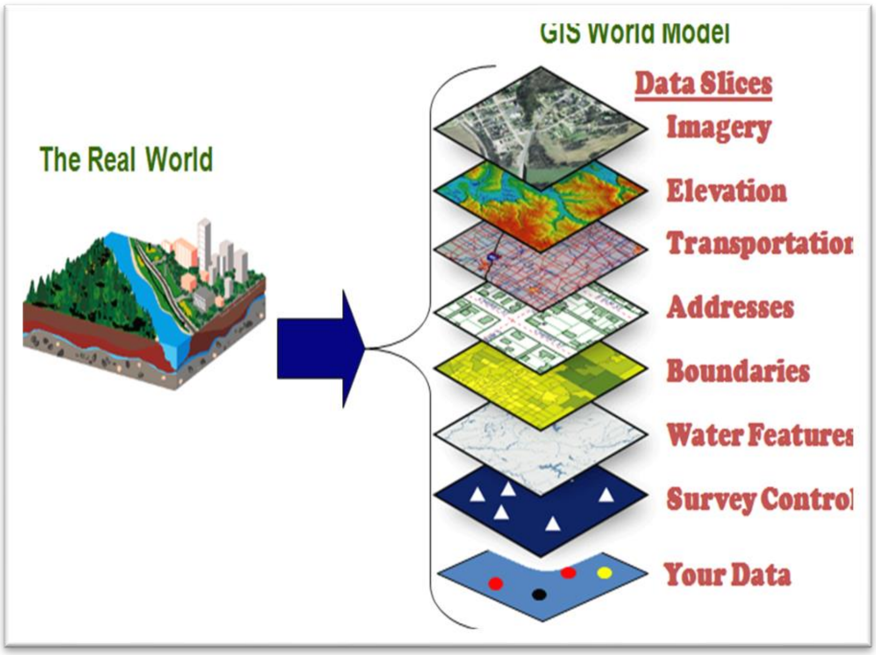


Figure 9: GIS concept (go.dewpoint.com)

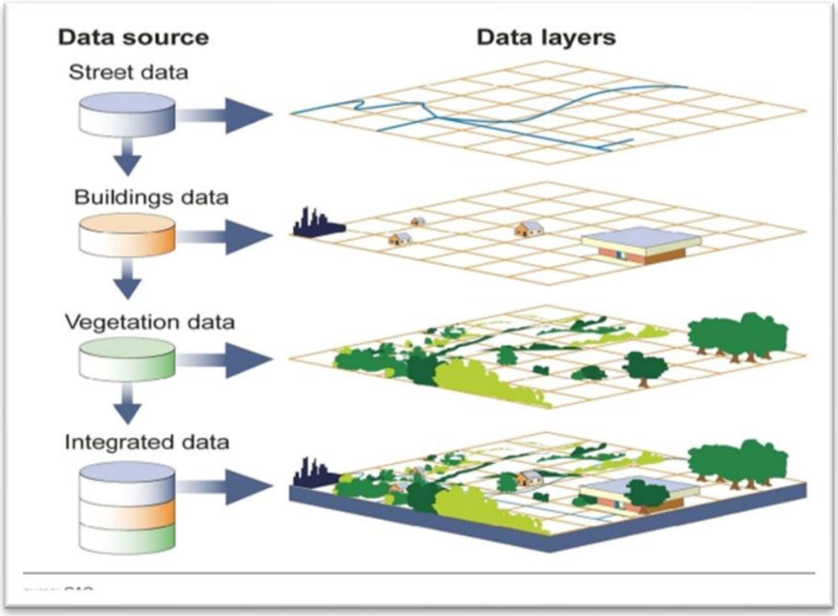


Figure 10: GIS Technology (bellaregisindia)

2.2.1. Applications of GIS in Various Fields:

Geographic Information Systems are applied in various domains. The count of its applications is only growing day by day. Below are some of the well-known applications concerning GIS. (EDUCBA).

2.2.1.1. Urban and Town Planning

Developers, Builders, Architects, and Engineers now use spatial data sets to plan the futuristic township. With the help of granular information, it becomes easier for engineers and architects to miss out on any of the parts hardly. Governing bodies like CIDCO for New – Mumbai and BMC for greater Mumbai have also used GIS data and tools to plan various mega projects. The data is also helpful in tackling water clogging during floods and cloud bursts in monsoons. It has also helped in redesigning the drainage models. (EDUCBA).

2.2.1.2. Disaster Management:

GIS actively monitors areas prone to disasters and tracks natural calamities. The geospatial data sets and databases allow organizations to store data at all levels. The database can contain all the information related to risk-prone places like hospitals and isolation centers near the risk-prone zones, quick habitation centers, the history of the calamities in that area, and the effect of the past disaster to plan for further contingency plans. Most Remotes Sensing and GIS are used in areas prone to Volcanic eruptions and earthquakes. Technologies play a crucial role in enabling organizations and municipalities to prepare and minimize the impact of disasters, thus enhancing their readiness to mitigate potential risks. Utilizing GIS in disaster situations can enhance awareness, preparedness, and readiness for the future. (EDUCBA).

2.2.1.3. Agriculture:

"Is one of the essential tasks of human civilization. It is not only done to feed the bellies but also to run the global business. GIS has spearheaded this field with many applications.

- Drought: Identifying the drought area or land to avoid further damage of plant seeds, human effort, and costly fertilizers.
- Pest control: Predicting the pest attacks like locust and rodent attacks from the available spatial data sets of particular agricultural lands. This will allow the governing body and farmers to plan out various things.
- Land and Soil Analysis: Using previous data sets, satellite imagery, or even field analysis, which field workers do.
- Planning of future food demand: Depending on the population's needs, the governing body and the farmers can plan to produce sufficient crops. Geospatial data sources and GIS will allow excellent decision-making and avoid further hassle". (EDUCBA).

2.2.1.4. Oil Spill:

"Oil Spill can be intentional or accidental, depending on the conditions. The Marine life and the humans with frequent access to that particular sea route always pay the price. GIS and geospatial data sets are used to curb such havoc-spreading spills. According to various reports, most oil spills happen in the Malaysian coastal areas. Governing bodies have implemented GIS to tackle such spills. It is more cost-effective than a hazardous oil spill, which also harms marine life". (EDUCBA).

2.2.1.5. Mapping and Navigation:

"The best example of today's world mapping and navigation is Google Maps. It is the most widely used service of Google by people. Humans around the world use it while traveling to a new place and also to review any place. It has also become a popular tool within Cab and carpool service providers. GPS, with the help of GIS, adds crisper and edge to the navigation experience. It is not just about looking at the data on an application; consumers are also allowed to post any anonymous or unnamed information in the map data set. Google accepts consumer map edits and also has its map maker. In addition, Here Maps gathers data from local consumers and individuals through its proprietary tool called Map Creator". (EDUCBA).

2.2.1.6. Reservoir and Dam Site location:

Geospatial data is crucial in identifying the optimal location for constructing a reservoir and dam. Selecting a dam site location involves considering various factors, including economic, environmental, and engineering conditions. Geospatial data have all the information concerning this; hence, GIS's feasible before implementing any major engineering projects.

2.2.1.7. Deforestation and Vegetation Management:

"Using GIS and geospatial data on forest lands allows organizations and governments to track the deforestation rate. Analysis for planning reforestation and vegetation involves utilizing past information from different periods. Due to the increasing deforestation, government bodies also keep track of forest and tree-related data. The datasets serve the purpose of further analysis for reforestation initiatives. By utilizing heat maps and imagery sources, one can classify and visualize the data, enabling the implementation of further actions".

2.2.1.8. GIS for Business, Marketing, and Sales

"Besides the above applications, GIS also has unusual usage in making business and marketing sales. Geospatial databases store data on target customers, marketing campaigns, and sales territories. This application enables companies and organizations to become strategically more competitive and stronger in the market". (EDUCBA).

2.2.1.9. Conclusion

This robust system's applications and uses are never-ending, like its vast amount of geospatial data sets and databases. Every day, analysts and researchers are innovating new applications of this technology. The count of applications is never going to fall. GIS has not just limited itself to the above 6-7 applications but also finds applications in various fields with over 1000+ uses and applications.

Archaeology, geology, Waste Management, Natural Resources Management, Asset Management, and Aviation and Banking. It seems that shortly, GIS will get integrated with everything, and that's why companies like HERE Maps and GOOGLE are working on prototypic concepts like the Internet of Things, where everything will be interconnected.

3. CONCLUSION:

Finally, GIS can also include data in table or spreadsheet form, such as population demographics. Demographics can range from age, income, and ethnicity to recent purchases and internet browsing preferences.

GIS technology allows all these different types of information, no matter their source or original format, to be overlaid on top of one another on a single map.

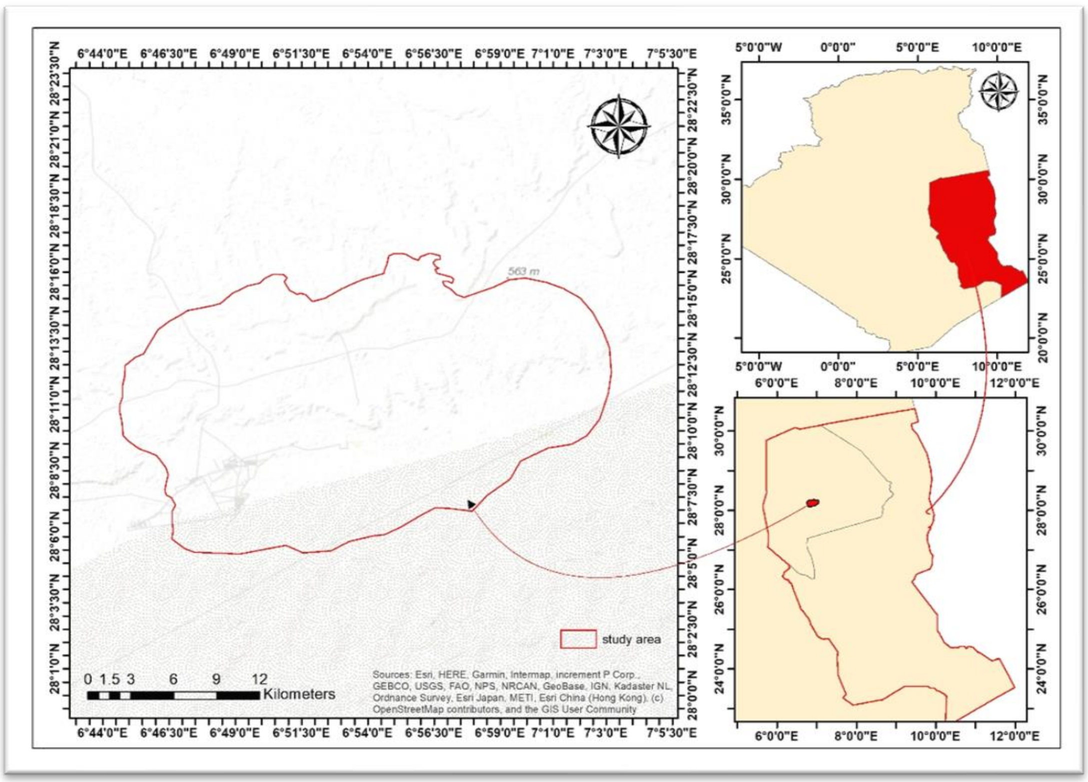
III. Chapter 02:

Materials and Methods

1. Presentation of the study area:

1.1.1. Geographical and Administrative Situation:

The municipality of Bordj Omar Idris is located in a semi-level basin surrounded by highlands in the far northwest of the Illizi province in Algeria. Its coordinates are approximately 6°45'49.111"E and 28°13'21.894"N, with an elevation of 354 meters above sea level.



Source: student **Figure 11: The geographic location of the study area**

The municipality of Bordj Omar Idris is bordered by the following:

- To the north and northwest: The province of Ouargla.

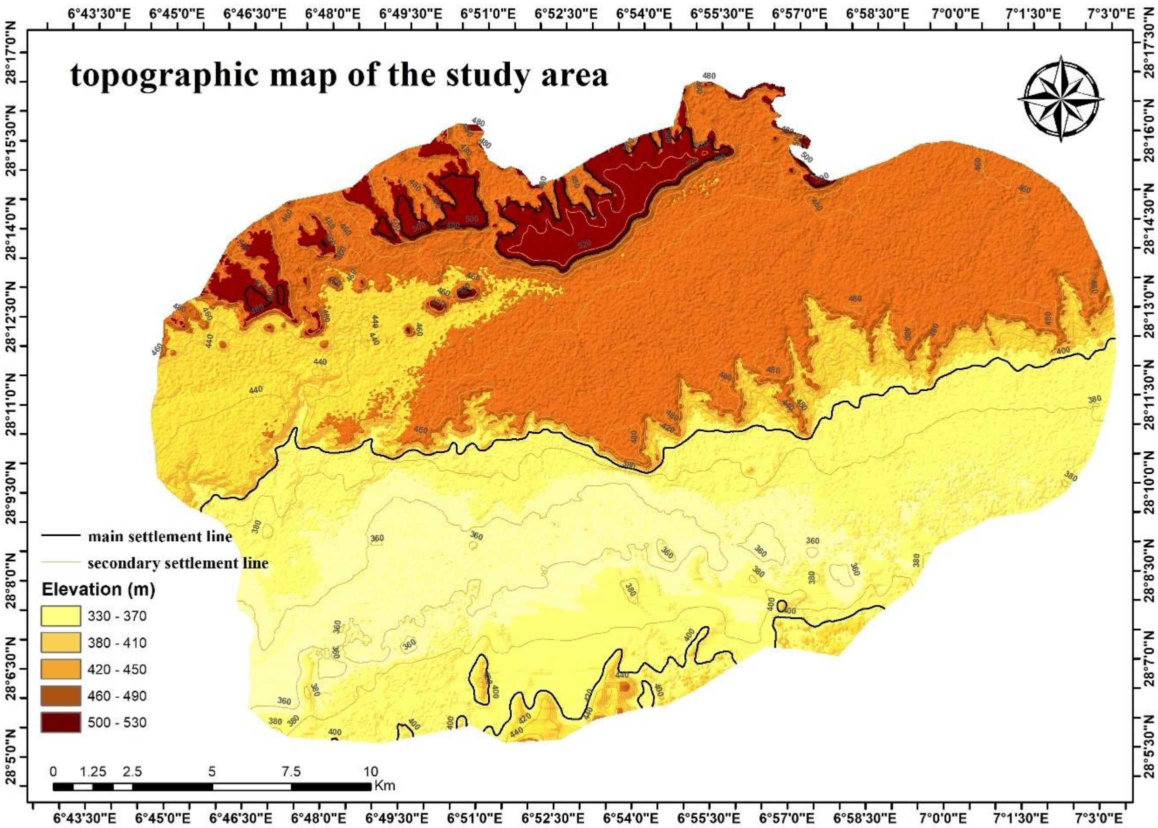
- To the east and northeast: The municipalities of Debdeb and In Amenas.

- To the west and southwest: The province of Tamanrasset.

- To the south: The municipality of El Oued.

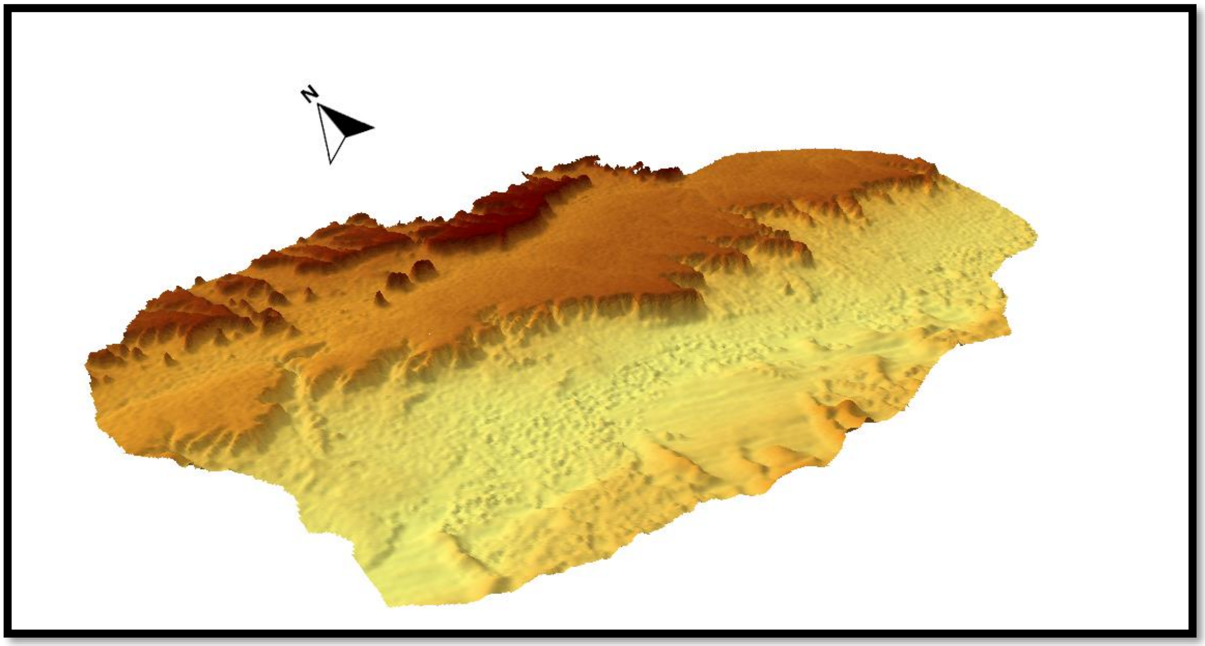
1.2. Topography:

The study site consists of sandy terrains located in the northern and northwestern parts of the study area, with elevations exceeding 500 meters. Additionally, there are flat terrains that stretch from the southwest to the northeast, with elevations ranging from 250 to 583 meters.



Source: student **Figure 12: Topographic map**

The terrain map created using a Digital Elevation Model (DEM) represents the elevation or topography of an area. A DEM is a digital representation of ground surface elevations, derived from remote sensing data and survey measurements.



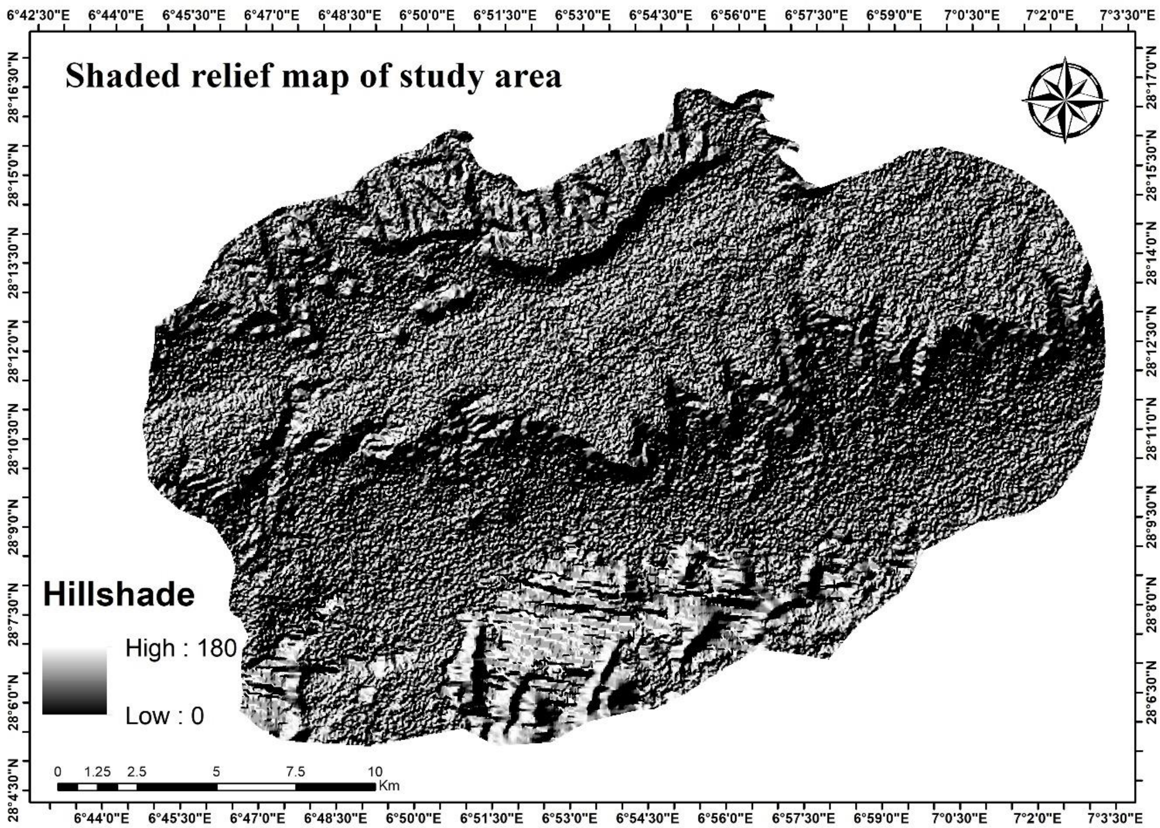
Source: student **Figure 13: A 3D view of a Digital Elevation Model (DEM)**

1.3. Hill shade map:

An elevation shading or hill shade map is a three-dimensional depiction of the surface that uses grayscale shading to produce shadows in the picture. The sun's location is specified using the altitude and azimuth attributes.

A gradient of grayscale hues is used to replicate the appearance of relief in the study region and to highlight discontinuities between sections of various morphologies. This relief map vividly depicts the major height changes between plains, plateaus, etc.

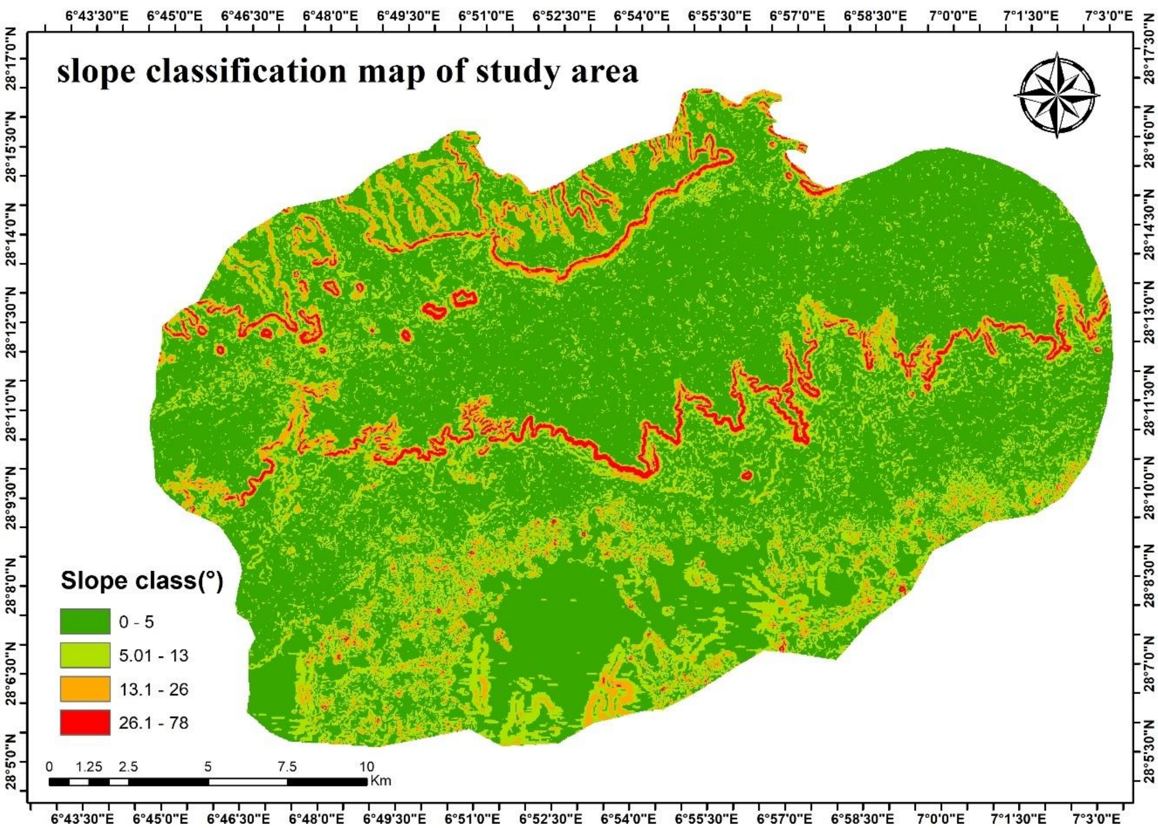
The hill shade map uses shading techniques to create a visual depiction of the terrain's three-dimensional qualities. places in direct sunlight look brighter, while places in shade appear darker, producing a feeling of depth.



Source: student **Figure 14: Shaded relief map**

1.4. slope map:

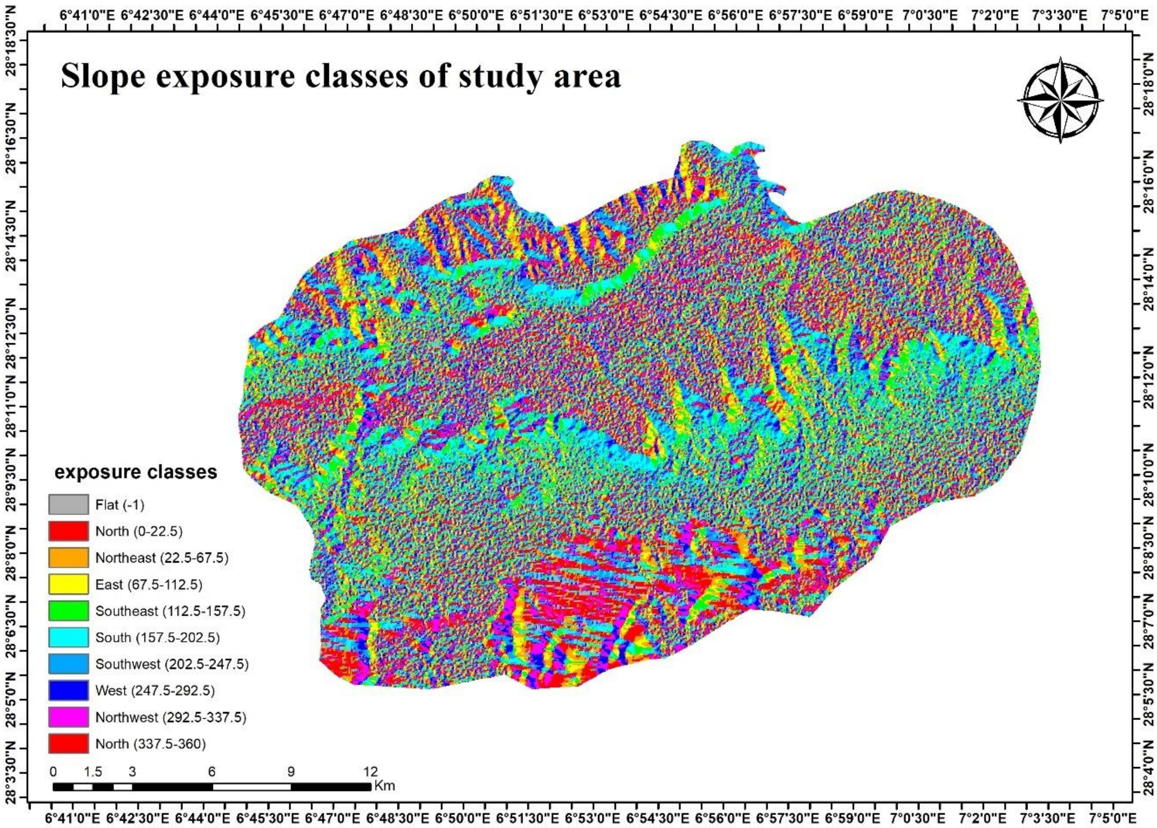
For the study area, the terrain is somewhat fragmented and consists mainly of flat, sandy, and rocky terrains. The dominant slope category is 0-5 degrees. This means that most areas in the region have slight elevations and gentle slopes.



Source: student **Figure 15: Slope classification map**

1.5. The slope exposure map:

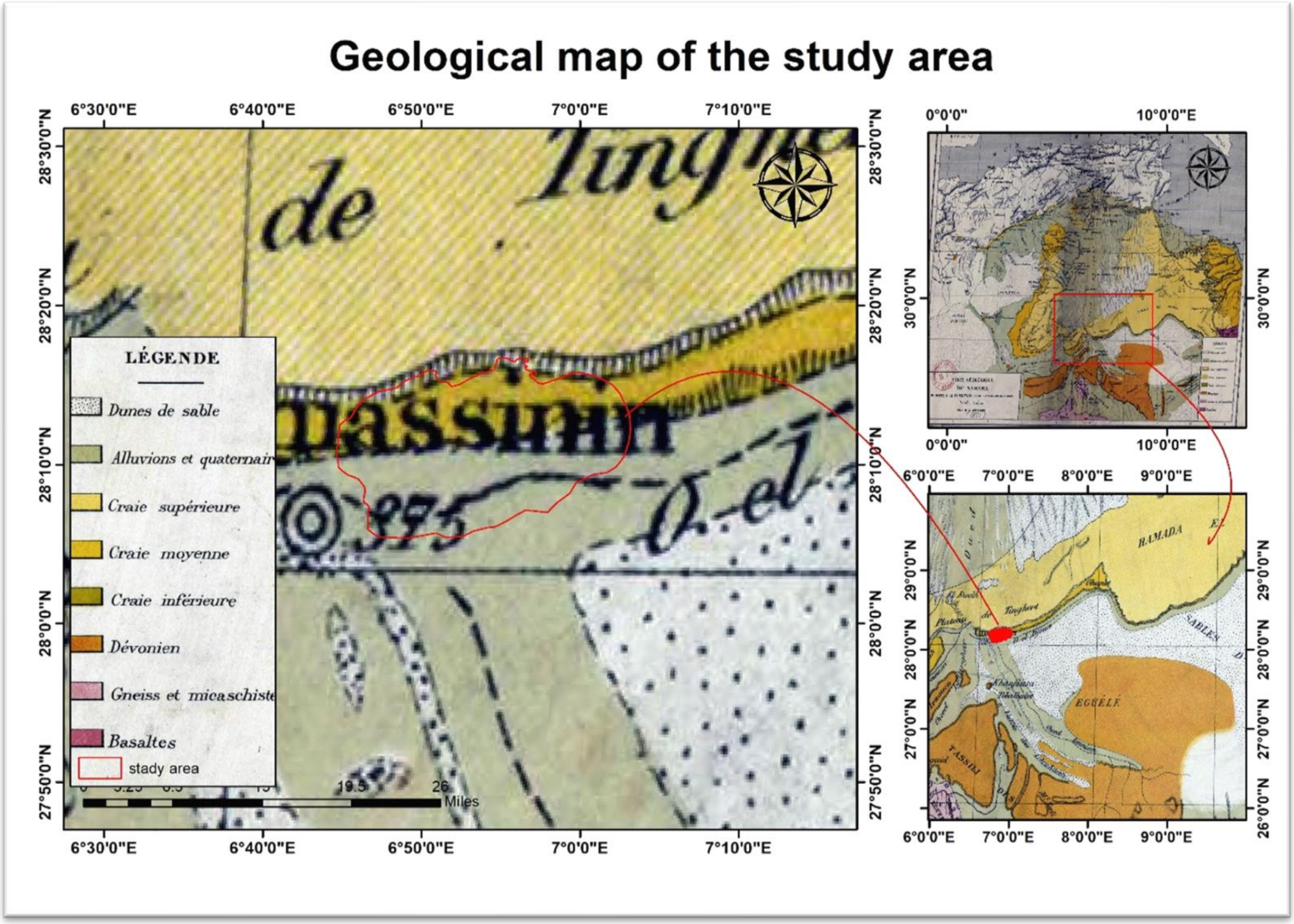
According to Figure, it can be observed that in the study area, there is no dominant exposure.



Source: student **Figure 16: Slope exposure classes of study area**

1.6. Geological study:

The city of Bordj Omar Idriss is built in a nearly level basin surrounded by highlands. This basin appears to represent an ancient seabed lined with geological layers, primarily consisting of thin sedimentary layers composed mainly of fossils. The thickness of these layers is only a few tens of centimeters. These marine sediments are of intercontinental marine origin. As for the Quaternary period, it is characterized by the abundant presence of sand dunes, especially in the eastern and southern regions of the city, as well as in the western region.



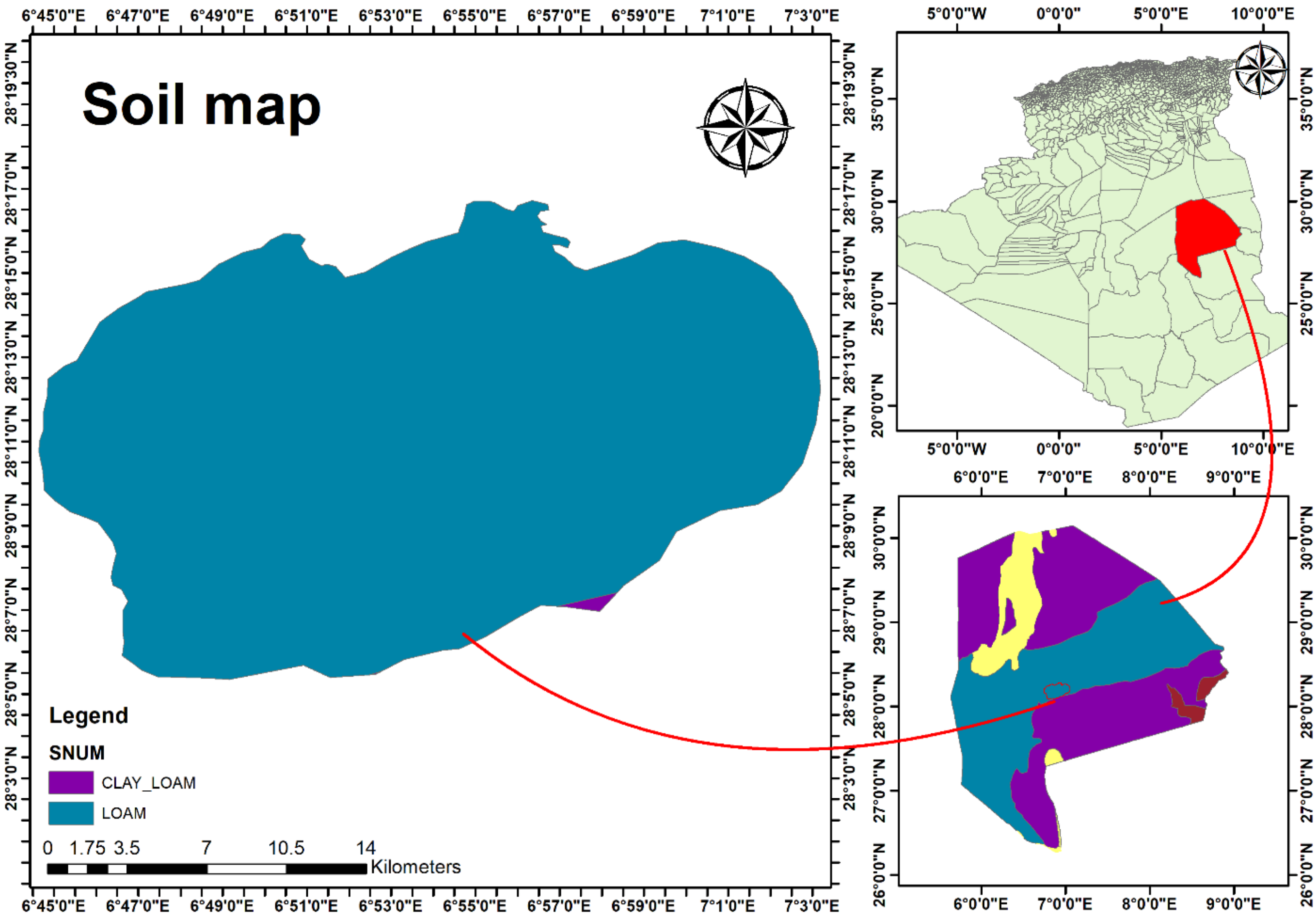
***S*ource*:* Geologic and hydrologic of Sahara Algerian map (Modification by the student)**

Figure 17: Geological map of study area

1.7. Soil map:

Based on the instructions provided by the National Laboratory for Housing and Construction and the geotechnical studies of the soil, for the land occupation plans in the municipality of Burj Omar Idris, we can deduce the following:

- We observe that the soil in the area consists of two layers. The upper layer is composed of fine sand, reaching a depth of 10 meters. It is overlaid by a compact layer of brown gypsum clay, extending to a depth of 10 meters.



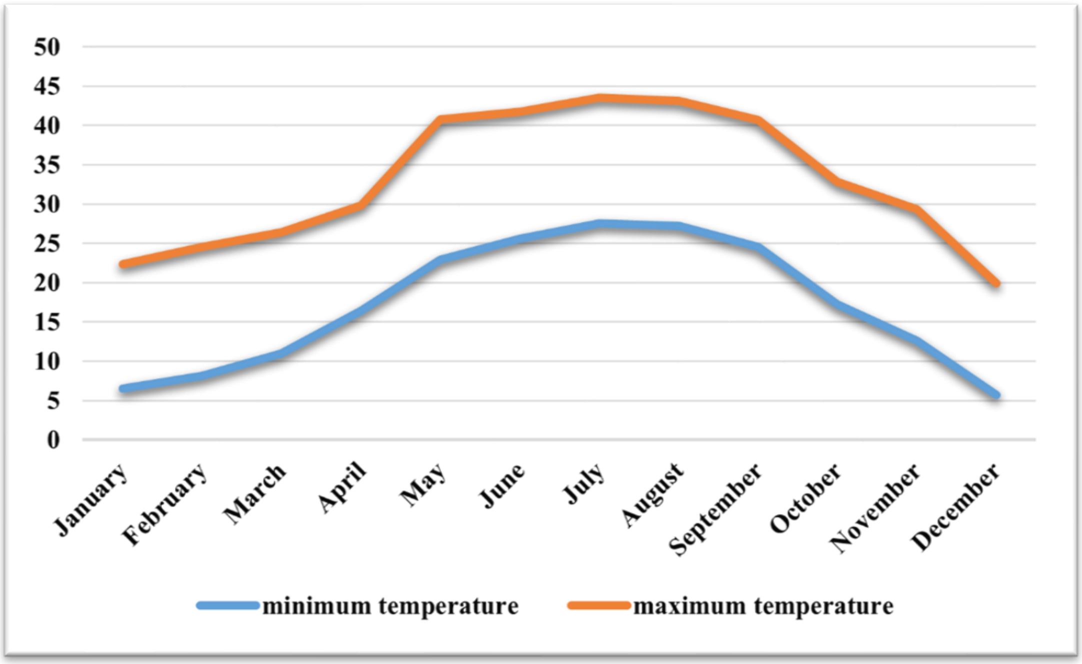
Source: student **Figure 18:Soil map**

1.8. Climate:

The climatic study holds great importance due to its direct impact on humans, their activities, and urban development. It is one of the influential factors in the emergence of a city, such as the direction of its growth and expansion, particularly in the design of its buildings, roads, and other land uses, which are significantly influenced by temperature, wind, and rainfall variations.

1.8.1. Temperature:

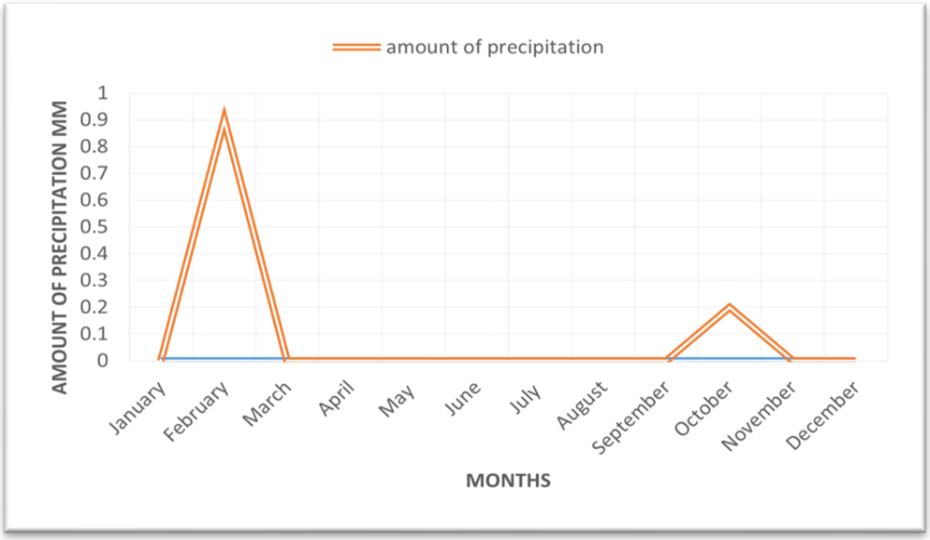
The average temperature during the hot months is 42.24, while in the cold winter months, the average temperature drops to 5.98. From these results, we can infer that the temperature range is significant in the region due to the large difference in temperatures between day and night, estimated to be 15.46.



Source: DPSB ILLIZI *(Modification by the student)* **Figure 19: Temperature graph**

1.8.2. Precipitation:

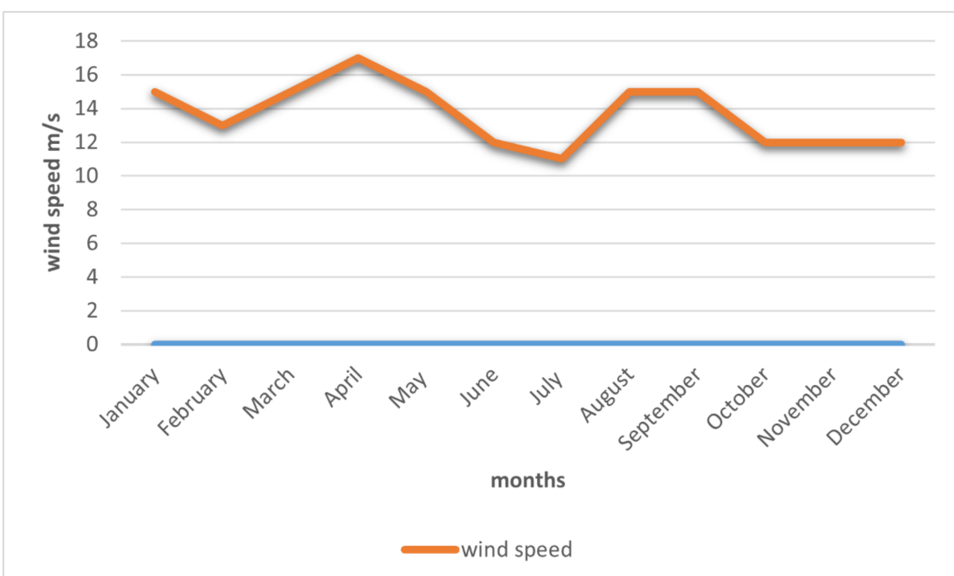
The region is characterized by local rainfall, which is sporadic and occurs mainly during the summer and autumn seasons. The precipitation patterns vary across different areas, with higher amounts of rainfall in the southern and eastern parts.



Source: DPSB ILLIZI **Figure 20: graphical chart of precipitation amounts**

1.8.3. Winds:

The municipality, like other desert regions, is exposed to the influence of various wind currents. It experiences southeast winds and east winds, which can be strong and impactful, especially during the months of March, April, May, and September. Generally, the wind speed is low, but occasionally it can reach up to 120 km/h.



Source: DPSB ILLIZI **Figure 21:graphical chart of wind speed**

1.9. The cadastral and land situation:

Non-cadastral registration of the entire region: This means that many properties in the area have not been formally registered in the cadastral records, which means they lack official documents confirming ownership rights. Property owners are constantly threatened with expropriation for both public and non-public reasons, which can raise legal issues and tensions.

Property classification: Properties in the region are classified as commercial, residential, agricultural, and public facilities. This illustrates the diversity of land use in the area and defines the many functions of properties in the area.

Property ownership types: The area has a variety of property ownership types, including private, public, and state ownership. This implies that certain properties may be held by individuals while others may be owned by the government.

2. Materials and Methods:

2.1. The methodology:

The method we propose involves the use of a combination of geographic information and remote sensing, as illustrated in Figure 22.

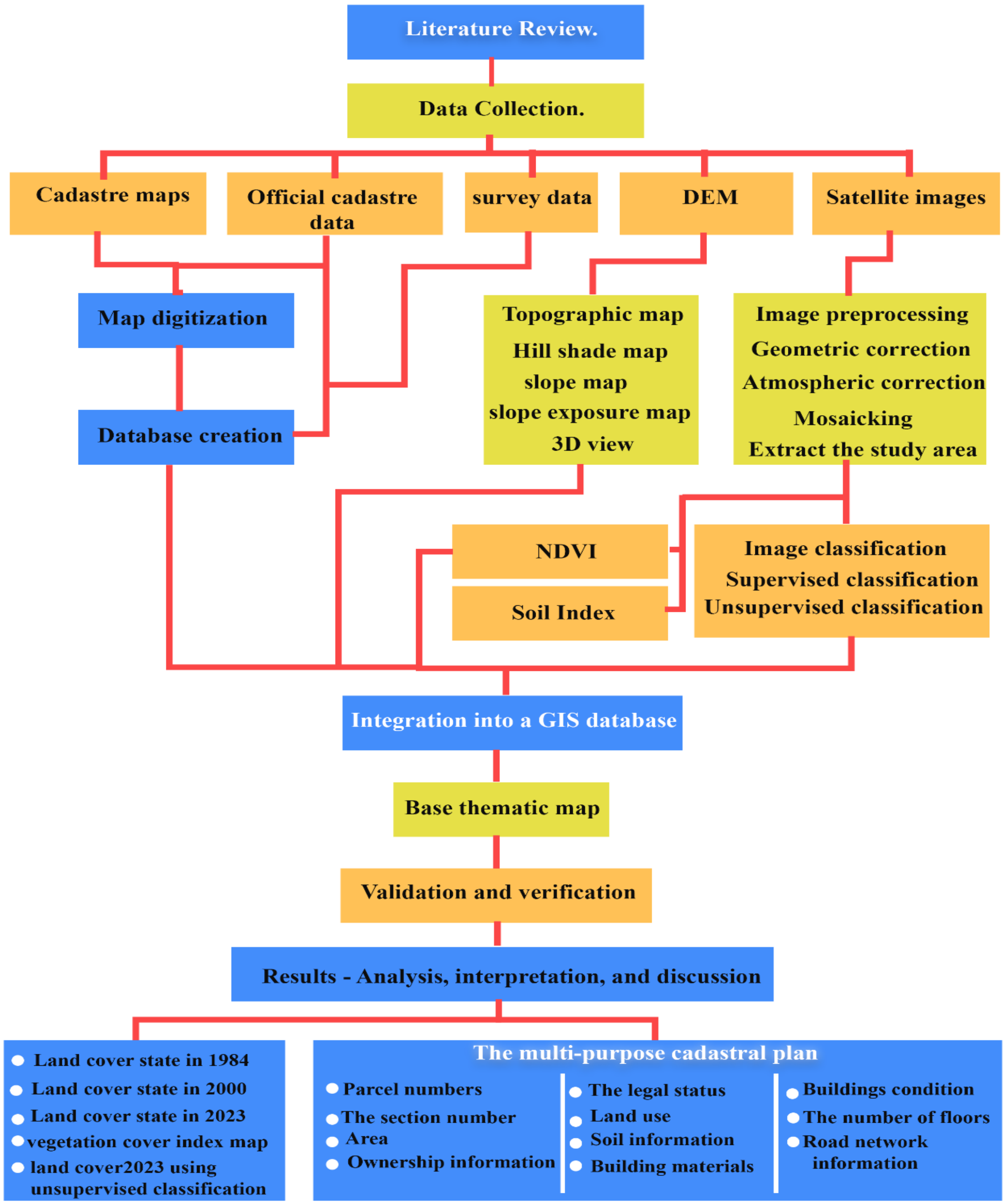


Figure 22:Methodological flowchart

2.2. Materials

2.2.1. Data Collection:

We present the data sources utilized in this part, including satellite images and additional data obtained at different times and scales. We have coordinated the differing information into the same geographic reference system for change detection and the creation of land cover and land use maps, as well as the development of a spatial database.

2.2.2. Satellite Data:

In this study, Landsat satellite sensor data were used (landsat5 TM), (landsat7 ETM+), (landsat9 OLI-TIRS), Each generation of satellite sensors has its own characteristics and advantages, including differences in temporal, spatial, and spectral resolution, as well as the number of bands.

The table N° shows the characteristics and specifications of the Landsat satellite, including the types of sensors onboard, the temporal resolution, the spatial resolution.

Table 1 Spectral bands and their applications (USGS)

Spectral bands	Applications
Blue(B)	❖ Differentiating between soil and vegetation ❖ Coastal mapping. ❖ Identification of cultural and urban features.
Green(G)	❖ Mapping green vegetation (measuring peak reflectance). ❖ Identification of cultural and urban features.
Red(R)	❖ Discrimination between plant species with leaves and without leaves based on chlorophyll absorption. ❖ Identification of cultural and urban features.
near-infrared (NIR)	❖ Identification of vegetation and plant types; health and biomass content. ❖ Delimitation of water bodies and soil moisture.
short-wavelength infrared (SWIR1)	❖ Sensitive to soil moisture and plant moisture. ❖ Discrimination between snow and clouds.

Short-wavelength infrared (SWIR2)	❖ Discrimination between minerals and rock types. ❖ Sensitive to vegetation moisture content.
thermal infrared	❖ Discrimination of vegetation stress and soil moisture related to thermal radiation. ❖ Thermal mapping.

Source: USGS

Table 2 Landsat image characteristics (USGS)

Characteristics	Landsat-5	Landsat-7	Landsat-9
Start and end of mission	Landsat-5: 1984- 2013	1999-present day.	2021-present day.
Instruments	TM (Thematic Mapper)	ETM+ (Enhanced Thematic Mapper Plus)	OLI (Operational Land Imager)
Spectral bands	-	-	Aerosol 0.433-0.45 µm.
	(B)0,45-0,52 µm	0,45-0,52 µm	0,45-0,515 µm
	(G) 0,52-0,6 µm	0,53-0,61 µm	0,525-0,6 µm
	(R)0,63-0,69 µm	0,63-0,69 µm	0,63-0,68 µm
	(NIR) 0,76-0,9 µm	0,78-0,9 µm	0,845-0,885 µm
	(SWIR)1,55-1,75µm	1,55-1,75 µm	1,56-1,66 µm
	(SWIR)2,08-2,35µm	2,09-2,35 µm	1,36-1,39 µm
	-	-	2,1-2,3 µm
Thermal	(SWIR) 10,4-12,5µm	10,4-12,5 µm	10,3-11,3 µm

infrared			11,5-12,5 µm
Panchromatic	-	0,52-0,9 µm	0,5-0,68 µm
Resolution	General: 30 m.	General: 30 m.	General: 30 m.
	Thermal infrared: 120 µm.	Panchromatic: 15 m.	Panchromatic: 15 m.
		Thermal infrared: 100 µm.	Thermal infrared: 60 µm.
Orbit	Altitude: 705 km.	Altitude: 705 km.	Altitude: 705 km.
	Cycle: 16 days.	Cycle: 16 days.	Cycle: 16 days.
	Time: 9:30-10:00H	Time: 10:00-10:15H	Time: 10:00 H.

Source: USGS

2.2.3. The Digital Elevation Model (DEM):

A Digital Elevation Model (DEM) is a representation of the bare ground (bare earth) topographic surface of the Earth excluding trees, buildings, and any other surface objects. (USGS).

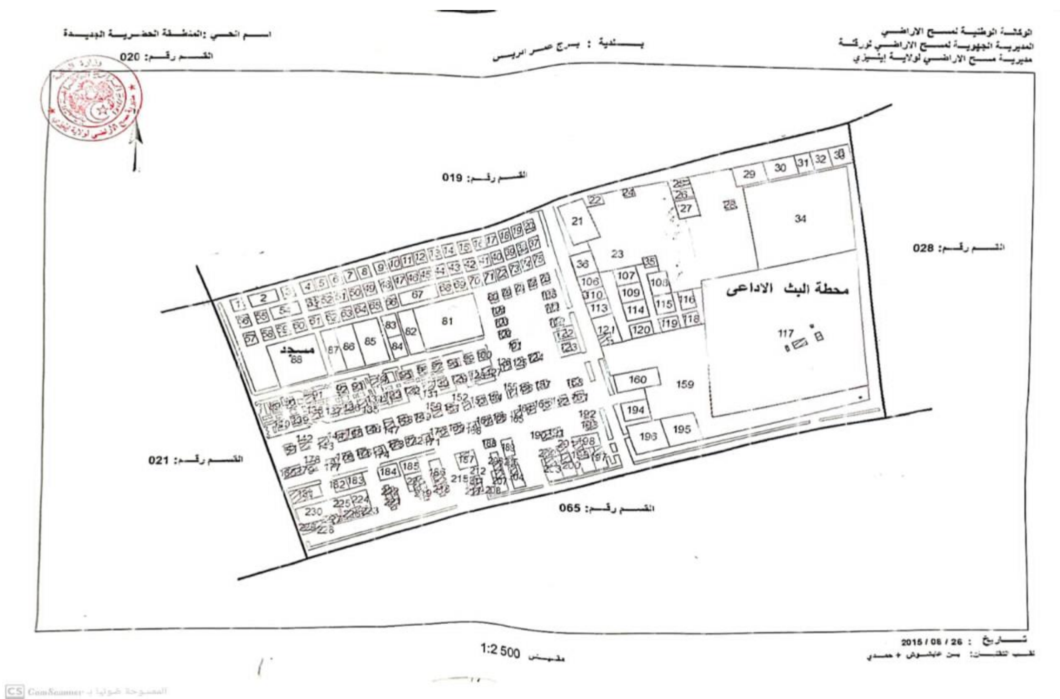
A Digital Elevation Model, also known as a DEM, is a type of raster GIS layer. They are raster grids of the Earth's surface referenced to the *vertical datum*—the surface of zero elevation to which heights are referred to by scientists, insurers, and geodesists. (USGS).

At most scales and environments, a generic term like DEM can be used because the differentiation between the bare-earth and a surface object is not significant, with DEMs commonly having spatial resolutions of 20 m or more. (USGS).

The smaller the grid cells are, the more detailed the information within a DEM data file is. So, if you're looking to model with lots of detail, then small grid spacing (or small cell size) is the one to go for. (USGS).

2.2.4. Cadastral maps:

In this study, the surveyed area maps were used to delineate land boundaries and obtain all relevant information, such as property type, ownership, and plot number. These maps provided the necessary details for accurately identifying and documenting the parcels of land within the study area.



Source*: Cadastral* Directorate ILLIZI **Figure 23: cadastral map**

2.2.5. The survey data:

We were able to survey the site, on one hand, to identify the owners of some areas that were not surveyed, and on the other hand, to obtain information regarding agricultural lands, monitoring, and the nature of crops in the study area. It is worth mentioning that during our investigation, we found that many parcels were registered as "unknown" or with unidentified owners.

2.2.6. Software used:

2.2.6.1. ArcGIS:

ArcGIS is a general-purpose GIS software system developed by ESRI. It is an extensive and integrated software platform technology for building operational GIS. ArcGIS comprises four key software parts: a geographic information model for modeling aspects of the real world; components for storing and managing geographic information in files and databases; a set of out-of-the-box applications for creating, editing, manipulating, mapping, analyzing and disseminating geographic information; and a collection of web services that provide content and capabilities (data and functions) to networked software clients. Parts of the ArcGIS software system can be deployed on mobile devices, laptop and desktop computers and servers. (Springe Link).

2.2.6.2. ENVI 5.3:

ENVI is the ideal software for the visualization, analysis, and presentation of all types of digital imagery. ENVI's complete image-processing package includes advanced, yet easy-to-use spectral tools, geometric correction, terrain analysis, radar analysis, raster and vector GIS capabilities, plus extensive support for images from a wide variety of sources, and much more. (ITTVIS).

2.2.6.3. Google Earth Pro:

Google Earth Pro is a free software that, albeit not a true GIS, allows visualization, assessment, overlay, and creation of geospatial data. This user-friendly resource is often a useful intermediary for learners who are interested in learning more about GIS and want to start with more basic processes and tools. Google Earth Pro can also be leveraged to view its extremely high-resolution satellite imagery, upload or download geospatial data in its native interoperable file format (KML), and also find locations (e.g., for simple geocoding). (uOttawa library).

2.2.6.4. Excel:

a software program created by Microsoft that uses spreadsheets to organize numbers and data with formulas and functions. Excel analysis is ubiquitous around the world and used by businesses of all sizes to perform. (CFI).

2.2.7. Image date selection:

For the study area, it is essential to select the image acquisition date carefully, considering that ground conditions can vary significantly throughout different seasons of the year. Since remote sensing relies on capturing reflected light, we have chosen a date with clear weather conditions for obtaining the satellite imagery.

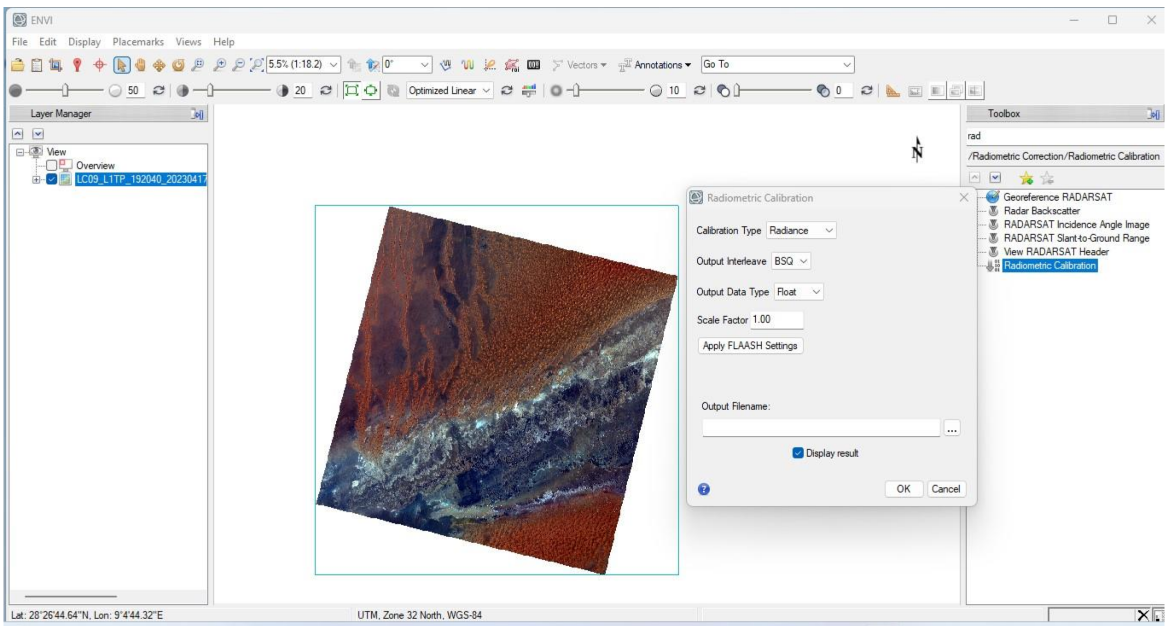
2.2.8. Preprocessing of satellite images:

After downloading satellite images of various types, they need to be prepared and processed before they can be effectively used. This is because the raw imagery often contains geometric distortions that need to be corrected. Geometric correction is carried out using remote sensing software and various geographic information systems.

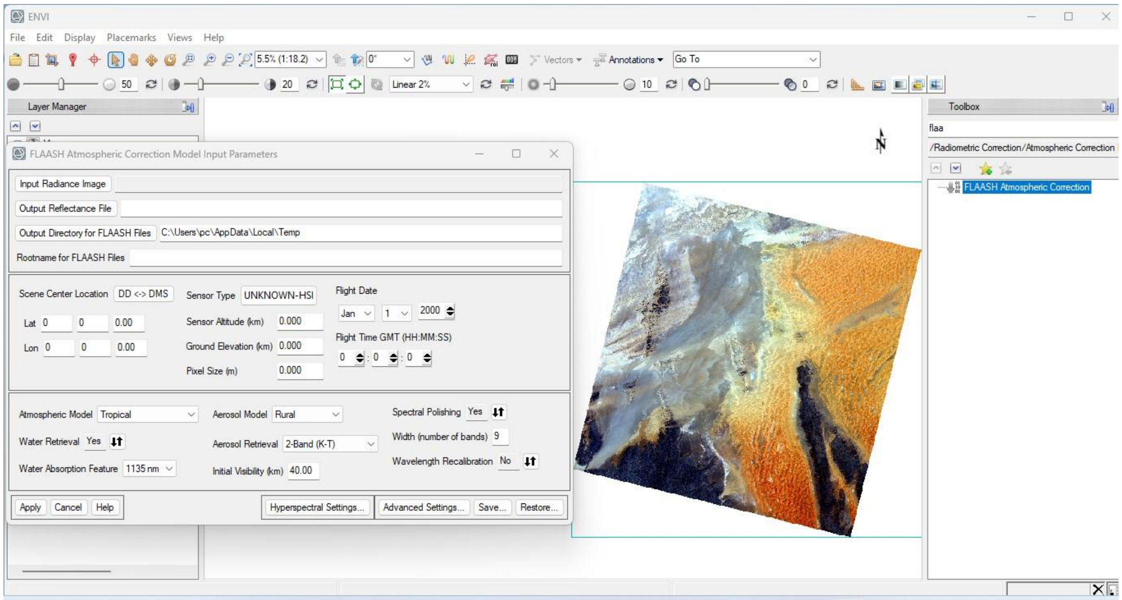
Among the procedures commonly applied to satellite imagery are:

2.2.8.1. Atmospheric correction:

First, we performed radiometric calibration, such as sensor-specific corrections, to ensure accurate and consistent radiance values across the image. This step helps to normalize the data and remove any sensor-related biases or variations.



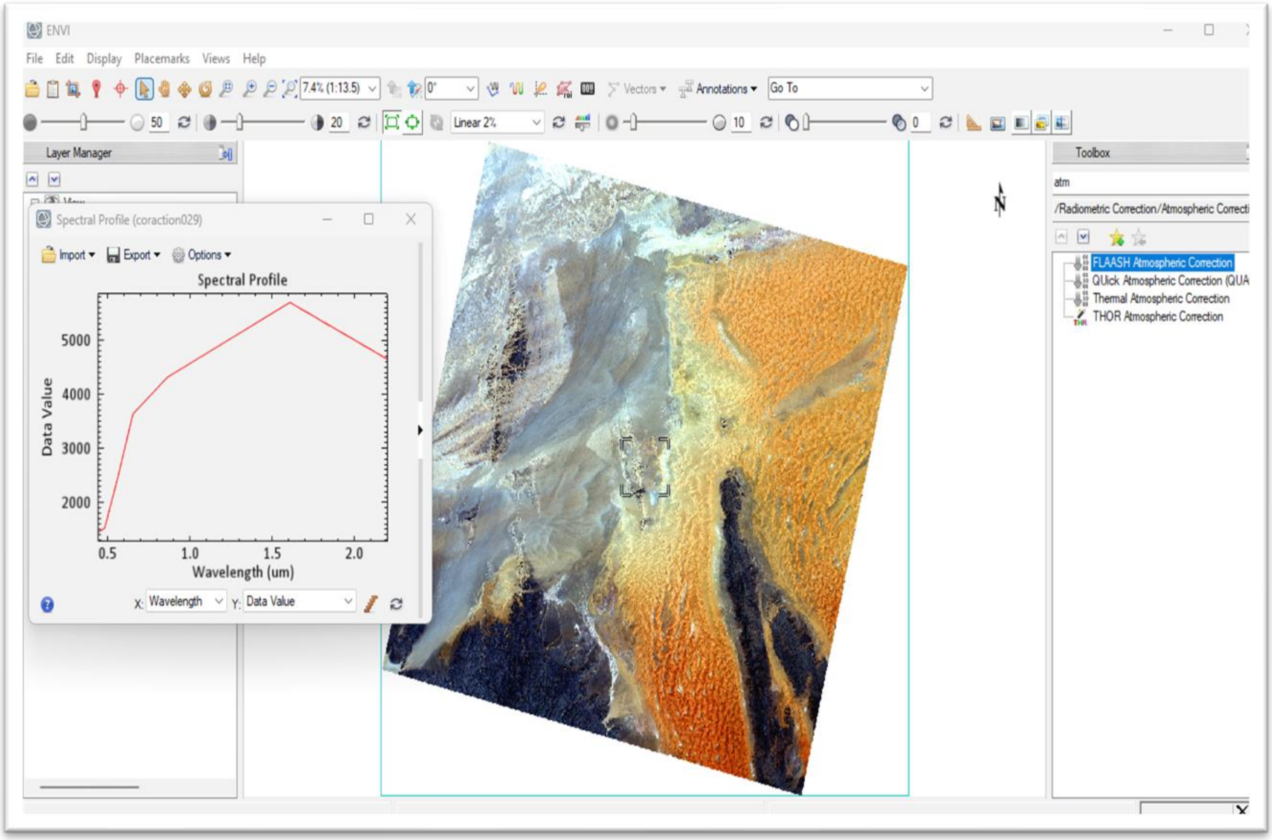
Source: student **Figure 24: Radiometric Calibration**



Source: student **Figure 25: Flaash atmospheric correction**

Afterward, we applied atmospheric correction techniques, such as the FLAASH (Fast Line-of-sight Atmospheric Analysis of Spectral Hypercubes) algorithm, to correct for atmospheric effects. Atmospheric correction aims to remove atmospheric interference and obtain surface reflectance values, allowing for more accurate analysis and comparison of the images.

By performing both radiometric and atmospheric corrections, we enhance the quality and reliability of the data, enabling us to derive meaningful geophysical parameters and facilitate the comparison of images acquired from different sensors.



Source: student **Figure 26: The final result of atmospheric correction**

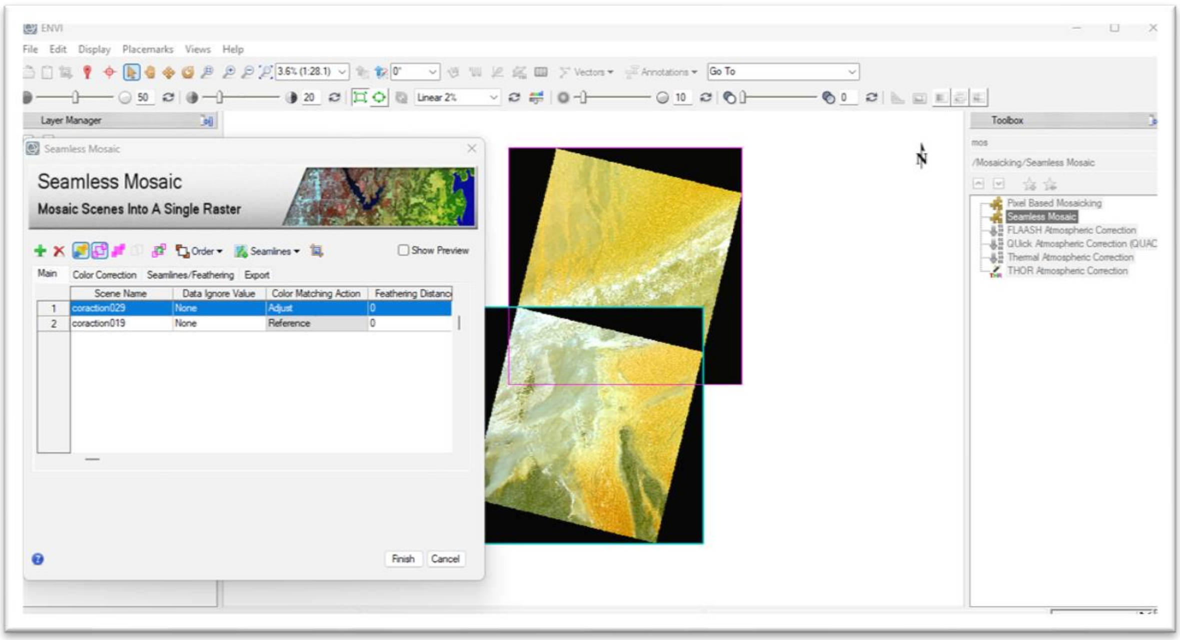
2.2.8.2. Geometric correction:

Geometric correction, also known as geometric rectification or geometric calibration, is a process used to correct geometric distortions present in satellite imagery. These distortions can arise due to various factors such as sensor orientation, Earth's curvature, and relief displacement.

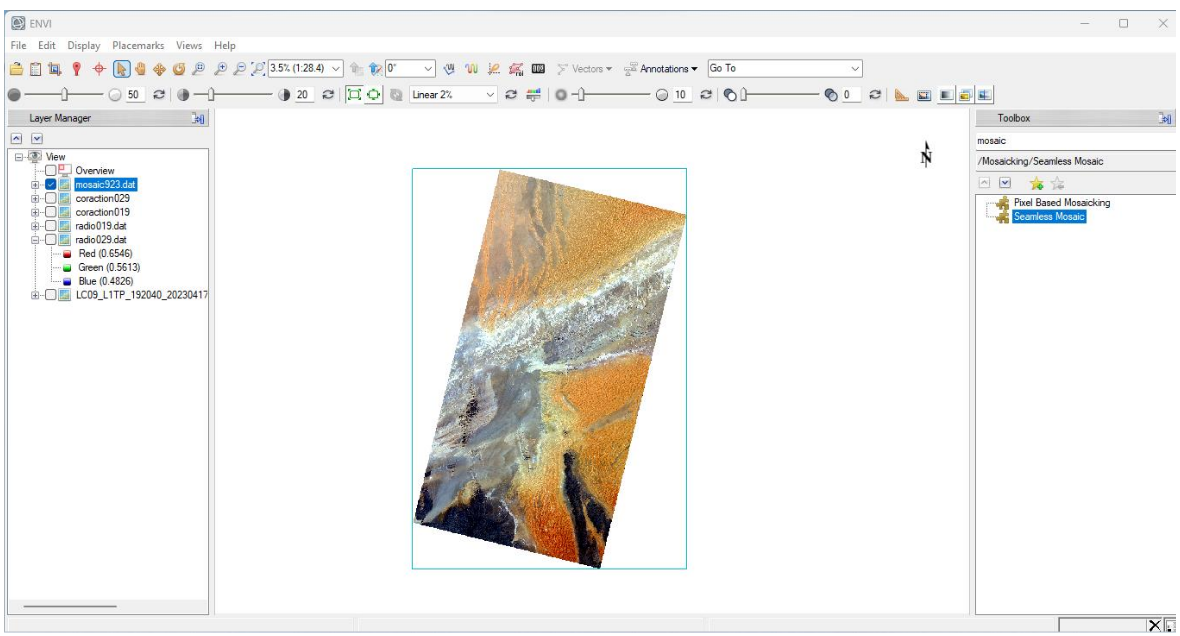
The goal of geometric correction is to align the satellite image with a known and accurate coordinate system, allowing for precise spatial analysis and measurement. This correction ensures that the image accurately represents the true locations and shapes of features on the Earth's surface.

2.2.8.3. Image Mosaicking:

Mosaicking, also known as image mosaicking or image stitching, is the process of combining multiple overlapping satellite or aerial images to create a single seamless image covering a larger area. This technique is used to overcome the limitations of individual images and provide a broader and more comprehensive view of the landscape.



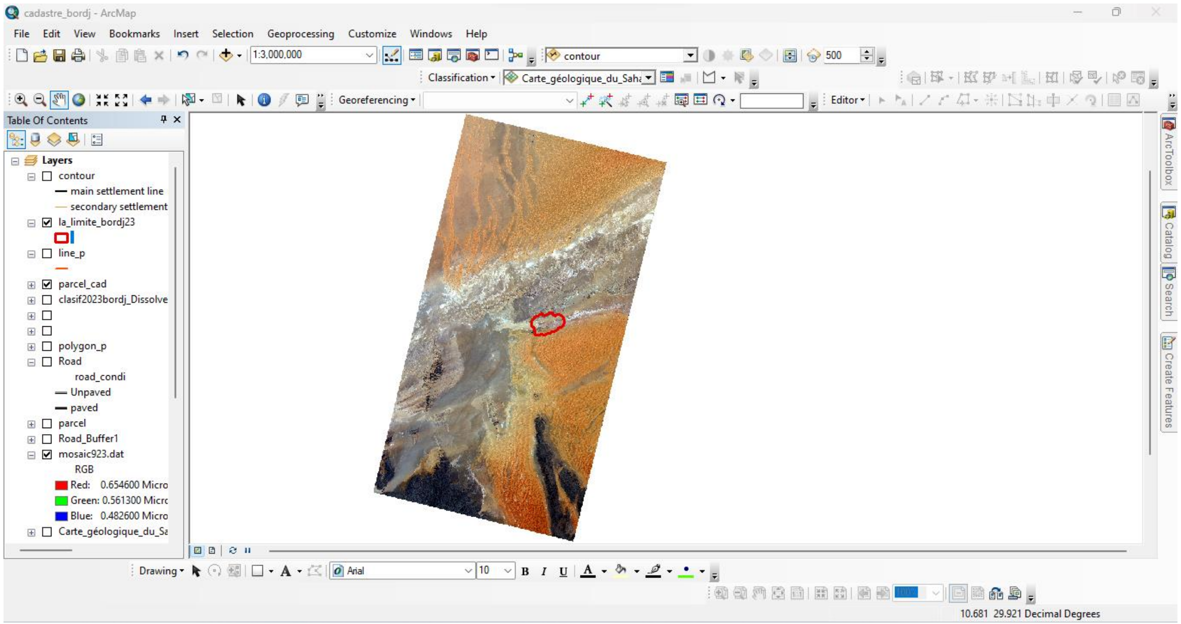
Source: student **Figure 28: Before mosaic**



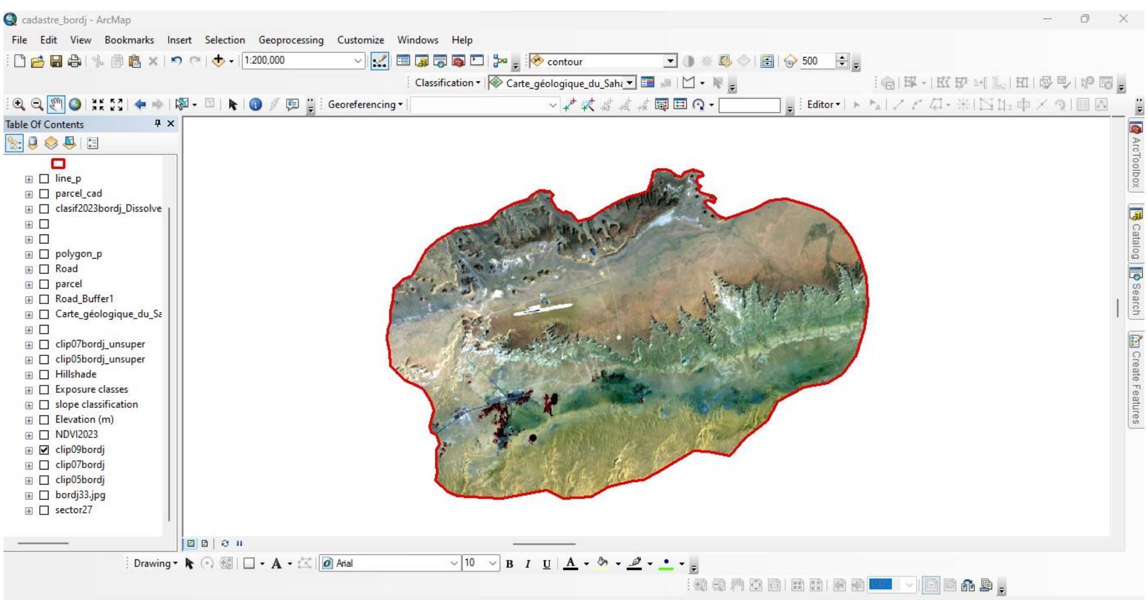
Source: student **Figure 27: After mosaic**

2.2.8.4. Data Extraction:

We applied a Shapefile type mask to the satellite images which represents the administrative boundary of the city Bordj Omar Idriss.



Source: student **Figure 29: Masking process**



Source: student **Figure 30:Extraction of the study area in progress**

2.2.9. Image classification:

In this study, we used two types of classification, supervised classification and unsupervised classification.

2.2.9.1. Supervised Classification:

Supervised classification methods require input from an analyst. The input from analyst is known as training set. Training sample is the most important factor in the supervised satellite image classification methods. Accuracy of the methods highly depends on the samples taken for training. Training samples are two types, one used for classification and another for supervising classification accuracy.

1- Maximum Likelihood Classification:

We chose to use the Maximum Likelihood algorithm for supervised classification over the entire study area. This algorithm requires the selection of training samples. It allows classifying unknown pixels by calculating the probability for each class that the pixel belongs to the class with the highest probability. If the membership value is too low, the pixel is considered unclassified or assigned to an unknown class.

2- Thematic classes:

The classes used in the classification are:

1. Urban areas.
2. Rocks.
3. Bare soil.
4. Vegetation.
5. Sand dunes.
6. Water.

Conventional methods for assessing the thematic accuracy of a map were employed, including the confusion matrix and analysis using the Kappa coefficient (Congalton, 1991).

These methods rely on random sampling strategies. The confusion matrix is used to categorize discrepancies between the classified map and the reference data (Story and Congalton, 1986; Lunetta et al., 1991; Stehman and Czaplewski, 1998).

2.2.9.2. Unsupervised classification:

Unsupervised classification technique uses clustering mechanisms to group satellite image pixels into unlabeled classes/clusters. Later analyst assigns meaningful labels to the clusters and produces well classified satellite image. Most common unsupervised satellite image classification is ISODATA, Support Vector Machine (SVM) and K-Means.

The Normalized Difference Vegetation Index (NDVI) is a widely used vegetation index that quantifies the greenness and health of vegetation based on satellite data. NDVI is considered the best indicator of vegetation growth and photosynthetic activities due to its effectiveness in capturing changes in vegetation over time.

2.2.9.3. NDVI:

NDVI is calculated using the following formula:

$$NDVI = (NIR - Red) / (NIR + Red)$$

Where:

- NIR (Near-Infrared) is the reflectance in the near-infrared spectrum (usually band 4 or 5 in satellite imagery).

- Red is the reflectance in the red spectrum (usually band 3 in satellite imagery).

The NDVI values range from -1 to +1. Higher positive values indicate dense, healthy vegetation, while lower values indicate less vegetation or non-vegetated areas.

By comparing NDVI values across different time periods, it is possible to monitor changes in vegetation cover and track the health and growth of plants. This information can be used for various applications such as agricultural monitoring, forest health assessment, and land cover classification. Additionally, by creating vegetation maps over time using NDVI, researchers can gain insights into spatial patterns and dynamics of vegetation in a given area.

2.2.10. Digitization:

In this step, I digitized the Cadaster maps by performing georeferencing in ArcGIS software. Then, I drew the boundaries of the land parcels and roads. For drawing the roads, I used the buffering technique.

Regarding the use of the buffering technique in drawing the roads, it means creating an area around the road lines based on a specified distance. This is achieved by defining the desired distance and applying the buffering operation to the lines, resulting in a parallel area representing the geographical boundaries of the roads.

2.2.11. Creating a database:

In this step, I added all the relevant information regarding the land parcels to the Cadaster database. The database consists of the following fields:

1. Owner's name: The name of the owner of the land parcel.

2. Section number: The section number of the land parcel.

3. Parcel number: The parcel number of the land.

4. Account number: The account number associated with the land parcel.

5. Location: The location or address of the land parcel.

6. Property type: The type of property ownership, such as residential, commercial, or industrial.

7. Land use: The intended use of the land, such as agricultural, residential, or commercial.

8. Soil type: The classification of the soil in the land parcel.

9. Area: The area or size of the land parcel.

10. Legal status: The legal status of the land parcel, including ownership rights and any legal restrictions.

11. Number of floors: The number of floors or stories allowed for buildings on the land parcel.

12. Slope: The slope or gradient of the land parcel.

13. Agriculture type: The type of agriculture practiced on agricultural lands.

14**.**Building Materials: stores information about the materials used in the construction of buildings within the cadastral area

15- Building Condition: documents the current condition of the buildings, indicating whether they are in good condition.

IV. Chapter 03:

Results and Discussion

Chapter 03: Results and Discussion

1.1. Production of basic maps of the study area:

1.1.1. Valuation of classification accuracy in 1984:

Through the evaluation of classification accuracy results using confusion matrices for the 1984 image (78.5%) and the Kappa 0.71 coefficient for 1984, it is evident that the classifications are of good quality.

Table 3: Confusion matrix for the 1984 classification.

	vegetation	rooks	sand dunes	barren lands	Urban	Water	Total (User)
vegetation	8	0	1	1	-	-	10
rooks	0	9	0	1	-	-	10
sand dunes	1	0	7	2	-	-	10
barren lands	2	0	1	9	-	-	12
Urban	-	-	-	-	-		-
Water	-	-	-	-	-	-	-
Total Producer	11	9	9	13	-	-	42

Source: student

1.1.2. Valuation of classification accuracy in 2000:

The evaluation of classification accuracy results using confusion matrices (83.7%) for the 2000 image and the Kappa coefficient (0.80) respectively for 2000 indicates that the classifications are of good quality.

Table 4: Confusion matrix for the 2000 classification

	vegetation	rooks	sand dunes	barren lands	Urban	Water	Total (User)
vegetation	9	0	0	1	1	0	11
rooks	0	11	0	1	0	0	12
sand dunes	1	0	8	1	0	0	10

barren lands	**1**	**0**	**1**	**11**	**0**	**0**	**13**
Urban	**1**	**0**	**1**	**1**	**13**	**0**	**16**
Water	**0**	**0**	**0**	**2**	**0**	**10**	**12**
Total Producer	**12**	**11**	**10**	**17**	**14**	**10**	**74**

Source: student

1.1.3. Valuation of classification accuracy in 2023:

The evaluation of classification accuracy results using confusion matrices (86.1%) for the 2023 image and the Kappa coefficient (0.82) respectively for 2023 indicates that the classifications are of good quality.

Table 5:Confusion matrix for the 2023 classification

	vegetation	**rooks**	**sand dunes**	**barren lands**	**Urban**	**Water**	**Total (User)**
vegetation	**11**	**0**	**0**	**1**	**2**	**-**	**14**
rooks	**0**	**10**	**0**	**1**	**0**	**-**	**11**
sand dunes	**0**	**0**	**10**	**1**	**0**	**-**	**11**
barren lands	**1**	**0**	**1**	**12**	**0**	**-**	**14**
Urban	**1**	**0**	**0**	**1**	**13**	**-**	**15**
Water	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Total Producer	**13**	**10**	**11**	**16**	**15**	**-**	**65**

Source: student

1.2. Mapping and analyzing land cover states for each year from 1984 to 2000 and 2023 using the maximum likelihood method:

1.2.1. Analysis of land cover states for 1984, 2000, and 2023:

Using remote sensing data, three land cover maps were generated for the years 1984, 2000, and 2023. Additionally, respective statistics were obtained for all land cover classes for each of these dates. These classification results have enabled a diachronic analysis to understand the changes and evolution in land cover between the studied periods.

By comparing the land cover maps and analyzing the statistics, it becomes possible to identify and interpret the temporal variations in land use patterns. This analysis provides valuable insights into the transformations and trends in land cover over time, allowing for a better understanding of the dynamics and changes in the study area's land use.

Table 6: Surface area in square kilometers and percentage of land cover classes (1984, 2000, 2023).

	Area (Km²)			%		
Classes	**1984**	**2000**	**2023**	**1984**	**2000**	**2023**
vegetation	0.93	3.24	3.09	0.21	0.72	0.69
rooks	13.89	22.9	18.14	3.09	5.1	4.04
sand dunes	44.7	66.2	45.99	9.95	14.73	10.24
barren lands	389.78	356	376.98	86.75	79.24	83.91
Urban	0	0.52	5.08	0	0.12	1.13
Water	0	0.42	0	0	0.09	0
Total	449.29	449.29	449.29	100	100	100

Source: student

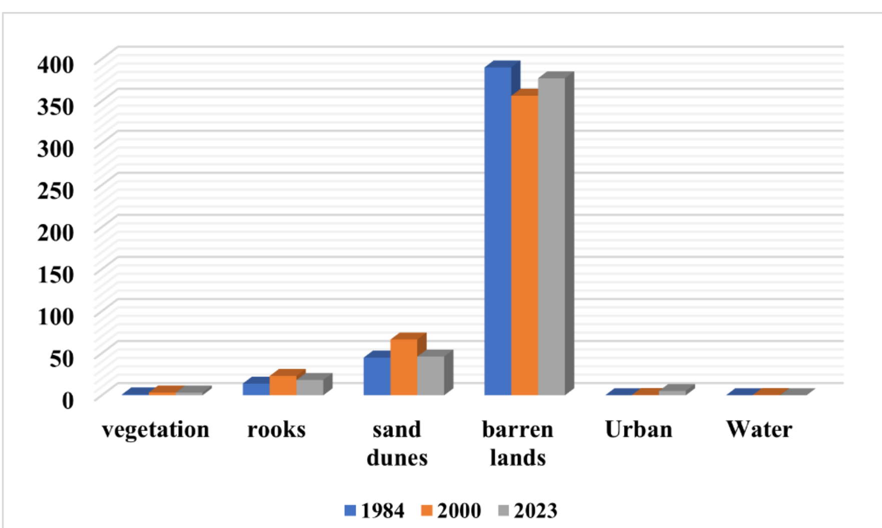


Figure 31: Bar chart of land cover class areas.

1.2.2. Land cover state in 1984:

At that time, barren lands dominated the land cover, covering an area of 389.78 square kilometers, representing 86.75% of the total area. The vegetation class only covered an area of 0.93 square kilometers, accounting for 0.21% of the total area. The rock class occupied an area of 13.89 square kilometers, representing 3.09%. Sand dunes, on the other hand, accounted for 9.95% of the land cover with an area of 44.7 square kilometers.

Table 7:Land cover in 1984

Classes	Area (Km²)	%
vegetation	0.93	0.21
rooks	13.89	3.09
sand dunes	44.7	9.95
barren lands	389.78	86.75
Urban	0	0
Water	0	0
Total	449.29	100

Source: student

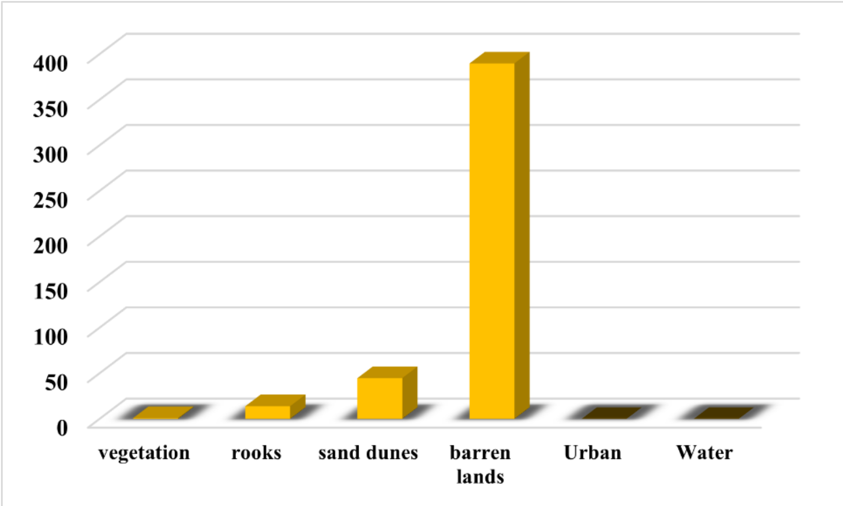
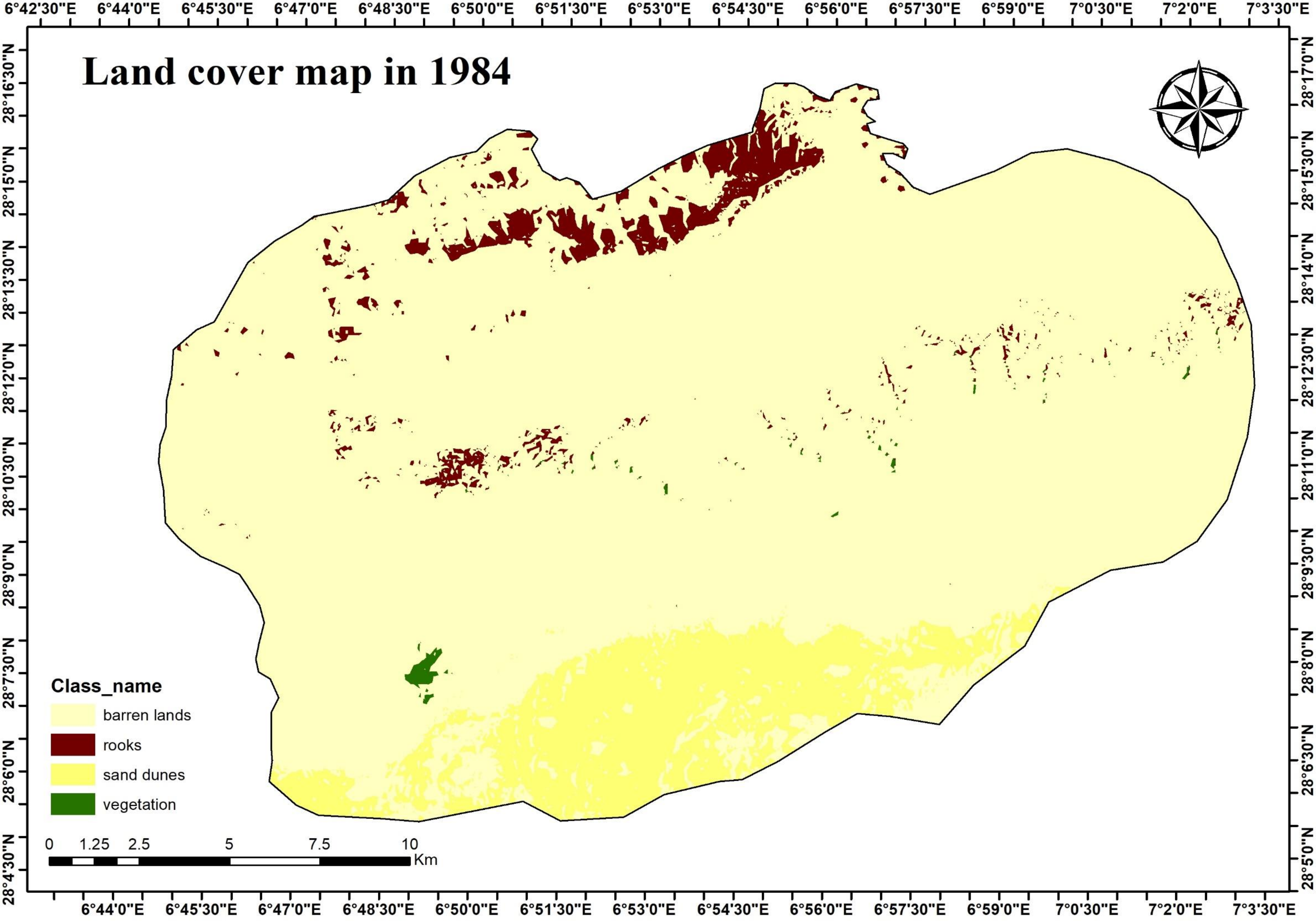


Figure 32:Bar chart of land cover distribution in 1984



Source: student *Figure 33 :* **Land cover map in 1984**

1.2.3. Land cover state in 2000:

We can observe changes in land cover between the years 1984 and 2000, including the emergence and expansion of the urban area, which covered an area of 0.52 square kilometers, representing 0.12% of the total area. We also see an expansion in the vegetation cover, with an area of 3.24 square kilometers accounting for 0.72%. As for barren lands, they were estimated to cover 356 square kilometers, representing 79.24%, indicating a slight decrease compared to 1984. The area of sand dunes was estimated at 66.2 square kilometers, accounting for 14.73%, while rocks covered an area of 22.9 square kilometers, representing 5.1%. Furthermore, the presence of water ponds indicates significant precipitation, with the area of water ponds estimated at 0.42 square kilometers, representing 0.09%.

Table *8:* Land cover in 2000

Classes	Area (Km^2)	%
vegetation	3.24	0.72
rooks	22.9	5.1
sand dunes	66.2	14.73
barren lands	356	79.24
Urban	0.52	0.12
Water	0.42	0.09
Total	449.29	100

Source: student

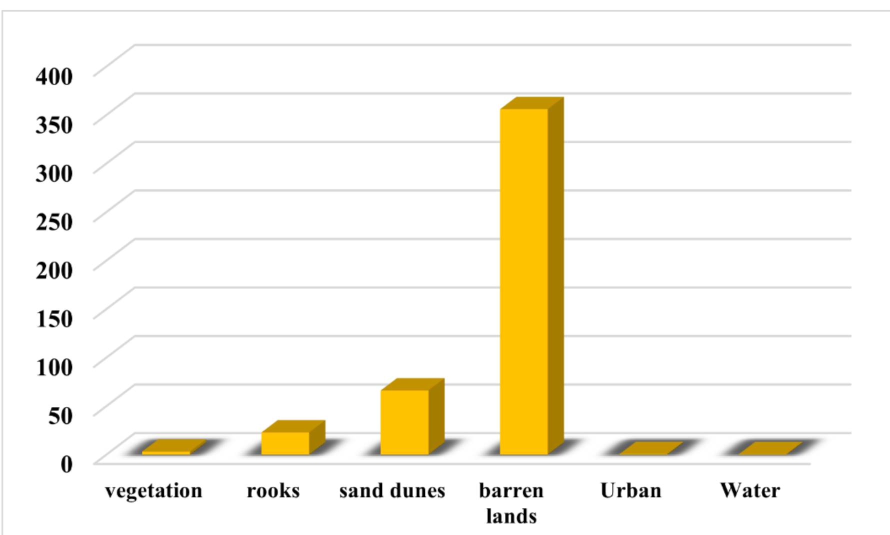
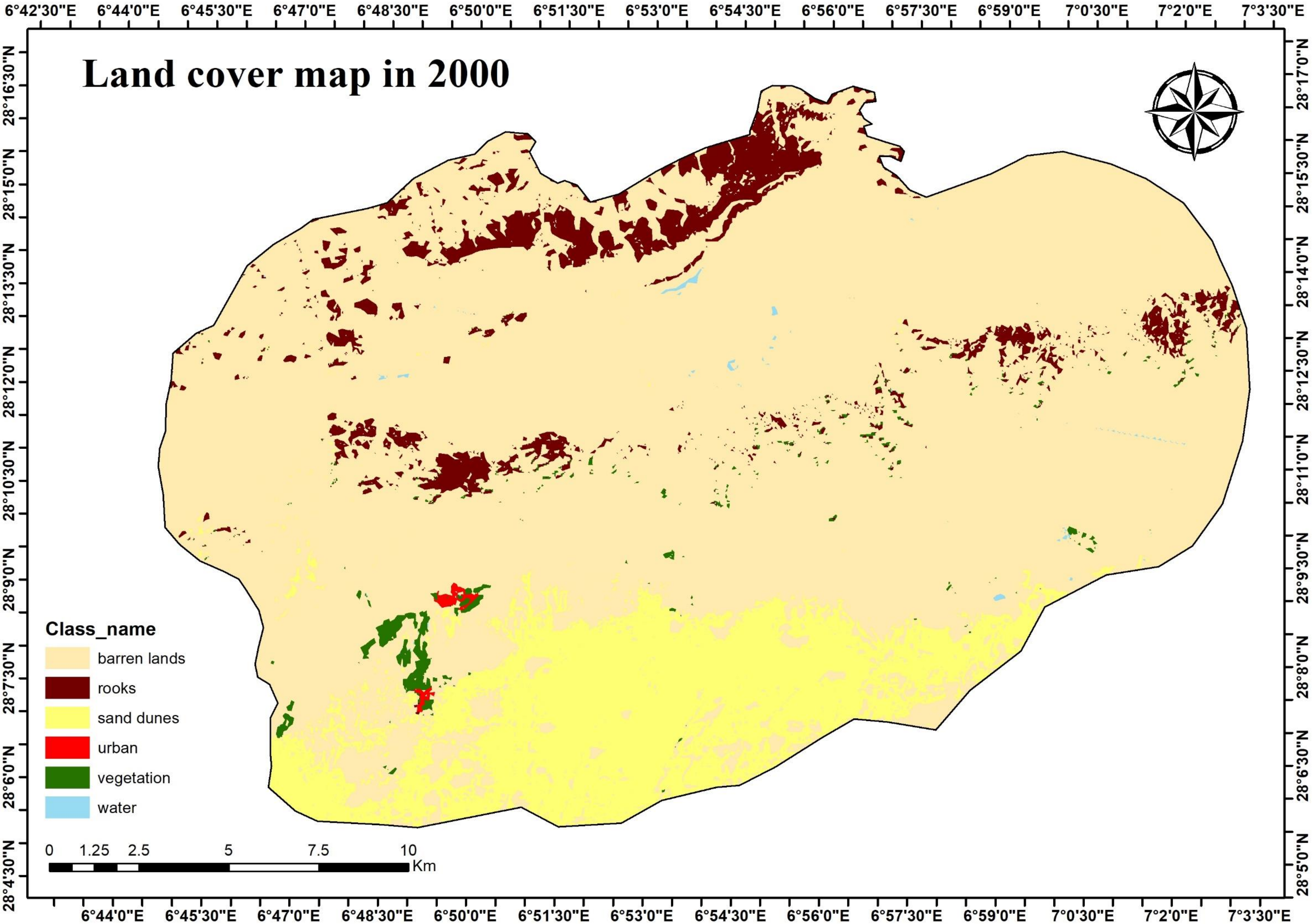


Figure 34: Bar chart of land cover distribution in 2000



Source: student *Figure 35:* **Land cover map in 2000**

1.2.4. Land cover state in 2023:

The urban area is estimated to cover 5.8 square kilometers, representing 1.13% of the total area. The vegetation cover occupies an area of 3.09 square kilometers, accounting for 0.69%. Barren lands cover a larger area, estimated at 376.98 square kilometers, representing 83.91%. Sand dunes account for 45.99 square kilometers, representing 10.24%. Rocks cover an area of 18.14 square kilometers, representing 4.04%.

These changes indicate an expansion of the urban area, a slight increase in vegetation cover, and a relatively stable extent of barren lands, sand dunes, and rocks compared to the previous years.

Table 9 : Land cover in 2023

Classes	Area (Km²)	%
vegetation	3.09	0.69
rooks	18.14	4.04
sand dunes	45.99	10.24
barren lands	376.98	83.91
Urban	5.08	1.13
Water	0	0
Total	449.29	100

Source: student

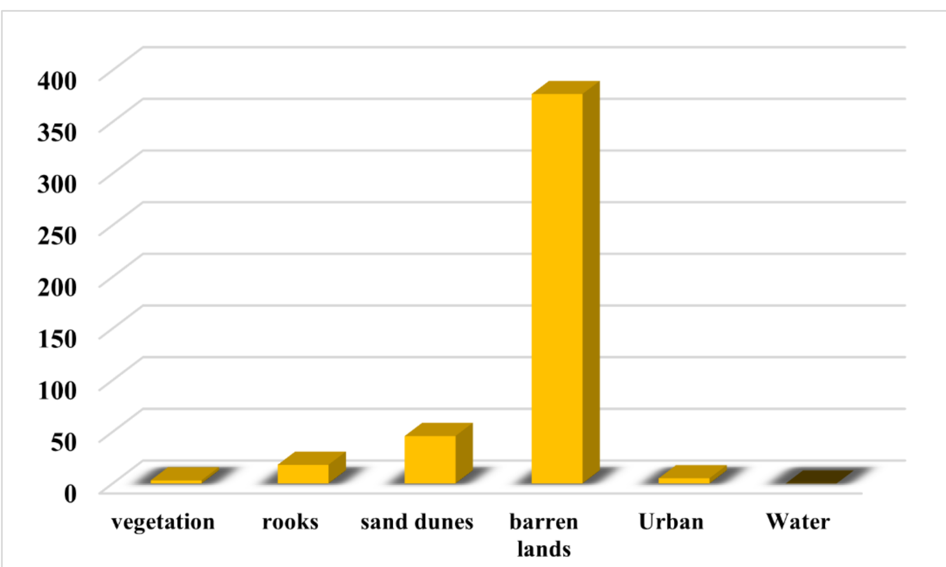
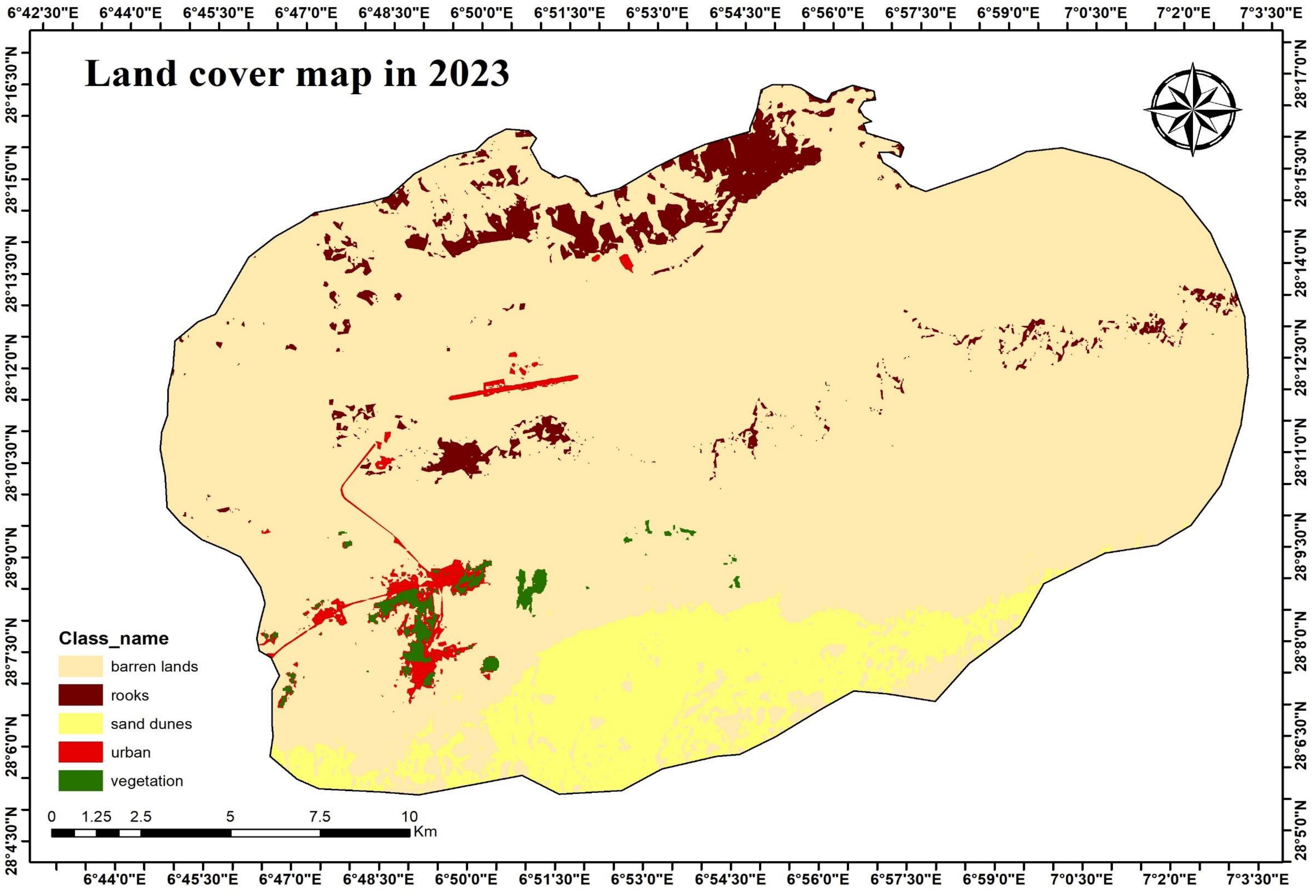


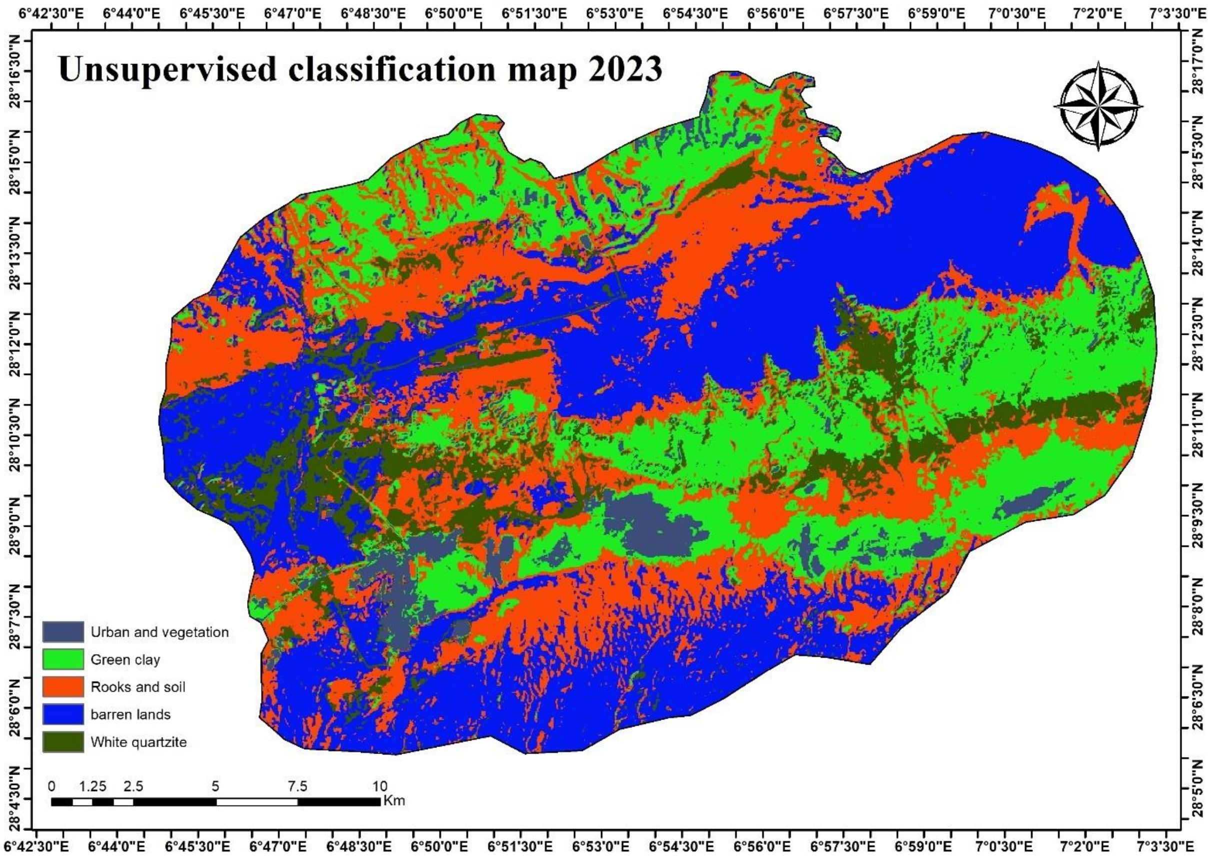
Figure 36: **Bar chart of land cover distribution in 2023**



Source: student ***Figure 37:*** **Land cover map in 2023**

1.2.5. Unsupervised classification:

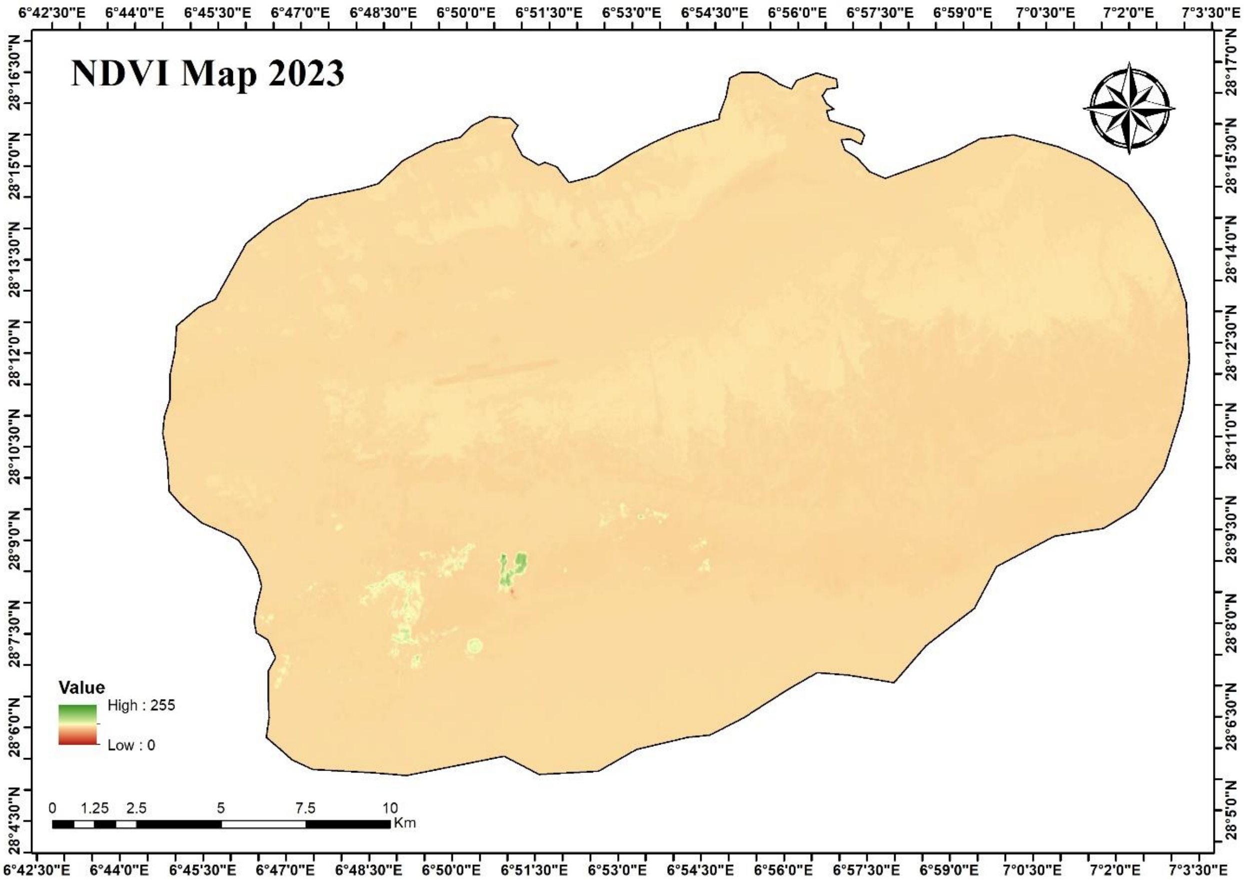
Through unsupervised classification, land uses can be identified as follows: vegetation cover, urban areas, white quartzite rocks, green clay, rocks, sand, and barren lands, as shown in the figure.



Source: student *Figure 38: The land cover using unsupervised classification 2023*

1.3. NDVI:

From the vegetation cover index map, it is evident that the vegetation cover is weak and sparse, occupying a small percentage of the total study area. This indicates that the area has limited vegetation and may be characterized by factors such as aridity, soil quality, or human activities that have resulted in the reduction of vegetation cover. The low vegetation cover percentage suggests potential ecological challenges in sustaining plant life in the study area.



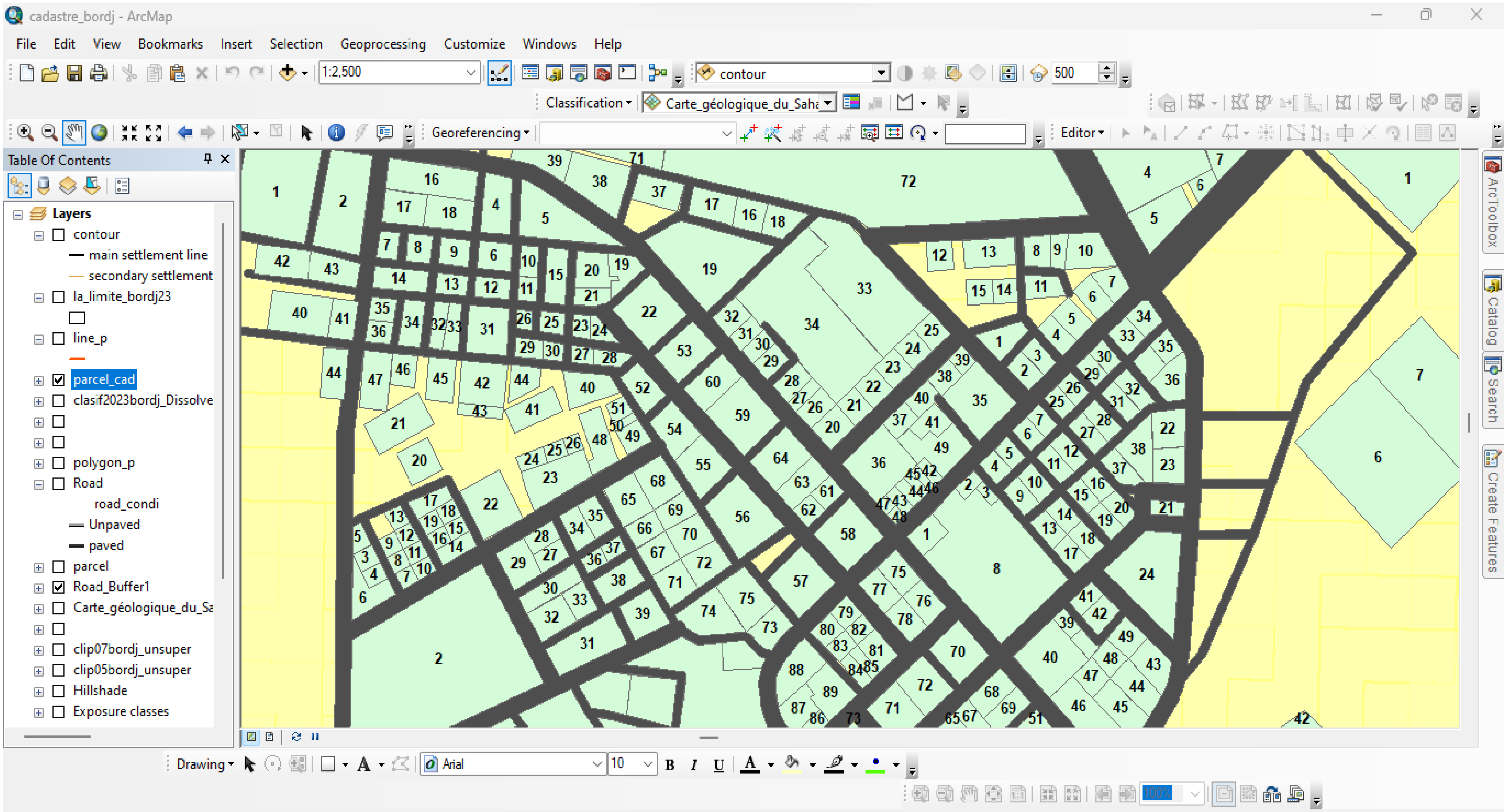
Source: student **Figure 39: Vegetation cover index**

1.4. Cadastral Data Results:

1.4.1. The multi-purpose cadastral plan:

After inputting the cadastral plans obtained from the Land Survey Directorate into ArcGIS and adding the corresponding database, the following results were obtained:

- A precise and up-to-date cadastral map reflects the actual status of lands and properties, facilitating easy access to information.
- A database enables spatial analysis and gave decision-making regarding land management and property ownership.
- Road network information
- A three-dimensional cadaster plans



Source: student **Figure 40:The multi-purpose cadastral plan**

2. Suggestions:

1. Study other environmental factors: Expand the study to incorporate other environmental factors, such as climate change or natural disasters. These factors may have a significant impact on land cover changes and public lands.

2. Analyze environmental and social impacts: Expand the study to analyze the environmental and social impacts of the observed changes in land cover and land use changes. These analyses can help understand the impact of urban growth and land use change on the local community and the environment.

3. Utilize temporal analysis techniques: Explore the use of temporal analysis techniques to understand the temporal trends and patterns of land cover changes. Techniques such as spatial quantitative modeling and statistical analysis can be employed to identify the factors influencing changes over time.

4. Develop a predictive model: Based on the collected data and conducted analyses, consider developing a predictive model to determine future trends in land cover and property changes in the area.

5. Expand the multi-purpose use of land records: Investigate the potential for using multi-purpose land records for other purposes such as urban planning, natural resource management, and sustainable development.

V. Conclusion:

The study presented contributes to understanding the use of geographic information systems and remote sensing in the preparation and management of multi-purpose cadastre. The methodological approach used in this study involves the intersection of several data sources, including aerial and satellite imagery, statistical data, field visits, cadastral maps, cadastral data, and geological maps of the study area.

The main objectives were achieved by studying and analyzing the evolution of land cover between 1984, 2000, and 2023. This was done by using supervised classification with Landsat 5, 7, and 9 satellite images to update the land cover classification for 2023. Additionally, the vegetation cover index was studied to obtain information on agricultural areas and vegetation cover in the region. Furthermore, digital elevation models were used to create maps of the natural environment, including terrain maps, slope maps, and 3D views.

All these data were organized into spatial layers and stored in a dedicated geographic database for the multi-purpose cadastre data of the study area, Burj Umar Idris. Throughout the analyzed period from 1884 to 2023, a comprehensive analysis of the detected changes in the study area revealed that 80% of the land cover classes remained constant, while 20% of the classes showed changes. Barren lands decreased from 86.75% to 83.91%, while urban areas increased from 0% to 1.13%. Vegetation cover experienced a slight increase from 0.21% to 0.69%.

All the data obtained in this study were used to digitize and update the cadastral maps using the buffer method for road representation. Each parcel was assigned a database containing information such as owner's name, section number, parcel number, account number, location, land use, soil type, area, legal status, number of floors, slope, agriculture type, building materials, and building condition. These data facilitate the management and informed decision-making regarding land administration, enabling effective cadastre management.

From this work, it can be concluded that accurate data, remote sensing, and geographic information systems are important and effective tools in the management and preparation of multi-purpose cadaster. They facilitate the collection, storage, and retrieval of information, as demonstrated in this graduation project summary.

Bibliographic References:

Shamsul Abdul, M. (2000). *A multi-purpose cadaster prototype on the web* [PDF *A multi-purpose cadaster prototype on the web*]. http://hdl.handle.net/11343/38968

Vaiopoulos, D. Vassilopoulos, A., Evelpidou, N. Vassilas, N. Perantonis. S. Charou, E. S. V. (1999). Land cover thematic map production by photointerpretation and quantitative analysis of satellite imagery. (February 2020). Retrieved from https://www.researchgate.net/publication/339166228%0ALand

Abdeta Daba, A. (2022). Development of Cadastral Information System using by Geographical Information System (GIS): A case of Around Gabriel sefar in Assosa Town [Review of *Development of Cadastral Information System using by Geographical Information System (GIS): A case of Around Gabriel sefar in Assosa Town*]. *International Journal of Engineering, Management & Technology (IJEMT)*, *1*(II), 133–160. https://ijemt.com/wp-content/uploads/2022/04/GSV-260422-01-IJEMT.pdf

Abdul Majid, S. (2000). BENEFITS AND ISSUES OF DEVELOPING A MULTI-PURPOSE CADASTRE [Review of *BENEFITS AND ISSUES OF DEVELOPING A MULTI-PURPOSE CADASTRE*]. *International Archives of Photogrammetry and Remote Sensing*, *XXXIII*, 22–29. https://www.isprs.org/proceedings/xxxiii/congress/part4/22_XXXIII-part4.pdf

Williamson, I. P. (1983). *A modern cadaster for New South Wales* [PDF *A modern cadaster for New South Wales*]. http://hdl.handle.net/1959.4/66222

Web site:

1- ***(**GISGigography**):*** What is Remote Sensing? The Definitive Guide - GIS Geography

2- (EDUCBA): Applications of GIS | Top 8 Applications of Geographic Information Systems (educba.com)

3- (Springe Link): ArcGIS: General Purpose GIS Software System | SpringerLink

4- (ITTVIS): ENVI - Image Processing and Analysis Software Solution - ITTVIS

5- (uOttawa library): Google Earth Pro - Geographic Information Systems (GIS) - Guides de recherche · Research guides at University of Ottawa (libguides.com)

6- (CFI): Excel Definition - What is Microsoft Excel? Overivew, Definition (corporatefinanceinstitute.com)

7- (Oicrf): 5fe2d7b1-87b4-0430-215f-1fb8bcd86594 (oicrf.org)

Abstract:

The presented study discusses the use of Geographic Information Systems (GIS) and remote sensing in the preparation and management of multipurpose cadaster. The study utilized aerial and satellite imagery, statistical data, field visits, cadastral maps, and geological maps of the study area. The analysis focused on the land cover changes between 1984, 2000, and 2023 using supervised and unsupervised classification techniques with satellite images. The vegetation cover index was also used to assess plant changes in the area. All the data were organized in a dedicated geographic database for the multipurpose cadaster of the studied area. It includes information such as owner's name, section number, parcel number, account number, location, property type, land use, soil type, area, legal status, number of floors, slope, agriculture type, building materials, and building condition. These data can be used for land management and informed decision-making. Overall, the study demonstrates that remote sensing and GIS are valuable tools for the comprehensive and effective preparation and management of multipurpose cadaster.

Key words: Multipurpose cadaster, Satellite images, cadaster, Land use, Land parcels, Land cover, Geographic information systems (GIS), Remote sensing, Digital elevation model, Landsat.

الملخص:

تتناول الدراسة المقدمة استخدام أنظمة المعلومات الجغرافية والاستشعار عن بعد في إعداد وتسيير الكادستر متعدد الأغراض. استخدمت الدراسة صوراً جوية وصور أقمار صناعية وبيانات إحصائية وزيارات ميدانية وخرائط الكادستر والبيانات الكادستر والخرائط الجيولوجية لمنطقة الدراسة. تم تحليل تطور الغطاء الأرضي بين عام 1984 و2000 و2023 باستخدام تقنيات التصنيف الموجه وغير الموجه للصور القمر الصناعي. كما تم استخدام مؤشر الغطاء النباتي لتقييم التغيرات في النباتات في المنطقة. تم تنظيم جميع البيانات في قاعدة بيانات جغرافية مخصصة للكادستر متعدد الأغراض للمنطقة المدروسة. يشمل كل سجل كادستر معلومات مثل اسم المالك ورقم القسم ورقم القطعة ورقم الحساب والموقع ونوع الملكية واستخدام الأرض ونوع التربة والمساحة والوضع القانوني وعدد الطوابق والميل ونوع الزراعة ومواد البناء وحالة المباني. يمكن استخدام هذه البيانات لإدارة الأراضي واتخاذ القرارات المستنيرة. بشكل عام، تظهر الدراسة أن استخدام الاستشعار عن بعد ونظم المعلومات الجغرافية يمثل أدوات مهمة لإعداد الكادستر متعدد الأغراض بطريقة شاملة وفعالة.

الكلمات المفتاحية: الكادستر متعدد الأغراض، الصور الفضائية، الكادستر، استخدام الأراضي، قطع الأراضي، تغطية الأرض، أنظمة المعلومات الجغرافية (GIS)، الاستشعار عن بُعد، نموذج الارتفاع الرقمي، لاندسات (Landsat).