OPTIMIZING SUSTAINABLE LANDSCAPE MAINTENANCE TECHNIQUES THROUGH DIGITAL TOOLS AND DATA ANALYTICS

Done by

Elghonaimy, I., Moosa, S.

* Department of Architecture and Interior Design, College of Engineering, University of Bahrain.

**Freelance Landscape Architect, Kingdom of Bahrain

#OmaintecConf

An Initiative by

OMAINTEC
المجلس العربي للتشغيل والصيانة
Arab Operations & Maintenance Council

Organized by

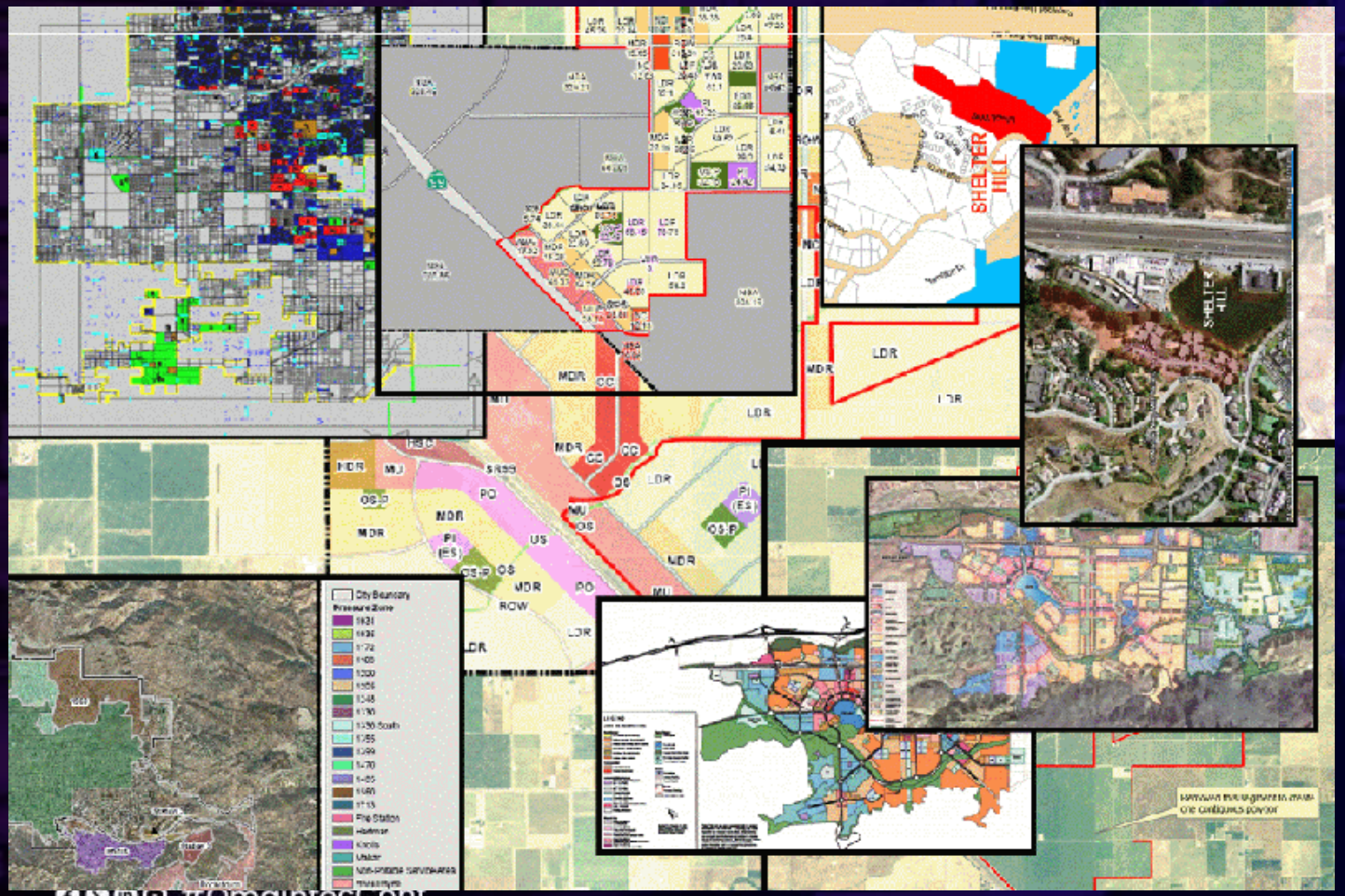
EXICON.
International Group
مجموعة أكزيكون الدولية

This pilot project was conducted successfully using the cooperation between the private (“LIF” Consultant Architecture Office) and academic (Department of Architecture and Interior Design, College of Engineering, University of Bahrain) sectors to propose a maintenance method that the governmental sector could use to operate open spaces in an innovative, sustainable way.

Introduction

This pilot project was conducted successfully using the cooperation between the private (“LIF” Consultant Architecture Office) and academic (Department of Architecture and Interior Design, College of Engineering, University of Bahrain) sectors to propose a maintenance method that the governmental sector could use to operate open spaces in an innovative, sustainable way.

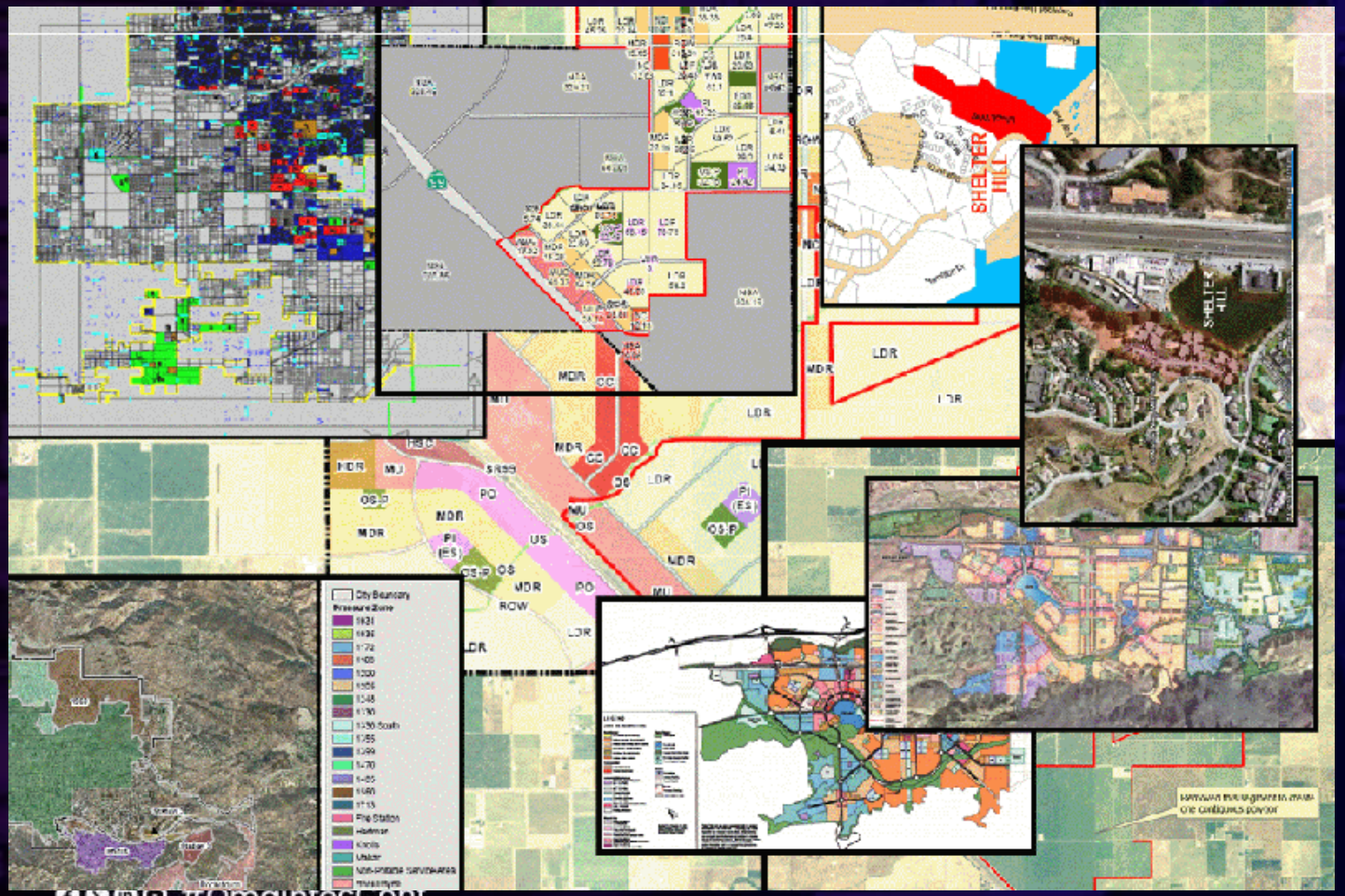
Introduction



The world continues to urbanize at various statuses, encountering the challenges of sustaining national resources.

The ***MAINTENANCE*** of urban space projects presents exceptional challenges, including Softsacpe resource constraints, environmental impacts, and the need to improve efficiency in addressing green spaces as well as Hardscape elements.

Introduction



In response to these challenges, incorporating ***DIGITAL*** instruments has emerged as an advantageous solution to optimize ***SUSTAINABLE*** landscape maintenance techniques.

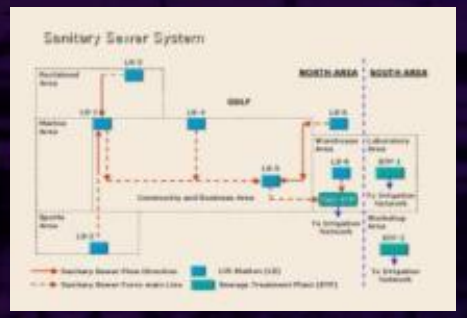
By leveraging technology and real-time data, landscape architects can enhance resource management, and ***REDUCE THE ECOLOGICAL FOOTPRINT***.

Facts and the overall problem

At the macro level, Bahrain has many parks of different sizes and are allocated in different areas. The **HUMAN ERRORS,** the **MISS MAINTENANCE** plans and the limited resources **COST** the country a huge amount of money

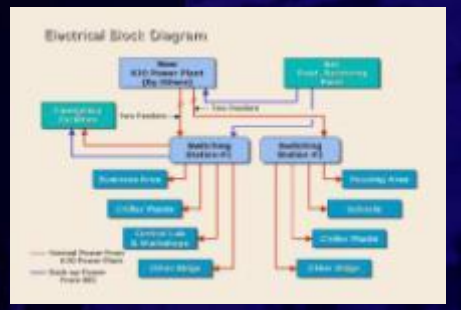
Study problem

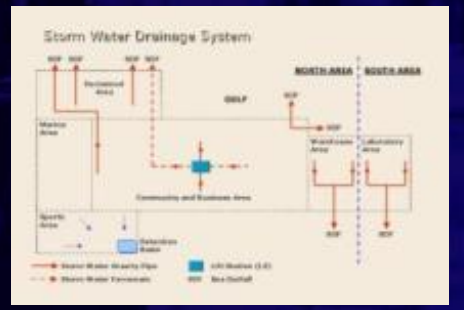
Why does dealing with infrastructure look complicated and costly?



Electri
city

Wate
r





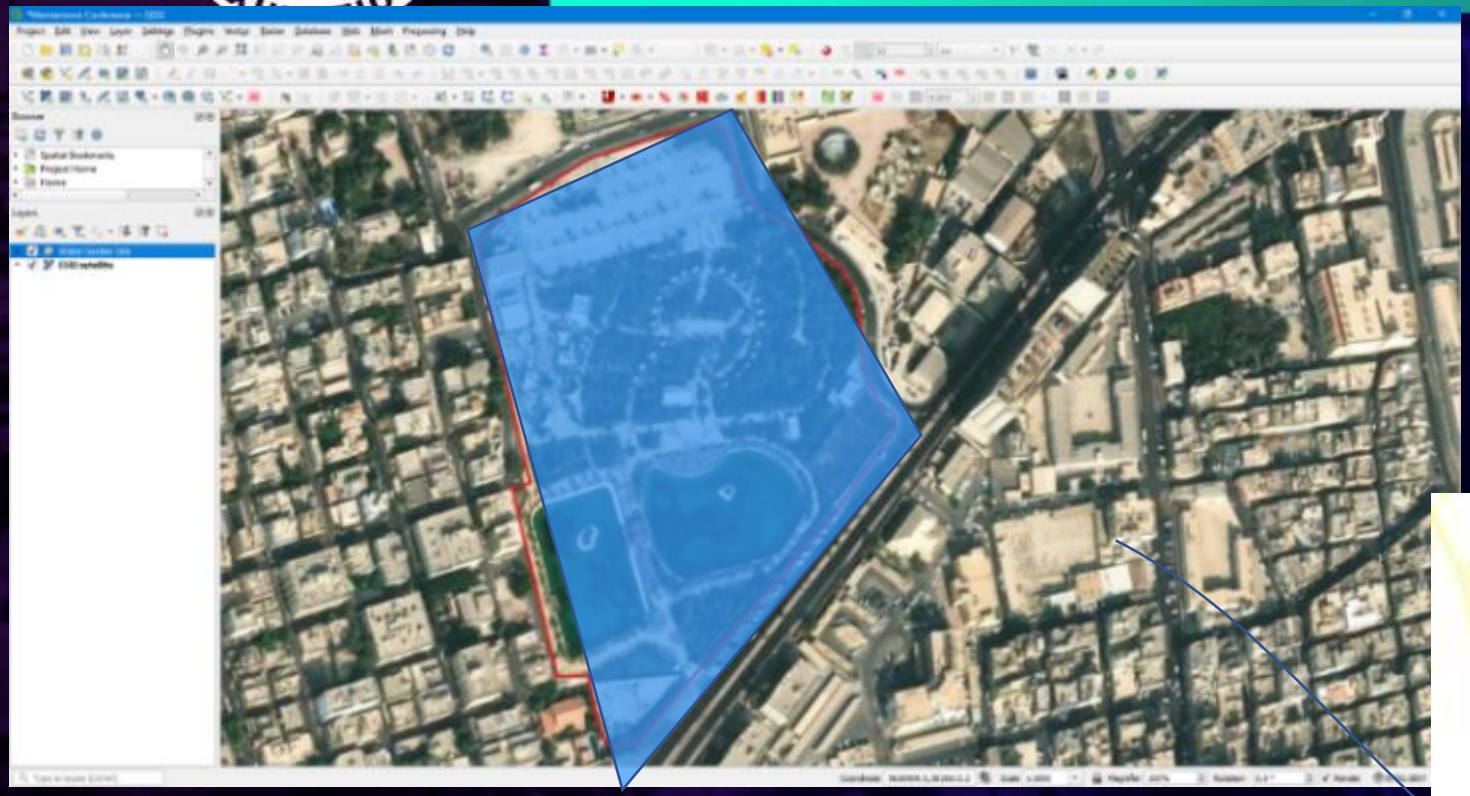
Sewag
e

GAS

#OmaintecConf

At the macro level, Bahrain has many parks of different sizes and are allocated in different areas. The **HUMAN ERRORS,** the **MISS MAINTENANCE** plans and the limited resources **COST** the country a huge amount of money

Study problem



The pilot study “Water Garden Park” in Bahrain,

Who is responsible, when he can decide, How could he know that his decision is correct, Emergency cases , Country resources

Key solving points

It is needed to:

1- consider the different **PRIORITIES** for each teamwork,

2- implementing in proper **TIME**,

3- controlling the **COST**.

4- The **USE** of such a park should continue.

How could be organized?

Considering **SUSTAINABILITY** and preserving the country's **RESOURCES**, there is a necessity for appropriate **COOPERATION** between different municipal departments.

Undertaking this job needs:

1- High **ACCURACY**

2- Using advanced **TECHNIQUE**

Key solving points

What is the effective tool
&
how could achieving the:

Key solving points

a. Digital Tools for Irrigation Optimization:

Research by Ullah, R. et al. (2021) demonstrates how ***intelligent irrigation controllers, weather data, and soil moisture sensors significantly reduce water consumption*** by dynamically adjusting irrigation schedules based on real-time conditions.

Similarly, Hafian, A., Benbrahim, M., and Kabbaj, M.N. (2021) found that implementing ***IoT-based irrigation systems*** led to a notable decrease in water usage while maintaining healthy vegetation in urban landscapes. These studies underscore the importance of digital tools in water conservation, a critical aspect of sustainable landscape maintenance.

Key solving points

b. Remote Monitoring and Real-time Data Analytics:

The incorporation of ***remote monitoring systems***, including IoT sensors and cameras, has been investigated in several studies for its potential to revolutionize landscape maintenance practices.

Ali, T. (2020) research demonstrates how ***real-time environmental data collected*** through IoT sensors facilitated timely responses to ***plant health issues***, enabling proactive pest management and early disease detection.

Additionally, Joyce, G.M. and Priyadarshini, J.S. (2023) revealed that integrating remote monitoring and data analytics improved ***resource allocation, reduced maintenance costs, and enhanced landscape resilience.***

Key solving points

c. Successful experiences and Implementations provide valuable insight into successfully integrating digital tools in landscape maintenance.

Joyce, G.M. and Priyadarshini, J.S. (2023) examined a pilot project, where ***adopting intelligent irrigation controllers***.

Similarly, Tiwary, A.N. (2016) presented a case study of sustainable landscape development in a city center, showcasing ***how digital mapping tools and remote sensors facilitated efficient maintenance practices while enhancing the urban environment.***

Key solving points

d. The challenges and opportunities associated with integrating digital tools in landscape maintenance.

Shurtz, K.M. et al. (2022) pointed out that investment in ***technology and training*** could be a barrier for some organizations.

Additionally, ***privacy and data security*** concerns have been raised in using remote monitoring systems.

However, the ***long-term benefits***, such as ***resource savings***, presenting an opportunity to adopt sustainable technologies.

Key solving points

e. Projects Optimized Digital Tools in Maintenance

- These projects provide a comprehensive view of the ***successful integration of digital tools and data analytics*** in sustainable landscape maintenance practices in the Arab region.

- Implementing ***intelligent*** irrigation controllers, remote monitoring, native plant identification apps, and predictive analytics demonstrated notable improvements in water conservation, resource efficiency, and ecological preservation.

- the transformative impact positively contributing to the region's environmental sustainability and urban development.

Key solving points

e. Projects Optimized Digital Tools in Maintenance

Table 1 shows the implementation of Digital Tools and Data Analytics in different concepts.

concept	The project	focuses	Digital Tools Implemented	Results
▪ Sustainable Landscape Maintenance in an Urban Park	City Center, Dubai, UAE: The park spans several hectares and features various green spaces, water features, and plantings	challenging maintenance scenario in a water-scarce environment	Smart irrigation controllers were strategically installed throughout the park, connected to weather data and soil moisture sensors.	Reducing water consumption in the park by approximately 30%; the park's overall sustainability improved, with a noticeable reduction in energy consumption and maintenance costs.
▪ Ecological Restoration Project in a Desert Region	Al-Ula, SA: aimed to rehabilitate degraded desert landscapes,	promote biodiversity, and reintroduce native plant species, arid-adapted vegetation, and innovative irrigation techniques	Improved plant species management, Weather. Monitoring and Predictive Analytics.	A higher survival rate and reduced water requirements.
▪ Data-Driven Sustainable Campus Landscape	Education City, Doha, Qatar	maintenance practices incorporate sustainable design principles to create a green and environmentally responsible environment.	Intelligent Lighting Control System. Monitoring System: incorporated IoT sensors.	Significant reduction in energy consumption for outdoor lighting. Monitoring systems enhanced maintenance, reducing resource wastage.
▪ Smart Parks Initiative in Riyadh, Saudi Arabia	Riyadh, Saudi Arabia	The municipality of Riyadh launched the Smart Parks initiative to improve the maintenance and sustainability of public parks across the city.	Smart watering stations equipped with weather sensors and soil moisture. Mobile App encourages park visitors to report maintenance issues.	Significant water savings. Improved quality and reduced noise in parks. encouraged public involvement in park maintenance with the Maintenance teams.
▪ Sustainable Landscape Management	Corniche Beach, Abu Dhabi, UAE	explores the sustainable landscape management practices of Corniche Beach.	Soil Moisture Sensors and Irrigation to monitor. Remote Plant Health Monitoring. Innovative Waste Management.	Significant water savings Early detection of plant health issues. Innovative waste management.
▪ Urban Green Space Maintenance	Cairo, Egypt	The sustainable maintenance practices of urban green spaces limited water resources.	Optimize innovative irrigation and water recycling water usage. Water recycling systems. Innovative Waste Management.	Significant water savings. Improved the efficiency of waste collection.
▪ Sustainable Campus Grounds	Masdar City, Abu Dhabi, UAE	Sustainable landscape management practices adopted within the innovative, eco-friendly city of Masdar.	Automated Irrigation and Smart Landscape Lighting soil moisture sensors and weather data. A centralized Maintenance Platform.	Improved maintenance coordination, optimized water usage, and reduced energy consumption.

Study Idea & Aims

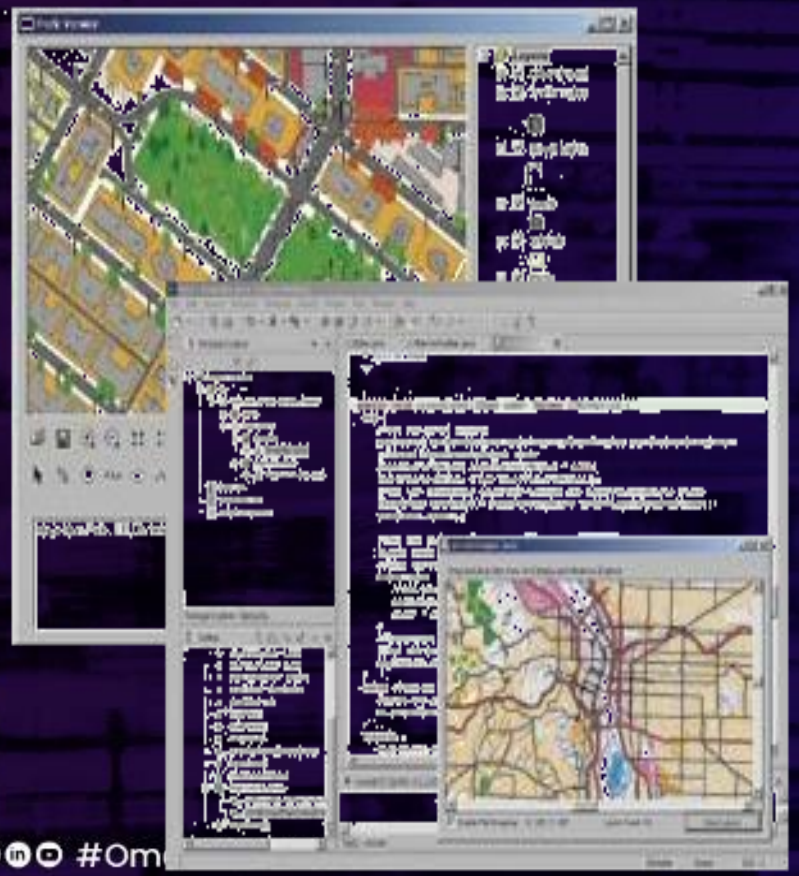
- This study explores the vast potential of various apps and digital tools that contribute to advancing sustainable landscape maintenance practices in the Arab region.

- The study aims to shed light on the transformative impact of technology in elevating landscape management to new levels of **EFFICIENCY, SUSTAINABILITY, AND RESILIENCE**.

- The **QGIS** (Quantum Geographic Information System) is a powerful open-source software that can significantly aid in achieving the aim of the pilot study.

Study Idea

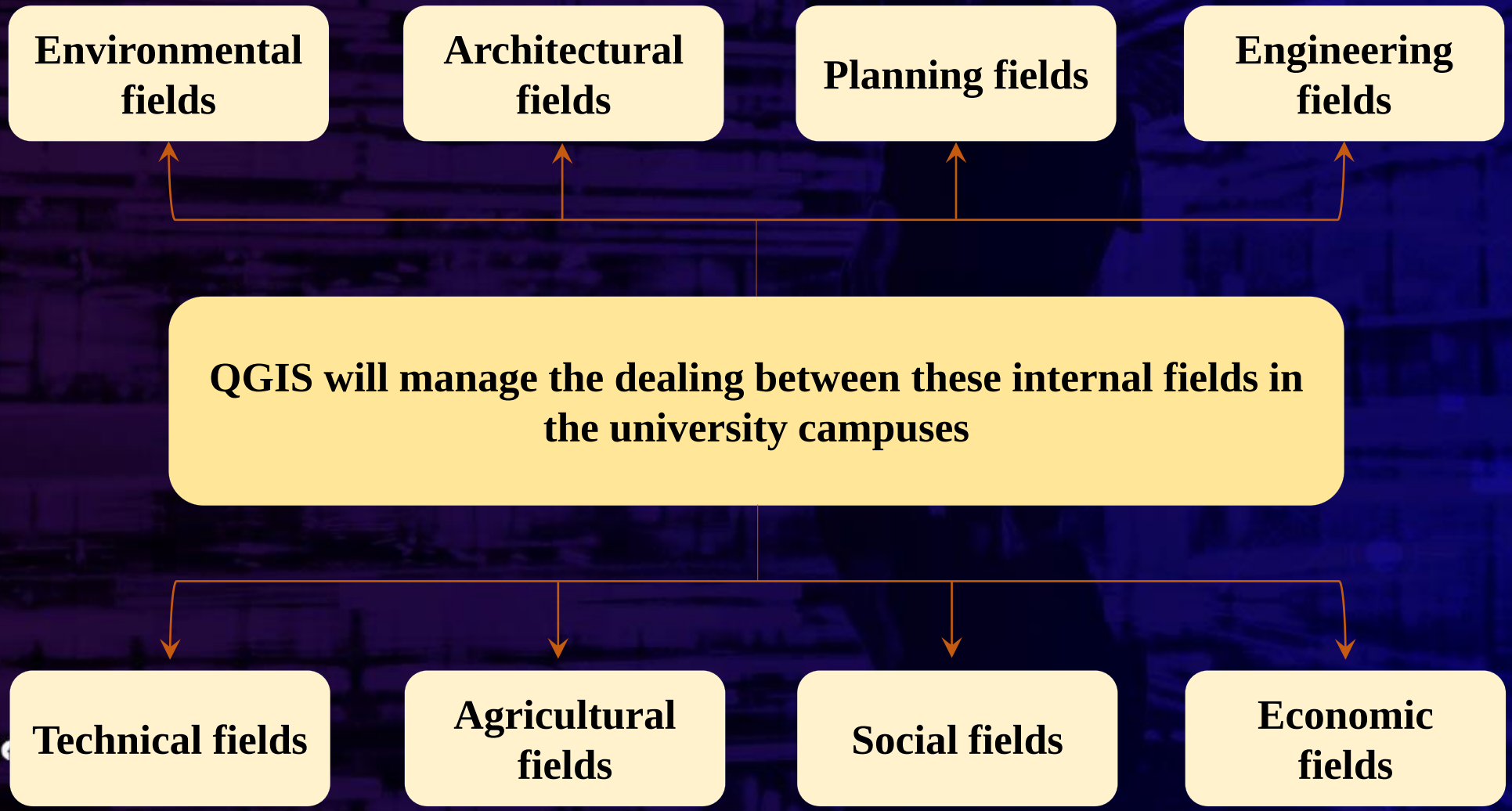
QGIS scope can cover



- Urban Planning
- Site Planning
- Urban Design
- Landscape Architecture
- Architecture
- Interior Design

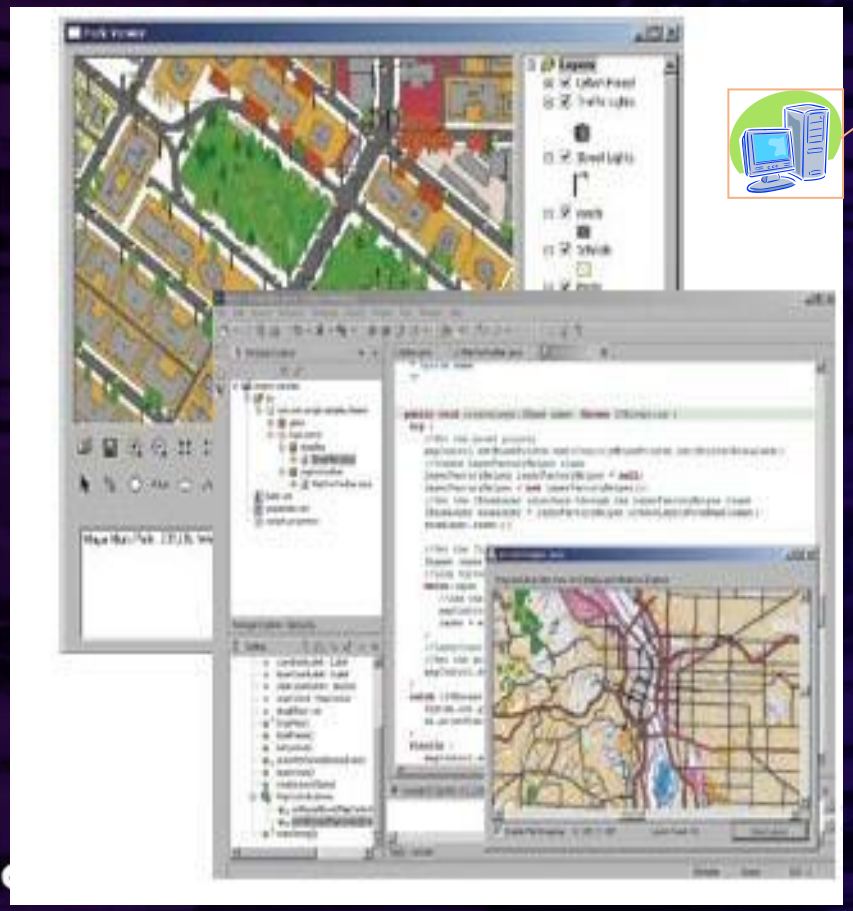
Study Idea

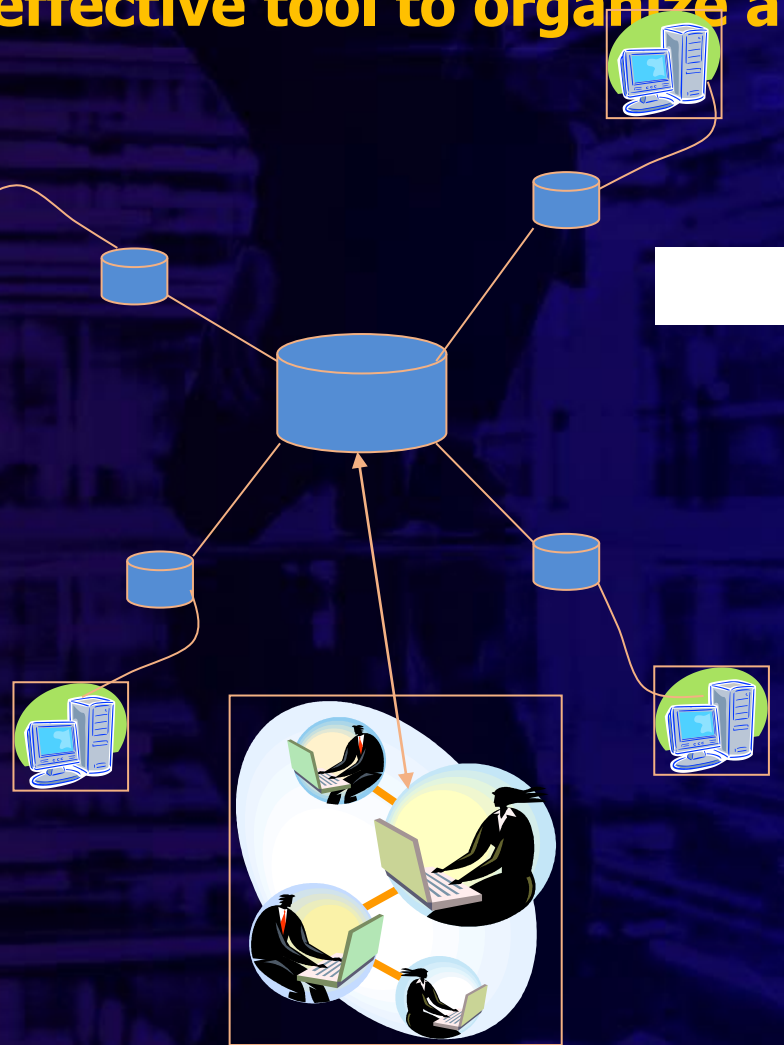
QGIS will manage with different braches



Study materials

So, Can QGIS be an effective tool to organize and manage the job .....





Data:

- Collection & Storing
- Analysis & Response
- Managing & Maintaining
- Developing and enhancing
- Coordinating & Organizing
- Response to decision makers

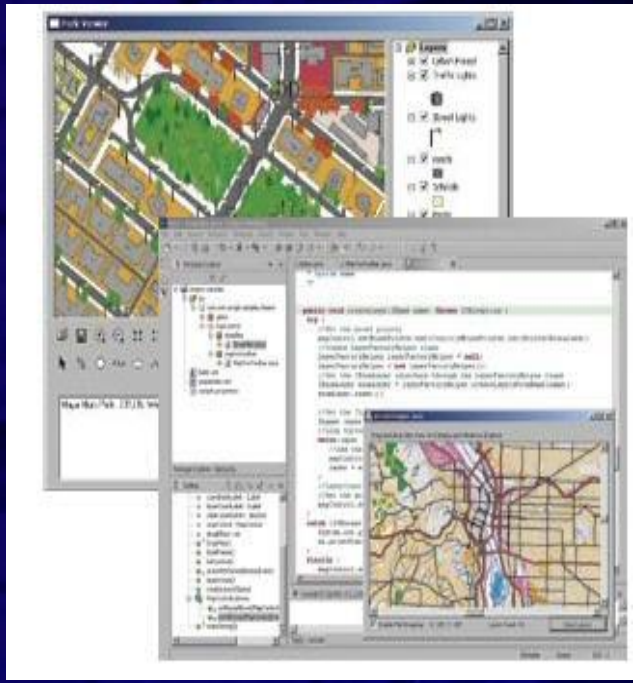
We need to understand carefully the requirements
And design
"GIS Enabled Portal"
To be used as smart tool

Study materials

- Due to the previous reasons, the QGIS was selected in the study to facilitate managing and operating the maintenance map
- Overall, QGIS offers a versatile and user-friendly platform for spatial analysis, visualization, and data integration,
- It empowers operators, Decision makers, managers, maintenance teams, and researchers to perform complex geospatial analyses, create informative maps, and communicate research findings visually and compellingly.

Study Methodology

The pilot study selected "Water Garden Park," located in Manama, Bahrain, to implement the lessons gained using the QGIS.

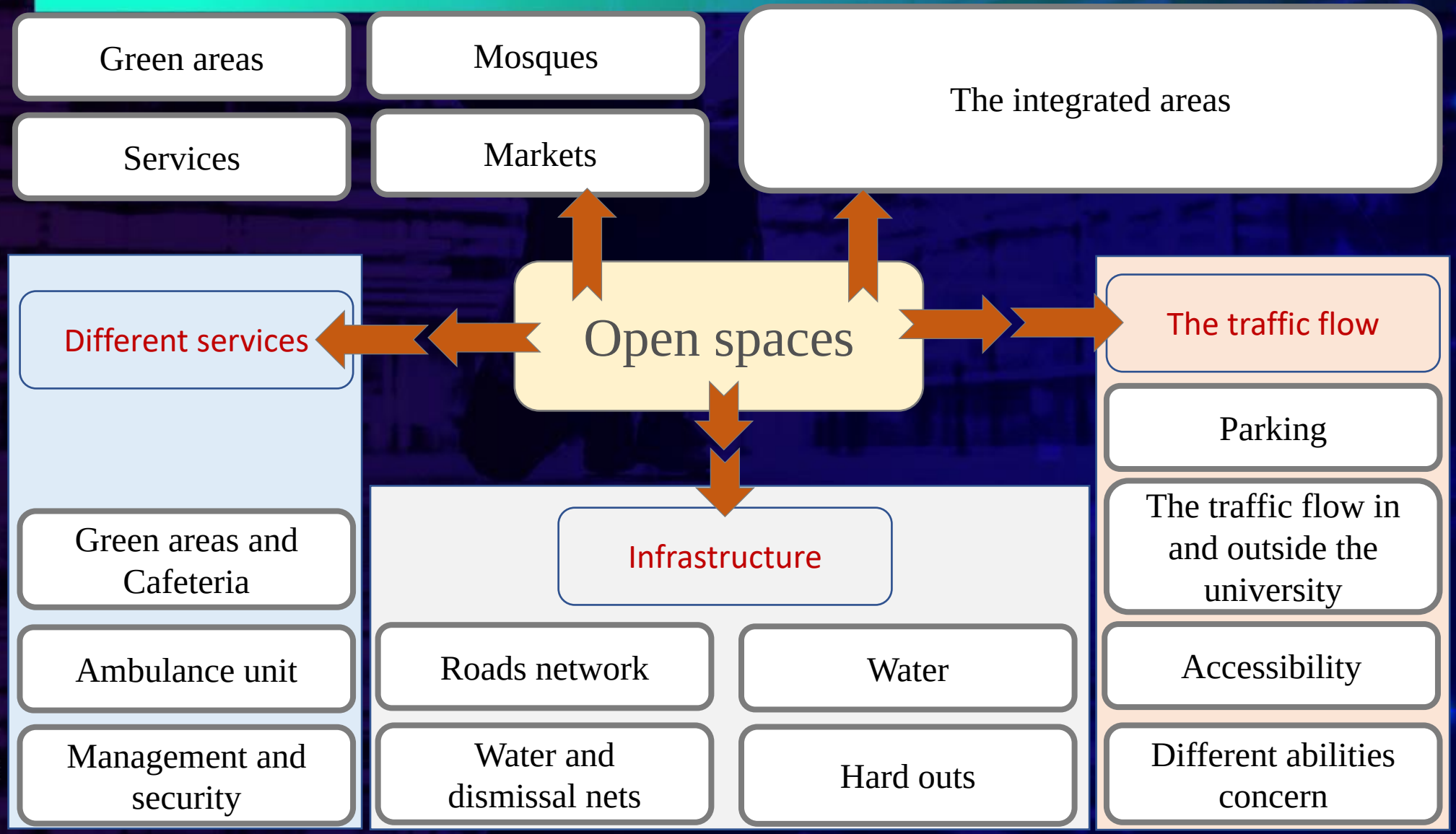


Therefore, the research methodology using Spatial data analysis within the framework of QGIS offers, including satellite imagery, topographic maps, and GIS layers.

Incorporating the QGIS application into the management of landscape project maintenance is described through an organized series of steps coordinated to enhance the efficiency and sustainability of the project. The outlined process incorporates the following stages:

a. Data Compilation and Integration.
b. Data Analysis and Categorization.
c. Digitization within QGIS.

Study implementing

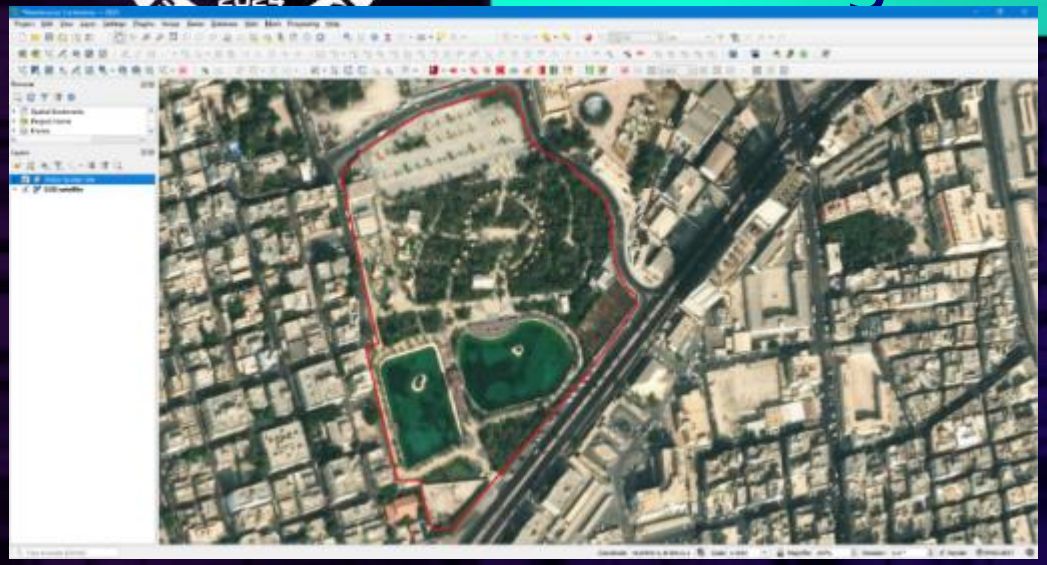


Work stages

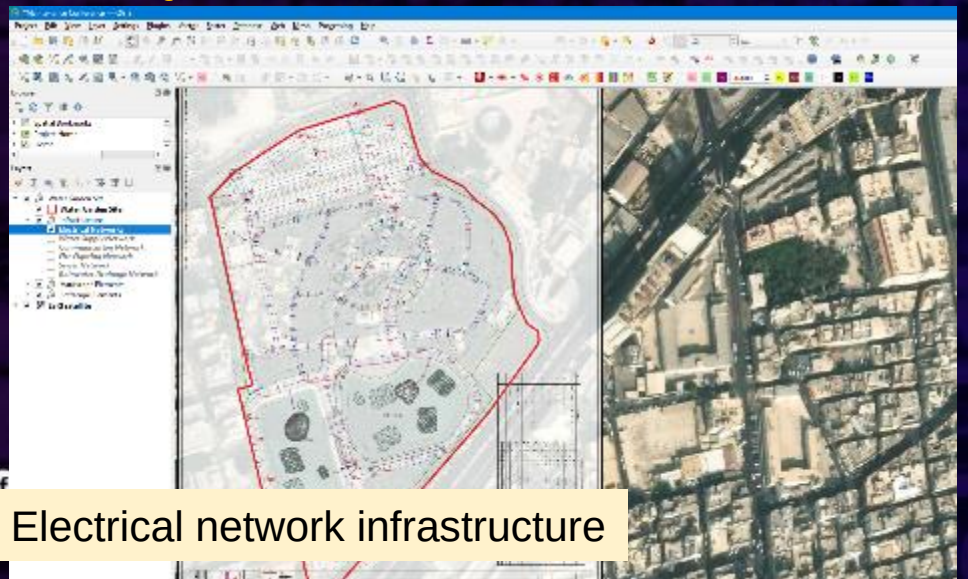
The various elements influencing the design of the study idea

Surrounding environmental context		
Natural environment	**Human constructions**	**Humane environment**
Geography	**Environmental pollution Resulting from interrupted urban development**	**Civilization**
Typography		**Culture – heritage – history**
Geology		**Ethnographic background**
Soil		**Beliefs – norms – laws**
Climate		**Economy**
Water resources		**Economic resources**
		Human resources

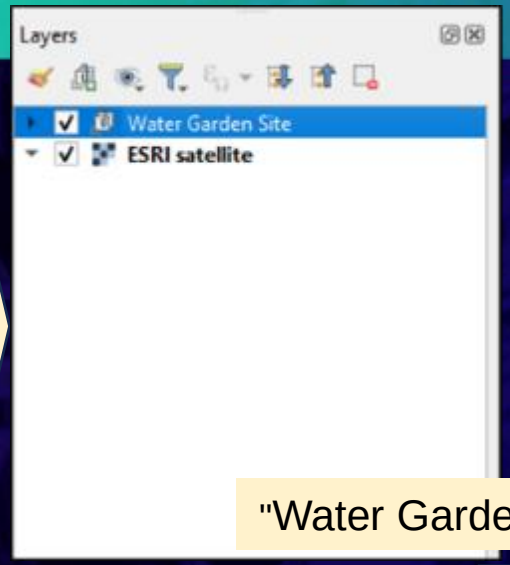
Work stages

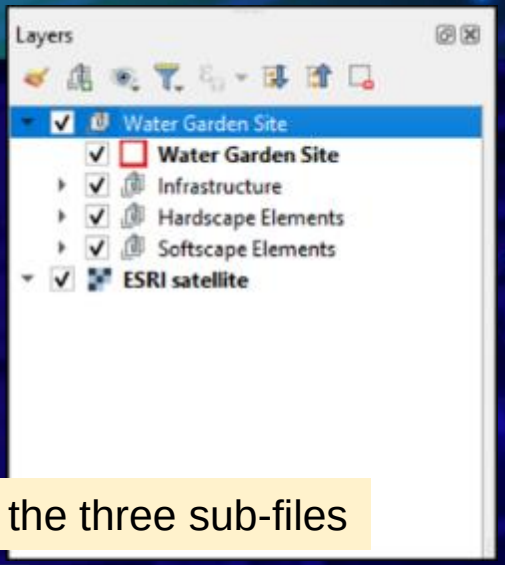


QGIS interface " Water Garden Site"

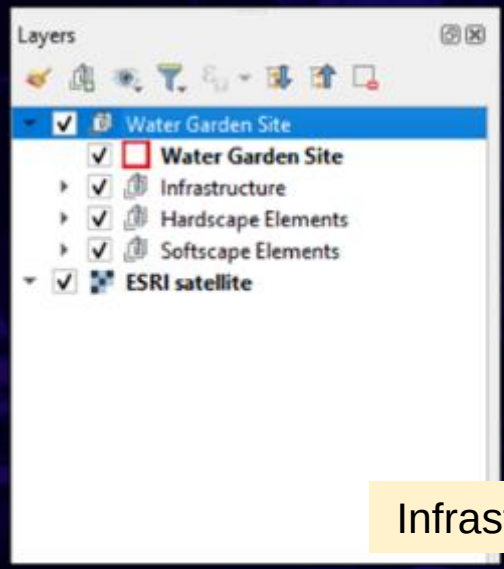


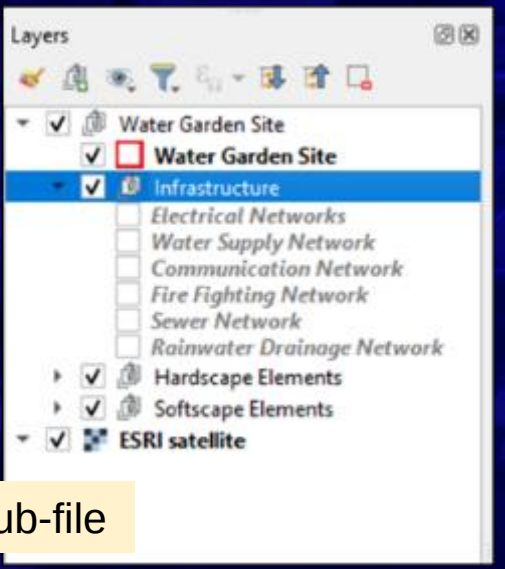
Electrical network infrastructure





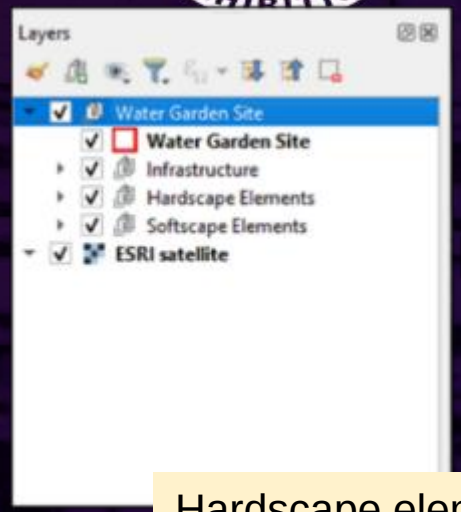
"Water Garden Site" to the three sub-files

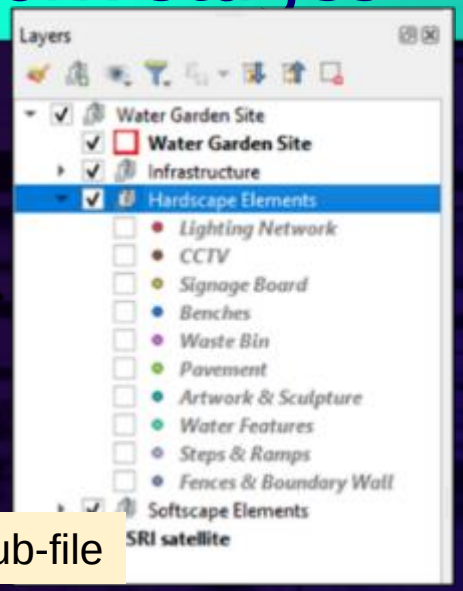




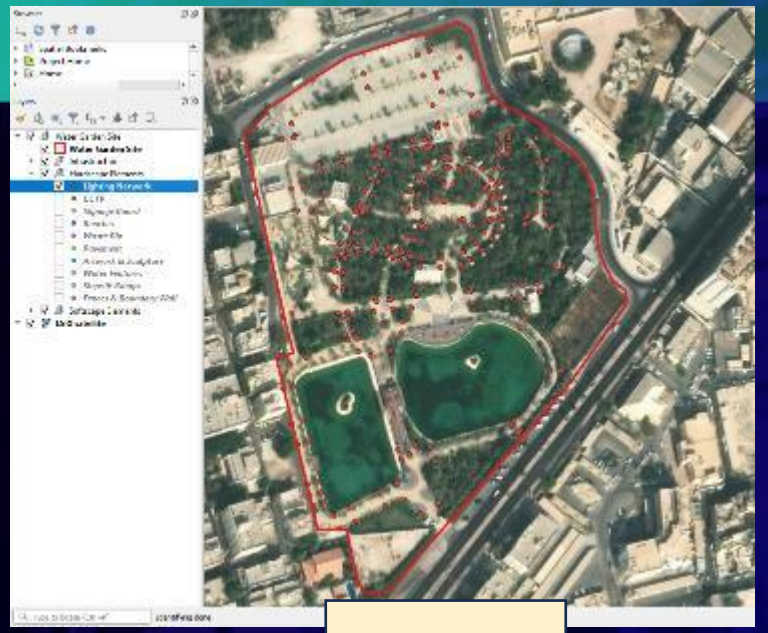
Infrastructure sub-file

Work stages

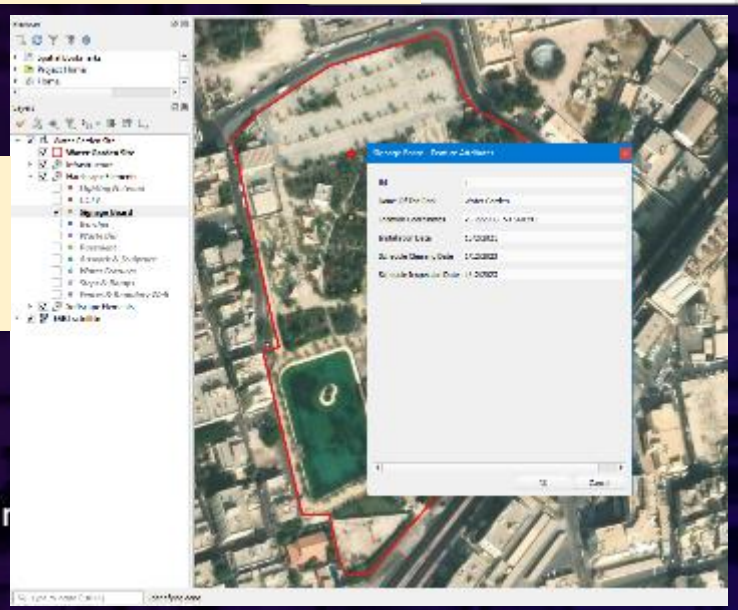




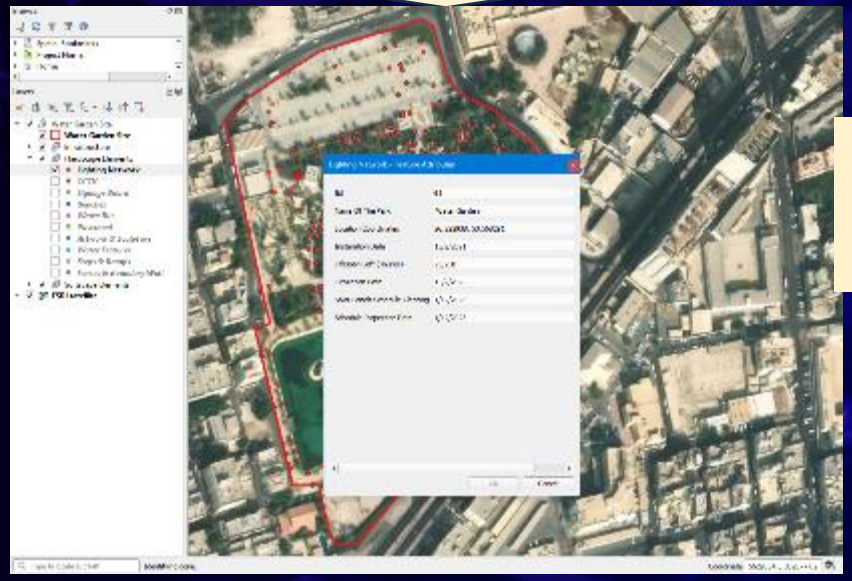
Hardscape elements sub-file



Lighting network layer

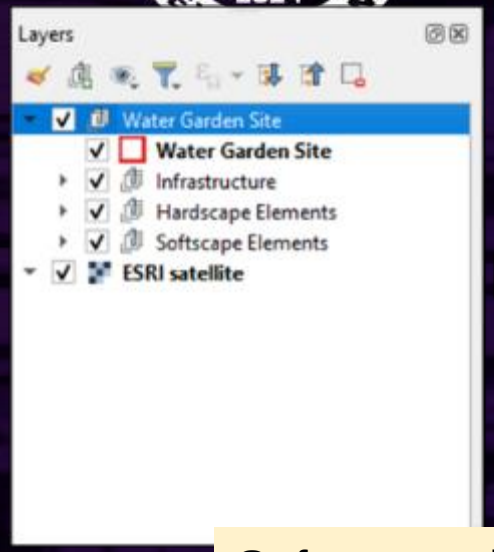


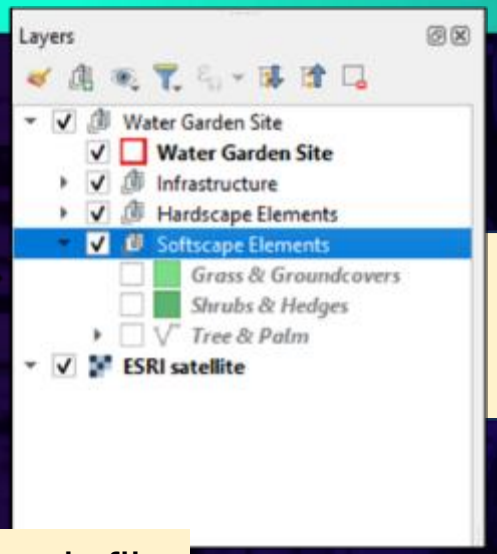
Signage board element information



Lighting network element information

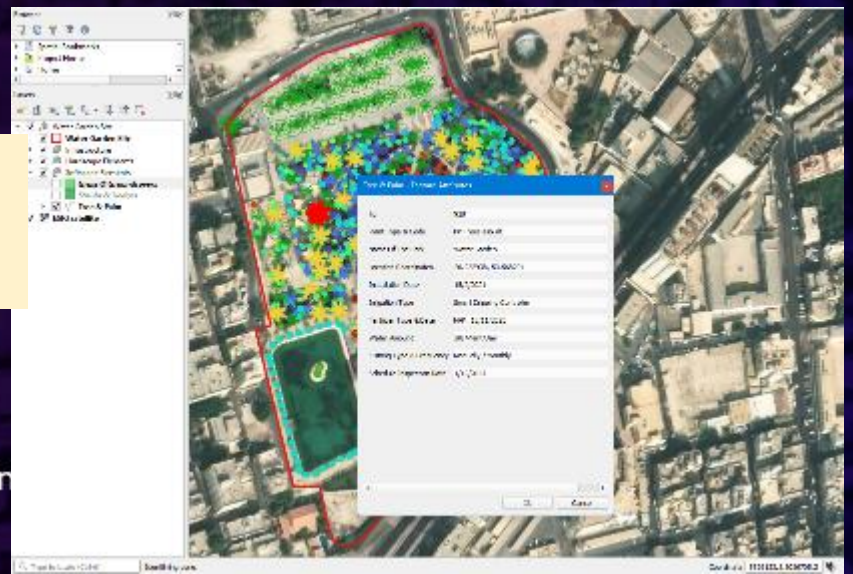
Work stages



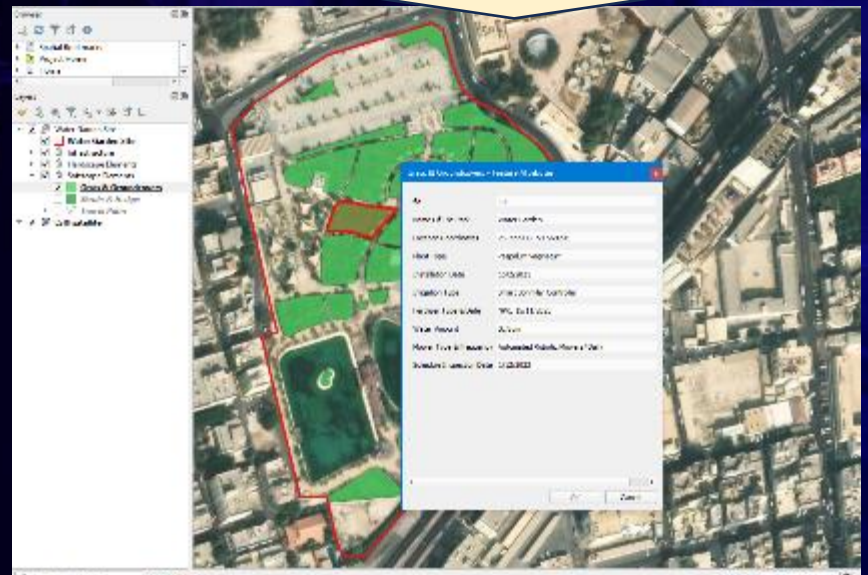


Softscape elements sub-file

Grass and groundcover layer



Tree and palm element information



Grass and groundcover element information

Study Findings

Several apps and digital tools can aid in optimizing sustainable landscape maintenance techniques and data analytics to enhance resource management, decision-making, and overall efficiency in landscape maintenance.

Here are some notable apps and digital tools that can be beneficial:

a. Smart Irrigation Controllers.
b. Plant Identification Apps.
c. Weather Monitoring Apps.
d. Mapping and GPS Tools.
e. Remote Monitoring Systems.
f. Data Analytics Platforms.
g. Mobile Task Management Apps
h. Sustainable Material Sourcing Apps.
i. Green Waste Recycling Apps.
j. Carbon Footprint Calculators.

Results & Achievements

The pilot study in " Water Garden Site" provides valuable insights for professionals, policymakers, and city planners, guiding them toward innovative and evidence-based strategies for sustainable landscape maintenance,

The major result of the research is as follows:

a. Impact of Digital Tools on Water Conservation:
b. Resource Efficiency and Cost Savings:
c. Improved Landscape Health and Biodiversity:
d. Data-Driven Decision-Making:
e. Community Engagement and Public Participation:
g. Overcoming Challenges and Future resilience Directions:
h. Broader Implications for Urban Sustainability:

Conclusion

The incorporated approach to **MAINTENANCE MANAGEMENT**, empowered by the QGIS application, results in a streamlined, sustainable, and effective system.

The pilot study underscores the fundamental value of QGIS in complicated, complex spatial data, **ASSISTING INFORMED DECISION-MAKING AND FACILITATING ACCURATE RESOURCE ALLOCATION.**

This comprehensive strategy has numerous advantages for the maintenance process:

a. Efficiency. b. Transparency. c. Sustainability.
d. Cost Savings. E. Enhanced Communication.

The Arab region can lead the to set an inspiring example for other global communities facing similar challenges.

Challenges :

Collaborative efforts between public and private sectors should focus on developing and implementing intelligent systems initiatives that promote sustainable landscape management for operation and maintenance, thereby enhancing the quality of maintenance performance in outdoor spaces and parks, particularly in the Arab region.

Continued studies and research and innovation the landscape architecture and the smart technology will play a vital role in advancing the sustainability and efficiency of future landscape maintenance practices.

The successful support from the private sector in this pilot study with the academic sector **ENCOURAGE** the vision of the collaboration and join venture between the private and governmental sectors

Acknowledgment :

Acknowledgment of “LIF” consultant office for their support along the study

And

Dr. Dalia El Dardiry, College of Design, Imam Abdulrahman Bin Faisal, for her valuable contributions in this pilot study.

CONFERENCE OMAINTEC 2024 EXHIBITION

THE 21ST INTERNATIONAL OPERATIONS & MAINTENANCE CONFERENCE IN THE ARAB COUNTRIES

THANK YOU!

Arch Saifallah Moosa
Prof Islam Elghonaimy,

#OmaintecConf

An Initiative by

OMAINTEC
المجلس العربي للتشغيل والصيانة
Arab Operations & Maintenance Council

Organized by

EXICON.
International Group
مجموعة أكزيكون الدولية