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Research Article

Smart Urban Water Management in Green Spaces

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ABSTRACT

The research aims to address the environmental challenges facing green spaces in modern cities, with particular focus on water pollution and its negative effects on ecosystems, soil, and biodiversity. The primary purpose is to explore smart urban water management strategies that enhance the sustainability and health of green spaces. The research adopts a qualitative analytical methodology, incorporating global case studies such as Singapore and Thailand, where innovative approaches to water resource management have been successfully implemented. These international examples provide valuable insights into the integration of smart technologies, including advanced irrigation systems, rainwater harvesting, and the use of vegetation into sustainable urban planning. By highlighting the lack of awareness surrounding these solutions, the research emphasizes the importance of adopting smart systems such as advanced irrigation techniques, rainwater harvesting, and native plant cultivation. The results show that implementing such methods not only reduces the environmental impact of urbanization but also ensures the long –term viability of green areas. The study concludes that smart water management is not only a technical solution but a necessary framework for ensuring a balanced relationship between environmental protection and urban growth.

Keywords: smart urban management, water pollution, impact, green spaces.

1. PREVIOUS STUDIES:

Al-Husseini's study dealt with the environmental effects of desertification, which cause great disasters in the natural and human environment, which threaten its energies and resources, and addressed the concept of desertification, its causes and the concept of climate change .The study aimed to reveal the role of climate changes in Iraq and what are the appropriate solutions To mitigate their effects. While the (Alsadiq) study dealt with the concepts of Water Resources and their importance and the impact of repercussions on water resources, especially in the Arab countries, the importance of water for the Arab land and what agreements to preserve water and land from desertification. As for the study (Mahdawi and Abdul Amir) dealt with the impact of the collapse of water scarcity and water pollution in Iraq since 2003-2010 and was interested in reducing the severity of pollution in order to achieve sustainable development through mechanisms and policies to reduce pollution and waste treatment by adapting to the needs of our contemporary reality ،We find in Hashem's study, with his interest in using smart agriculture and smart systems, a solution to the growing population and increasing the demand for food and green spaces to make agriculture more productive and profitable, less harmful to the environment and less consumption of land resources. The Albalawneh study dealt with smart technologies and possibilities in order to develop agriculture and make it smart inside green spaces, as well as in many places to provide abundant amounts of food and afforestation.

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2. INTRODUCTION

Green spaces in cities suffer from water pollution, and this appears in parks, public parks, agricultural areas and even green and water bodies, and water pollution leads to environmental and health problems that affect humans in particular and then affect the green spaces in cities frequented by humans in general. The use of smart technology achieves smart urban management of Water Resources in green spaces and improves water management, and is interested in reducing the use of chemicals harmful to plants and applying the best strategies for smart urban water management to improve the reality of green spaces.

3. GREEN AND BLUE URBAN SPACES

They are open areas dedicated to gardens and other "green spaces", including plant life and water features. The landscaping of urban spaces can range from playgrounds to highly maintained environments to relatively landscaped (Majid, 2022, P. 58). Urban green spaces are generally open to the public, sometimes privately owned, such as higher education campuses, community parks / gardens, institutional or corporate land. Areas outside the city limits, such as state and national parks as well as open spaces in the countryside are not considered urban green spaces. Urban streets and squares are not always defined as green urban spaces in land-use planning, (Al-Ahbabi, Al-Khafaji, 2011). Urban green spaces have wide-ranging positive effects on the health of individuals and communities close to green spaces. Green urban spaces are one of the most important elements of sustainable and healthy city design, and play a vital role in improving the quality of urban life of the population (Waqf, 2014, pp. 8-15). As for the blue spaces, they are called blue infrastructure, which are all the spaces where surface water bodies or waterways are located and are associated with green spaces from (Parks and Gardens) (Al-Khafaji, kamouneh, 2015), and these spaces help in reducing the high heat in urban areas (urban heat island), activating green spaces and enhancing social interaction large urban water bodies are found in many green spaces and constitute historical geopolitical importance, such as The Thames River in London, lakes in Central Park in New York, etc. the presence of blue as a strategy to improve health and wellness and to enjoy hearing the sounds of water Because of its impact on the psychology of visitors. (Mohammed, Ahmed, 2011, p. 4).

4. THE IMPACTS OF WATER IN GREEN SPACES

a) Water pollution in the green and blue spaces: chemical, biological and microbial pollution has affected the lives of residents, we note the high percentage of salts and the deterioration of equipment, machinery and treatment units, and heavy water is discharged to the rivers without biological treatments and the percentage of water pollution reaches 15-40% as a result of poor water drainage as a result of industrial wealth and the development of cities and their expansion, and the establishment of factories on the beaches, (Al-Mahdawi, Abdulamir, 2012). Most lakes and rivers suffer from water pollution, especially cities where the blue space is a major source of hiking, it is considered the most dangerous types of pollution, and global statistics confirm the death of millions of people annually due to water pollution because of physical and chemical change, which affects living organisms, (Galiani, 2005, pp: 83-120).

b) Water scarcity (drought) in green spaces: -is a major environmental problem that has become widespread in most cities of the world and increasingly due to climate change, population growth, pollution and unsustainable water use. The need for fresh, Low salinity water is increasing, which affects the soil, while the available resources are decreasing, and cities play an important role in the design of parks, gardens and forests, in mitigating the effects of water scarcity, but they are also vulnerable to its effects, including health, environmental and economic impacts. (Alzahrani, A., 2022). Because water scarcity has an impact on health through the spread of diseases such as cholera and diarrhea, as well as affects agriculture and affects the productivity of agricultural crops, which causes

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food shortages in cities, and drought has an impact on the economy of cities through the impact of industries lack of water and thus affects the local and global economy, but the impact of lack of water is great, the environment depends on water and lack of it causes deterioration in systems as well as in the balance of the city and loss of Biological Diversity(Zakka, S. D.,2017). One of the reasons for the scarcity of water in the table (1) (Al-Sadiq, 2022).

Table (1) causes of water scarcity- (researcher)

Causes	Impact
Climate change	Climate change causes an impact on rainfall patterns and causes drought in regions
Population growth	Urbanization and the increase in population need an increase in demand for water, for domestic purposes, irrigation, industry, agriculture and others
Pollution	The impact of industrial and agricultural pollution on water quality and therefore causes it to decrease and become unusable
Ineffective management	Poor water management and lack of awareness in its management cause water scarcity and drought areas

5. WATER SCARCITY (DROUGHT) IN GREEN SPACES

Is a major environmental problem that has become widespread in most cities of the world and increasingly due to climate change, population growth, pollution and unsustainable water use. The need for fresh, Low salinity water is increasing, which affects the soil, while the available resources are decreasing, and cities play an important role in the design of parks, gardens and forests, in mitigating the effects of water scarcity, but they are also vulnerable to its effects, including health, environmental and economic impacts. (Alzahrani, A., 2022). Because water scarcity has an impact on health through the spread of diseases such as cholera and diarrhea, as well as affects agriculture and affects the productivity of agricultural crops, which causes food shortages in cities, and drought has an impact on the economy of cities through the impact of industries lack of water and thus affects the local and global economy, but the impact of lack of water is great, the environment depends on water and lack of it causes deterioration in systems as well as in the balance of the city and loss of Biological Diversity(Zakka, S. D.,2017). One of the reasons for the scarcity of water in the table (1) (Al-Sadiq, 2022).

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Table (2): The impact of negative repercussions (water pollution) on green spaces. (Researcher).

Water pollution	
Negative effects	**Causes and types**
Water pollution can kill plants and animals in green spaces. It can also make it difficult for people to use green spaces for recreation, as the water may be unsafe for swimming or drinking. 	Changing the natural properties of water and becoming unfit for human consumption (changing the degree of salinity and the high percentage of harmful compounds in it, which changes its color and smell. Chemical pollution due to the presence of toxic substances and compounds in the water such as lead, pesticides and mercury and causes harm to organisms Water pollution through sewage and causes the spread of harmful bacteria (Salmonella), which are transmitted by drinking and bathing. Oil pollution and leaks through channels or marine tankers and is transmitted to people through eating marine organisms. Contamination with pesticides by discharging them without recycling them.
Ways to get rid of water pollution : Building contaminated water treatment units Enacting laws and legislations to conserve water and prevent its exploitation Educating people through seminars and associations to keep water from pollution Smart electronic monitoring of lakes and closed water to avoid exposure to harmful human pollution Separating the pipes for sewage from the pipes of the water source and maintaining them continuously Disposal of materials such as oil by burning or pulling Providing landfills for human waste away from spaces, especially water sources Burying nuclear waste away from groundwater to preserve water reserves	

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6. THE IMPACT OF DROUGHT (WATER SCARCITY) ON URBAN GREEN SPACES IN THE CITY

Drought significantly affects urban green spaces and these spaces depend on water to maintain diversity in their vegetation and trees (Niemelä, J., 2010). To mitigate the environmental consequences of water scarcity and protect the important role that green spaces play in our societies. Water scarcity can have a number of social and economic impacts on green spaces. For example, it can lead to increased costs for irrigation and maintenance of green spaces, reduced access to green spaces for recreation and relaxation, and lower property values in areas with limited green spaces. (Zakka, S. D., 2017). These impacts can disproportionately affect low-income communities and communities of color. It is clear that water scarcity poses a serious threat to green spaces. We need to take action now to protect these important areas and mitigate the environmental consequences of water scarcity. They can be seen in the following table (3).

Table (3) the Effect of Water Scarcity in Green Spaces - Researcher

Effects of water scarcity	The impact of water scarcity(drought)
Lack of plant growth	Drought reduces the amount of water available to plants, thus reducing their growth, and they are exposed to water stress and make them vulnerable and vulnerable to pests. Green spaces provide habitats for life, and drought can affect the food and water resources available to these organisms and threaten their survival (Zakka, S. D., 2017).
Decreasing vegetation 	When not enough water is available, plants and trees can die or be subjected to stress. This can lead to a decrease in vegetation, which can have a negative impact on air quality, microclimate, biodiversity and thus loss of green spaces. (Wolch, J. R., et al., (2014)
Increased soil erosion 	Water scarcity can also lead to increased soil erosion, degradation, structural degradation and loss of fertility, because there is less water to hold the soil in place, dry out and become vulnerable to erosion. Erosion can drive away nutrients and sediments, which can damage waterways, pollute water bodies, and affect future plant growth. (Niemelä, J., 2010).
Prevalence of invasive species 	Invasive species are plants and animals that are not native to any given area. It can outperform native species on resources such as water. In areas with water scarcity, invasive species are more likely to thrive, which can lead to further damage to the environment. (Al-Husseini, 2019)

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Increased risk of fire 	Water scarcity can also increase the risk of fires. By increasing the drought in the spaces, this is due to the lack of water available to put out the fires. Fires can destroy green spaces, affect biodiversity, release greenhouse gases into the atmosphere and further exacerbate climate change. (Zakka, S.D., 2017).

7. SMART URBAN WATER MANAGEMENT IN GREEN AND BLUE SPACES

Water management is through identifying water treatment plants and in smart ways; therefore, knowledge of water quality plays an important role in the development of water quality monitoring and management strategies. A geographic information system (GIS) that enables the capture, modeling, processing, retrieval and analysis of geographically referenced data can be used to manage the existing database and spatial analysis that provides an environmental alarm system by doing water quality modeling in the GIS environment, the outputs of pollutant records can be obtained as spatial records in the form of map layers (Al-Suhaili, Al-Khafaji, 2009, p.4205.)

a. **Efficiency of water use in green spaces:-**water consumption for irrigation of urban green spaces depends on the water needs of plants, which in turn depends on the species grown and on local climatic conditions. Native species are generally those that require less irrigation, because they are adapted to local climatic conditions, water use efficiency in urban green spaces is achieved when the supplied water corresponds to real water needs. However, water consumption for irrigation is often higher than the estimated demand for green spaces, which means that there is a possibility of savings. In order to achieve optimal efficiency in irrigation of green spaces, advanced irrigation technologies have been developed and adopted in recent years. These technologies are aimed at optimal irrigation by accurately estimating the plant's water needs and the optimal efficiency of irrigation systems, in order to minimize over-watering. The state-of-the-art irrigation system is a sustainable, forward-thinking solution designed to address water conservation issues in urban green spaces. It takes advantage of the power of artificial intelligence and real-time weather data to estimate soil moisture levels, bypassing traditional irrigation systems that rely on physical soil sensors (Suhaili, 2008, p. 2657), and water efficiency can be determined by collecting water samples and knowing if it is suitable for the soil and if it contains sulfates and hydrogen sulfide and through laboratory analysis it is possible to know the percentage of pollution, (Ibrahim, 2011, p. 1159).

b. **the water footprint of urban green spaces:** - the water footprint of urban green spaces is defined as the measurement of the volume of water used (rain and irrigation water) to produce goods and services that we use in these green urban spaces, and the volume of water that evaporates and includes the measurement of three types of them:

- Blue water : it is groundwater and surface water used for irrigation and production
- Green water: it is rainwater stored in the soil and used for plants and agriculture.
- Gray water: The water is used to dilute the pollutants that are produced from the productions to something more or less acceptable.

The importance of the water footprint is used in water resources management by measuring how to use water and manage it better, as well as agricultural planning by determining the appropriate crops and the amount of water consumed to improve the efficiency of consumption of Water Resources. the water footprint contributes to increasing environmental awareness about the amount of water used in daily life as well as in the field of industry by educating companies in improving their production processes to be more efficient in reducing environmental impact (Widomski, M. K.,2023).

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8. WATER-SENSITIVE URBAN LANDSCAPE DESIGN CRITERIA

Although many researchers have identified Water-Sensitive Landscape Design principles, very few have analyzed the impact of each design principle on the intelligent water management process, in other words, the relationship between Water-Sensitive Landscape Design/Management criteria and water conservation is targeted by "best management practices" (BMPs).

a. **Preference of plants over others:** the cultivation of local plants adapted to the local climate reduces the amount of water consumption as well as the cultivation of plants that resist water scarcity and need little irrigation.
b. **Modern irrigation technologies:** drip irrigation, which provides quantities of water directly to the roots of plants and reduces waste, and the use of intelligent irrigation methods using technological sensors that rely on accurate data to control the amount of water in irrigation and sustainably.
c. **Activating the soil and improving its quality:** by adding organic materials that improve the soil and retain water or using traditional materials found in the same area, which is known as (mulch) similar to straw or sawdust, it preserves the soil and reduces the amount of evaporation.
d. **Rainwater storage:** through the use of systems that store water such as rainwater and use it for irrigation, or by providing basins, ponds or yards that store rainwater, for example, and allow it to leak into the soil without drifting.
e. **Landscape design**: by dividing the areas into three types (dry, moderate and wet) to control the amount of rain and design green spaces in a way to direct irrigation water or rain to areas that need abundant watering.
f. **Water recycling:** it is the use of gray water, which is the wastewater resulting from showers, dishwashers, clothes, or other appliances. It differs from the black water obtained from toilets, and this is for green spaces that contain plants that tolerate a higher amount of salinity than others.
g. **Materials**: the use of materials characterized by high permeability allows water to seep into the soil instead of surface runoff or through the design of walkways in a way that allows water to flow instead of collecting it, preferably using corrosion-resistant and acid-resistant aluminum material (al-Ward and Zaki, 2014, p. 1040).
h. **maintenance, awareness and training:** the use of periodic maintenance programs, including effective monitoring of irrigation systems, organizing irrigation periods, repairing sediments according to seasonal needs, pruning plants to enhance their growth and reduce water loss, which affects their growth, through community awareness of the maintenance of water-sensitive landscapes and training the community and workers on how to use techniques and practices for accurate water management. (Wong. T.,et al., 2000).

9. URBAN MANAGEMENT OF WATER SYSTEMS

It is a management aimed at improving the possibility of using water and rationalizing its consumption to maintain the aesthetics of green spaces and relying on modern methods and techniques that ensure the optimal use of water. The water system is one of the most important parts of the infrastructure of green spaces, and it is built on a set of standards that contribute to shaping the general structure of water uses in a smart way in green spaces, and these uses are divided into: internal uses, external uses, The external uses due to their importance and effectiveness, we find that the use of rainwater on the roofs of buildings, sheds and umbrellas within or around green spaces by collecting basins and then making the necessary treatments for them and use them with the help of smart systems and sensors that contribute to water harvesting. Gray Water from green spaces can also be used in landscaping work on the design of green spaces after treatments. This is done by linking this water to digital controllers that allow the possibility of controlling the amount of water used as well as the required irrigation time. Moreover, the sub-components of the system:

- Water outlets with automatic control sensors
- Sensor systems in the wall and ceilings to detect any leakage or collection of water.

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- Wastewater recycling systems to be used in landscaping irrigation, including smart water control devices, also known as timing devices, including:

❖ Management of irrigation and sprinklers digitally or drip irrigation patterns: based on data collected through soil moisture and weather sensors, installation of systems to reduce water waste and deliver water to the roots of plants. As for personal smart irrigation, it is through the provision of devices for workers in the maintenance of green space plants, they are worn, and decisions and data are communicated to them regarding agriculture, irrigation, fertilization and others.

❖ Soil-based sensors: They measure the amount of moisture in the ground and data on the water needs of plants and determine the amount of irrigation needed based on soil type, terrain and other conditions. Weather sensors in the green space or at a local weather station can determine how much irrigation is required under the current and weather conditions (temperature, wind, humidity, precipitation, etc.). Weather data collected by sensors that are not in space can also be transmitted wirelessly to the park's control network via the Internet. (Al-Bowardi, 2024).

❖ Remote control systems: the use of irrigation or agriculture control systems and their intelligent management via smart phones and applications are dedicated to include irrigation schedules based on the weather or forecast and rely on the use of satellites and drones to monitor water and its resources through aerial photographs and thermal imaging. These technologies can be used to determine the distribution of water and monitor places suffering from water shortage or pollution (Shahin, Odeh, 2016).

❖ Smart water meter: combines physical water meters with digital communication components to measure water consumption and deliver data to utilities at regular intervals through radio signals, power line connections, satellites or the internet. Utility employees and others can access water usage data online and carry real-time control of meter readings and water flows. (Salem, 2019, P. 12).

❖ Gray water recycling: gray water recycling treatments consist of several stages that mimic natural water purification processes (artificial wetlands and other natural systems that filter water can also be included in the treatment steps):

- Preliminary treatment using filters to remove solids.
- Secondary treatment using oxygen and microorganisms to get rid of dissolved organic matter .
- Advanced treatment such as sterilization using chlorine or ultraviolet radiation to get rid of the remaining organisms.

F. Low-pressure and rotary water sprayers: the functions of low-pressure and rotary water sprayers include:

- Innovations in the design and operation of spray nozzles improve the use of water and its distribution on the ground.
- Low-pressure sprinkler heads produce less fine mist than conventional heads to keep the wind out of the water.
- Reduce and turn on the pressure to allow water to penetrate the ground uniformly instead of running or wind
- As for rainwater, it is collected through systems, stored and then reused for watering plants, for example.

❖ Smart agriculture: the importance of smart agriculture in green spaces lies in the process of choosing local plants adapted to the local climate, which is characterized by the fact that it needs little water, and Reliance is placed on smart fertilization that improves the soil capacity and reduces soil pollution and retains water and thus reduces the need for frequent irrigation .Precision agriculture for sustainable food production plays a role in climate change and is a victim at the same time. Artificial intelligence technologies, such as precision farming, offer solutions to improve agricultural practices. Machine learning algorithms analyze data from sensors, satellites and drones to provide farmers with insightful information about soil health, crop conditions and pest management. It allows more accurate and sustainable agricultural practices, reduces environmental impact, and improves overall crop productivity (Hashim, 2020).

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- Artificial intelligence: the use of intelligence applications through the analysis of data and predictive models to estimate irrigation times, the need for fertilization and sustainability in the future according to the climate and has a role in water management, as well as the use of digital signs that spread awareness about water use and conservation. Weather monitoring devices placed in green spaces are activated to monitor climatic conditions, predict water needs, future pests and diseases, use robots and unmanned aerial vehicles for fertilizing, spraying pesticides, sustainability, as well as in planting and arranging shrubs (Al-bawadiri, 2024, article).
- Water management infrastructure: includes the design of a smart water network that has the ability to detect leaks, repair, maintain and send alerts to the management, as well as the design of basins and ponds that collect excess water from rain and others and use it in irrigation. The Smart Water Network relies on the use of sensors and measurement points distributed in the network to collect actual data on water flow, pressure and quality. This data is transformed into valuable information that helps optimize network operation and make effective decisions. (Mihailović, B. 2023, p: 468).
- Hydrological modeling: this technique allows modeling the behavior and flow of water in the network. Hydrological models can be used to analyze network performance, predict future needs and optimize water distribution based on forecasts.
- Photoelectric and electrochemical analysis: photoelectric and electrochemical analyzers can be used to measure water quality indicators such as dissolved oxygen level and organic pollution. These technologies provide accurate data on water quality and help to monitor any abnormal changes and intervene in a timely manner.
- Machine learning and artificial intelligence technologies: machine learning and artificial intelligence can be used in the analysis of big data extracted from smart water networks. Intelligent models can learn patterns and behaviors, detect errors, and predict potential problems, (Al-balawneh, 2022).
- Cloud computing technology: it is a technology and applications that allow farmers to access a range of agricultural services and innovative applications that facilitate the operations of afforestation and agriculture management, where farmers can track the weather condition and monitor soil and plants with high accuracy through smart applications that provide them with the necessary tips and guidance to better manage afforestation and agricultural crops. Cloud platforms also provide data sharing and expertise between farmers and experts. Cloud computing supports the use of remote sensing systems to collect data, which contributes to improving the quality and efficiency of Agriculture. These technologies help determine the appropriate environmental conditions for agriculture, prevent pests and diseases, as well as predict weather conditions. It improves productivity and reduces crop production losses, (Al-balawneh, 2022).

10. SMART APPLICATIONS FOR WATER MANAGEMENT IN GREEN SPACES

10.1. Benjakitti Sponge Garden - Bangkok - Thailand

Approval was received for a major expansion of the park in 2006, for the construction of the Benjakitti Forest Park. The 652 million expansion makes Benchakitti Park the first park in Bangkok with a forest park, and expands the size of the park to 72 hectares. The facilities include elevated and illuminated walkways that rely on renewable energy from the sun and wind, as well as wetlands, rare vegetation areas, bicycle paths and an outdoor amphitheater. The expansion was fully opened in 2022. It is one of the existing solutions, especially during floods and as a result of heavy rainfall, and it provides more permeable spaces for water retention and filtration, and uses these spaces in spaces that contain trees, shrubs, ponds, structures and designs aimed at absorbing water, if it rains, to avoid disasters that affect the soil, dredging, and crops, and making sustainable use of them, and prevent filtration through the ground (the first sponge cities appeared in 2013) and water is absorbed by the soil and filtered into the aquifer and Extracted from wells and treated and used for irrigation or other use or collected in collection basins and runoff retention systems and can also be used on the roofs of green space buildings, rainwater retention, recycling and use for other purposes ،Sponge spaces are used to

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reduce the burden on sewage networks, water treatment plants, industrial canals and natural streams. Intelligent monitoring systems are used to identify leaks and inefficient use of water. Sponge green spaces (penjakiti forest) sponge Park in central Bangkok with an area of 102 acres have been designed and one million cubic meters of rainwater have been retained, as well as sponge cities in China are designed for better water distribution and storage, as in Wuhan, Chongqing, Xiamen and Harbin city in northern China water storage and full sponge spaces that store rainwater (Hashim, 2023, article) and we find that the sponge city in Thailand has the following qualities to manage Table Water Treatment (4):

Fig. 1 Benjakitti Forest park filled with hundreds of trees and green spaces

https://thursd.com/articles/benjakitti-forestpark-ecological-sanctuary

Tab. 4 the benefit of the sponge city in Thailand -researcher

Aim	Management	Adjective
Reduce flooding and improve groundwater quality	It depends on green roofs, permeable sidewalks and rain gardens in order to preserve and absorb rainwater instead of draining water	Rainwater Management
After collecting water, it is treated and reused in green spaces	After collecting water, it is treated and reused in green spaces	Water Reuse
Improve air quality, reduce heat island areas and provide a healthy environment	Increase vegetation and water absorption	Improving climate quality
It gives a smart and sustainable solution in dealing with drought or floods	Reduction of extreme weather	Climate adaptation

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10.2. Tingah City in Singapore:

Singapore is a city that applies smart urban management to preserve the environment and improve the quality of life in the city and is characterized by its picturesque nature, as most of its elements are inspired by innovation and sustainability. Formerly a military industrial zone and after brick factories and military training, Tengah Town is designed to be a smart, sustainable and healthy living environment within Singapore. (Al-Khatib, 2020, p. 73) The city has a temperature of 34.5 and to conserve water, Tengah Sustainability Town will use an intelligent water management system that monitors water use and detects potential leaks. It includes a system for collecting rainwater and draining it when needed and is characterized by the presence of a network of trees and shrubs to improve air quality and choose local trees suitable for their climate from (scarlet tree and tamarind) as well as ornamental trees have been distributed along the corridors and planting perennial trees in gardens to improve biodiversity and is employing smart management of trees by monitoring and checking their health and providing irrigation systems, (Khalidi, 2020). As show in Figure (2).

Fig. 2 Singapore's new eco town will sit alongside planned innovation and business districts. https://www.weforum.org/stories/2021/04/singapore-sustainable-smart-town-tengah/

As for the ways to use smart agriculture, it is in an innovative way and using smart technology such as vertical farming and relying on local supplies in agriculture and reducing the use of water resources and through desalination and its use for irrigation or using sewage or by collecting water and storing it for various uses to meet the needs of workers in green spaces, there is a plan to enrich plant diversity and manage the conservation of very less, less than 10% of the forest on the site. (Al-Khatib, 2020, p. 73) .

The environmental group proposed two additional zones "core forest areas" at both ends of the green corridor to boost biodiversity and protect migratory species of animals as well, (albayan.ae). The city also includes community farms, including: (Oscar Holland, 2021, article).

1. Central Park: it will be an interactive and natural entertainment facility, featuring a variety of fitness and cultural activities.
2. City square: the city center, with shops, restaurants, cafes and other facilities.
3. Car-free neighborhoods: the spaces will be car-free, to create a safe and pedestrian-friendly environment.

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4. District cooling system: it will be a space cooling system to reduce energy consumption and promote environmental sustainability.
5. Bicycle sharing system: Tengah Town will also have a bicycle sharing system, allowing residents to ride bicycles from one place to another easily.
6. Green facilities: there will also be many green facilities such as parks, green roofs and pocket parks, which will promote sustainable urban living.
7. Innovation: innovation is applied in the design of spaces with infrastructure that supports modern technology solutions such as the Internet of Things (IoT), artificial intelligence, and smart energy systems. These spaces aim at creating a smart life for the population using advanced technology. As well as in the use of renewable energy sources, water recycling system, Waste Management in innovative ways. The Tengah government is developing a smart infrastructure to build a green city this development will be built in an environmentally friendly way, while preserving the natural forest environment, (https://www.hdbec.com.sg/).

Analysis of examples: Through the study of the two examples, the research found that there are common points that can be activated to manage water and site to preserve green spaces and in the following table:

Table (5) features of healthy living in the city of Tenga and the city of benjakiti - the conclusion of the researcher

Axis	Detail
Smart Corridor Lighting	Tengah Town spaces will be equipped with smart street lighting that detects movement and adjusts intensity based on the level of activity in the area. This will reduce energy consumption and provide greater security for residents.
Eco-friendly waste management	Tengah Town will use an eco-friendly waste management system, with smart waste bins that allow waste collection and sorting remotely. This reduces pollution from trucking.
Biodiversity	City spaces will be planned to promote biodiversity, to create a wildlife habitat. Green urban spaces will also be connected to create a network of green corridors that will support the local ecosystem.
Sustainable energy	Tengah Sustainability Town will be powered by 100% renewable energy, including solar energy, wind energy and biogas, which is used for space
Smart grid system	To ensure the efficient use of energy, the city's green spaces will be equipped with a smart grid system that will enable network users to monitor their water and energy consumption and make informed decisions.
Electric car charging stations	To promote the use of electric cars for workers within the agricultural sector and water management, charging stations are available throughout the city.
Self-driving vehicles used in agriculture and watering	Self-driving vehicles will be available in Tengah Sustainability city, providing an efficient, safe and environmentally friendly way .Buses for Transport and agriculture as well as the subway and transport will be completed by 2028
Smart water management	To conserve water, Tengah Sustainability Town will use an intelligent water management system that monitors water usage and detects potential leaks. A system for collecting rainwater and dispensing it at the time of need, using smart methods and technologies, smart agriculture using robots and an airplane by control, computers and sprinklers that work time and need

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11. RECOMMENDATIONS AND CONCLUSION

a. **Recommendations**

The need to use modern technologies and smart systems sensing soil and climate in terms of time and quantity for irrigation to reduce consumption and can benefit from rainwater through storage and treatment to reduce traditional irrigation methods, as well as the need to take into account the selection of plants and trees suitable for the climatic conditions of each country and the use of materials such as mulch or organic covers to cover the soil to reduce evaporation, to help maintain soil moisture for longer periods by training employees and workers of green spaces with sustainable practices, methods and methods of irrigation and treatment and through educational awareness campaigns for workers and visitors to conserve water and reduce its consumption, with the need to take into account the maintenance of smart systems to detect and repair any malfunction as soon as it occurs, which reduces water losses, and the need to integrate water systems in gardens with smart city solutions that rely on data analysis and artificial intelligence to improve resource management in a sustainable manner.

b. **Conclusion**

Smart water management in green spaces is not just a technical or smart use, but an integral part of sustainable urban planning that balances environmental needs with available resources. Through the application of innovative technologies and thoughtful practices, these green spaces can be preserved as a source of comfort and well-being while achieving sustainable water resources and requires an integrated approach that combines modern technology with sustainable environmental practices. The use of smart irrigation systems, rainwater-harvesting technologies, and the cultivation of native plants are all effective steps in reducing water consumption and preserving green spaces. Awareness and training also play a key role in ensuring that these strategies are implemented efficiently to strike a balance between preserving the beauty and prosperity of parks and ensuring the sustainability of water resources for future generations.

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