Under the Patronage of His Excellency **Eng. Abdulrahman bin Abdulmohsen AlFadley**
Minister of Environment, Water & Agriculture

منتدى المياه السعودي
saudi water forum SWF 2024

Smart Water Management: Integrating AI for Sustainable Solutions

Dr. Latifah Almuqren

29 April – 01 May 2024

Hilton Riyadh Hotel & Residences
Riyadh, Saudi Arabia

Organized by

وزارة البيئة والمياه والزراعة
Ministry of Environment Water & Agriculture

المؤسسة العامة لتحلية المياه المالحة
Saline Water Conversion Corporation (SWCC)

شركة المياه الوطنية
National Water Company

Organizing Partners

الشركة السعودية لشراكات المياه
Saudi Water Partnership Company

المؤسسة العامة للري
Saudi Irrigation Organization
المملكة العربية السعودية

شركة نقل وتقنيات المياه
WATER TRANSMISSION AND TECHNOLOGIES CO.

منظم المياه
Water Regulator

المركز الوطني لكفاءة وترشيد المياه
NATIONAL WATER EFFICIENCY AND CONSERVATION CENTER
MAEE

Presentation Outline

منتدى المياه السعودي
saudi water forum SWF 2024

Introduction

Challenges in Water management

Artificial Intelligence (AI)

AI Technologies

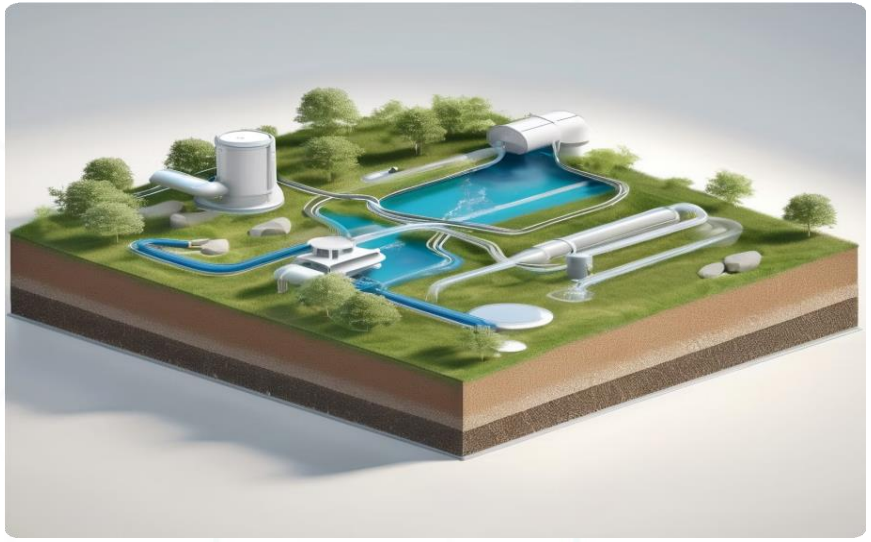
Role of AI in Water Management

Smart water system

Using of AI in Water Management

AI Applications in Water Management

Introduction



Importance of Efficient Water Usage

Efficient water usage is crucial for sustainable water management and ensuring the availability of clean waterfor future generations.

Water Conservation

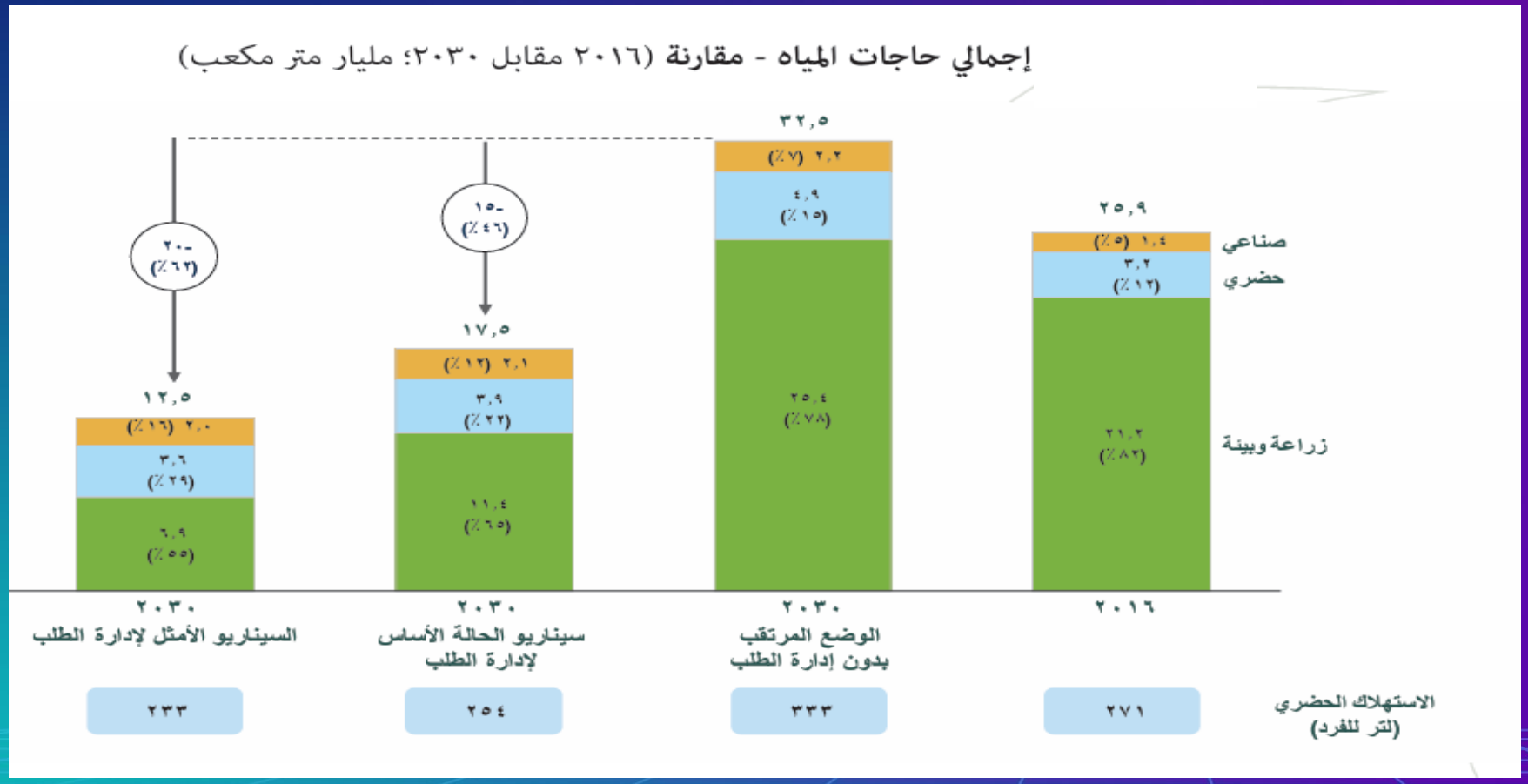
Water conservation is an essential aspect of water management, as it helps reduce water waste and preserve precious water resources.

Challenges in Water Management

منتدى المياه السعودي
saudi water forum SWF 2024

Water Scarcity

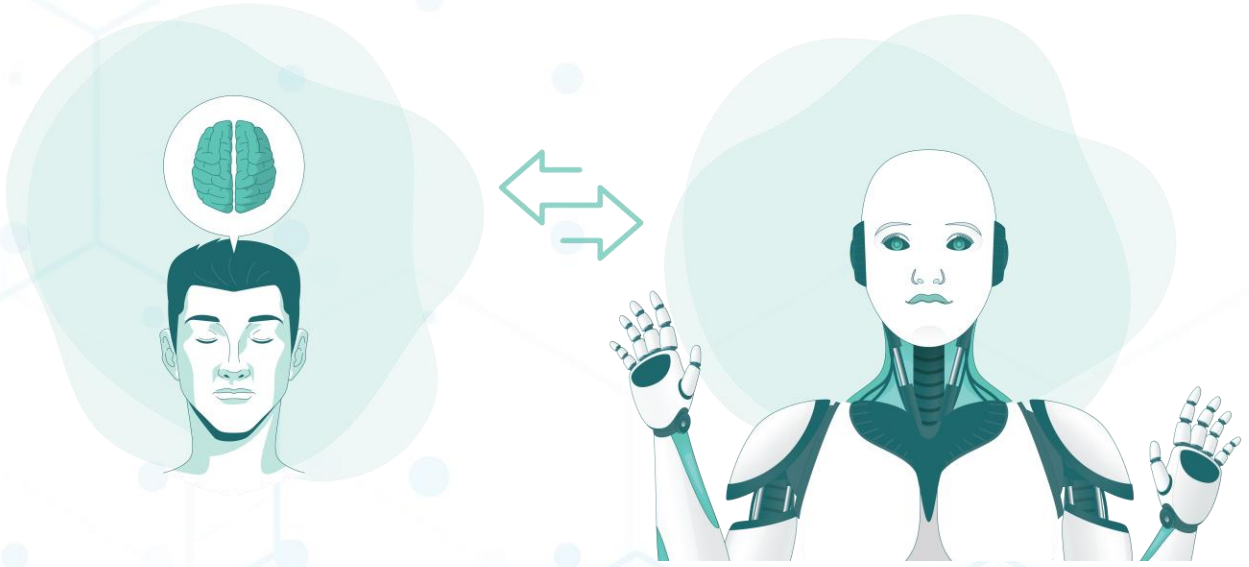
High Cost



الاستراتيجية الوطنية للمياه ٢٠٣٠ pdf (mewa.gov.sa)

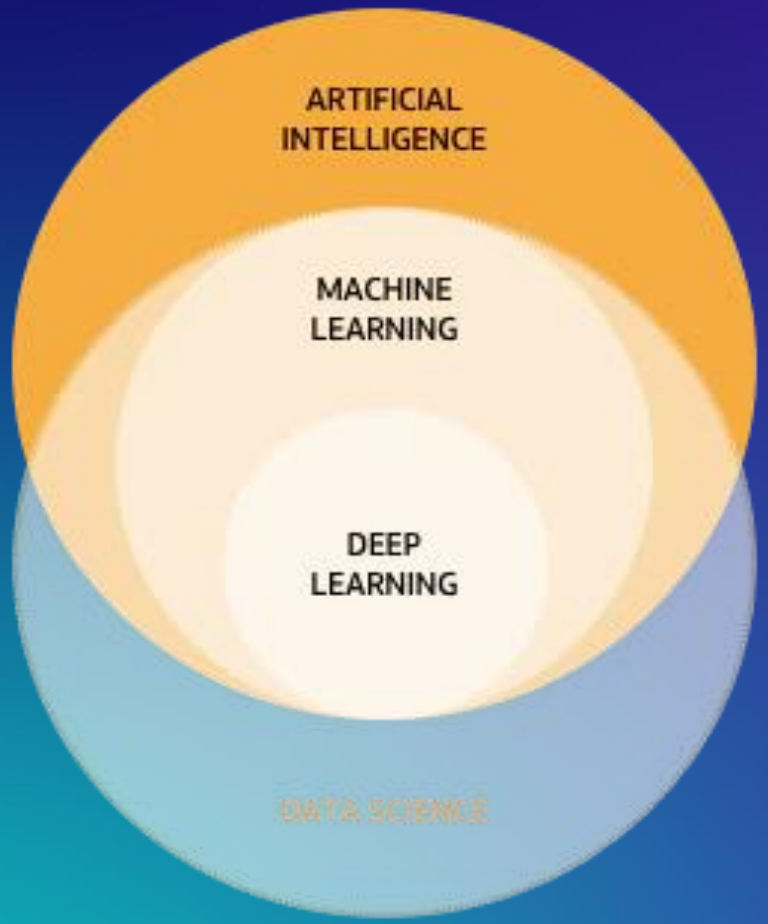
Artificial Intelligence (AI)

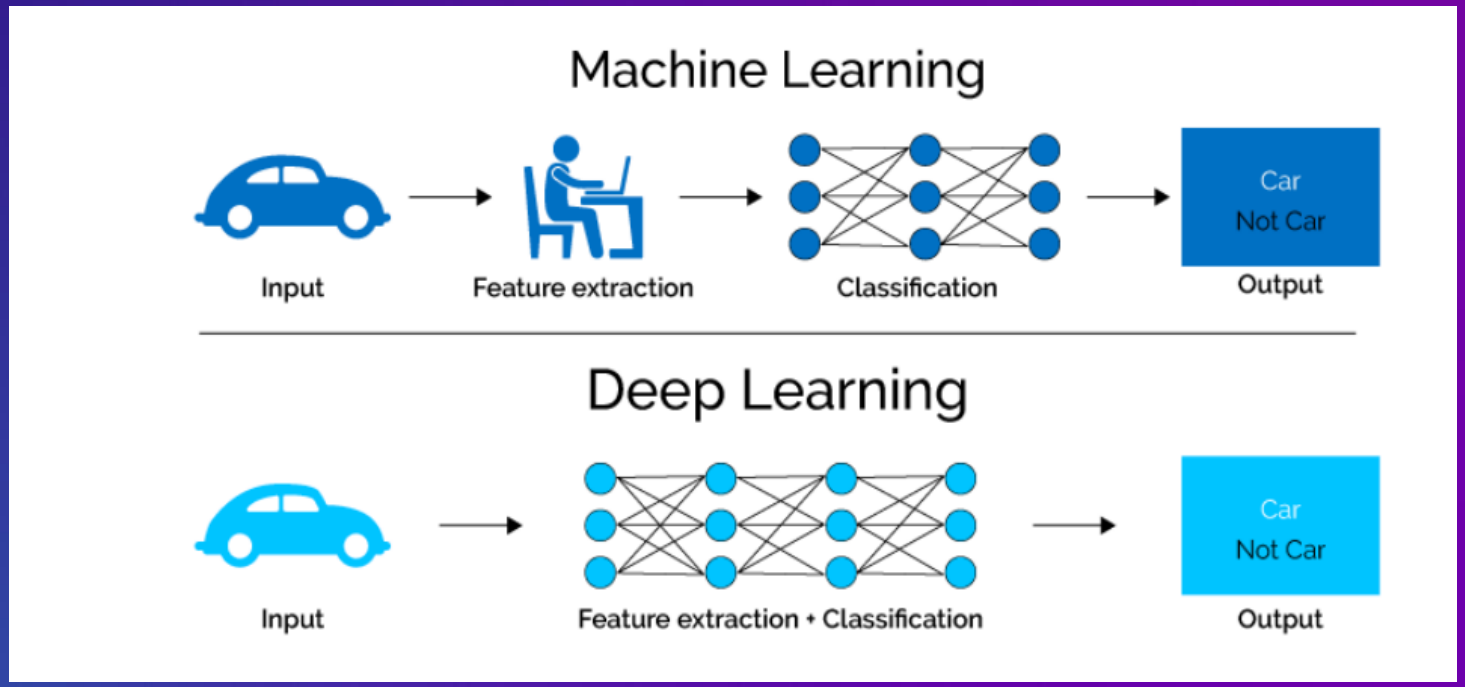
It involves the development of computer systems that can perform tasks that would typically require human intelligence, such as visual perception, speech recognition, decision-making, and problem-solving. Examples of AI include virtual assistants such as SIRI or Alexa, smart thermostats, facial recognition, and Google maps.



AI Technologies

Machine Learning



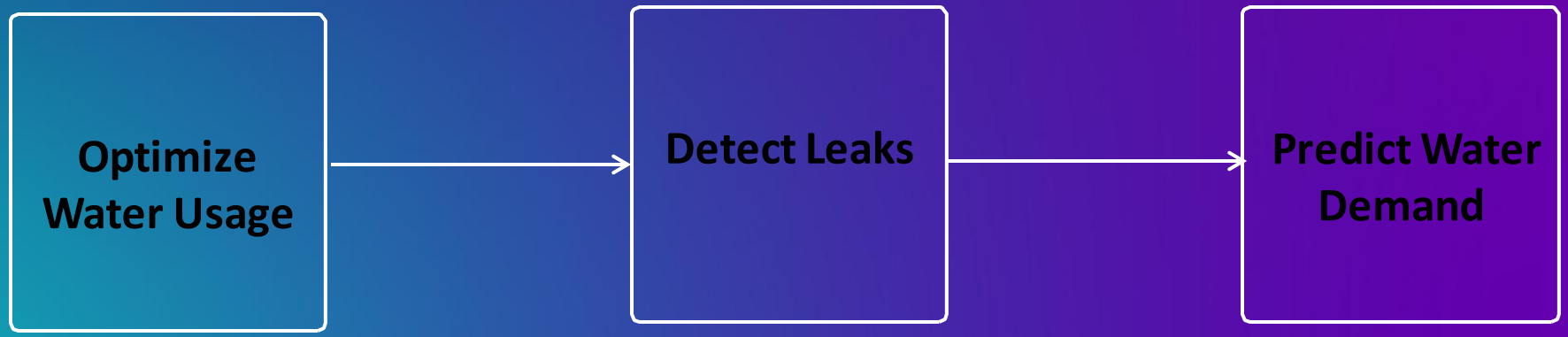


AI Algorithms

1. **Artificial Neural Networks (ANN)** [13]
   - Effective and efficient model for stream flow
   - Challenges: Low accuracy, further assistance required for experts, managers, and officials
2. **Hybrid Model with Convolutional Neural Network (CNN) and Long Short-Term Memory (LSTM)** [13]
   - CNN for predicting water level, LSTM for monitoring water quality
   - Limitations: Used limited dataset, not focused on certain parameters
3. **Support Vector Machine (SVM), Support Vector Regression (SVR) Random Forest Regression** [13]
   - Proposed IoT smart system for automating the agriculture industry
   - Constraints: Incompatibility with dynamic systems, limited dataset, low accuracy
4. **Deep Learning Neural Network Models, Belief Rule-Based Model (BRDM)** [13]
   - Advantages: Low power consumption, low-cost, high detection accuracy
   - Limitations: Applicability restricted to small areas, neglects certain parameters

Role of AI in Water Management

AI plays a crucial role in water management by utilizing advanced algorithms and machine learning techniques to optimize water usage, detect leaks, and predict water demand. By harnessing the power of AI, water management systems can become more efficient, sustainable, and responsive to the needs of both individuals and communities.



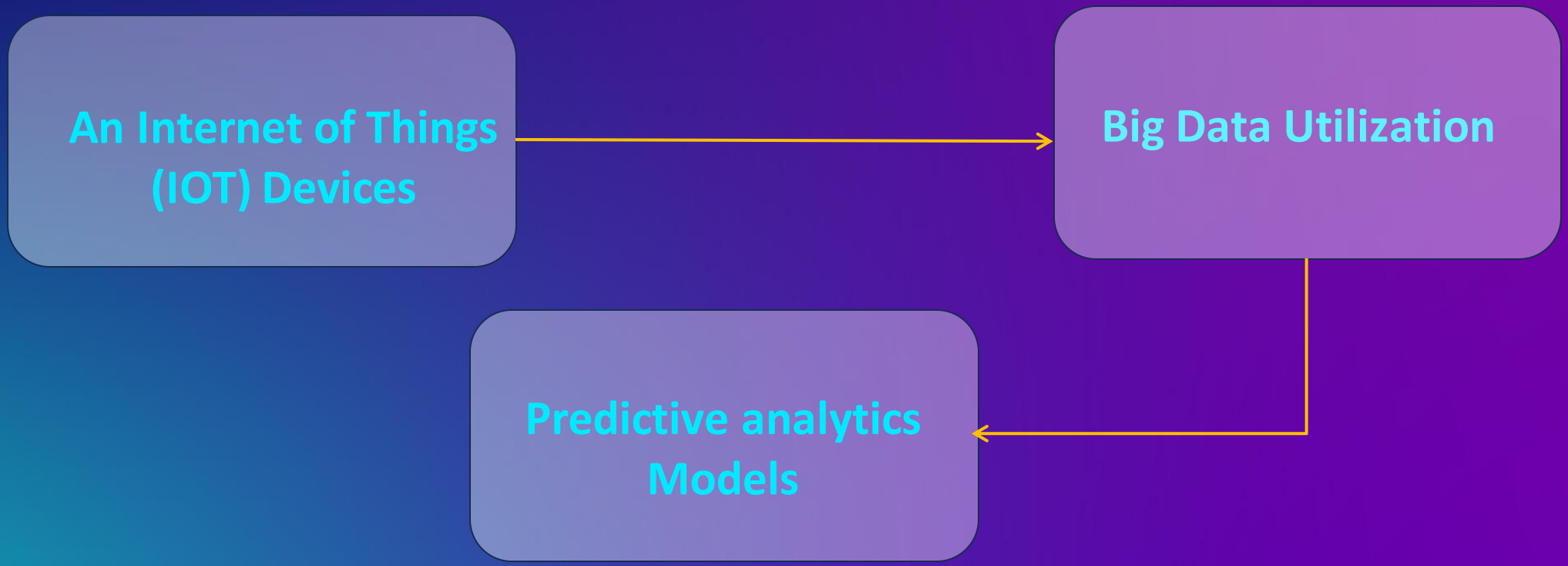
Using of AI in Water Management

Smart water system

The goal of developing **smart cities** is to securely integrate different Information and Communications Technology (ICT) solutions to help manage city resources.

In **smart water systems**, there can be progress via smart water metering. Smart water metering encompasses two precise elements, meters that employ modern technology to gather data on water use and communication systems that can gather and transmit information on water usage in real time [14].

Components of Real-Time Data Integration in Smart Water System



Components of Real-Time Data Integration in Water Management

منتدى المياه السعودي
saudi water forum SWF 2024

IoT Devices

Components of Real-Time Data Integration in Water Management

منتدى المياه السعودي
saudi water forum SWF 2024

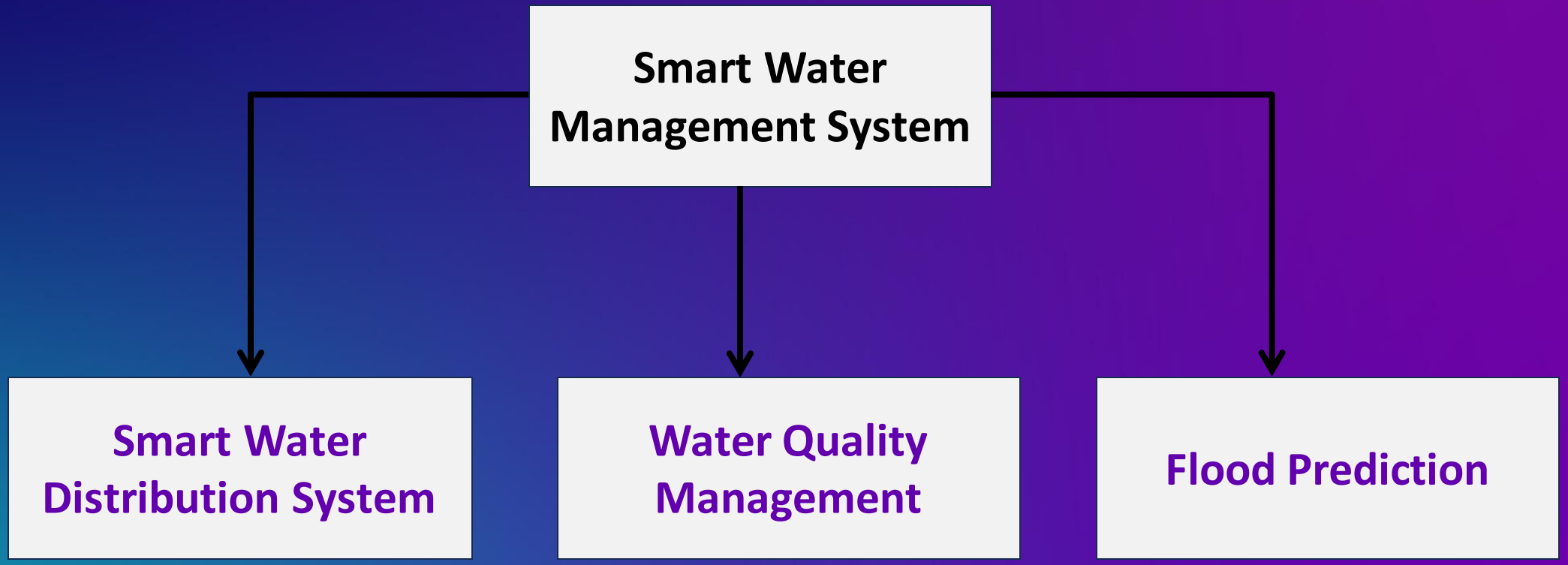
Big Data Utilization

The large amount of data from IoT devices and other sources is analyzed using big data analytics in smart water systems .This helps to understand water usage patterns , identify inefficiencies ,and optimize water management strategies.

Components of Real-Time Data Integration in Water Management

Predictive analytics Models

AI Applications in Water Management



AI Applications in Water Management

Smart Water Distribution System-Leakage Detection System

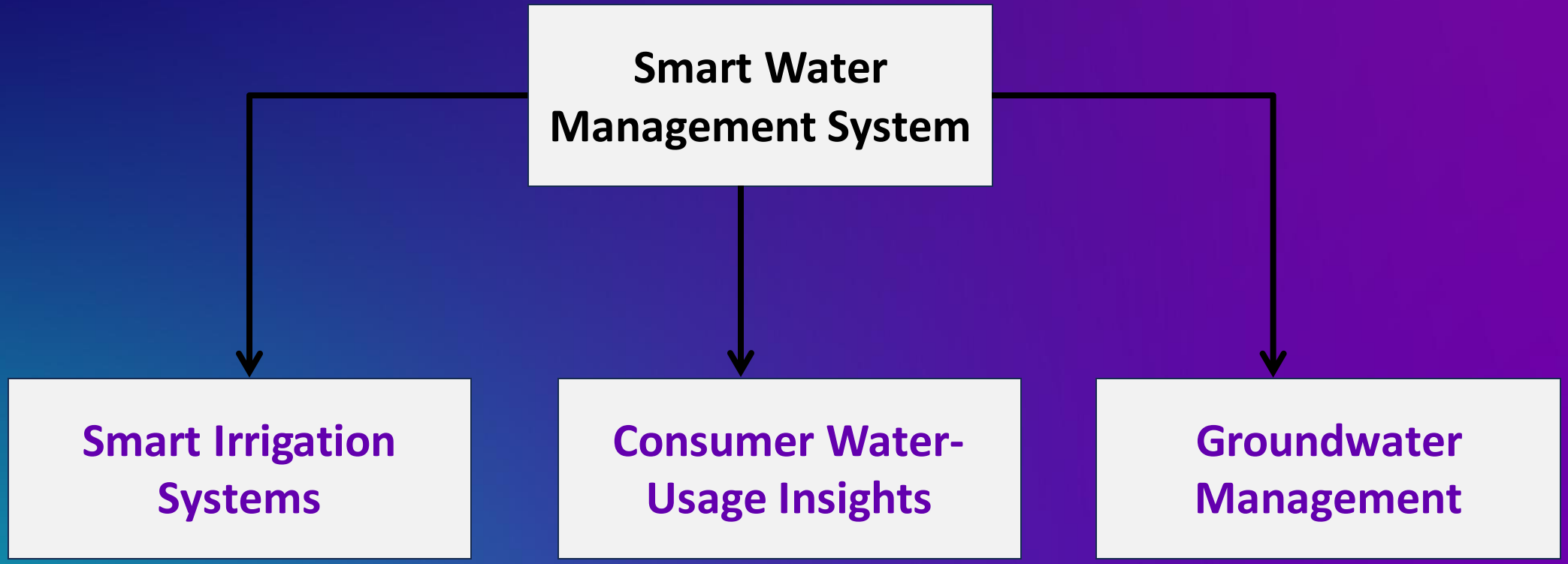
Ref	Methodology	Findings	Limitations
3	Machine Learning Algorithms (Random Forest, Decision Trees, Neural Networks, SVM) with multiple sensors for real-time data collection.	Achieves 75% leak detection accuracy.	Detecting leaks using machine learning with a constrained data set has been the subject of limited research.
6	Machine learning techniques (Support Vector Machines, Decision Trees) for horizontal pipeline leak detection.	Addresses horizontal pipeline leaks with machine learning.	The study overlooks the influence of external factors, lacks clarity on scalability, and does not address computational requirements.
5	Machine learning models (CNN ensemble) to analyze pressure profiles.	Effective in analyzing pressure profiles for leak detection.	Concentrated on identifying leaks rather than precisely pinpointing their locations.

AI Applications in Water Management

Water Quality Management

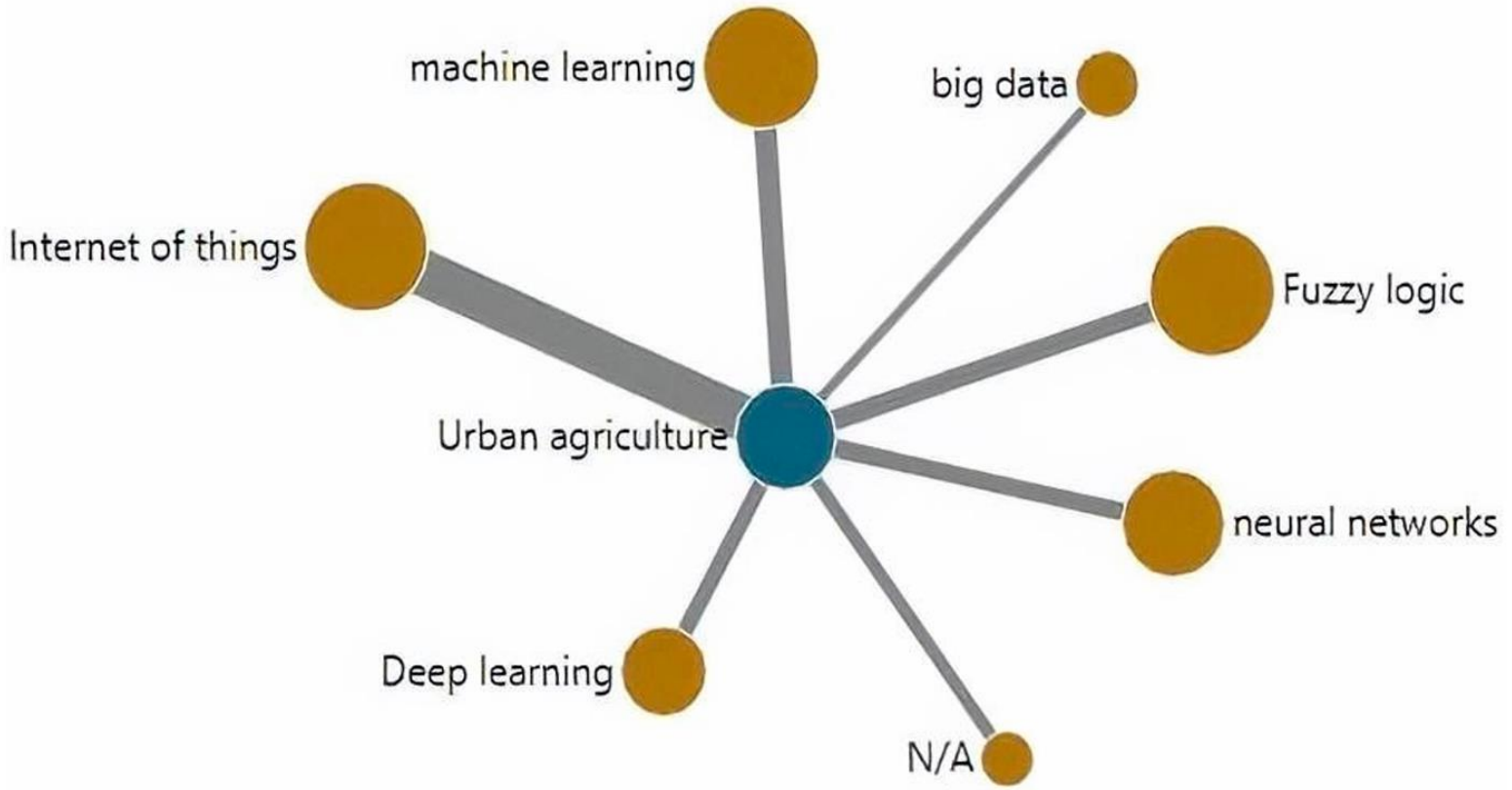
Ref	Methodology	Findings	Limitations
4	AI algorithms for predicting water quality index and classification	Accurate prediction of WQI and WQC using various AI models. Contribution to water management.	Not mentioned.
11	LSTM-based deep learning for time series data in IoT systems	Proficient monitoring of water quality Not mentioned. indicators historical data. warnings to users.	Use of publicly available datasets instead of actual sensor data.
10	Machine learning for predicting water quality	Specific methodologies not detailed. Focus on study region, techniques, assessment metrics.	Lack of explicit methodology details.

AI Applications in Water Management



AI Applications in Water Management

Smart Irrigation Systems



A nodal diagram of urban agriculture technologies. Obtained using VantagePoint.

Using of AI in Water Management

Predictive Analytics

Predictive analytics for water demand

- Storing data
- Pattern Recognition
- Weather Impact Assessment
- Demand Forecasting

Data Sources

- Historical Water Usage
- Weather Data
- Demographic Information

Challenges

منتدى المياه السعودي
saudi water forum SWF 2024

Data Volume and Velocity

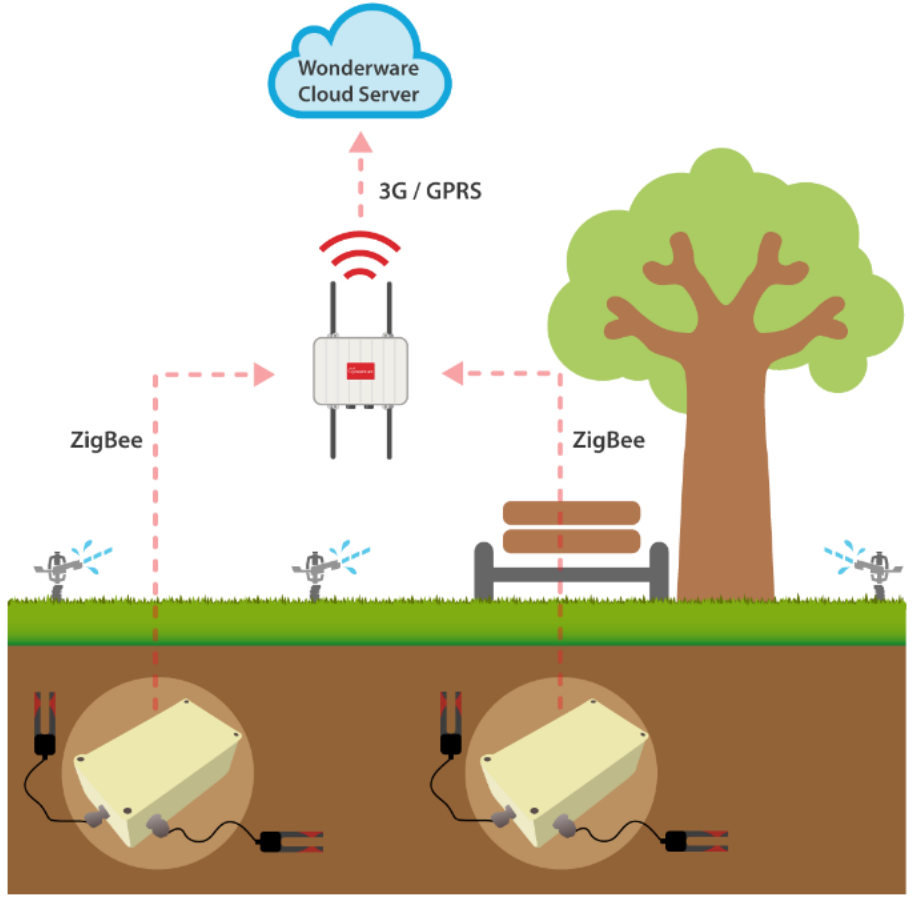
Data Security and Privacy

Data Quality

Dynamic Factors

Real-World Example: Smart Irrigation Grids- Barcelona

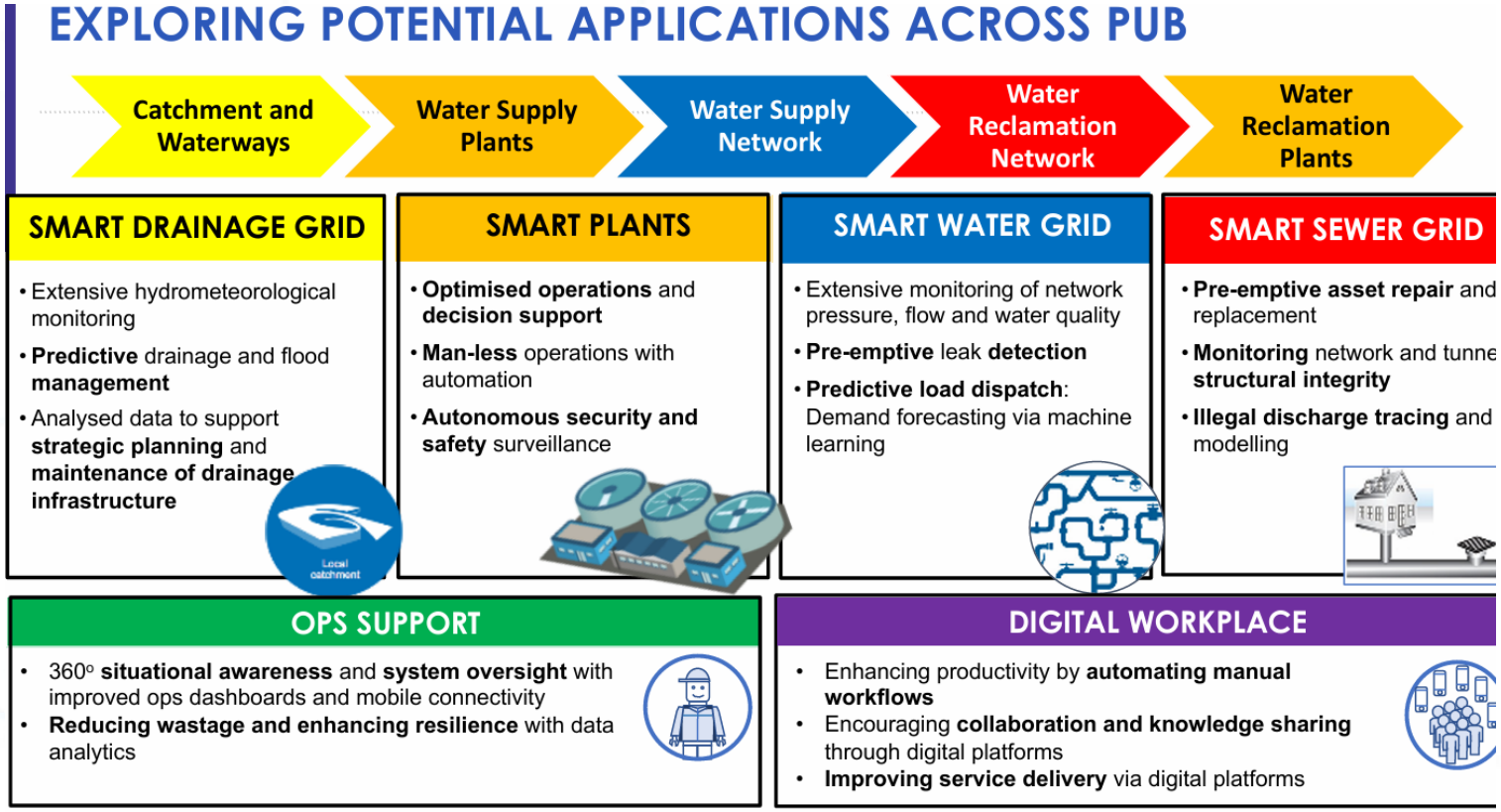
Cities like Barcelona and Singapore have implemented AI-driven smart water grids to optimize water distribution, reduce energy consumption, and minimize leakages.

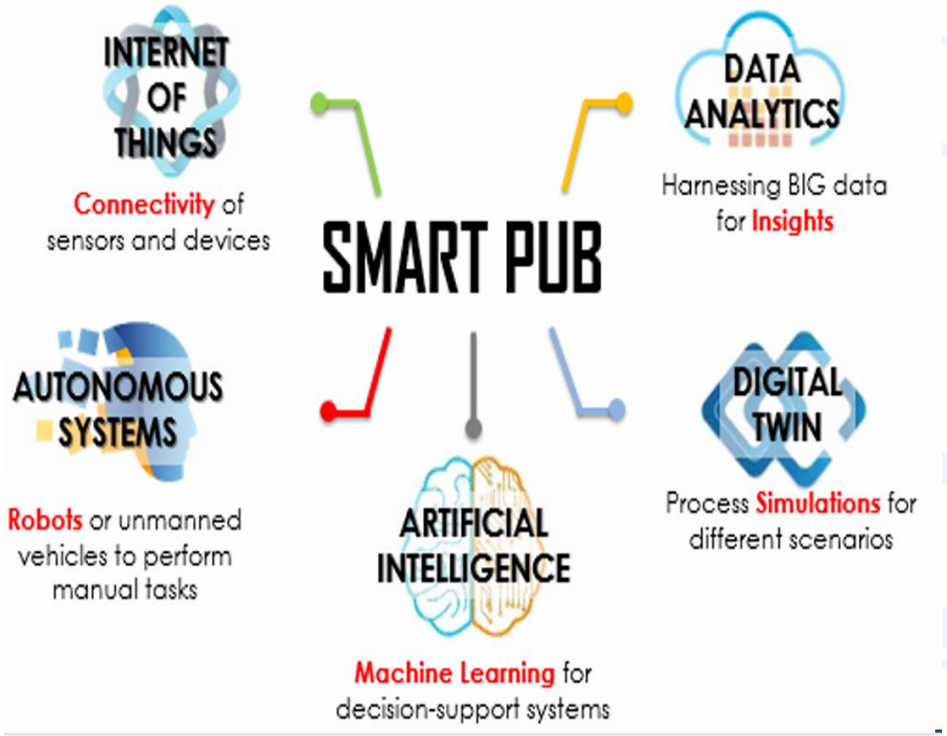


Smart Irrigation System

[Saving water with Smart Irrigation System in Barcelona - Libelium]

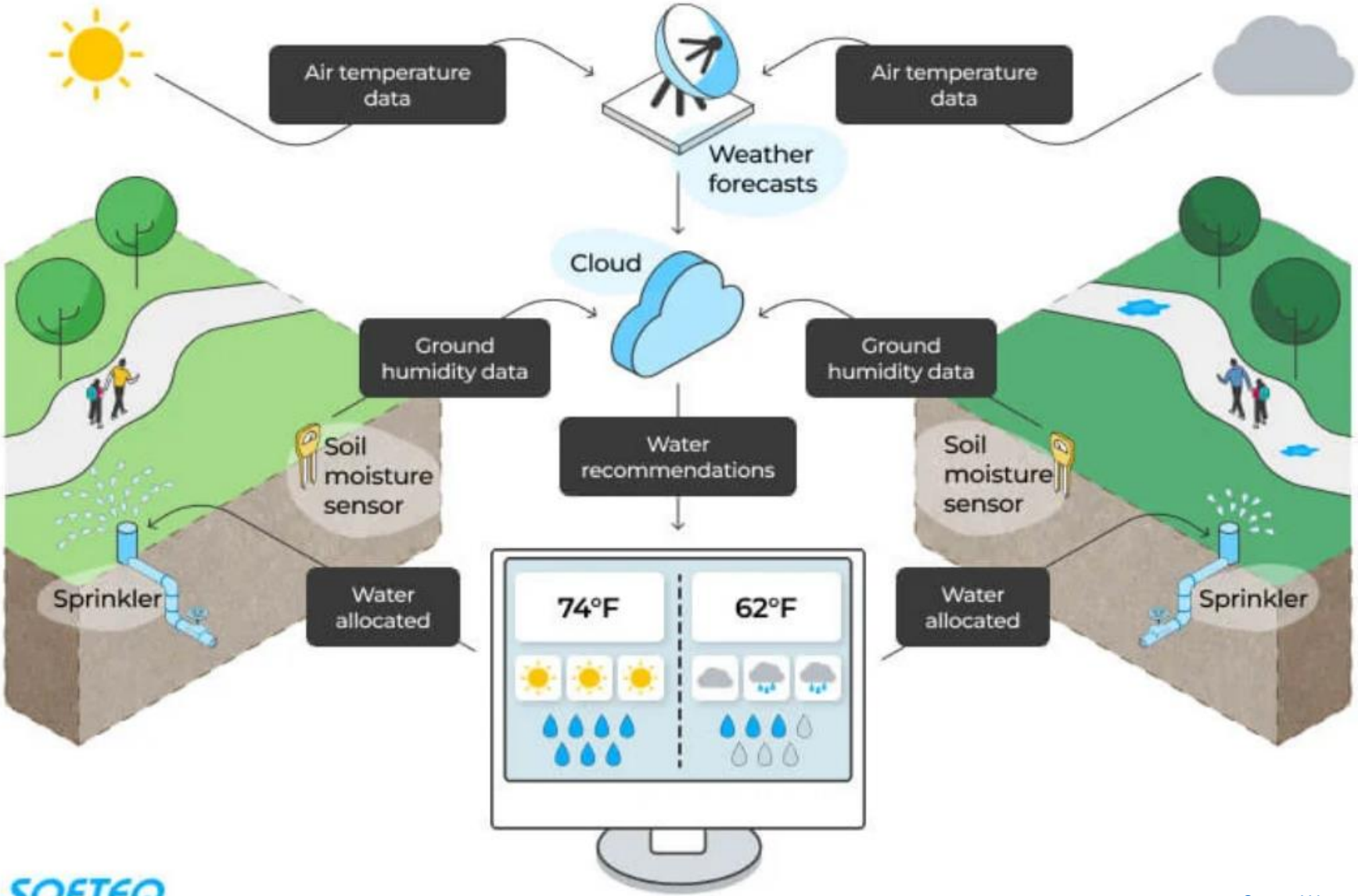
Real-World Example: Smart Water System-Australia





202011-smart-water-management-singapore-experience.pdf (development.asia)

Real-World Example: Smart Irrigation of City Parks



Smart Water Management with IoT: Key Application Areas (softeq.com)

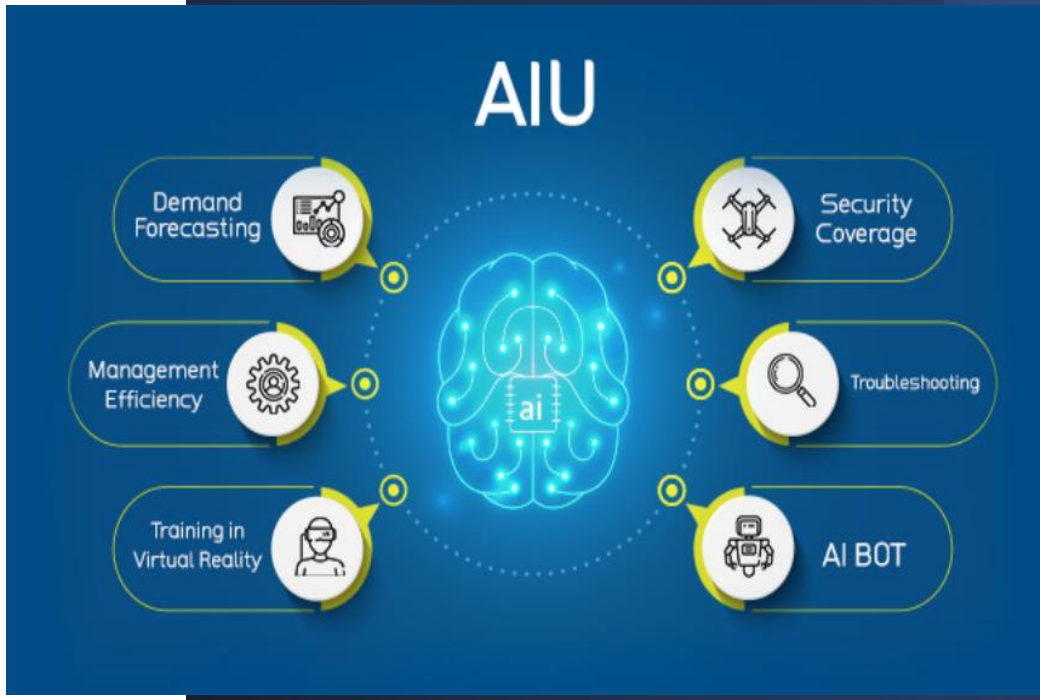
Real-World Example: Saudi Arabia

PROGRAM4: RESEARCH AND DEVELOPMENT

SWIC CENTER

THE SALINE WATER CONVERSION CORPORATION (SWCC)

ARTIFICIAL INTELLIGENCE UNIT AT THE SALINE WATER CONVERSION CORPORATION (SWCC)



Future Trends in AI for Water Management

منتدى المياه السعودي
saudi water forum SWF 2024

Integration of AI with Other Technologies

AI is being integrated with other technologies such as remote sensing, satellite imagery, and data analytics to improve water management strategies and decision-making processes.

Real-time data

As technology continues to evolve, the integration of real-time data in water management will become more sophisticated, with the potential for enhanced automation, adaptive control systems, and real-time decision support. This will enable water managers to respond to dynamic conditions with agility and precision, ultimately improving the efficiency, reliability, and resilience of water management systems.

References

1. Aigües de Barcelona's technical report on sustainability, 5b89b335-afb8-86c1-e767-52274ba93fe8 (aiguesdebarcelona.cat)
2. Ali, A.S.; Abdelmoez, M.N.; Heshmat, M.; Ibrahim, K. A solution for water management and leakage detection problems using IoTs based approach. Internet Things 2022, 18, 1–16.
3. Alves Coelho, João, André Glória, and Pedro Sebastião. "Precise water leak detection using machine learning and real-time sensor data." IoT 1.2 (2020): 474-493.
4. Aldhyani, Theyazn HH, et al. "Water quality prediction using artificial intelligence algorithms." Applied Bionics and Biomechanics 2020 (2020).
5. Fuentes Jr, Vivencio C., and Jhoanna Rhodette I. Pedrasa. "Leak detection in water distribution networks via pressure analysis using a machine learning ensemble." International Conference on Society with Future: Smart and Liveable Cities. Cham: Springer International Publishing, 2019.
6. Gomez Camperos, July Andrea. "Application Of Machine Learning Techniques For Leak Detection In Horizontal Pipelines."Webology 19.4 (2022).
7. Kotwal, Mrs Vasifa S., Sangram Pati, and Jaydeep Patil. "Review On Ai And Iot Based Integrated Smart Water Management And Distribution System." Educational Administration: Theory and Practice 30.4 (2024): 594-605.
8. Okoli, Nwakego Joy, and Boniface Kabaso. "Building a Smart Water City: IoT Smart Water Technologies, Applications, and Future Directions." Water 16.4 (2024): 557.
9. Ramos, Helena M., et al. "Smart water grids and digital twin for the management of system efficiency in water distribution networks." Water 15.6 (2023): 1129.
10. Singh, Bharath, S. Nirmitha, and S. S. Kaviya. "Smart urban water quality prediction system using machine learning." Journal of Physics: Conference Series. Vol. 1979. No. 1. IOP Publishing, 2021.
11. Thai-Nghe, Nguyen, Nguyen Thanh-Hai, and Nguyen Chi Ngon. "Deep learning approach for forecasting water quality in IoT systems." International Journal of Advanced Computer Science and Applications 11.8 (2020): 686-693.
12. Vallejo-Gómez, David, Marisol Osorio, and Carlos A. Hincapié. "Smart irrigation systems in agriculture: A systematic review." *Agronomy* 13.2 (2023): 342.
13. Krishnan, Siva Rama, et al. "Smart water resource management using Artificial Intelligence—A review." Sustainability 14.20 (2022): 13384.
14. Stewart, R. A., Willis, R., Giurco, D., Panuwatwanich, K., & Capati, G. "Web-based knowledge management system: linking smart metering to the future of urban water planning." Australian Planner 47.2 (2010): 66-74.

Under the Patronage of His Excellency **Eng. Abdulrahman bin Abdulmohsen AlFadley**
Minister of Environment, Water & Agriculture

منتدى المياه السعودي
saudi water forum SWF 2024

THANK YOU!

29 April – 01 May 2024

Hilton Riyadh Hotel & Residences
Riyadh, Saudi Arabia

Organized by

وزارة البيئة والمياه والزراعة
Ministry of Environment Water & Agriculture

Organizing Partners

المؤسسة العامة لتحلية المياه المالحة
Saline Water Conversion Corporation (SWCC)

شركة المياه الوطنية
National Water Company

الشركة السعودية لشراكات المياه
Saudi Water Partnership Company

المؤسسة العامة للري
Saudi Irrigation Organization
المملكة العربية السعودية

شركة نقل وتقنيات المياه
WATER TRANSMISSION AND TECHNOLOGIES CO.

منظم المياه
Water Regulator

المركز الوطني لكفاءة وترشيد المياه
NATIONAL WATER EFFICIENCY AND CONSERVATION CENTER
MAEE