Workshop On

Artificial Intelligence for Sustainable Water Resources Management in the GCC Countries
December 16-17, 2025, State of Kuwait

Final Report

Title: **Artificial Intelligence for Sustainable Water Resources Management in the GCC Countries**
Organizers: **Kuwait Institute for Scientific Research (KISR) in cooperation with the GCC Water Science and Technology Association (GCC-WSTA) and The GCC Secretariat General (GCC SG)**
Date: **December 16-17, 2025**
Venue: **Kuwait Institute for Scientific Research (KISR), Al-Shuwaikh**
Attendees: **360 participants from Kuwait and other GCC countries**

Executive Summary

The Regional Workshop on "*Artificial Intelligence for Sustainable Water Resources Management in the GCC Countries*" convened with the participation of international and regional experts to explore the transformative potential of the Fourth Industrial Revolution (4IR) emerging technologies[1] and cutting-edge AI in the water sector. Against a backdrop of acute water scarcity, climate change, and steadily increasing water demand, the discussions underscored the role of AI not as a mere technological upgrade, but rather as a strategic enabler that must be embedded within strong data governance frameworks, skilled human capital, sound policy environments, and effective regional cooperation mechanisms to achieve water security, economic sustainability, and climate resilience. The Workshop presentations and deliberations highlighted a clear consensus: **successful integration of AI into water resources management requires a holistic and coordinated approach that combines advanced technological solutions with sustained foundational investments in data governance, institutional and human capacity development, enabling policies, and regional cooperation**. Discussions also addressed practical applications across key water sector domains, as well as the importance of managing risks and ensuring the responsible and ethical use of AI technologies. This report consolidates and synthesizes the key recommendations derived from the workshop presentations and discussions, structured around three main thematic areas addressed during the event (**refer to Annex A for the list of presentations**):

1. Data Governance, National Readiness, and Emerging Technologies

The session established the foundational pillars for successful AI adoption, emphasizing that effective AI implementation must be grounded in robust data availability, sound institutional frameworks, and adequate human capacities. It also highlighted key opportunities for applying emerging technologies and AI solutions to address the principal water-related challenges facing the GCC countries. Additionally, the discussions underscored the importance of data integrity, interoperability, cybersecurity, and clear governance arrangements as critical enablers for trustworthy and sustainable AI deployment.

[1] Emerging Technologies include: Geo AI, Internet of Things (IoT), Blockchain, Quantum Computing, Big Data Analytics, Robotics/Drones, ..

2. Applications in the Water Sector and the WEFE Nexus

The session showcased the transformative potential of emerging technologies and AI in optimizing the entire water value chain, while effectively managing the critical interlinkages between water, energy, food, and ecosystems. Recognizing that agriculture accounts for the largest share of water consumption in the GCC, this session focused more on the role of AI and AI-based models, particularly ANNs integrated with IoT, as a key to unlocking significant efficiency gains and enhancing the sustainability of water use within the agricultural sector. The discussions further emphasized the need to move beyond isolated pilot projects toward integrated, system-wide deployment of AI-enabled solutions across the water sector.

3. AI Capacity Development, Education, and Awareness Raising

This session emphasized that successful technological transformation is ultimately dependent on human capital, highlighting the need to address ethical considerations and promote the responsible use of artificial intelligence as an integral component of AI adoption. Participants also highlighted the importance of managing risks associated with AI adoption, including over-reliance on automated systems, data bias, and the need to preserve and strengthen core hydrological and engineering expertise alongside digital capabilities.

In addition, two short post-workshop training sessions were conducted on “Emerging Technologies Applications for Water Management” and “GEO AI Applications in the Water Sector”, which were attended by 83 participants (**Refer to Annex B for the topics of the training**).

The workshop’s main recommendations are as follows:

A. Data Governance, National Readiness, and Emerging Technologies

1. Establish Robust National Data Governance Frameworks (water data observatories):

- Develop and implement comprehensive national data strategies (as exemplified by Saudi Arabia's alignment with the Saudi Data and AI Authority, SDAIA), to ensure data/met data harmonization procedures embodying data quality, interoperability, security, and ethical use. These elements are fundamental prerequisites for the development and deployment of reliable AI models.
- Establish centralized and authoritative data platforms (e.g., Saudi Arabia National Irrigation Geo Databases) to serve as a single, trusted source of water-related data, thereby supporting evidence-based planning, management, and decision-making.

These frameworks should incorporate clear data ownership, cybersecurity safeguards, and ethical oversight mechanisms to ensure trustworthy and responsible AI deployment.

2. Assess and Build National AI Readiness:

- GCC Countries should undertake systematic assessments of their digital maturity across data acquisition and control, policy, infrastructure, regulatory environments, human capital, and institutional capacity. Progressing beyond basic digitization toward comprehensive digital transformation is critical.
- Strong leadership and clearly defined governance structures are essential to guide this transformation, reducing the risks associated with poor-quality or fragmented data, and ensuring the reliability and sustainability of AI investments and potential impacts.

These assessments should inform clear national roadmaps that support the scaling and institutionalization of AI solutions beyond pilot initiatives.

3. Adopt a Portfolio of Emerging Technologies:

- In addition to core AI solutions, GCC water sectors should strategically explore, pilot and integrate complementary 4IR technologies, including the Internet of Things (IoT) for sensing and monitoring, blockchain for traceability and smart contracts, drones and remote sensing technologies for large-scale monitoring and assessment, and beyond with digital twins for system simulation.

Priority should be given to technologies that demonstrate clear operational value and can be integrated into existing water management systems.

B. Applications of Emerging Technologies in the Water Sector and the WEFE Nexus

1. Deploy AI for System-Wide Optimization and Resilience:

- Implement AI-driven digital twins (virtual replicas) of integrated Water-Energy-Food-Ecosystem (WEFE) systems to simulate complex synergies, assess trade-offs, and support transition from siloed sector-specific management toward proactive and integrated system-wide governance.
- By integrating and prioritizing bundled Socio-Ecological Technologies (SETs), AI can transform complex data into accessible visual interfaces that outperform isolated interventions. This approach fosters informed dialogue among diverse stakeholders, reducing institutional fragmentation and ensuring more effective outcomes across the WEFE Nexus.
- Leverage and reinforce artificial intelligence for predictive maintenance and operational optimization of critical water infrastructure, including desalination plants (where energy consumption can be reduced by approximately 10-20%) and water distribution networks (where AI applications can contribute to reducing non-revenue water by more than 20%).
- Apply AI-based tools to enhance groundwater sustainability through economic well design optimization and advanced modeling of aquifer behavior, particularly in data-scarce and hydrogeologically complex environments.
- Develop AI-based scenarios for groundwater contamination issues, specifically for coastal aquifers to avoid salinity excess for agricultural requirements.

These applications should be progressively integrated into national water planning and operational frameworks to ensure continuity, scalability, and long-term institutional ownership.

2. Leverage AI for the Safe and Efficient Use of All Water Sources:

- Develop AI models to support predictive blending of conventional and non-conventional water sources, including treated wastewater, brackish groundwater, and harvested water, based on clearly defined "fit-for-purpose" water quality requirements.
- Use AI-driven real-time monitoring and anomaly detection systems in wastewater treatment and reuse operations to safeguard water quality, enhance process stability, and strengthen public confidence in reclaimed water systems.

Robust quality assurance protocols and regulatory oversight should accompany these applications to manage risks and maintain trust in AI-supported water reuse systems.

3. Scale AI-Powered Precision Agriculture:

- Promote the widespread adoption of AI-enabled precision irrigation systems that integrate soil moisture sensors, weather forecasting data, and satellite-derived indicators (e.g., NDVI) to achieve significant reductions in water use (typically in the range of 30-50%) and appropriate fertilizers need, while maintaining or enhancing agricultural productivity and crop yields.
- Support the development and deployment of integrated AI-agronomy platforms that offer comprehensive decision support tools for crop selection, early detection of pests and diseases, yield forecasting, and optimization of agricultural inputs.

Targeted policies, incentives, and service-based business models should be introduced to support large-scale adoption and ensure accessibility for small and medium-scale farmers.

4. Address the Specific Challenges of AI in Arid Agriculture:

- Recognize and address the key barriers to the adoption of AI technologies in arid agricultural settings, including high initial investment costs, limited sensors reliability under harsh environmental conditions, data scarcity on crop water requirements, and insufficient technical capacity among farmers by planning sensitization and dissemination training.
- Advocate for supportive policies and innovative business models (e.g., service-based contracts, performance-based payment schemes) that enhance the economic feasibility and accessibility of AI solutions for small- and medium-scale farmers.

Pilot demonstration farms, localized validation of AI tools, and extension services should be strengthened to build trust, demonstrate value, and accelerate adoption under real arid-field conditions.

C. AI Capacity Development, Education and Awareness Raising

1. Integrate Fourth Industrial Revolution (4IR) Technologies and AI into Water Education and Training:

- Modernize/update academic curricula to develop a new generation of "Water Data Scientists" and water professionals who are proficient in data literacy, AI, and system-based thinking.
- Establish immersive learning environments, such as "Living Labs" that utilize real GCC water infrastructure and digital twin technologies for pilot demonstration, to effectively bridge the gap between theoretical knowledge and practical applications.
- Provide targeted professional on-the-job training programs, short courses, and micro-credentials for water sector professionals focused on the application of emerging technologies and the operation and management of smart water systems.
- Fund Knowledge Exchange initiatives to transfer knowledge between academic institutions and industrial partners. These initiatives will accelerate AI adoption and reduce associated risks

Capacity-building initiatives should be aligned with national digital transformation strategies to ensure consistency, relevance, and long-term impact.

2. Develop Value-Based and Engaging AI Educational Tools:

- Design AI-enabled environmental education programs that extend beyond traditional knowledge transfer by promoting water conservation values and encouraging behavioral change among younger generations through personalized learning approaches and interactive simulations.
- Implement comprehensive capacity-building initiatives targeting water sector professionals, policymakers, and farmers to ensure they are equipped with the skills and competencies required to effectively use, manage, and oversee AI-based systems.

These programs should explicitly address ethical considerations, data responsibility, and the limitations of AI to promote informed and responsible use.

3. Foster a Culture of Innovation and Collaboration:

- Promote open innovation through developing public-facing data platforms and providing targeted support for local technology startups and entrepreneurs operating within the water sector.
- Strengthen public-private-academic partnerships to accelerate R&D activities and facilitate the deployment of AI solutions that are specifically tailored to the needs and challenges of the water sector.

Clear governance arrangements and performance evaluation mechanisms should be established to ensure that collaborative initiatives deliver measurable and scalable outcomes.

Across all recommendation areas, participants emphasized the importance of moving from isolated pilots toward integrated, system-wide AI deployment, supported by strong governance, risk management, and sustained regional cooperation.

Overarching Conclusions and Strategic Pathways Forward

The workshop presentations collectively outlined a clear and coherent pathway for the water sector in the GCC countries to effectively harness the potential of Emerging Technologies and Cutting-Edge AI in the water sector in order to enhance water sustainability and security across the region.

1. **From Pilots to Systems:** Transition beyond isolated and fragmented pilot initiatives toward fully integrated, AI-enabled water governance systems that are predictive, proactive, and resilient in addressing complex water challenges.
2. **Balance Opportunity with Prudence:** Proactively manage the risks associated with AI deployment, including data bias, cybersecurity vulnerabilities, model drift, environmental impacts (energy/water footprint of data centers), and the risk of over-reliance on AI at the expense of essential hydrological expertise.
3. **Prioritize Digital Sovereignty:** Build in-house capacity and strengthen regional collaboration to develop solutions tailored to the GCC's unique arid context, thereby reducing dependence on foreign proprietary systems and ensuring long-term control over critical digital infrastructure and data assets.
4. **Embrace Regional Cooperation:** Leverage the shared challenges and opportunities across GCC countries by promoting collaborative action, including the establishment of shared data platforms, harmonization of policies, co-development of open-source tools, and sustained knowledge exchange through regional platforms such as WSTA.

Finally, achieving these strategic pathways will require sustained political commitment, coordinated institutional action, and long-term investment in governance frameworks, human capital, and regional cooperation mechanisms.

Conclusion

The integration of Artificial Intelligence into water resources management has moved beyond being a future option for the GCC to become an immediate necessity. Through the strategic application of these technologies within a framework founded on "**strong governance**" structures, "**resilient infrastructure**", sustained "**investment in human capital**", and effective "**regional cooperation**", the GCC has the potential to convert its water challenges into a leading model of sustainable and intelligent water resources management for arid regions around the world.

Next Steps

The workshop organizers - KISR, WSTA, and the GCC Secretariat General (GCC SG) - will build on the outcomes of the workshop to further advance and strengthen the implementation of emerging technologies and cutting-edge AI within the water sector across GCC countries. To this end, the following initiatives have been agreed upon:

1. Develop a "**Policy Brief**" on AI Applications in the Water Sector in the GCC Countries to raise awareness on the potential of AI, its prerequisites, and associated challenges. The policy brief will be targeted at policymakers and water sector specialists, **with the WSTA Scientific Committee leading the process and contributions provided by all workshop speakers.** The suggested title of the Policy Brief: **Artificial Intelligence for Sustainable Water Resources Management in the GCC: Priorities, Policies and the Path Forward**
2. Prepare a comprehensive **bibliography** of all emerging technologies and AI applications in the water sector and all AI-Water initiatives, covering the GCC countries and potentially extending to the Arab and other regions. **KISR will take the lead in compiling this bibliography.**
3. Follow up on the workshop outcomes during **WSTA's upcoming 16th Gulf Water Conference** (Oman, April 2026), through appropriate formats such as a physical or virtual special session, panel discussion, or related activities, with coordination **led by the WSTA Scientific Committee**.
4. Submit the Workshop Conclusions and Recommendations to the GCC SG. **KISR jointly with WSTA will submit these to GCC SG (Dr. Mohammed Al-Rashidi).**
5. KISR-WSTA will further engage with the GCC SG to explore support opportunities for existing and new initiatives aimed at enhancing the adoption of AI and other emerging technologies in the water sector, with **WSTA's Scientific Committee preparing proposals in this regard.**

Acknowledgement:

All organizers, and the organizing and scientific committees would like to extend their sincere appreciation for the sponsors of this workshop for their generous support of the event. Their contribution played a vital role in the success of the workshop, and their commitment to supporting initiatives such as this is truly valued. Thanks to their support, we were able to deliver a successful and impactful experience for all participants.

We are proud to have them as partners and look forward to future opportunities to collaborate.

Sponsors:

- Kuwait Petroleum Corporation and Subsidiaries
- Kuwait Foundation for the Advancement of Sciences
- Federation of Arab Scientific Research Councils
- Kuwait United Poultry Company

Annex A

List of Workshop Speakers and their presentation titles

- National Readiness for Artificial Intelligence Adoption, Dr. Zeyad AL-SHIBAANY, International Expert in Digital and Intelligent Systems
- Leveraging AI and Digital Sovereignty for Smart and Sustainable Water Governance in the MENA Region, Dr. Mustafa EZZYANI, Professor of Computer Science, FST Tangier, Morocco
- AI as a tool for Economic Sustainability and Water Security in the GCC Countries, Prof. Mohamed ALRASHED, Kuwait Institute for Scientific Research, Kuwait
- The Smart Water Revolution: Harnessing Emerging Technologies for Sustainable Water Management in the GCC Countries. Prof. Waleed ALZUBARI, Arabian Gulf University, Kingdom of Bahrain
- The impact of Applying AI Technology on the Overall Performance of Small and Medium-sized Water-related Enterprises in the Sultanate of Oman. A case study of Azr Engineering, Investment and Holding Company, Dr. Ali AL-HAMDI, CEO, Azer Engineering & Investment Holding
- Integrated Flood Management: Data, Models, and AI (Uncertainty and Knowledge), Prof. Driss OUAZAR, Hassan II Academy of Science and Technology, Morocco
- An Artificial Intelligence Framework for the Economic/Optimal design of Dual-Well Systems in Kuwait's Aquifers, Dr. Amjad ALIEWI, Kuwait Institute for Scientific Research, Kuwait
- AI - Driven Approaches for Sustainable Water Management: Insights from Groundwater Modeling, Agricultural Drainage Treatment and Smart Hydroponic Systems, Prof. Hoda Farouk ZAHRAN, Pollution Management Department, Environment and Natural Materials Research Institute (ENMRI), City of Scientific Research and Technological Applications (SRTA), Egypt
- AI Driven Solutions for Sustainable Water Management in Arid Regions: Harnessing Smart Technologies for Resilient Future, Eng. Adnan AKBER, Kuwait Institute for Scientific Research, Kuwait
- Leveraging Artificial Intelligence for Sustainable Water Management in Saudi Arabia, Dr. Mohammad AL-OMAIR, Saudi Irrigation Organization, Kingdom of Saudi Arabia
- AI for WEFE Nexus: Strengthening Climate Resilience and Water-Smart Irrigation, Prof. Jordi Morato MORATÓ, UNESCO Chair on Sustainability, Universitat Politècnica de Catalunya, Spain
- Smart User of Non-conventional Water and AI-Driven Agriculture for Food Production, Dr. Kamel Mostafa AMER, Arab Organization of Agricultural Development (AOAD)
- Challenges of AI in Managing Irrigation Water, Prof. Abdrubalrasoul AL-OMRAN, King Saud University, Riyadh, Saudi Arabia
- From Losses to Efficiency, the role of automatic power factor correction towards enhancing the reliability of desalination and pumping systems, Eng. Ahmed AL GHAMDI, Renewable Energy Group Leader, WTIIRA, Kingdom of Saudi Arabia
- The educational role of artificial intelligence technologies in promoting water Conservation values and their importance among young generations, Dr. Najwa AL-MUTAIRI, Academic and Educational Researcher, Kingdom of Saudi Arabia.

- Artificial intelligence for sustainable water resource management: A Saudi Arabian perspective, Aws AL-FOUZAN, Student (11th Grade), Kingdom of Saudi Arabia **Annex B**

Post-Workshop Training Sessions

Training 1: Emerging Technologies Applications for Water Management, by Prof. Adel BOUHOULA, Arabian Gulf University.
This workshop explored how emerging technologies are revolutionizing water management. Machine learning enables water management to shift from a reactive to a proactive approach, enhancing efficiency, sustainability, and resilience. Blockchain technology offers transparency, decentralization, and robust security for water data, with smart contracts enabling automated, reliable, and transparent water allocation and management processes. The Internet of Things (IoT) helps reduce costs, promote resource conservation, and minimize waste through smart monitoring. Quantum computing brings precision in contaminant detection, enables detailed simulations for sustainability, and solves complex problems more efficiently. Together, these technologies drive innovative and sustainable water management solutions.

Training 2: GEO AI Applications in the Water Sector, by Dr. Manaf ALKHUZAI, Arabian Gulf University.
The workshop contents are: Water Challenges & Why GeoAI? What is GeoAI? GeoAI Basics in Simple Terms; Types of Geographic Data for Water Management; Common AI Methods in GeoAI; The GeoAI Workflow: From Data to Decisions; Validation & Accuracy (How We Know GeoAI Works); Limitations & Considerations; Live Demonstrations: Demo A: Coastal Water Quality Monitoring, Demo B: Urban Flash Flood Susceptibility Mapping, Demo C: Water Leak Hotspot Detection (Non-Revenue Water), Demo D: Groundwater Salinity Prediction; Implementation Roadmap; Costs & Return on Investment; Critical Success Factors; Common Pitfalls to Avoid; Key Takeaways & Discussion; References & Further Reading.