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Sustainable Management Strategies for Non-Conventional Water Resources: Enhancing Food and Water Security in Arid and Semi-Arid Regions

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The escalating threat of water scarcity presents a dual challenge to both food production and water-related systems. The degradation of conventional water resources (e.g., surface water and ground water), coupled with insufficient investment in infrastructure, has compelled the water sector to seek alternative sources such as Non-Conventional Water Resources (NCW), encompassing reclaimed water reuse and desalination of brackish and seawater, as a long-term strategy, particularly in arid and semi-arid environments where irrigation is a vital component.
Recognizing the substantial potential of NCWs, this research presents the outcomes of an extensive study **[1]**. The study adopts a multidisciplinary approach, specifically employing Multi-Criteria Decision Making (MCDM), to assess the effectiveness of smart city water management strategies within the framework of NCWs. Utilizing representative criteria, our analysis involves objective judgment, assigns weights through the Analytic Hierarchy Process (AHP), and scores strategies based on their adherence to these criteria.
Our findings underscore the pivotal role of the "Effectiveness and Risk Management" criterion, carrying the highest weight at 15.28%, in shaping strategy evaluation and ensuring robustness. Criteria with medium weight include "Resource Efficiency, Equity, and Social Considerations" (10.44%), "Integration with Existing Systems, Technological Feasibility, and Ease of Implementation" (10.10%), and "Environmental Impact" (9.84%), focusing on ecological mitigation. Recognizing the importance of community engagement, "Community Engagement and Public Acceptance" (9.79%) is highlighted, while "Scalability and Adaptability" (9.35%) address the dynamics of changing conditions. Balancing financial and governance concerns are "Return on Investment" (9.07%) and "Regulatory and Policy Alignment" (8.8%). Two low-weight criteria, "Data Reliability" (8.78%) and "Long-Term Sustainability" (8.55%), emphasize data accuracy and sustainability.
Strategies with higher weights, such as "Smart Metering and Monitoring, Demand Management, Behavior Change," and "Smart Irrigation Systems," prove highly effective in enhancing water management in smart cities. Notably, medium-weighted strategies (e.g., "Educational Campaigns and Public Awareness," "Policy and Regulation," "Rainwater Harvesting," "Offshore Floating Photovoltaic Systems," "Collaboration and Partnerships," "Graywater Recycling and Reuse," and "Distributed Water Infrastructure") and low-weighted strategies (e.g., "Water Desalination") also

contribute significantly, allowing for customization based on each smart city's unique context.
This research is of significance as it addresses the complexity of urban water resource management, offering a multi-criteria approach that enhances traditional single-focused methods. It comprehensively evaluates water strategies in smart cities and provides a criteria-weight-based resource allocation framework for sustainable decision-making, thereby boosting smart city resilience. It is essential to acknowledge that results may vary depending on specific smart city needs and constraints. Future studies are encouraged to explore factors such as climate change's impact on water management in smart cities and consider alternative MCDM methods like Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) or Elimination and Choice Expressing the Reality (ELECTRE) for strategy evaluation.

[1] Bouramdane, A.-A., Optimal Water Management Strategies: Paving the Way for Sustainability in Smart Cities. Smart Cities 2023, 6, 2849–2882. https://doi.org/10.3390/smartcities6050128