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## System Dynamics Modeling for Resilient Water Resource Management in Arid Regions

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Arid regions confront significant challenges due to the scarcity of natural water resources, leading to the depletion of non-renewable reserves and an escalating reliance on unconventional water sources. The intricacies of water resource management within such regions are compounded by the dynamic interplay of influential factors, including rapid urbanization and population expansion.

This research employs an innovative System Dynamics (SD) methodology to construct a comprehensive model aimed at understanding the complex dynamics inherent in water resource management within Qatar, characterized by an arid climate. A Decision Support System (DSS), functioning as a simulated environment, was developed to project the behavioral patterns of Qatar's water resource system from 2021 to 2070. This projection encompasses nine distinct scenarios, categorically addressing changes in physical, environmental, and socio-economic dynamics. These scenarios were further evaluated against Water Sustainability and Reliability Indexes to provide a comprehensive assessment. The outcomes of this study underscore that the conventional "business-as-usual" approach to water resource management can ensure a sustainable balance between water supply and demand for a limited span of 32 years, with the most optimistic scenario extending this sustainability horizon to 50 years. Furthermore, groundwater conservation strategies were integrated and simulated, accentuating the imperative to preserve groundwater resources as an indispensable "backstop" for the nation.

The developed model not only addresses Qatar's specific challenges but also offers insights applicable to other Gulf Cooperation Council (GCC) countries and similar arid regions. This research contributes a robust decision-making tool for policymakers and stakeholders to assess the long-term implications of various management scenarios. It contributes to the development of sustainable and resilient water policies for the years to come, particularly in navigating the uncertainties inherent in arid region water resource management.