Water management: conventional methods or innovative systems thinking using System Dynamics?

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Water planning and management issues have significant short and long-term effects. They are often contentious issues under constant pressure from population growth, intensive irrigation, climate change effects, and short-term politics. Indeed, conventional analysis of water resource systems can often propose unsustainable management strategies. However, systems thinking seeks to further understand the interactions and feedback between subsystems that determine the overall behavior of a system. System Dynamics, a policy-based approach that assesses the effect of policy changes on a system, facilitates a holistic understanding of water resource systems and policy decision-making. This approach also facilitates participatory modeling and analysis of system behavioral trends, which are essential for sustainable water management. The water resources field has not used the full capacity of System Dynamics in integrated water resources management. Yet, this critically important phase is provided by System Dynamics, which offers unique qualitative tools to improve the understanding of complex problems. Our study provides an overview of the System Dynamics approach, highlights water resource management methods used in Morocco and internationally, and compares water resource management using dynamic systems models to conventional integrated models, citing the advantages and disadvantages of each method. It is clear that traditional management approaches focus on increasing supply and reducing demand without considering the complex interactions and feedback loops that govern the behavior of water resources. Although these approaches can provide quick fixes, they often lead to unexpected, sometimes catastrophic, and delayed results. Therefore, water management should take a holistic approach that considers the interrelated physical (water inputs and outputs) and behavioral (decision rules, perceptions) processes of the system. In contrast to reductionist approaches, System Dynamics adopts a system-level view to model and analyze the complex structure (cause-and-effect relationships, feedback

loops, stock and flow diagrams, latency, reference modes of dynamic behavior, and system archetypes) that generates systemic behavior and demonstrates the use of these qualitative tools for the holistic conceptualization of water resource problems. The model simulation allows for the assessment of long-term impacts on the overall system, exploration of leverage points, and communication of results to decision-makers.