Over the past decades, cost-effectiveness principle or cost-benefit analysis has been employed oftentimes as a typical assessment tool for the expansion of drinking water utility. With changing public awareness of the inherent linkages between greenhouse gas (GHG) emissions and climate change, the addition of such a new consideration in the assessment regime has altered the landscape of traditional evaluation matrix. Nowadays, urban drinking water infrastructure requires careful long-term expansion planning to reduce the risk from climate change during both the periods of economic boom and recession. Meanwhile, accurate prediction of municipal water demand is critically important to water utility in a fast growing urban region for the purpose of drinking water system planning, design and water utility asset management. As a part of the adaptation management strategies, capacity expansion in concert with other management alternatives responding to the population dynamics, ecological conservation, and water management policies should be systematically examined to balance the water supply and demand temporally and spatially with different scales. This research is based on a real-world drinking water infrastructure system expansion program in Manatee County, Florida. Four components of the drinking water infrastructure system are investigated and studied, which consists of water demand analysis, global climate change evaluation, system optimization for infrastructure expansion and decisions under uncertainties. In the water demand analysis component, a new system dynamics model is developed to reflect the intrinsic relationship between water demand and macroeconomic environment. This system dynamics model is based on a coupled modeling structure that takes the interactions among economic and social dimensions into account offering a satisfactory platform for practical use. In the global climate change evaluation component, a lifecycle-based analysis is conducted to estimate the carbon footprint for all potential water supply alternatives. The result of the global climate change evaluation study provides an extra dimension for decision makers in planning water infrastructure expansion strategies. In the system optimization for infrastructure expansion component, a multiobjective optimization model is developed for the optimal facility expansion strategies. With the aid of a multi-stage planning methodology over the partitioned time horizon, such a systems analysis has resulted in a full-scale screening and sequencing of multiple competing objectives across a suite of management strategies. In the decisions under uncertainties component, due to the uncertainties imposed by the nature of the real-world problem, the nested minimax regret (NMMR) solution method is proposed to handle the uncertainties of the system optimization model. The proposed NMMR solution method is applied in a reduced scale of the real-world problem and a robust solution is recommended.

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The public is welcome to attend.