Hydrological Modeling of Atoll Islands in the Federated States of Micronesia

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Water shortages pose a grave concern to the inhabitants of atoll islands. The small size, unique geology, and high solar isolation on atoll islands combine to subject entire populations to the stresses of drought, and difficult, expensive, and sometimes untimely aid operations. Under normal conditions, water demand is met by rooftop rain catchment. Prolonged droughts, such as those associated with El Niño, exhaust water storage tanks and reduce island water supply to extremely limited alternatives. Tropical storms or typhoons can also destroy or severely damage rain catchment facilities.

At such times groundwater is the only alternative to importation. On most islands, groundwater is not utilized or the use of it is not systematic, however. Atoll aquifers have thin freshwater lenses immediately underlain by saltwater. High permeability and near sea-level elevation make the aquifer susceptible to saltwater intrusion and even depletion of the freshwater lens during times of limited or no recharge. The unique characteristics of atoll island aquifers, such as disproportionately thick transition zones between freshwater and saltwater, render traditional coastal aquifer models inappropriate. Moreover, sophisticated numerical models, such as are built for research purposes, are expensive and impractical for public or private sector planners and resources managers. The development of simple and elegant models to support groundwater resource assessment and management is needed by FSM resource managers to aid them in establishing sustainable and prudent groundwater extraction, protection and land use practices. The goal of this project was to produce a model consisting of two components, a steady-state GIS-based analytical model using hydrological and geological data assembled this past year during the first phase of this project, and a three-dimensional, dynamic computer model to simulate freshwater lens responses to changing levels of recharge, extraction, and tidal and sea-level fluctuations. The dynamic model will be used to calibrate the simpler analytical model, enhancing its accuracy. Based on the more sophisticated model, appropriate correction factors will be integrated into the analytical model to develop a user-friendly and reliable, Excel Spreadsheet-based tool for water resource managers. The model will also incorporate supply and demand related to the availability and production of rainwater catchment and agricultural water uses.

The model, aside from its practical importance will contribute to a greater understanding of the hydrogeology and water use on atoll islands. The models will provide FSM water resources managers with a better understanding of the conditions and processes that control the capacities and demands on atoll aquifers. They will also aid island leaders in developing practical and comprehensive water resources plans. Outside of the models, the report generated from this work will review general water-use practices to ensure that the proposed management plans are both culturally and economically feasible.