Hydrological modeling of atoll islands in the Federated States of Micronesia

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This project is a direct response the need for "research directed toward the development of an accurate and practical groundwater evaluation model for the low islands" identified at the WERI Advisory Council Meeting in Pohnpei on October 11, 2005. 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 is to produce a model consisting of two components. The first will be a steady-state GIS-based analytical model using hydrological and geological data assembled this past year during the first phase of this project. The second model will be a three-dimensional, dynamic computer model which will simulate freshwater lens response 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 will not only be practical, but will also contribute to a greater understanding of the hydrogeology and water use on atoll islands. The project will engage a multi-disciplinary team composed of a hydrogeologist, anthropologist, GIS specialist, and a graduate student in environmental studies. Use of the models will require some basic but readily deliverable training, which meets the interest of FSM state officials to better understand the conditions and processes that control the capacities and demands on atoll aquifers.

The construction of the models will require additional data collection with an emphasis on field-testing model parameters and predictions. The protocol is intended to aid island leaders in developing practical and comprehensive water resources plans. Outside of the models, the report will review general water-use practices to ensure that the proposed management plans are culturally and economically feasible.