1.2 Dissertation Significance, Objectives, and Outline

The purpose of this work is to improve scientific understanding of hydrogeologic processes in tropical island environments, and on a local level, to address a set of American Samoa's most critical water resources management questions through applied scientific investigation of climatic, geologic, hydrologic, geochemical, and biological phenomena. American Samoa is located over 2000 miles away from the nearest continent, and with a total land area of only 199 km^2 (slightly larger than Washington, D.C.) any water resource challenge in the territory is a critical one. Currently the challenges faced in American Samoa include salinization of drinking water wells, anthropogenic contamination of aquifers, and degradation of environmental water quality. While these issues are complex and involve many stakeholders, this work seeks to contribute information towards their solutions by addressing a set of specific research questions that are carefully designed to consider some of the most pertinent needs of resource managers and stakeholders in American Samoa.

While the work presented in the following chapters is generally motivated by applied questions based on management priorities, the application of advanced, cross-cutting geochemical and numerical techniques as tracers of human impact provides a testing ground for these methodologies in this new setting, thereby furthering scientific knowledge regarding the utility of these techniques. However, the most significant contribution made by this work is in advancing the understanding of American Samoan hydrogeology. This may benefit future scientists, resource managers, and policy makers who strive to address the critical water resources challenges that lay ahead for the territory.

Chapter 1, *Introduction*, provides background on the study setting of Tutuila, American Samoa, and also introduces a conceptual hydrogeologic model to support the hydrogeologic framework upon which the other chapters are built.

Chapter 2, *Isotopes, Microbes, and Turbidity: A Multi-Tracer Approach to Understanding Recharge Dynamics and Groundwater Contamination in a Basaltic Island Aquifer*, applies geochemical and biological tracers including turbidity, fecal indicator bacteria, and water isotopes, to assess the mechanism of contamination in wells that have contributed to one of the longest-standing-boil water notices in U.S. history. The primary objective of this chapter is to determine if existing wells can be simply repaired or re-drilled, or if abandonment of the entire aquifer may be necessary.

Chapter 3, *Understanding Surface Water - Groundwater Interaction, Submarine Groundwater Discharge, and Associated Nutrient Loading in a Small Tropical Island Watershed*, shows how comprehensive, tracer-based field assessment of submarine groundwater discharge (SGD) can be complimented by watershed modeling to better understand groundwater-surface water interaction and watershed scale nutrient dynamics. The primary objective of this chapter is to quantify coastal nutrient loading from different anthropogenic sources as they contribute to terrestrial hydrologic pathways including surface runoff, lateral flow, baseflow, and SGD.

Chapter 4, *Assessment of Terrigenous Nutrient Loading to Coastal Ecosystems along a Human Land-Use Gradient, Tutuila, American Samoa*, expands the techniques used in Chapter 3 to four separate watersheds spanning a human-impact gradient, and also incorporates the assessment of macroalgal tissue parameters as a biological indicator of anthropogenic impact in these watersheds. The main objective of this chapter is to provide tools for coastal resource managers to detect or predict which nearshore areas may be at the highest risk of nutrient imbalance.

Chapter 5, *Groundwater Recharge for Tutuila, American Samoa Under Current and Projected Climate as Estimated with SWB2, a Soil Water Balance Model*, presents the development and results of a water budget assessment for Tutuila Island, specifically designed to estimate spatially distributed groundwater recharge. The main objective of this chapter, besides production of a groundwater recharge map, is assessing the effects of future climate change on groundwater resources.

Chapter 6, *Collaborative Groundwater Modeling: Open Source, Cloud-Based, Applied Science at a Small-Island Water Utility Scale*, takes a distinctive approach to groundwater modeling; instead of focusing on model results, this chapter focuses on a vertically-integrated, cloud-based, and process oriented collaborative modeling framework developed cooperatively between our research group and the American Samoa Power Authority. The main objective of this chapter is to present a case study that details the components in this process. These components include weather station and stream gauge installation, water budget modeling, and ongoing groundwater modeling. This case study shows how a collaborative approach can be applied to develop modeling products that have greater longevity and applicability to the needs of resource managers.