Managing Coastal Marine Nutrient Loads: Point and Nonpoint Sources in West Hawai‘i

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The Problem
Multiple terrestrial sources contribute to nutrient pollution in groundwater. On the Kona Coast of Hawai‘i Island, primary contributors include fertilizer from commercial and residential landscaping; wastewater from treatment plants, cesspools, and septic systems; and nitrogen-rich litterfall from kiawe trees. Although some of the nutrients are lost to sorption and denitrification as groundwater travels subterraneously toward the ocean, the remainder ultimately discharges at the coast, where it can potentially damage the nearshore environment (e.g. hypoxia, habitat degradation, algal blooms).

Research Objectives
The primary objectives of the project are to determine which nutrient sources should be targeted first, how much to abate from each source over time, and what kind of policies to implement in order to induce the desired levels of abatement. Achieving this objective will require calculating the costs of various nutrient abatement instruments, as well as comparing the cost-effectiveness of different nutrient-reducing regulatory policies.

Progress
Control mechanisms have been identified for the three primary sources of nutrient input to groundwater. Nitrogen can be reduced at wastewater treatment plants via denitrifying bacteria. Nutrient inputs from fertilizer can be reduced by decreasing total fertilizer use, substituting away from fast-release fertilizers that are more prone to leaching, and/or employing more efficient application practices. Mechanical removal, herbicide application, and/or burning will be required to reduce inputs from nitrogen-fixing kiawe trees. Subsurface nitrate barriers can reduce nitrogen from all sources at sites with concentrated groundwater discharge.

The theory of pollution abatement has been explored from an economic standpoint, and two optimal abatement principles will be considered in formulating regulatory policies. First, nutrient sources should be targeted in the order of least marginal abatement cost, which means that if multiple abatement channels are used, their marginal abatement costs should be equal. Second, abatement via some activities may always be dominated by more cost-effective abatement channels. Depending on the data, zero abatement may be optimal for some sources.

Lastly, several key features of regulatory policy design have been analyzed. Nutrient management will require not only an optimal abatement plan, but also a plan for financing the control mechanisms. Financing will depend on the source. For example, wastewater denitrification can be financed through increased water/sewage fees, but kiawe removal or nitrate barrier construction would need to be financed from general revenue. Although across the board water surcharges could leave poorer households worse off, pro-poor block pricing schemes can be designed to ensure that all users are at least as well off, while incorporating the surcharge required to finance the nutrient reduction measure. In other cases, incentive-based mechanisms may be required to induce individuals to adopt desired practices. To achieve reductions in non-point source fertilizer contributions, policy may include any combination of the following: outreach and education programs, a statewide tax on fertilizer, and/or a ban of fast-release “nitrogenous” fertilizers.