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Assessing the potential for food and energy self-sufficiency on the island of Kauai, Hawaii

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ABSTRACT

Food and energy security are major concerns in the Pacific and around the world. They are key planning priorities in the state of Hawaii as well. Approximately 90% of energy and food resources are imported to Hawaii from the continental USA or other parts of the world. While food and energy independence is a goal in many jurisdictions, assessment of the potential for local food and energy production is lacking. Research is needed to examine how agricultural lands can be used to meet food and energy demands, particularly on islands where land is limited. The contribution of this paper is the development of a community-orientated method for evaluating and prioritizing lands for food and energy self-sufficiency, based on local preferences and production possibilities. Based on a review of the literature, community meetings, and expert interviews, three scenarios were developed to assess food and energy production possibilities on Kauai. The first scenario considers maximum food production, the second assigns equal importance to food and energy production, and the third scenario maximizes energy production. Our analysis shows that while currently zoned agricultural lands on Kauai are capable of meeting the energy and nutritional needs of the current population under some conditions, it is not possible under the strictest definition of "important agricultural lands". Some aspect or interpretation of the criteria will always have to be relaxed in order to fulfill energy and food-self sufficiency goals. This work broadens policy discussions regarding the preservation of agricultural lands on small islands.

Introduction

Food and energy security are important goals in the U.S. and the rest of the world, especially, within island communities (Sharma, 2006). With increased interest in biofuel production, the tradeoff between food and energy production will continue. Over time, more agricultural land will be used for energy production (Johansson and Azar, 2007). While there is not a consensus regarding a definition of food security, there are many arguments that it should be part of efforts to increase sustainability (Feenstra, 1997) and resilience (McGrarrell, 2005). With an appropriate combination of food and energy crops, farming can minimize greenhouse gas emissions from the agricultural sector while improving local food self-sufficiency (MacRae et al., 2010). Others question the benefits of localizing food and energy (Cunningham, 2010; Peters et al., 2009b). Research regarding the feasibility of reaching goals of food security has become more prevalent as communities increasingly demand locally-sourced food. Peters et al. examined the ability of New York State to localize food production, and found that with the exception of New York City, most smaller cities could theoretically have most of their food needs sourced in-state (Peters et al., 2009a). Thompson et al. (2008) conclude that based on dietary needs, San Francisco could feed itself from what is produced in farms and ranches within 100 miles. Based on land requirement estimates, Erickson et al. (2013) find that Chittenden County, Vermont has the necessary land to produce most of its local food demands. A similar study in Oakland, concluded that available land could provide between 5% and 10% of the city's vegetable needs (McClintock and Cooper, 2009). Kremer and DeLiberty examined urban Philadelphia using physical, administrative, and zoning data and determined the potential for food production (Kremer and DeLiberty, 2011). Another study in Waterloo, Canada analyzed food consumption and calorie intake patterns projecting required acreage of land to meet food requirements for the population by 2026 (Desjardins et al., 2010).

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There is much research on energy self-sufficiency that focuses on biofuel and solar production. Biofuels are categorized as generations 1(G1), 2(G2), and 3(G3) (Murphy et al., 2011). First generation biofuel (G1) is produced from food crops (Murphy et al., 2011; Sims et al., 2010). Second generations biofuel (G2) is produced with lingo-cellusic feedstock and third generation (G3) biofuel is produced with the use of micro algae, and is the most advanced form of biofuel (Murphy et al., 2011). This study focuses mainly on 2nd generation biofuel production. Compared to G1 biofuel, the process of producing G2 biofuel offers a tremendous reduction in environmental costs and conflict between food and energy production (Hill, 2007). Second generation biofuel technologies and energy crops are expected to be more efficient than first generation (López-Bellido et al., 2014). Furthermore, there is growing attention surrounding research and development of ethanol production in Hawaii including a legislative mandate of achieving 20% energy from renewable sources by 2020. G1 technology presents the issue of competition of crop use for biofuel and food. But with G2 technology, competition is minimized because raw materials for G2 biofuel production are not food crops; instead it uses remains and byproducts of food production and any other woody or grassy biomasses. An important caveat is that developing G2 energy sources in liquid biofuels still has both technical and economical challenges.

It has been shown that cellulosic energy crops can be beneficial to food crop farming by controlling pests, protecting biodiversity, reducing soil erosion, reducing crop management, and minimizing transportation energy cost (MacRae et al., 2010). There are several crop types for biomass conversion to ethanol globally. The primary categories are grassy (sugarcanes, banagrass, guinea grass, sweet sorghum, etc.), and woody (eucalyptus, leucaena, etc.) biomass for ethanol production. There is extensive research on suitable biomass crops for ethanol production in Hawaii. Biofuel crops considered in this study are either in commercial production in Hawaii or in the research and development phase. Eucalyptus is in commercial production and banagrass, leucaena and oil palm are in the trial phase in Hawaii (College of Tropical Agriculture and Human Resources, 2009). The research and trials for banagrass and leucaena have been successful for commercial production (Keffer et al., 2009). We also consider oil palm, which has same type of water and soil requirements as banagrass.

Transportation is a key sector for biofuel use. Biofuels, however, account for use less than 2% of total global road transportation fuel and the use is concentrated in Brazil, European Union and the US (Johnson and Silveira, 2014). There are innovations in the automotive technology to accommodate biofuels, with the mix of biofuel with gasoline being the most common. There are E10, E15, and E20 technologies that accommodate a 10%, 15%, and 20% mix of biofuel with gasoline. Hawaii has established a legislative mandate that the state will replace highway fuel use by 10% with alternative fuel by 2010, 15% by 2015 and 20% by 2020 (Keffer et al., 2009; State of Hawaii, 2008a, 2008b). In the case of solar energy, photovoltaic is the most suitable technology of sustainable energy in the world and is rapidly growing (Razykov et al., 2011). It is widely available, inexhaustible and the cleanest of all energy sources (Parida et al., 2011). Hawaii has abundant sunshine for solar electricity and it has higher than average electricity prices (Department of Business Economic Development and Tourism, 2006). In Hawaii, local production of renewable energies may be particularly important because it is the most isolated landmass in the world and more than 87% of its energy is imported to fulfill current energy demand (Keffer et al., 2009).

Given the geographic isolation of the state, there have been attempts to establish food and energy self-sufficiency in Hawaii through legislation, research and agricultural initiatives. Factors including land, labor and transportation have thwarted the growth of a thriving agricultural sector (Arita et al., 2012; Parcon et al., 2010; Suryanata, 2000; Yu and Leung, 2012). Food consumption in the state has exceeded local production making Hawaii less food self-sufficient (Leung and Loke, 2008). Recently a state strategic/-functional plan was prepared, entitled, "Increased Food Security and Food Self-Sufficiency Strategy" (Department of Business Economic Development and Tourism, 2012). Over the last 50 years, Hawaii's agricultural sector has become more diversified (Cai and Leung, 2006), especially since the decline in production of sugar and pineapple. Initiatives are more visible at the county level. Efforts in the County of Hawaii have focused on the production of food for local consumption. In 2007, the Omidyar Family Foundation funded the Hawaii Whole System Project, which aimed to identify the barriers to more local production and consumption (Page et al., 2007). In 2010 the County of Hawaii updated its 1992 Agricultural Development Plan. This report called for a baseline study "to determine the current inventory of resources on Hawaii Island as they relate to increased food production including land, water, labor, energy, materials and supplies" (The Kohala Center, 2010). This lead to the Hawaii County Food Self-Sufficiency Baseline (Melrose and Delparte, 2012), which created a digital archive of current agricultural activity. This study informed the Hawaii Island Crop Probability Map (Kemp, 2012) which uses a Maximum Entropy modeling technique to find locations where similar crops could have existed on the island of Hawaii. Other studies have been conducted to better understand agricultural markets and stakeholders (Suryanata, 2002). Most recently a study was conducted to set benchmark estimates for Hawaii's food consumption and supply sources, allowing agricultural production for local consumption (Loke and Leung, 2013) to be better targeted.

This analysis considers three scenarios of varying degrees of food and energy self-sufficiency on the island of Kauai. Scenario planning is common in planning and policy practice. While most scenario-based planning is futuristic, practice of multiple scenarios is growing, selecting a single best scenario among a variety of alternatives (Lowry and Kim, 2003). Scenarios can also be thought of as objects or sets of objects that create transitions between past, present and future while constructing new social understandings (Curry, 2009; Hayward and Morrow, 2009). Scenario based planning is based on the assumption of possible change, which helps decision makers understand and assess alternative actions and uncertainties (Shearer, 2005), helping them to rehearse decisions before they happen (Hayward and Morrow, 2009). Normally, scenarios emphasis the role of experts, which may not be appropriate to reflect the social context and uncertainties in the course of scenarios (Curry, 2009). Greater participation by communities impacted by decisions made in the scenarios may be more relevant than expert opinion. Scenarios can be constructed simply as reasoned judgment and intuition, or as sophisticated as structured probabilistic algorithms and simulation (Khakee, 1991). Scenarios in this study are semi-structured while incorporating community preferences. Literature on scenario based analyses can be found in both biofuel production (Wise et al., 2014) and food self-sufficiency (Desjardins et al., 2010). Little research, unfortunately, is focused on island states where the energy and food self-sufficiency is most critical because of isolation from the rest of the world. Few studies cover food and energy self-sufficiency simultaneously and provides trade-off scenarios. This paper addresses these knowledge gaps.

This paper informs active policy discussions regarding food and energy independence in Hawaii, and specifically for the island of Kauai. The University of Hawaii received a grant from the County of Kauai to develop and implement a process for evaluating important agricultural lands. There have been several legislative attempts by the state and local governments to move toward