# Geographic Information System Resources to Support Biomass/Bioenergy/Biofuel Decision Making

**Prepared for the**

**U.S. Department of Energy**
**Office of Electricity Delivery and Energy Reliability**

**Under Cooperative Agreement Number DE-FC26-06NT42847**
**Hawai‘i Distributed Energy Resource Technologies for Energy Security**

**Subtask 12.1 Deliverable (item 6)**
**Report on Bioenergy Analyses**

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**September 2012**

*Acknowledgement:* This material is based upon work supported by the United States Department of Energy under Cooperative Agreement Number DE-FC-06NT42847.

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**Abstract**

The Hawaii Natural Energy Institute assessed potential biomass/bioenergy/biofuel resources that can be produced in Hawaii including *Leucaena*, *Eucalyptus*, and banagrass for fiber, sugarcane for both sugar and fiber, and algae for oil or other intermediate products. The objective of this report is to provide computer-based, geographic information system tools on biomass/bioenergy/biofuel resources for use in improving the effectiveness of decision making. 58 GIS layers were produced in total. Data sets include information on soil suitability, slope, sugar and fiber resources, and selected biofuel production resources. These data were provided to the Hawaii Statewide GIS Program for posting on their website.

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## Introduction

Hawaii is the most isolated island archipelago in the world and the most fossil fuel-dependent state in the nation. In 2009, over 90% of Hawaii's electricity was generated from fossil fuels and all are imported. This geographic isolation and import dependence puts Hawaii at risk from interruptions in supply and fluctuations in fuel prices. In recognition of this energy security dilemma, the Hawaii Natural Energy Institute assessed potential biomass/bioenergy/biofuel resources that can be produced in Hawaii including *Leucaena*, *Eucalyptus*, and banagrass for fiber, sugarcane for both sugar and fiber, and algae for oil or other intermediate products.

The objective of this report is to provide valuable computer-based information on biomass/bioenergy/biofuel resources for use in improving the effectiveness of decision making. This information can support government decisions regarding industry development and provide a basis for private parties who are interested in producing biomass/bioenergy/biofuel, locating facilities, and make land use decisions. This report also updates information included in earlier reports [1, 2] and provides geographic information system-based data necessary to assess algae/fiber/sugar production potential on a county by county basis.

## Methods

Assessments [1, 2] to identify suitable lands for producing ethanol and algae in the state of Hawaii were conducted. The criteria for each assessment are provided below.

Criteria for phototrophic algae production in open pond systems:

- Rainfall < 40 inches/ year;
- Solar insolation≥400 cal/cm$^2$/day;
- Slope ≤ 20%;
- Non-residential zoning.
- Distance from production resources.

Criteria for feedstocks for ethanol production

In this report, sugarcane, banagrass, *Eucalyptus*, and *Leucaena* were selected as potential ethanol feedstock (sugar and fiber) crops in Hawaii. The following list depicts the main criteria for in each energy crop. For complete details consult the original reports [1, 2].

| Criteria | Sugarcane/Banagrass | Eucalyptus | Leucaena |
|---|---|---|---|
| **Rainfall** | Identified rainfed and irrigated production areas; assumed irrigation was available | Rainfed; assumed rainfall ≥40 in/yr | Rainfed; assumed 20 ≤ rainfall ≤ 40 [in/yr] |
| **Soils** | Suitable for sugarcane production based on NRCS* Guide to Mapping Units | Suitable for wood production based on NRCS* Guide to Mapping Units | Suitable for wood production based on NRCS* Guide to Mapping Units |
| **Slopes** | ≤ 20% | ≤ 20% | ≤ 20% |
| **Zoning** | Agricultural zoning | | |

*NRCS – Natural Resources Conservation Service

ESRI's ArcGIS 10.0 Geographic Information System (GIS) software was used to layer these criteria together and identify the spatial distribution of potential biomass/bioenergy/biofuel production lands. Rainfall, soil series, solar insolation, and zoning district can be downloaded via the Hawaii State GIS Program website. Slope data were derived from Interferometric Synthetic Aperture Radar (IfSAR) elevation data which are published by the National Oceanic and Atmospheric Administration and marketed by Intermap Technologies [*http://www.intermap.com/en-us/home.aspx*].

**Results**

GIS layers suitable for assessing the potential for biomass/bioenergy/biofuel production in Hawaii were generated. The GIS layers available to be placed on the Hawaii Statewide GIS Program website include:

i. Slope from 2 to 20%

The algae assessment [2] used slope data generated from the IfSAR data set. Slope data used in the original ethanol assessment [1] were based on data available from the NRCS soil series. The ethanol assessment using the higher resolution IfSAR data set was updated and this data set was provided to the Hawaii Statewide GIS Program for posting.

ii. Guide to Mapping Units (GTMU)

The guide to mapping units information was documented in the *Soil Survey of Island of Hawaii, State of Hawaii* [3], and *Soil Survey of Islands of Kauai, Oahu, Maui, Molokai, and Lanai, State of Hawaii* [4]. Layers available from the NRCS [*http://soildatamart.nrcs.usda.gov/Survey.aspx?State=HI*] and Hawaii Statewide GIS Program [*http://hawaii.gov/dbedt/gis/soils.htm*] websites do not include the GTMU information. GTMU information was developed into a comprehensive GIS layer for the State of Hawaii and provided to the Hawaii Statewide GIS Program for posting.

iii. Potential Algae Production Areas

The algae assessment was updated using the most recent rainfall data set [*http://rainfall.geography.hawaii.edu/downloads.html*]

iv. Potential Biomass/Bioenergy/Biofuel Feedstocks
The ethanol assessment [1] based on sugarcane, banagrass, *Leucaena*, and *Eucalyptus* was updated using the most recently available rainfall, GTMU, and slope data to provide estimates of sugar and fiber production potential.

v. Production Resources
A GIS layer for power plants, wastewater treatment plants, landfills, transfer stations, and agriculture waste production sites was created for the algae assessment. These represent potential production resources for algae or for integrated biorefinery applications.

In total, 58 GIS data layers were produced as listed below.

| Category | Data set names | Status |
|---|---|---|
| **Algae** | Algae_slope2_bi<br>Algae_slope5_bi<br>Algae_slope10_bi<br>Algae_slope20_bi<br>Algae_slope2to20_ka<br>Algae_slope2to20_mala<br>Algae_slope2to20_mo<br>Algae_slope2to20_oa | Updated |
| ***Eucalyptus*** | bi_slope2_ eucalyptus<br>bi_slope5_ eucalyptus<br>bi_slope10_ eucalyptus<br>bi_slope20_ eucalyptus<br>ka_slope2to20_ eucalyptus<br>ma_slope2to20_ eucalyptus<br>mo_slope2to20_ eucalyptus<br>oa_slope2to20_ eucalyptus | Updated |
| **GTMU** | GTMU | New |
| ***Leucaena*** | bi_slope2_ Leucaena<br>bi_slope5_ Leucaena<br>bi_slope10_ Leucaena<br>bi_slope20_ Leucaena<br>ka_slope2to20_ Leucaena<br>ma_slope2to20_ Leucaena<br>mo_slope2to20_ Leucaena<br>oa_slope2to20_ Leucaena | Updated |
| **Slope** | bi_slope2<br>bi_slope5<br>bi_slope10<br>bi_slope20<br>kaslope2to20<br>malaslope2to20<br>moslope2to20<br>oaslope2to20 | New |

| Category | Data set names | Status |
|---|---|---|
| **Sugarcane/Banagrass** | bi_slope2_ sugar<br>bi_slope5_ sugar<br>bi_slope10_ sugar<br>bi_slope20_ sugar<br>ka_slope2to20_ sugar<br>la_slope2to20_ sugar<br>ma_slope2to20_ sugar<br>mo_slope2to20_ sugar<br>oa_slope2to20_ sugar | Updated |
| **Agriculture Waste** | AgwastesHawaii<br>AgwastesKauai<br>AgwastesMaui | Submitted once to HI Statewide GIS Program |
| **Landfill** | HawaiiLandfill<br>KauaiLandfill<br>MauiLandfill<br>Oahulandfills | Submitted once to HI Statewide GIS Program |
| **Power Plants** | PowerPlants | New |
| **Transfer Station** | HawaiiTransferStation<br>KauaiTransferStation<br>OahuTransferStation | Submitted once to HI Statewide GIS Program |
| **Waste Water Treatment Plants** | HawaiiWWTP<br>KauaiWWTP<br>MauiWWTP<br>OahuWWTP<br>WWTP_DOH | Submitted once to HI Statewide GIS Program |

**Conclusion**

- The ethanol (sugar and fiber resources) and algae assessment data were updated using the most recently available zoning, slope, and rainfall data.
- The ethanol (sugar and fiber resources) assessment was updated using more comprehensive information available from the NRCS GTMU data.
- GIS layers for slope, GTMU, and selected biofuel production resources were provided to the Hawaii Statewide GIS Program for posting on their website.

**Reference**

[1] University of Hawaii at Manoa, Hawaii Natural Energy Institute. "*Potential for Ethanol Production in Hawaii*," Honolulu: Dept. of Business, Economic Development & Tourism, State of Hawaii, 2006.

[2] University of Hawaii at Manoa, Hawaii Natural Energy Institute. "*Analysis of Land Suitable for Algae Production, State of Hawaii*", Office of the Electricity Delivery & Energy Reliability, Under Award No. DE-FC26-06NT42847, Hawaii Distributed Energy Resource Technologies for Energy Security, Task 12.1 Deliverable, Report on Bioenergy Analyses, 2011.

[3] United States Department of Agriculture, Soil Conservation Services. "*Island of Hawaii, State of Hawaii*", in cooperation with the University of Hawaii Agricultural Experiment Station, 1973 <http://soils.usda.gov/survey/printed_surveys/state.asp?state=Hawaii&abbr=HI>.

[4] United States Department of Agriculture, Soil Conservation Services. "*Island of Kauai,Oahu, Maui, Molokai, and Lanai, State of Hawaii*", in cooperation with the University of Hawaii Agricultural Experiment Station, 1972 <http://soils.usda.gov/survey/printed_surveys/state.asp?state=Hawaii&abbr=HI>