

FAA CENTER OF EXCELLENCE FOR ALTERNATIVE JET FUELS & ENVIRONMENT

Regional Supply Chain Analysis for Alternative Jet Fuel Production in the Tropics

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Opinions, findings, conclusions and recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of ASCENT sponsor organizations.



Overview



- Introduction/motivation
- Objectives
- Selected results
- Summary

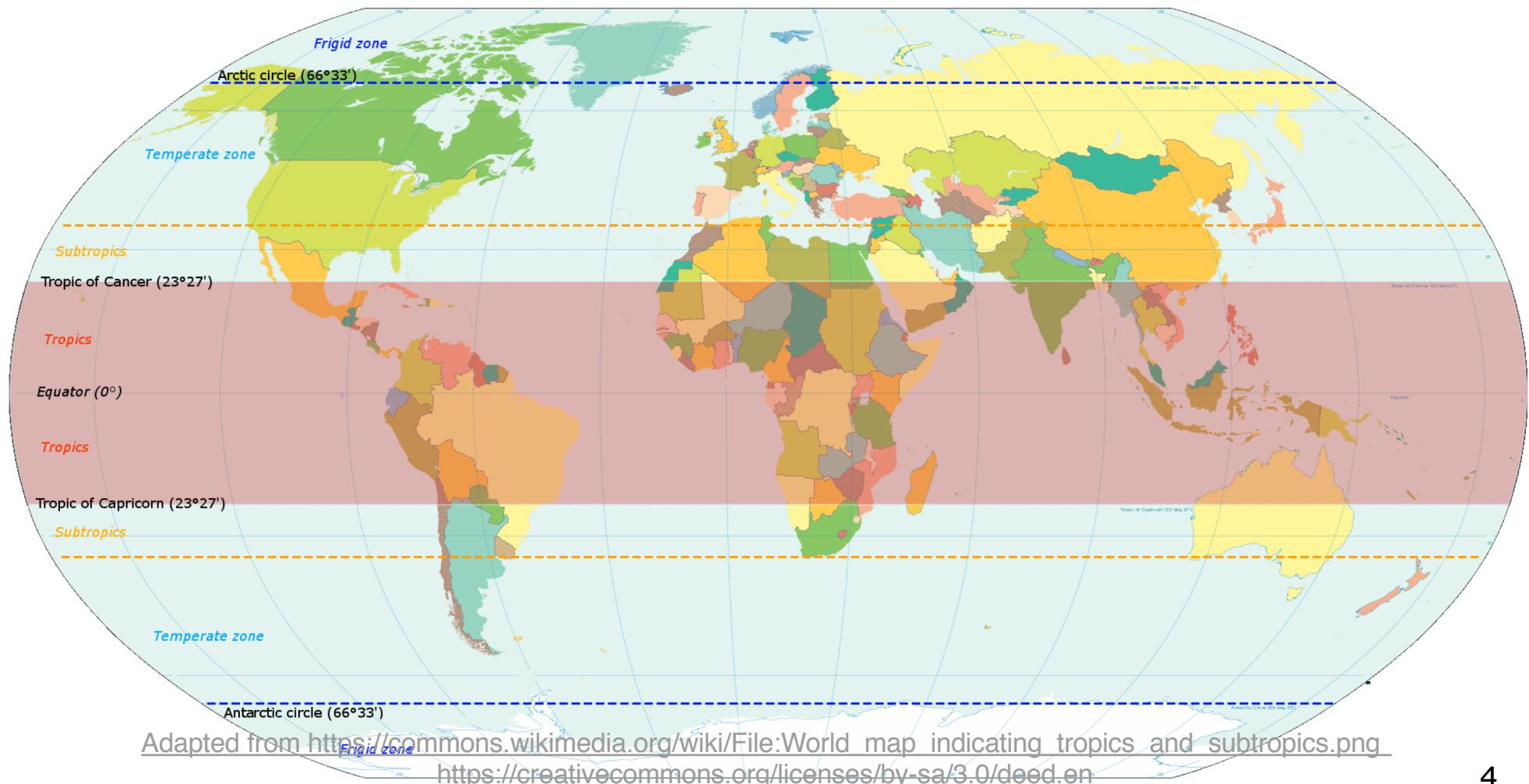
Overview



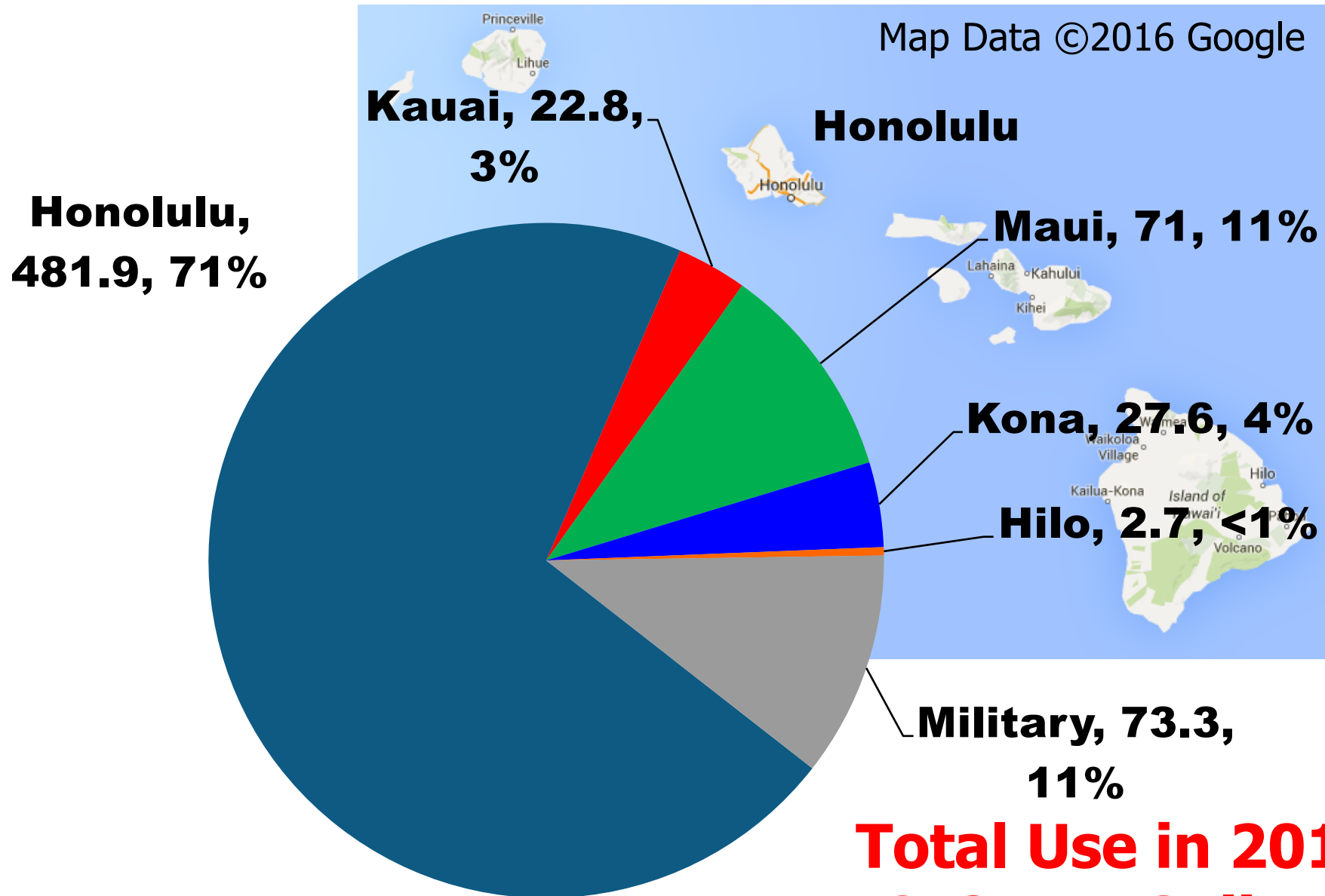
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Alternative Jet Fuel Supply Chain, Tropical Region Analysis -- Motivation

- The tropics account for 36% of the world's land mass
- Tropics are home to unique biomass materials, production practices/systems, and temporal availabilities



Jet Fuel Use in Hawaii, 2015 Commercial Airports and Military (million gallons)



**Total Use in 2015
678.4 M Gallons**

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University of Hawaii Objectives



- Conduct literature review of tropical biomass feedstocks and data relevant to their behavior in conversion systems for AJF production
- Engage stakeholders to identify and prioritize general AJF supply chain barriers (e.g. access to capital, land availability, technology risk, etc.)
- Develop geographic information system (GIS) based technical production estimates of AJF in Hawaii
- Develop fundamental property data on biomass resources
- Develop and evaluate regional supply chain scenarios for AFJ production in Hawaii

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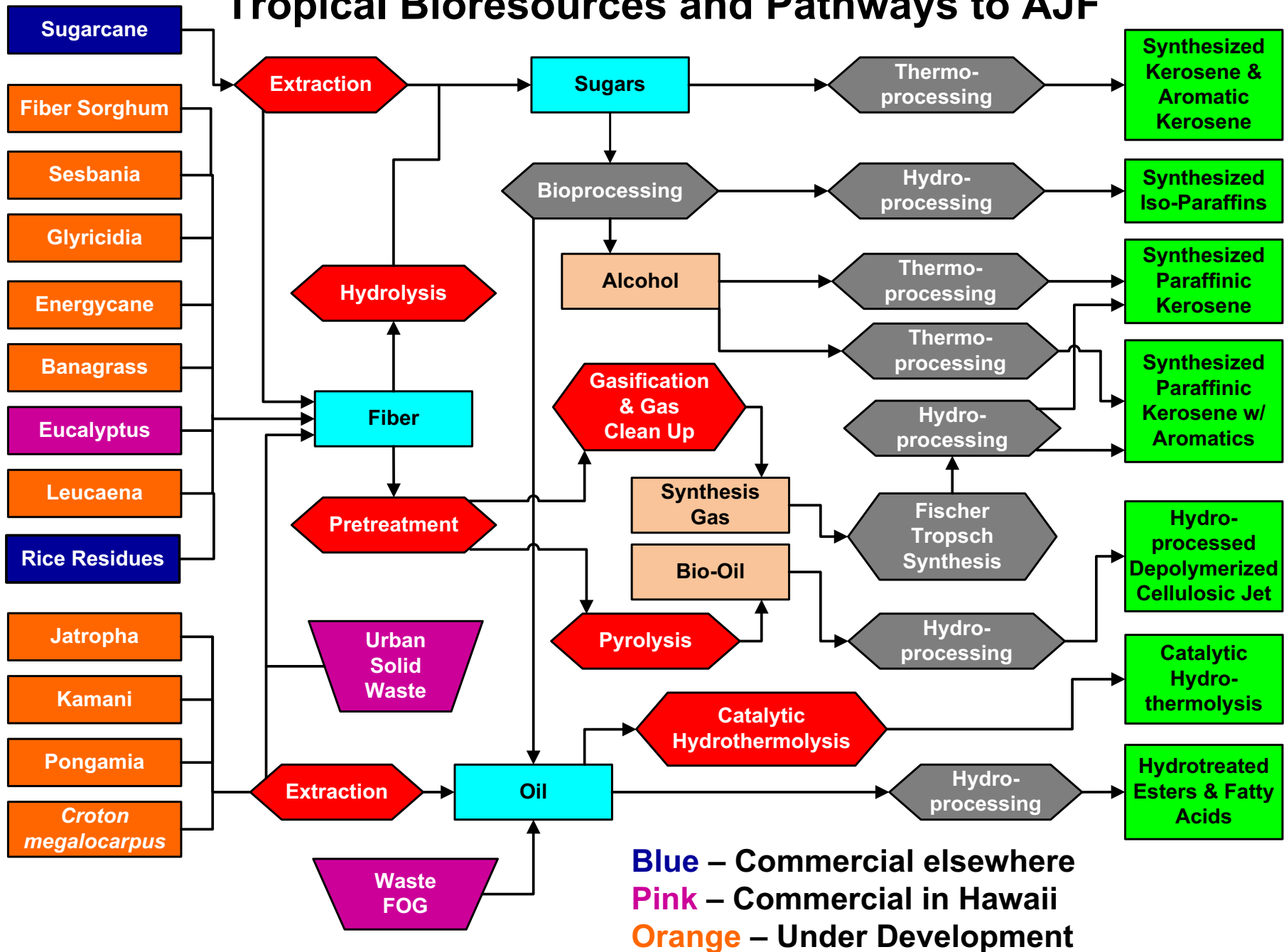
- Conduct literature review of tropical biomass feedstocks and data relevant to their behavior in conversion systems for AJF production (completed)
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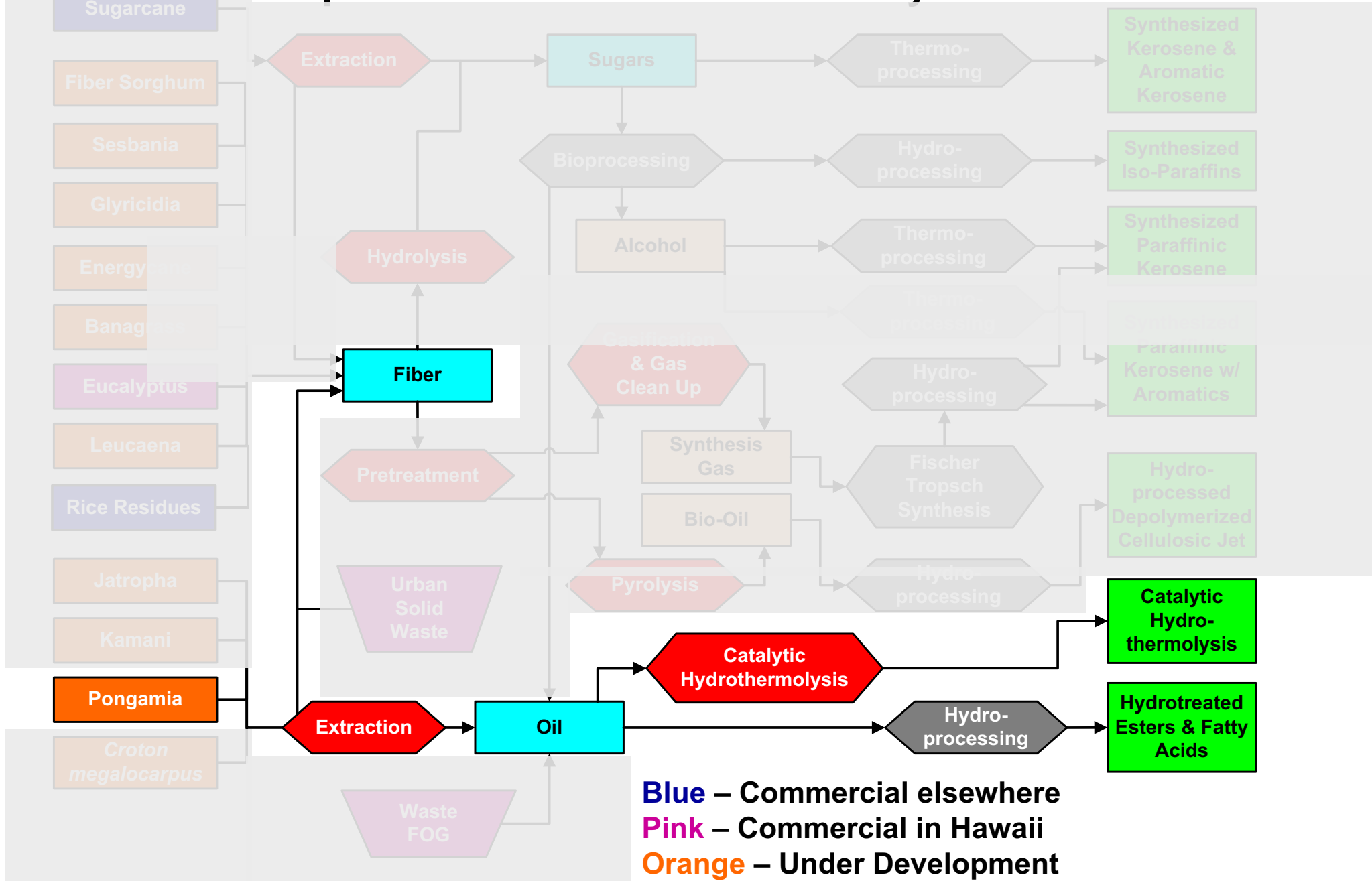
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Tropical Bioresources and Pathways to AJF



Bioresource	Intermediate Products & Conversion Technologies	Alternative Jet Fuel
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Tropical Bioresources and Pathways to AJF



Bioresource

Intermediate Products & Conversion Technologies

Alternative
Jet Fuel

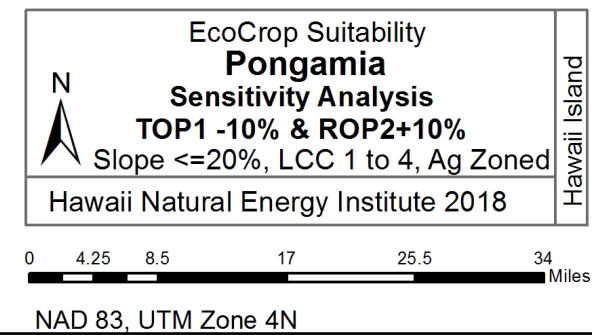
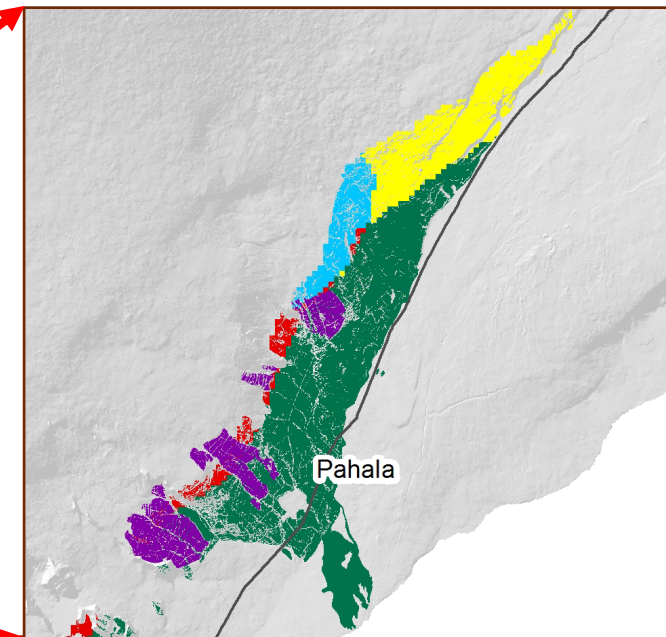
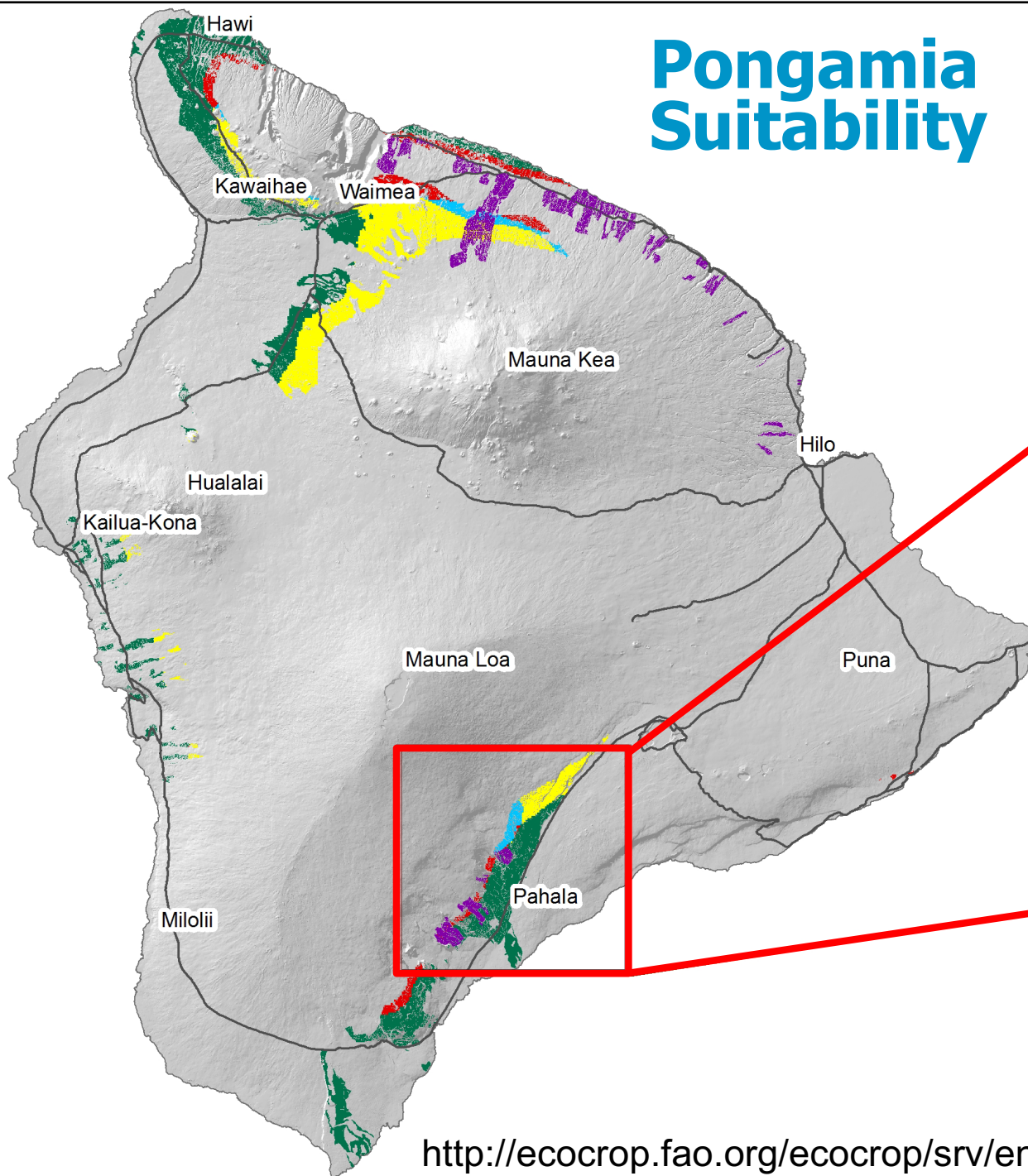
Pongamia (*Millettia pinnata*)

- Background
 - Leguminous oil seed tree with current productivity estimated ~5 Mg/ha/year
 - U.S. production potential in Hawaii, Florida, U.S. Trust Territories
 - *Terviva* – start up company focused on providing pongamia germplasm for agricultural producers and value added processing
 - Acreage planted on Oahu and Maui and in Florida
- Research foci
 - GIS analysis of technical production potential in Hawaii
 - Invasiveness assessment based on plants established in Hawaii
 - Property data of pongamia oil, oil seed cake, seed pod material
 - Longer term goal -- energy input/output analysis production system and coproduct development

Pongamia Suitability






Capability

Capability	Acres
Commercial Forestry	21,061
Pongamia Base Case	77,731
Pongamia -1.6°C	44,857
Pongamia +200mm	11,947
Pongamia-1.6°C& +200mm	5,303

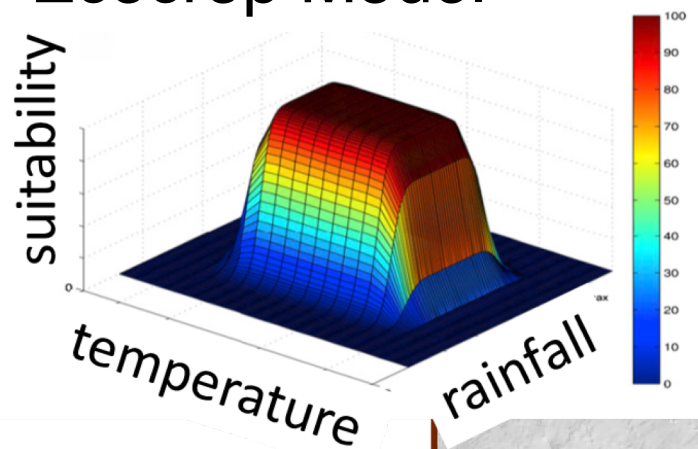


<http://ecocrop.fao.org/ecocrop/srv/en/home>

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Ecocrop Model



Pahala

T_{min}	10° C
T_{op1}	16° C
T_{op2}	40° C
T_{max}	50° C
R_{min}	400 mm
R_{op1}	500 mm
R_{op2}	2000 mm
R_{max}	2500 mm

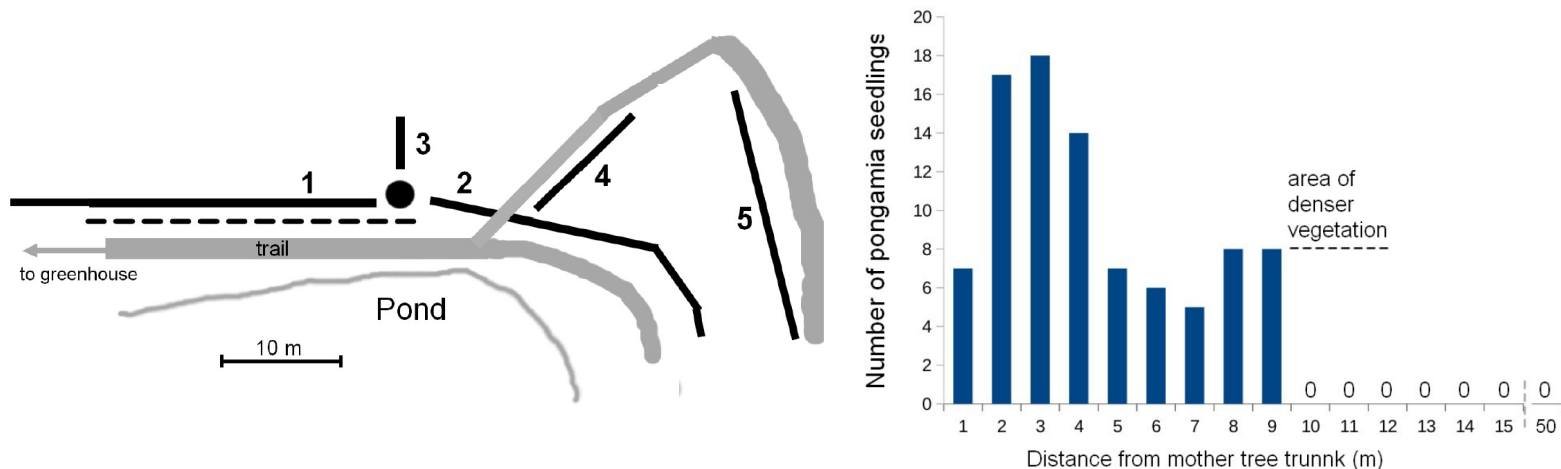
Pongamia on O`ahu



0 6,250 12,500 25,000 Meters

Pongamia Invasiveness Assessment

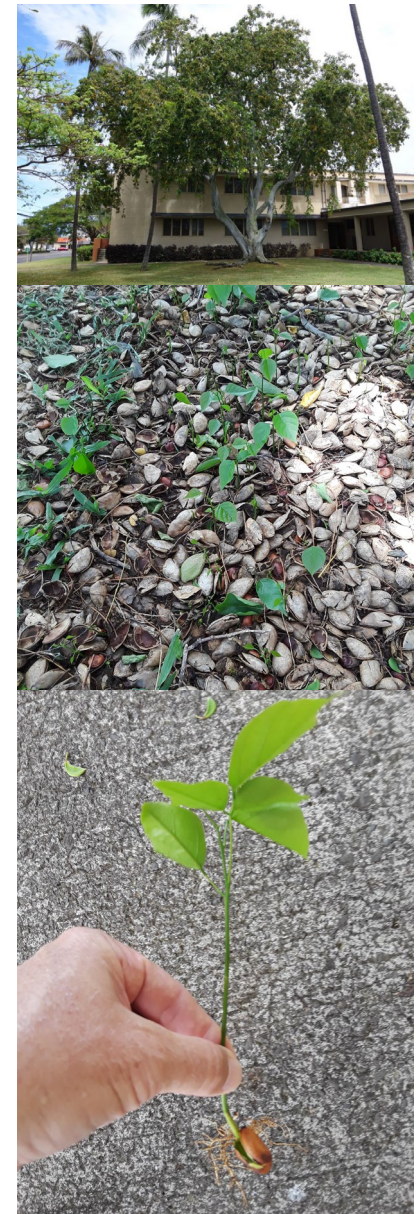
- Hawaii-Pacific Weed Risk Assessment tool predicted pongamia had high risk of becoming invasive weed
- Field assessment of seven sites on Oahu with pongamia established in varied environments was conducted
- Seedlings were found; no evidence of effective seed dispersal
- Invasiveness can be mitigated by monitoring and targeted control and choice of planting locations



Daehler, C.C. 2018. "Observational field assessment of invasiveness of pongamia (*Milletia pinnata*), a candidate biofuel crop in Hawai'i" available at

[https://www.hnei.hawaii.edu/sites/www.hnei.hawaii.edu/files/](https://www.hnei.hawaii.edu/sites/www.hnei.hawaii.edu/files/Observational%20Field%20Assessment%20of%20Invasiveness%20of%20Pongamia.pdf)

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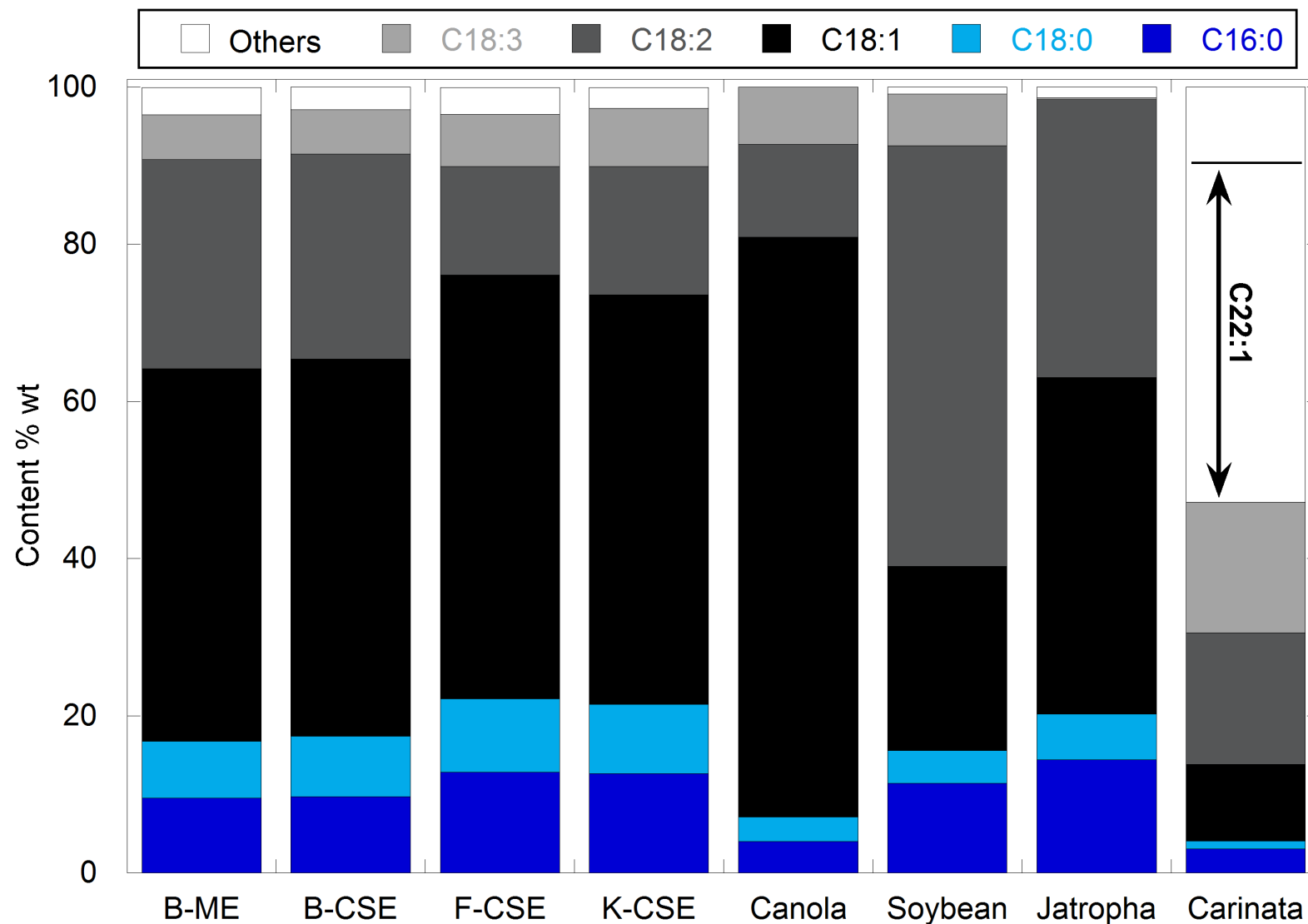


Pongamia Characterization

- **Oil properties**
 - **Viscosity, density, iodine number, free fatty acid content, fatty acid profile, flashpoint, phase transition temperatures**
- **Seed, oil, seed cake, pods**
 - **Ultimate analysis for major elements: C, H, O, N, S**
 - **Proximate analysis § : volatile matter, fixed carbon and ash**
 - **Major ash species: K, Cl, Na, P, Mg, Si, Fe, Ti, Al, and Ca**
 - **Minor ash species: Mn, Fe, Cu, Zn, Rb, and Sr**
 - **Moisture content**
 - **Energy content or heating value**
- **Properties needed for logistics: particle size distribution of materials, bulk densities, etc.**

§ proximate analysis not performed on oil samples

Fatty Acid Profiles of Pongamia Oil from Trees at Three Locations



-----Pongamia-----

B-Bachman F-Foster K-Keehi

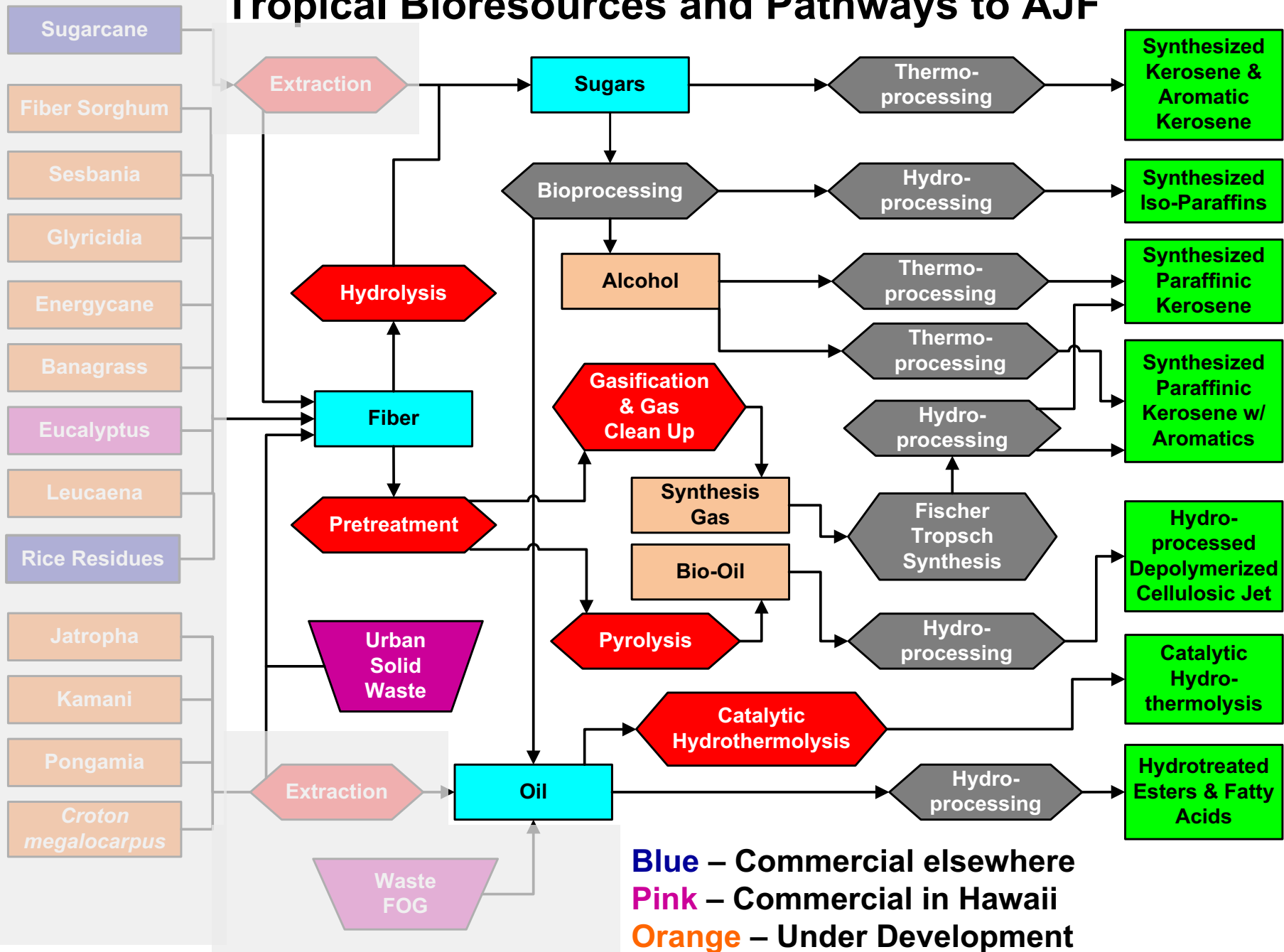
20% oil yield from seed

University of Hawaii Objectives



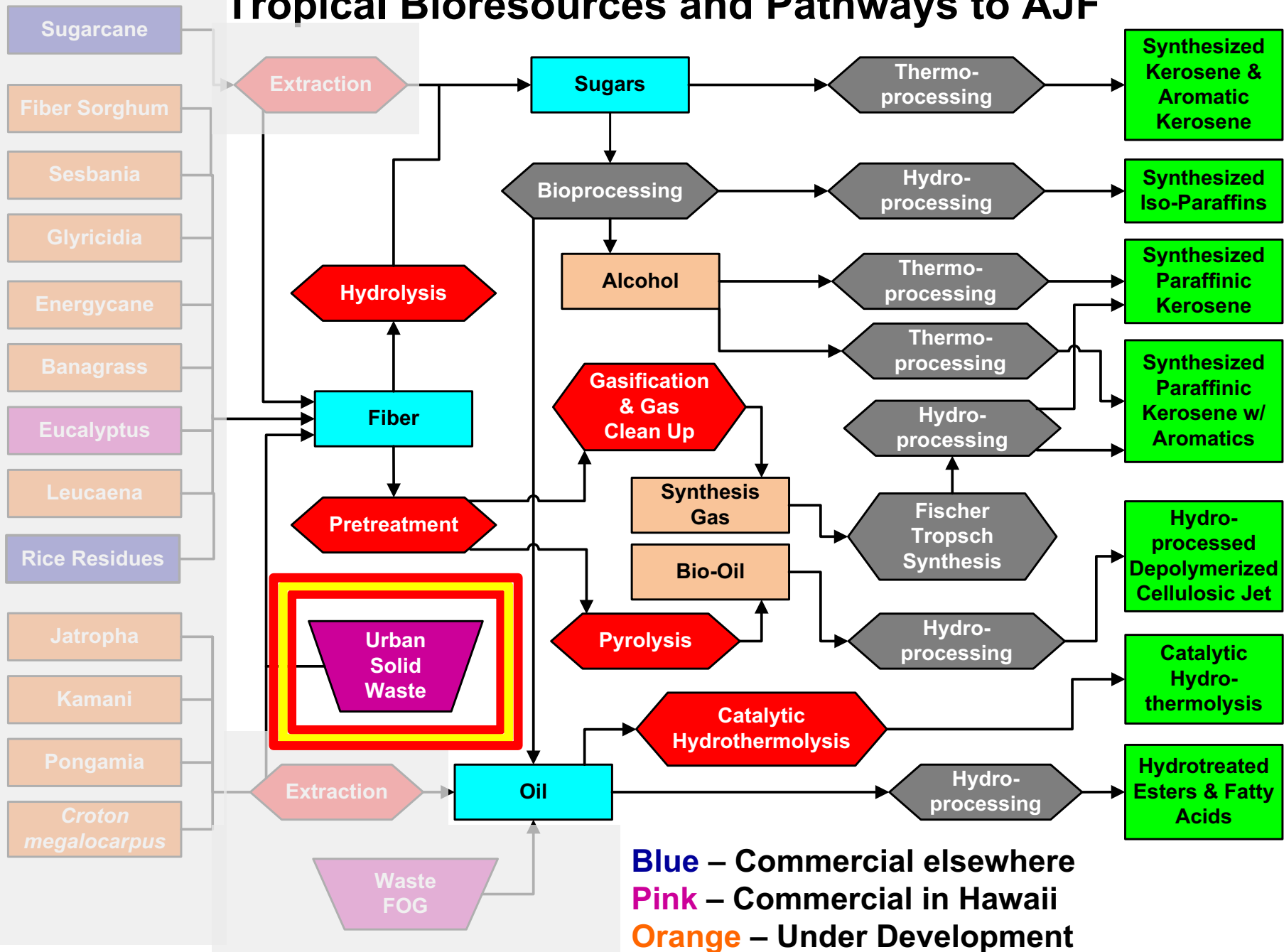
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PVT Land Company Nānākuli, Hawaii <http://www.pvtland.com>



Map data ©2017 Google

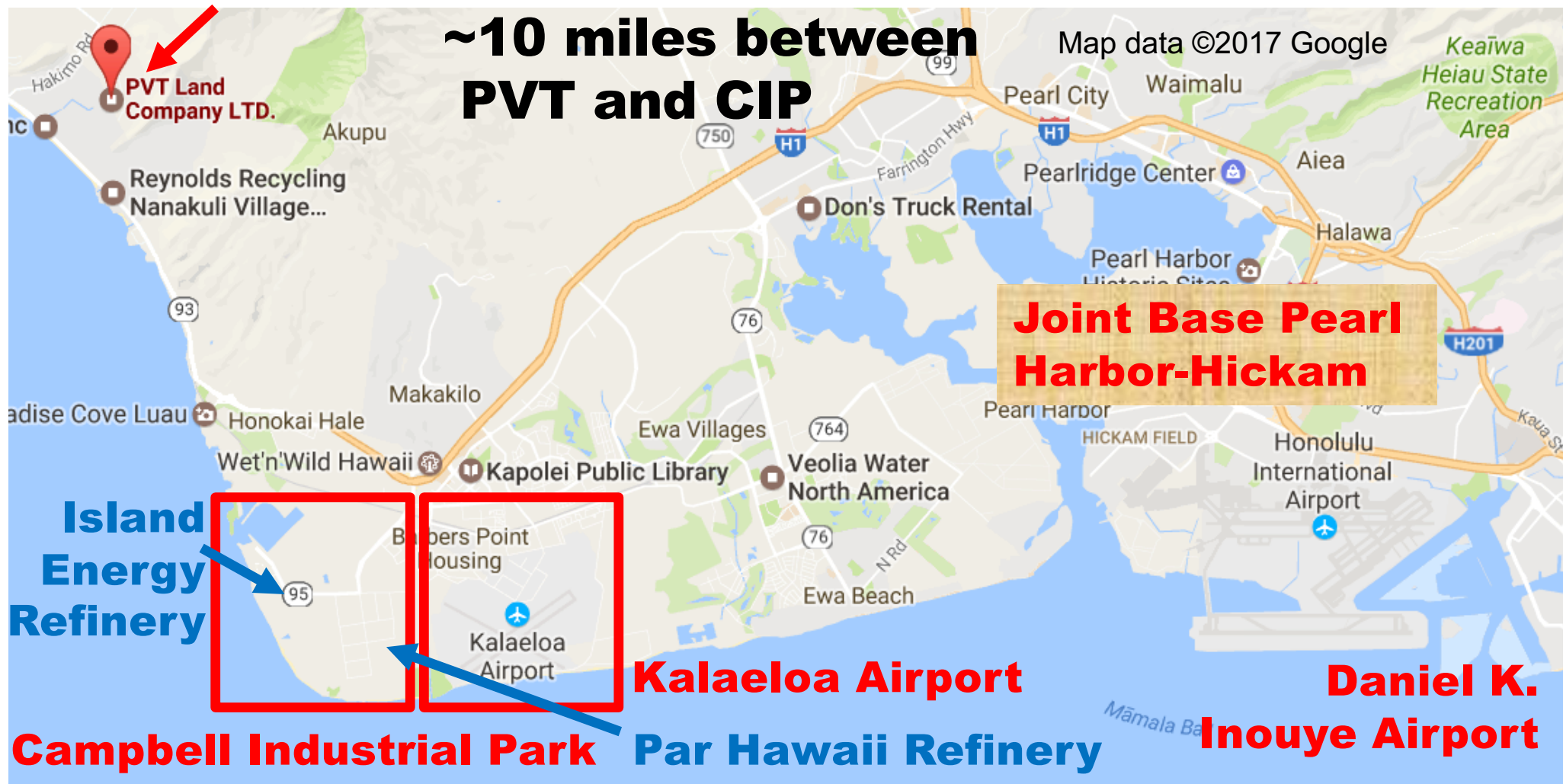
- **PVT is the only construction & demolition landfill on Oahu**
- **Current intake 1,775 tons C&D waste per day**
- **~50% of intake converted to feedstock, up to 900 tpd**
- **Waste-in-place also “mined” for additional “feedstock”**
- **Feedstock: wood, plastic, cloth, paper, and other organics**
- **Tipping fee \$50 per ton, or \$54 per ton for LEED certified**

Possible Locations of Value Chain Participants



PVT Land Company

**~10 miles between
PVT and CIP**



- **Characterization of feedstock properties needed to inform conversion process design**
 - **Ultimate analysis for major elements: C, H, O, N, S**
 - **Proximate analysis: volatile matter, fixed carbon and ash**
 - **Major ash species: K, Cl, Na, P, Mg, Si, Fe, Ti, Al, and Ca**
 - **Minor ash species: Mn, Fe, Cu, Zn, Rb, and Sr**
 - **Moisture content**
 - **Energy content or heating value**
- **Characterization of feedstock properties needed for logistics particle size of materials, bulk densities, etc.**
- **Time series data to assess variability in supply**

Characterization Challenges



C&D Waste As Received



Sorting
and
Processing



Processed Feedstock



Analytical
Sample

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Summary



- Tropics provide unique biorenewable resources for AJF feedstocks
- >100,000 acres of land in Hawaii could support pongamia production
- Pongamia presents manageable invasiveness risk
- Fatty acid profiles were similar in pongamia oil extracted using mechanical and solvent methods
- Fatty acid profiles vary between trees at different locations, suggesting need for controlled GxE study
- C&D waste stream characterization and supply chain analysis ongoing

University of Hawaii Contributors

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Questions?