Big Island Impacts:

Effects of Current and Potential Future Land Use

on Water Quality, Carbon Emissions, and Wildlife Habitat at Kohala Institute

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Background

The Big Island of Hawaii supports some of the most unique ecosystems in the world, but these ecosystems have been highly altered by human activities. Kohala Institute (KI) is tasked with stewarding 2,418 acres on Hawaii Island while providing economic opportunities for the local community.

However, land managers like KI often struggle with the balance between environmentally responsible land use and economic productivity. This project provided KI with the knowledge needed to minimize their environmental impacts when determining future land uses as their organization continues to grow.

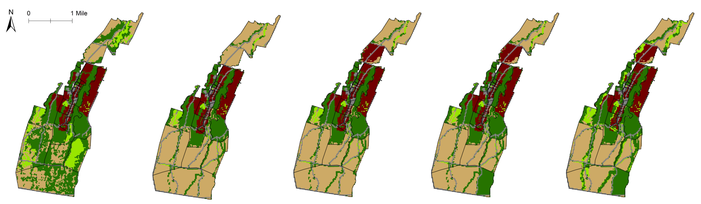
Project Objectives

The purpose of the Big Island Impacts project was to give KI the knowledge necessary to expand their land use activities in an environmentally sustainable way. The project had three primary objectives:

1. Describe KI's current land uses and land characteristics, assess property accessibility, and identify alternative future land uses.
2. Analyze the effects on KI's water quality, carbon footprint, and wildlife habitat under five land use scenarios over a 20-year planning horizon.
3. Recommend land uses and management practices to minimize KI's environmental impacts.

Conceptual Framework

All analyses were performed on five different land use scenarios. These land use scenarios represent different levels of development that KI could implement on their property as they continue to expand their operations.



Baseline Scenario: No changes to current land use activities.

Pasture Scenario: Expand pasture land and improve road network.

Agriculture Scenario: Maintain changes from Pasture Scenario *and* expand agricultural land.

Forest Scenario: Maintain changes from Agriculture Scenario *and* preserve or restore forest land.

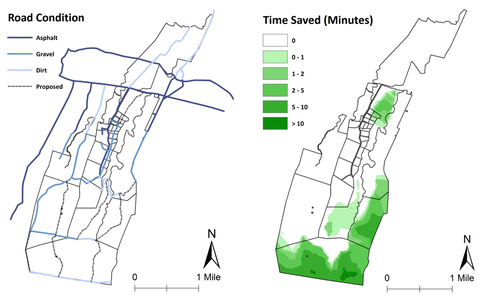
Riparian Buffer Scenario: Maintain changes from Forest Scenario *and* preserve or restore natural vegetation within riparian buffers.

Methods and Results

Property Access

Under present conditions, certain parts of KI's property are so inaccessible that implementing any of the land use conversions proposed in the alternative scenarios would be impossible. A travel cost analysis was performed in ArcGIS to investigate accessibility of the property, and found that the southeastern (mauka) edge was the least accessible.

Access to this region could be enhanced by >10 minutes of travel time or over 50% with the addition of new and improved roads.

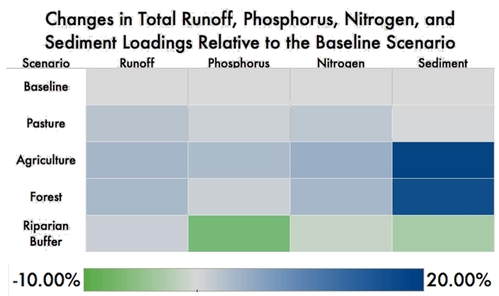


Accessibility. Current access to the property (left) could be substantially improved with a revitalized road network (right).

Water Quality

A water quality analysis using the Nonpoint Source Pollution and Erosion Comparison Tool (NSPECT) calculated total annual runoff, phosphorus, nitrogen, and sediment loadings, and found that row cropping and orchards had the highest loadings per acre.

These can be minimized with the addition of riparian buffers in areas that are prone to water quality degradation, which will help mitigate existing water quality issues in the Wainaia Gulch on KI's property.

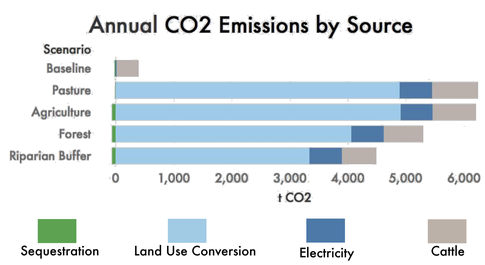


Water Quality. Total runoff, phosphorus, nitrogen, and sediment loadings varied relative to the Baseline Scenario.

Carbon Emissions

Four sources of carbon emissions and one carbon sink were identified at KI: land use conversion, purchased electricity, cattle, and erosion; and sequestration from the growth of woody biomass.

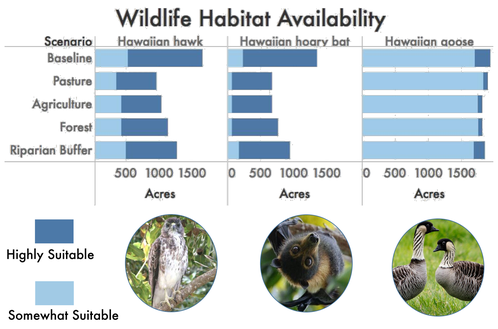
In the baseline scenario, cattle are the largest source of greenhouse gas emissions, emitting over 370 t CO_2 per year. Conversion of forest to pasture becomes the largest source of emissions in all four alternative scenarios, emitting an average of over 4,000 t CO_2/year, or the equivalent to burning over 4 million pounds of coal.



Carbon Emissions. Land use conversion in the four alternative scenarios was the greatest emitter of CO_2 overall, and cattle remained a large contributor to emissions in all five scenarios.

Wildlife Habitat

Three species were selected for review based on their endemism to the region, current level of endangerment, and likelihood to be present at KI: the Hawaiian hawk (*Buteo solitarius*), Hawaiian hoary bat (*Lasiurus semotus*), and Hawaiian goose (*Branta sandvicensis*). Habitat for these species at KI was classified as highly suitable, somewhat suitable, or not suitable, and calculated by acre.



Wildlife Habitat. Habitat for all three species of concern decreased under all alternative scenarios due to the conversion of natural to anthropogenic land, but the impacts were smallest under the Riparian Buffer scenario.

Conclusions

Lessons Learned

This study provided a first look into how KI's water quality, carbon footprint, and wildlife habitat could change under different land use scenarios. Three major takeaways were identified:

1. Agriculture caused the most negative water quality impacts;
2. Land use conversion contributed the most to carbon emissions; and
3. Land use conversion from natural to anthropogenic land cover types decreased habitat availability for wildlife species of concern.

Mitigation Strategies

After the environmental impacts had been studied under all scenarios, several strategies to reduce environmental impacts were recommended.

Water Quality

- Cover crops
- Mulching
- Minimizing the use of fertilizers

Carbon Emissions

- Biochar
- Reforestation

Wildlife Habitat

- Surveying for nests prior to land conversion
- Partnering with nearby conservation groups

All Environmental Impacts

- Riparian buffers (naturally vegetated 50m zones on each side of the gulches in which no land use conversion may occur)

Recommendations

This project represents the first water quality, carbon footprint, and wildlife habitat assessment ever conducted for KI. Further data collection is essential before another more comprehensive analysis can be performed. We recommend implementing water quality monitoring, field data collection for carbon content, and wildlife surveys in the future. An economic analysis of the costs and benefits of potential management actions should also be performed.

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For more information about the Big Island Impacts group project, visit us on the web at http://www.BigIslandImpacts.Weebly.com.
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