Soil Quality and Land Use Changes on a Humid Tropical Island – Palau

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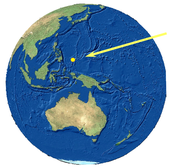


Republic of Palau
7° 35' N latitude
134° E longitude
3,700 mm rainfall
27° C air temperature

Introduction

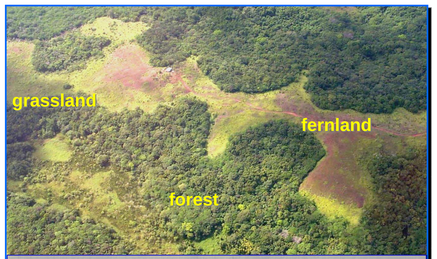
- Study examines soil quality and land cover changes on Babeldaob Island
- Mostly highly weathered soils (Oxisols) with very low fertility and high levels of soluble aluminum (Al toxicity)
- Soils: highly sensitive to disturbance and low resilience for recovery
- Increasing pressure to clear forest for housing and agriculture
- Clean-till agriculture is not sustainable, agroforestry is sustainable

Objectives

- Examine soil quality changes linked with land use change
- Examine conservation strategies to maintain soil quality

Methods

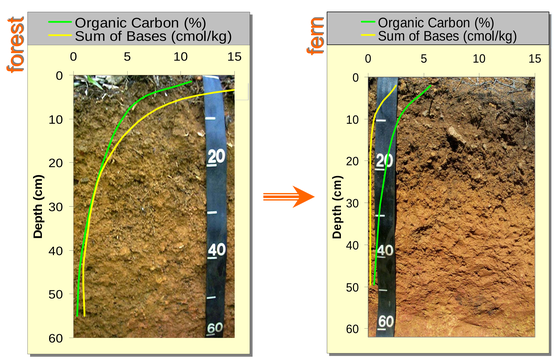
- Soil data from forest and fernland are compared
- Standard USDA soil analyses conducted to determine values for soil quality parameters
- Empirical observations



typical volcanic upland landscape

Key Soil Quality Parameters

- Land clearing via fire converts forest to grassland and fernland ⟹ affects soil properties
- Soil property changes mostly affect topsoil; all subsoils have similar properties
- Organic carbon (not soil minerals) provides nearly all nutrient exchange capacity
- Plant nutrients (sum of bases) are very low
- Soil fertility linked to topsoil organic matter
- Converting forest to fernland reduces carbon content and the capacity to hold plant nutrients

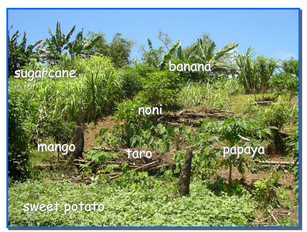


Typical Land Use

increasing land degradation

Forest

- About 80% of Babeldaob forested
- Intact active nutrient biocycling
- Biocycling of organic matter essential for forest health
- Relatively fertile topsoil but infertile subsoil
- Highest quality soil health



Agroforestry

- Maintains soil organic matter through mulching, reduced tillage
- Harvest different crops in different areas at different times to ensure groundcover protection from rainfall impact and water erosion
- Proven sustainability

Clean-till Agriculture

- High intensity rainfall erodes bare topsoil, especially on slopes
- Lowered carbon: oxidation, erosion
- High input of synthetic fertilizers, low input of organic matter
- Sediment and chemical pollution
- Low return on investment
- Not sustainable

Homesite Development

- Highly infertile subsoils exposed
- Inability to revegetate and stabilize sites due to very low soil fertility
- High intensity rainfall erodes bare soil, especially on slopes

Recommended Conservation Practices

agroforestry multi-story cropping

hillside ditches and vegetative barriers

groundcover prevents erosion

trees without groundcover

mulching prevents erosion and adds organic matter to the soil

Acacia with and without mulch, lime and fertilizer

Upland Volcanic Soils and Land Use - Conclusions

- ✓ Volcanic upland soils are highly sensitive to disturbance and have low resilience for recovery
- ✓ Managing for high soil organic matter levels is key for maintaining soil quality and productivity in the humid tropics on low fertility soils
- ✓ Clearing forest and repeated burning causes topsoil erosion and loss of soil organic matter, which holds nearly all the soil fertility
- ✓ Agroforestry uses sustainable organic matter management
- ✓ Organic mulch improves soil fertility, prevents erosion
- ✓ Clean-till agriculture reduces soil organic matter, accelerates erosion and is not sustainable

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