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Abstract: Ecosystem Services Benefits in Terrestrial Ecosystems for Iwi : Biophysical Accounting of Ecosystem Services

Ecosystem services offer a powerful framework for defining the goals, objectives, and justification for ecosystem management and conservation endeavors. A collaborative research programme has been undertaken in partnership with the Ngati Raukawa iwi in the central North Island of New Zealand to understand ecosystem services in biophysical, socioeconomic, and cultural contexts. The project consists of two objectives: (1) assessing natural resources by quantifying and valuing the ecosystem services located within the iwi's boundary; and (2) working in conjunction with the iwi so that both western ecological and traditional Maori knowledge can be used to improve natural resource management and to identify ecological restoration options.

The current study reports the biophysical accounting of the ecosystem services provided by the natural and managed landscapes within the iwi's boundary, which involves constructing an ecosystem services inventory and analyzing the resulting biophysical ecosystem service "portfolio" to identify the services various land covers contribute. The suite of biophysical ecosystem services (e.g. C sequestration, filtration, flood protection, and food production) present in each ecosystem type (held in a GIS database) are analysed to provide information about services in the various land-cover types themselves; spatial relationships among the cover types; and temporal changes in ecosystem services. These results will be merged with the work of other researchers, who will identify economic and cultural values of the services. The novel aspects of this project, with its biophysical focus and use of spatial analyses, could lead to strengthening ecosystem services research and its implementation in natural resource management.

Table 1. Biophysical parameters that comprise ecosystem services, as organized by the Millennium Ecosystem Assessment framework.

<b>Functional Category</b>	<b>Ecosystem Service</b>	<b>Biophysical Parameter</b>
<b>Supporting services</b>	soil formation & fertility	organic material (accumulation)/decomposition
		weathering of rock
		soil organisms (e.g. nitrogen fixers)
		soil C
		soil N
		cation exchange capacity
		water infiltration (closely correlated with SOM)
		water holding capacity
	nutrient cycling (storage, cycling, and/or capture & processing of nutrients)	vegetation cover (removal leads to increased runoff; decreased soil recharge)
		Nitrogen fixation
		other N cycles
		phosphorus
		Carbon storage- soils and vegetation (tonnes C/ha)
		other Carbon cycles
	primary production	other elemental cycles...
		primary production
	water cycling	O <sub>2</sub> as provided by photosynthesis
		flow volumes
	habitat provision/refugia	nurseries
		habitat for migratory species
measure of connectivity/fragmentation		
<b>Provisioning services</b>	food	crops
		livestock production
		forage land cover (intermediate for livestock)
		capture fisheries abundance/presence/production
		aquaculture
		wild foods
		waterfowl
		other food products
	area of habitat for food species (e.g. fisheries)	
	fiber	timber
		Flax
		wood fuel
		other fuels/energy sources
		raw materials for industry
	genetic resources	particular populations identified
		seed abundance/dispersal
		biodiversity layer
	biochemicals, medicines	vegetation cover of source materials
		biodiversity layer
	freshwater	water volume- rivers, lakes

<b>Regulating services</b>	air quality regulation	CO2/O2 balance
		contribution to O3 for UV protection
		contribution to O3 as smog
		contribution to SOx levels
	climate regulation- global	GHG emission
		GHG sequestration
		DMS production affecting cloud formation
		CO2, N, and S cycles (*see GHG above)
		biomass (and land cover change, e.g. deforestation/heat retention)
	climate regulation- local & regional	land cover (as affects temperature & precipitation)
	water regulation	water volume for agriculture, industry, transport
		irrigation
		water supply by watersheds, reservoirs, aquifers
		lake storage
		land cover (as affects water storage potential and timing of flows)
		land cover change (wetlands conversion or forest to crops)
	erosion regulation	vegetation structure for soil retention & preventing landslides
		rooting/belowground biomass
		storage of silt in lakes and wetlands
		soil "abundance" (volume, as potential to be lost)
	water purification and waste treatment	water volume
		decomposition of wastes/ filtering
		impurities
	disease regulation	vector populations (e.g. mosquitoes)
		pathogen population abundance (e.g. cholera)
		habitat of vectors
		habitat of predators of vectors
pest regulation/biological control	predator populations (of pest species)- for crops	
	herbivory measurements	
	habitat for keystone species	
	ecosystem change as indicator of prevalence of pests & diseases	
pollination	pollinator populations (abundance, distribution)-managed & wild bees (esp. honey bees); other insects (beetles, butterflies); birds	
	pollinator habitat	
natural hazard/disturbance regulation	vegetation structure (affecting storm, flood, drought protection & control)	
	coastal ecosystem presence	
	streamflow	
<b>Cultural services</b>	educational	
	aesthetic values	parks, scenic drives, residential locations
	recreation & ecotourism	visitor and business statistics
		water volume & flow (as basis of water sports)
	Inspirational, sense of place	art, folklore, national symbols, architecture, advertising
	cultural heritage and spiritual & religious values	ornamental resources, e.g. animal skins, shells, flowers
significant species		
	historical/cultural landscapes	