

Gross Ecosystem Product (GEP) for the Cook Islands

A Case Study for an Island Economy

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1 Introduction

The environment provides considerable value to human economies. But this value is often undervalued due to the non-market medium that ecosystem services enter into economic benefits. Natural capital accounting has begun to attempt to quantify the quantity of these services, and to a degree translate them into monetary terms. Gross ecosystem product (GEP) is emerging as a useful corralary to gross domestic product (GDP) for the value of ecosystem services. This value of the flow of ecosystem services into economy from environmental factors is summarized by a simple accounting identity.

$$GEP = \lambda \times P \times Q$$

This equation states that the gross production value of ecosystem services is equivalent to the unit price of the service (P), the quantity supplied (used) of the service (Q), and a weight for the percentage contribution of the ecosystem service derived from nature's contribution (λ). The quantity of services provided are estimated using biophysical models. Then prices are determined using either the market value of those services or non-market evaluation techniques to determine a willingness-to-pay for the services. And finally, the contribution of nature for the service partials out human contributions such as labor or capital inputs that increase the value of the ecosystem service.

GEP creates a money metric for the current value of ecosystem services at any given time. This identity can be applied to any type of ecosystem service, allowing for both a comparison between the value of services in the same units as well as allow for the aggregation of ecosystem services across several different environmental contributors to the economy.

We propose to estimate GEP for the Cook Islands as a case study in natural capital accounting for island economies. While GEP has been estimated for parts of China [Ouyang et al., 2020, Zheng et al. [2023], Lin et al. [2024]] and there is a current endeavour to globally estimate

national GEP [?], no one has yet estimated a panel of national GEP recognized at the federal level. We would like to partner with the Cook Islands in producing this world first, and hopefully incorporate it into the ongoing statistics by the federal government alongside the GDP estimates reported by the Cook Islands Statistics Office. Because the Cook Islands has a large oceanic territory, this allows leads to an estimation of important marine-based natural capital accounting.

While annual GDP for the Cook Islands trends around \$500 million USD, the large potential for ecosystem services generated by these Pacific islands may equal or eclipse this valuation. Given the environmental focus of the Cook Islands, this would be provide a valuable metric for highlighting the wealth of this nation beyond the traditional scope of economic production.

Below, we discuss a potential avenue for estimating ecosystem services valuable for the Cook Islands.

2 GEP for the Cook Islands

We aim to focus on the following sectors: Our scope is not limited to the following ecosystem services and we are open to expanding the list to the ecosystem services or environmental contributions that may generate value for the Islanders. For each service, we define the human benefit derived from the ecosystem and determine the methodology for determine the quantity, price, and nature's contribution values to estimate GEP for that service. Finally, we identify the data we would require to make these estimations.

2.1 Agriculture

- Both commercial and subsistence

2.2 Crop Pollination

- For main crops produced: Papaya and Taro; also Bananas, coconuts, mango, guava

2.3 Fisheries

- fish
- pearls and trochus
- sand and coral aggregate

2.4 Forest Products

- timber products
- non-timber products

2.5 Nature-based Tourism and Recreation

- Ecotourism
- Beach tourism
- Recreational fishing and water activities

2.6 Mining

- Straight from GDP values

2.7 Water Use

- Water demand/use
- Waste water disposal
- Water quality (COD, NH-N, TP)

2.8 Coastal Erosion Protection

2.9 Flooding Protection

2.10 Carbon Storage and Sequestration

- Forest cover for CO₂ emissions

2.11 Physical and Mental Health

- try to build off methods from Christine's group

3 Outputs

The final outputs of this project are two fold. The first is an accounting table of GEP values by sector and year. This accounting table is aimed at incorporation into the existing reports of the Statistics Office. The second is a technical white paper. This documents the methodology and data requirements necessary to replicate our work and continue to document GEP nationally beyond the scope of this project. Given the estimates generated, we may also be able to provide some descriptive statistics on the evolution of GEP over a period of time for the Cook Islands. This may identify trends to inform policy makers in sectors of growth and decline for GEP. Further, since GEP is measured in monetary terms it can be directly compared to the corresponding GDP generated by the Cook Islands at any given time.

4 References

- Z Lin, T Wu, E Rao, Y Xiao, and Z Ouyang. Using gross ecosystem product to harmonize biodiversity conservation and economic development in southwestern china. *People and Nature*, 6(5):1838–1848, 2024. URL <https://besjournals.onlinelibrary.wiley.com/doi/full/10.1002/pan3.10686>.
- Z Ouyang, C Song, H Zheng, S Polasky, Y Xiao, I J Bateman, J Liu, M Ruckelshaus, F Shi, Y Xiao, W Xu, Z Zou, and G C Daily. Using gross ecosystem product (gep) to value nature in decision making. *Proceedings of the National Academy of the Sciences*, 117(25): 14593–14601, 2020. URL <https://www.pnas.org/doi/full/10.1073/pnas.1911439117>.
- H Zheng, T Wu and Z Ouyang, S Polasky, M Ruckelshaus, L Wang, Y Xiao, X Gao, and G C Daily. Gross ecosystem product (gep): Quantifying nature for environmental and economic policy innovation. *Ambio*, 52:1952–1967, 2023. URL <https://link.springer.com/article/10.1007/s13280-023-01948-8>.