Pacific Regional Environmental Accounts Incorporating Ocean Accounts

An SPC Digital Earth Pacific Data Source and Foundation Augmented with FAME and GEM Data

FAME Economics

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1 Executive Summary

- This document is not a detailed blueprint. It is a signpost signalling a direction of travel.
- Its purpose is to support a conversation for developing a suite of statistics that support an increasingly complex Pacific climate change and economic landscape.
- It recommends developing a suite of Environmental Asset Accounts, including Ocean Accounts, in accordance with the System of Environmental-Economic Accounts - Central Framework 2012 (CEEA-CF) using SPC data sources.
- While CEEA-CF suggests monetarily valuing the environment, this paper suggests counting them initially in physical stocks and flows over time, focusing on getting the coverage at the Pacific level.
- The developed capability needs to be able to support the measurement and reporting of biodiversity and its change *in the future*.

Some unknown questions are:

- Could **Digital Earth Pacific** remote-sensing data be used to provide the geospatial framework for measuring land-based environmental assets, and land use measures which. Could it support both internal SPC (**LRD** and **CCES**) and member policy work?
- Might **FAME** Oceanic and Coastal data support the measurement of the biomass and catch components for a Pacific-wide set of Ocean Accounts? And if so, what type of caveats are around the data?
- Could **GEM** data be used to identify and geospatially allocate marine mineral deposits, and their exploitability?
- Would **SDD** be willing to provide oversight of the metrics and ensure their compliance to the international frameworks which give the measures legitimacy?
- What the timeframe frequency and geographical disaggregations can we acheive with the data, and would this level of time and geographical disaggregation generate value for policy analysis purposes?
- What is the minimum number of asset accounts that can be consistently derived for the pacific region, and which asset accounts are currently *infeasible*? For example, can we make Soil or Timber Asset Accounts?
- Other issues include:
  - Internally, within SPC, is this heading along the right direction? Are there internal interests or uses that have been overlooked?
  - Member country social license: Do we have permission to do this? How might we gauge our degree of *social license* for this work?
  - Data Access restrictions: What are the minimum time frequencies and geographical disaggregations?
  - Where might the funding for this work come from and *how* might be developed and delivered?

2 Background and context

A "confluence of factors" has come together for this paper.

Firstly, despite climate change being an existential threat for Pacific nations[1], the standard economic metrics developed according to international frameworks have not served Pacific Island Countries and Territories (PICTs) well. A better measurement framework is needed, and this paper suggests that framework be based on the System of Environmental-Economic Accounts - Central Framework 2012 (SEEA-CF).

Secondly, in an age where earth-observing satellite systems encompass the planet, the cost of employing remote-sensing satellite technologies for statistically measuring the environment is now relatively low. Efficiencies can be gained through employing The Pacific Community's Digital Earth Pacific (DEP) geospatial system as a data measurment tool to measure the SEEA-CF dimensions of member country all at once.

Thirdly, developing a centrally estimated suite of SEEA-CF accounts using remote-sensing lays a preparatory foundation for measuring member country marine-based biodiversity. Environmental Accounts provide an evidence-based framework for the development of markets in the protection of biodiversity, creating a funding source that becomes more valuable *with* climate change.

Climate change needs a better suite of metrics

For most of the 20th century and up until relatively recently into the 21st century, the environment's contribution to economic production had received little statistical measurement attention.

What was becoming *Issue de Jure* for countries - climate change - came onto the national accounting statistical radar in 1987 with the publication of the *Brudtland Report*.[2] The latest statistical framework with its origins from that report is the United Nations System of Environmental-Economic Accounts - Central Framework (SEEA-CF)[3]: a robust suite of measures that both supports the System of National Accounts[4] (SNA) measures and reflects SNA principals.

SEEA-CF and its theoretical companion, the System of Environmental-Economic Accounts - Exosystem Accounting (SEEA-EA), create a suite of environmental statistical measures that complement the economics metrics from the SNA. Countries now have the *theoretical* tools for connecting changes in their economic systems to environmental changes, and (importantly) ***vice versa***.

[1] https://www.spc.int/updates/news/2023/09/the-existential-threat-climate-change-poses-to-pacific-nations-presented-at
[2] https://www.are.admin.ch/are/en/home/media/publications/sustainable-development/brundtland-report.html
[3] (United Nations, European Union, Food et al., 2014)
[4] https://unstats.un.org/unsd/nationalaccount/sna.asp

Weather extremes regularly destroy PICT land-based capital…

The twin issues of rebuilding from and adapting to present day climate change, and securing meaningful and valuable sources of economic value are hot topics for PICT policy-makers. Rising sea levels and coastal erosion, together with increasingly violent and frequent weather extremes, decimate land-based physical capital. This destruction reduces PICTs productive capital stocks, and lowers their economic growth potential. Recovering from tropical cyclones and rebuilding buildings and equipment also saps scarce resources from more productive alternative uses.

The latest statistics from Kiribati' "Kiribati Natural Disasters and Climate Change Survey Report 2023–2024"[5] provides some scale to how climate change is impacting PICTs.

During the 2023–2024 period:

- A quarter (25%) of households reported being impacted by at least one natural disaster.
- The estimated economic losses from climate change totaled $1.25 million (AUD), with housing and agriculture most affected.
- Three-fifths (60%) of affected households experienced damage to their homes — mostly due to strong winds and heavy rain.
- A quarter (26%) of households affected by disasters reported agricultural losses, with drought the leading cause.
- One in 10 (10%) of households affected by disasters experienced health issues linked to climate events, including extreme heat and flooding.
- Nearly 4,000 people were temporarily relocated due to natural disasters.

… while ocean-based capital is more weather resilient

Measuring the environment through an ocean-based capital perspective offers PICTs alternative options from considering the economy through the SNA lens alone. By estimating the volume and type of ocean-based capital, the estimated value of ocean-based economic production can be quantified and potentially exploited. Fishing stocks and mineral deposits - ocean-based capital - present opportunities for PICTs to tap into overseas sources of funding, and generate value export incomes and licencing revenues independent of their land-based capital.

Unlike physical productive capital - factories, farms and land-based mechinery - ocean-based capital is less weather dependent and more resiliant against weather extremes.

[5] (Kiribati National Statistics Office and The Pacific Community, 2025)

As seen from Table 1, PICTs have generated an average $US463.66 million per year over the last 10 years from fishing license fees of tuna alone.

Table 1: Tuna Revenues: Access fees for offshore fishing 2014–2023 - $US Millions

Country	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Total Fishing License Revenue	370.6	454.4	446.5	496.1	496.9	490.3	481	483.5	458.3	459

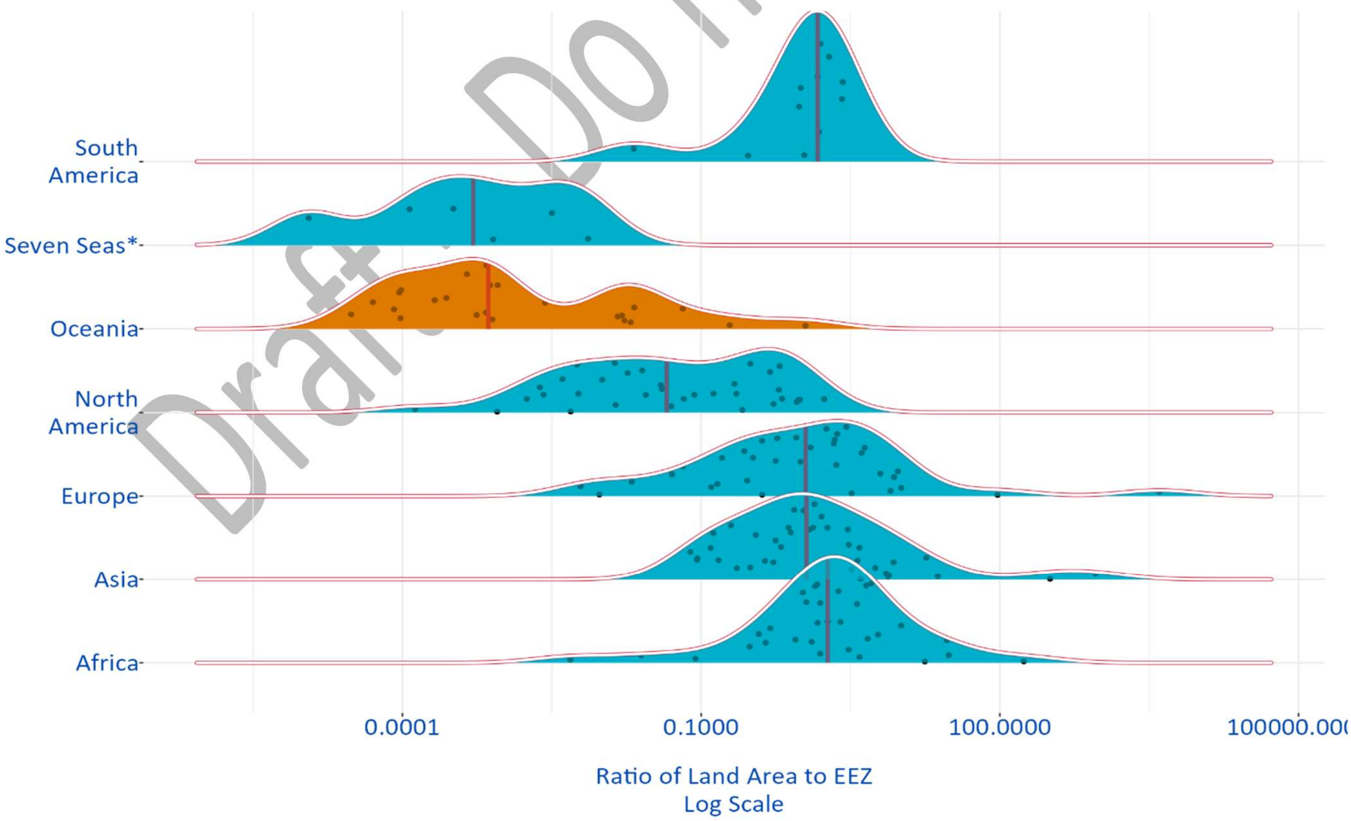
Forum Fisheries Authority, Compendium of Economic and Development Statistics 2024.xlsx, https://www.ffa.int/download/economic-development-indicators-and-statistics/

While the ocean is facing its own climate-related issues, having a “sea-based” alternative revenue source to more traditional “land-based” economic activity acts like a form of insurance against depending on one type of revenue source alone.

The value of simulatenously measuring both the enviromental and the economic system is high

Unlike large countries with larger land areas, the scarcity of land for PICTs relative to the area of their Exclusive Economic Zones (EEZ) implies the bulk of exploitable economic resources are marine-based. For PICTs, SEEA-CF allows countries to understand how value is created within their environment, and how their environment shapes their future economic opportunities.

Figure 1: Distribution of countries by land size relative to EEZ size (World Bank Groupings)



Note: These are: Clipperton Island, Maldives, Mauritius, Saint Helena, Seychelles, South Georgia and the South Sandwich Islands*

… and the cost of remote sensing is relatively low

The Pacific Community's (SPC) Digital Earth Pacific (DEP) platform is capable of measuring member country environmental assets through remote-sensing. DEP can measure both land and near-shore ocean-based environmental assets for all SPC member countries at the same time. DEP can also take repeated periodic measures, enabling change measures to be derived, and capturing the impact of climate change on member countries. In the future, DEP might also create measures of ocean-based pollution.

Markets in biodiversity: Unlocking the real Blue Pacific Prosperity

The end-goal for introducing SEEA measurement into pacific countries is to create a capability and a measurement platform for data sources that could measure pacific-oceanwide *biodiversity* and enable economic markets in biodiversity conservation to develop.

Biodiversity, centrally and consistently measured using authoritative and scientifically valid data sources, offers a new source for establishing markets in conservation and biodiversity protection. Somewhat ironically, as climate change worsens, the most increasingly valuable aspect of the Pacific Ocean could become the continued existence of its rich and life-sustaining biodiversity.

While climate change negatively impacts habitats, protecting existing habitats and preserving biodiversity becomes increasingly more valuable in harsher and more extreme world environment. If biodiversity and biodiverse areas can be readily identified, and their "level" and "difference" in biodiversity readily assessed, then the protection and expansion in those areas is valuable in a climatically changing world, and its conservation a future PICT revenue source.

Not only would biodiverse areas be identified, but *non-biodiverse* areas would also become identified. In non-biodiverse areas, alternative uses of the marine environment (like offshore oil exploration, or maritime transport paths) might be activities whose benefits outweigh their impacts on the environment.

> *The main allure of a market-based approach is its potential to achieve any given conservation goal at the lowest possible cost.*
>
> *Market-based policies have led to substantial improvements in air quality, reduced overfishing, and increased water provisioning and quality. Some coastal nations are already engaging in trade-based schemes to protect the marine environment—for example, The Nature Conservancy and the Republic of Seychelles' "Blue Bonds for Ocean Conservation" program, or the "Ocean Conservation Commitments" scheme recently announced by the Pacific Island nation of Niue.*
>
> *Both models have something in common: A deal is struck between a coastal nation that conserves a portion of the marine environment and an interested party who helps pay for the costs of conserving. These schemes show that nations*

> *are interested in innovative financing approaches that take advantage of trades in which buyers place higher values on conservation than sellers. Although these examples are promising, they do not fully harness the cost reductions that could be achieved with a global market for conservation.*
>
> — (Villasenor-Derbez, Costello, and Plantinga, 2024)

This is our collective efforts

This paper outlines how SPC's data sources might be leveraged to create an initial suite of Environmental-Economic Accounts for our Pacific member countries. It is the collective product from almost all of SPC's divisions

- Its impetus started in Fisheries, Aquatic and Marine Environment (FAME) Division, who is also contributing the ocean-based aquatic life data sources and measures.
- Digital Earth Pacific, mineral resources and maritime transport activity data is supplied by the Geoscience, Energy and Marine (GEM) Division.
- The Land Resources Division (LRD) is guiding the development of the land use metrics.
- Climate Change and Environmental Sustainability (CCES) Division are guiding the use of the metrics for member countries.
- The Statistics for Development Division (SDD) is providing oversight of the validity and compliance of the SEEA-based statistical measures.

3 Statistically measuring the environment

Measuring countries' economic processes had, since 1947, been guided by the United Nations Systems of National Accounts (SNA)[6]: a statistical methodological framework that maintained a robust adherance to a standard suite of economic measures for how countries measure their economic production, consumption, and exchange activity. Together with the Balance of Payments, it was a massive advance in the theory and practice of economics and has created commonly defined metrics for cross-country comparative analysis into the mechanics of economic growth and development.

Its main limitation has, until recently, been its treatment of capital and capital services and lack of recognition for enviromental assets and services. The SNA 2025 version[7] now incorporates the SEEA and recognises environmental assets that generate environmental services and explicitly moves in line with the SEEA. As a result, moving towards the SEEA also moves PICTs towards upgrading their national accounting metrics.

This paper suggests developing SEEA-CF's key metrics, its Environmental Asset Accounts differentiated into SEEA-CF's Classification Environment Activities [Table 3] and populated using Digital Earth Pacific, FAME and GEM data sources.

The statistical issues relate to measurement theory

Since its inception in 1947, the System of National Accounts[8] has been the international standard for how countries, including PICTs, measure their economic production, consumption, and exchange activity. Together with the Balance of Payments, (reflecting inter-country trade and economic flows) the SNA is the framework for measuring economic systems. It was a massive advance in the theory and practice of economics and has created commonly defined metrics for cross-country comparative analysis into the mechanics of economic growth and development.

The environment is recognised to the extent it could be captured within property rights and monetarily valued. Under the existing and previous SNA manuals, the environment is not seen as an input into a production process. The environment is something *ancillary-to* the economy and *within-which* economies undertake production, consumption and exchange.

The SNA only acknowledges man-made "produce" capital…

The concept that man-made capital generates "capital services" as inputs into the production was acknowledged in the 1993 version of the SNA;[9] however, the SNA93 stopped short of measuring environmental capital services as also inputs into production.

Physical capital; for example, a motor vehicle, provides "transport services": the ability to move inputs and outputs between locations. The transport services from a car differ from those of a truck. Similarly, the transport services of a new truck differ significantly from

[6] https://unstats.un.org/unsd/nationalaccount/sna.asp

[7] https://unstats.un.org/unsd/nationalaccount/docs/2025_SNA_Pre-edit.pdf Chapter 2, section 5 "Measures concerning the environment"

[8] https://unstats.un.org/unsd/nationalaccount/sna.asp

[9] https://unstats.un.org/unsd/nationalaccount/docs/1993sna.pdf

transport services of a vintage truck. Not only do the levels of inherent technology differ between vintage capital, but vintage capital also experiences economic depreciation, which reduces the *quantity* of the capital services it provides.

While SEEA-CF measures environmental services from environmental assets

There are direct parallels between man-made and environmental capital, yet until ***very recently***[10] enviromental assets were not recognised as providing economic services into production. Likewise, changes to the environment from economic activity were not reflected as economic costs of production.

Environmental capital, measured in environmental assets, generates environmental services which are inputs into economic production processes. Fish biomass stocks are the enviromental capital inputs into the fishing industry. Their capital services are the continuous supply of a maximum sustainable catch: the annual quantity of catch that can be extracted from the stock while still maintaining the reproductive capacity of the overall population.

Where man-made capital services are degraded from economic depreciation, environmental capital services are degraded through pollution and depletion. While man-made capital services are improved through technology, enviromental capital services have a regenerative capability.

SEEA-CF is a better measure framework for measuring the environment and the economy

SEEA-CF is a multipurpose statistical framework for understanding the interactions between the environment and the economy. It puts statistics on the environment and its relationship to the economy at the core of official statistics. Both the SEEA-CF and SNA systems operate together - one measuring the environment, and the other the economy. Changes in the “stock” of environmental assets over a period is matched against the economic flows derived from an associated industry through SNA supply/use tables.

SEEA-CF covers three main measurement areas:

(a) the physical flows of materials and energy within the economy and between the economy and the environment;

(b) the stocks of environmental assets and changes in these stocks; and

(c) economic activity and transactions related to the environment.

[10] https://unstats.un.org/unsd/nationalaccount/docs/2025_SNA_Pre-edit.pdf Chapter 2, section 5 “Measures concerning the environment”

Environmental assets are the naturally occurring living and non-living components of the Earth, together constituting the biophysical environment, which may provide benefits to humanity.[11] They can be either cultivated or natural resources.

In principle, all of the benefits delivered by environmental assets can be valued in monetary terms. In the Central Framework, consistent with the SNA, the scope of valuation is limited to the benefits that accrue to economic owners. An economic owner is the institutional unit entitled to claim the benefits associated with the use of an asset during an economic activity by virtue of accepting the associated risks. Further, following the SNA, an asset is a store of value representing a benefit or series of benefits accruing to the economic owner by holding or using the entity over a period of time.

Creating exosystem accounts is currently too hard

SEEA-EA extends the environmental measurement framework by considering clusters of environmental assets grouped together as "ecosystems" which are collectively important and collectively supply enviromental services to the economy. Ecosystems are the dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit.[12] Ecosystems make three types of contributions to economic and other human activity:

(a) *Provisioning services* (such as the provision of timber from forests);

Provisioning services are related to the material benefits of environmental assets, whereas the other types of ecosystem services are related to the non-material benefits of environmental assets.

(b) *Regulating services* (provided, for example, by forests when they act as a sink for carbon); and

(c) *Cultural services* (such as the enjoyment provided to visitors to a national park).

For example, mangrove areas are considered collective environments that support fisheries, filter pollutants from waterways and provide erosion protection to onshore areas.

The difficulty with developing SEEA-EA exosystem accounts is defining the boundary of the exosystem. SEEA-EA suggests five distinct measurement perspectives are relevant, each of which could be the basis of its own body of work within a Pacific context. None of these are "easy":

- *Spatial:* a comprehensive measurement base of statistical units is formed through use of the ecosystem concept to establish the number of occurrences of ecosystems within a defined territory that can be classified in mutually exclusive ways.
- *Ecological:* the ecosystem concept is the focus for measurement of ecosystem integrity, health and condition and serves to underpin concepts such as ecosystem resilience and the assessment of ecological thresholds.

[11] (United Nations, European Union, Food et al., 2014) section 2.17, page 13
[12] (United Nations, European Union, Food et al., 2014) section 2.21, page 14

- *Societal benefit:* ecosystems are viewed as a source of benefits for people, the economy and society, potentially in terms of a relational connection or in the more economic sense of supplying services and benefits.

- *Asset value:* ecosystems are viewed as assets that provide services and benefits into the future depending on their ecological status and the social demands for ecosystem services. Issues of ecosystem degradation and enhancement are considered from this perspective.

- *Institutional ownership:* ecosystems are considered in relation both to existing economic and legal entities and to issues of stewardship and allocation of degradation costs.

Developing SEEA-CF environmental asset accounts from SPC data is a good first step

Asset accounts for individual environmental assets in physical and monetary terms showing the stock of environmental assets at the beginning and the end of each accounting period and the changes in the stock. Asset accounts are compiled for individual types of environmental assets and record the opening and closing stock of environmental assets and the different types of changes in the stock over an accounting period. Environmental asset accounts also assess whether current patterns of economic activity are depleting and degrading the available environmental assets. The valuations of environmental assets in asset accounts combined with valuations of produced and financial assets to provide broader estimates of a national's wealth.

						Asset accounts (Physical and monetary terms)	
		Industries	Households	Government	Rest of the world	Produced assets	Environmental assets
						Opening stock	
Monetary supply and use table	Product-supply	Output			Imports		
	Product-use	Intermediate consumption	Household final consumption expenditures	Government final consumption expenditures	Exports	Gross capital	
Physical supply and use table	Natural inputs-supply						Extracted natural resources
	Natural inputs-use	Inputs of natural resources					
	Product- supply	Output			Imports		
	Product-use	Intermediate consumption	Household final consumption		Exports	Gross capital formation	
	Residuals-supply	Residuals generated by industry	Residuals generated by household final consumption		Residuals received from the rest of the world	Residuals from scrapping and demolition of produced assets; emissions from controlled landfills	
	Residuals-use	Collection and treatment of waste and other residuals			Residuals sent to the rest of the world	Accumulation of waste in controlled landfills	Residuals flowing to the environment[a]
						Other changes in volume of assets (e.g., natural growth, discoveries, catastrophic losses)	
						Revaluations	
						Closing stock	

Note: Dark grey cells are null by definition. Blank cells may contain relevant flows, which are articulated in detail in chap. III.

[a] While these residual flows (e.g., air emissions) are not flows of environmental assets, they may affect the capacity of environmental assets to deliver benefits. The changing capacity of environmental assets may also be reflected in other changes in the volume of assets.

Figure 2: Connections between supply and use tables and asset accounts

There are seven individual components of the environment that are considered environmental assets in the Central Framework. They are mineral and energy resources, land, soil resources, timber resources, aquatic resources, other biological resources (excluding timber and aquatic resources), and water resources.

1	**Mineral and energy resources**
1.1	Oil resources
1.2	Natural gas resources
1.3	Coal and peat resources
1.4	Non-metallic mineral resources (excluding coal and peat resources)
1.5	Metallic mineral resources
2	**Land**
3	**Soil resources**
4	**Timber resources**
4.1	Cultivated timber resources
4.2	Natural timber resources
5	**Aquatic resources**
5.1	Cultivated aquatic resources
5.2	Natural aquatic resources
6	**Other biological resources** (excluding timber resources and aquatic resources)
7	**Water resources**
7.1	Surface water
7.2	Groundwater
7.3	Soil water

Figure 3: Classification of environmental assets in the SEEA Central Framework

Biological resources include timber and aquatic resources and a range of other animal and plant resources such as livestock, orchards, crops and wild animals. Like most environmental assets, they provide physical inputs to economic activity. A distinction is made between whether the resources are cultivated or natural, based on the extent to which there is active management over the growth of the resource.

Many environmental assets are also economic assets. In particular, natural resources and land are considered non-produced assets, and cultivated biological resources may be either fixed assets or inventories, depending on their role in production.

	Mineral and energy resources	Land (including forest land)	Soil resources	Timber resources		Aquatic resources		Water resources
				Cultivated	Natural	Cultivated	Natural	
Opening stock of resources	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Additions to stock of resources								
Growth in stock	na	Yes*	Soil formation Soil deposition	Growth	Natural growth	Growth	Natural growth	Precipitation Return flows
Discoveries of new stock	Yes	na	na	na	na	na	Yes*	Yes*
Upward reappraisals	Yes	Yes	Yes*	Yes*	Yes*	Yes*	Yes	Yes*
Reclassifications	Yes	Yes	Yes	Yes	Yes	Yes	Yes	na
Total additions to stock								
Reductions in stock of resources								
Extractions	Extractions	na	Soil extraction	Removals	Removals	Harvest	Gross catch	Abstraction
Normal reductions in stock	na	na	Erosion	Natural losses	Natural losses	Normal losses	Normal losses	Evaporation Evapotranspiration
Catastrophic losses	Yes*	Yes*	Yes*	Yes	Yes	Yes	Yes	Yes*
Downward reappraisals	Yes	Yes	Yes*	Yes*	Yes*	Yes*	Yes	Yes*
Reclassifications	Yes	Yes	Yes	Yes	Yes	Yes	Yes	na
Total reductions in stock								
Closing stock of resources	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note: "na" means not applicable.
* An asterisk indicates that this entry is usually not significant for the resource or is typically not separately identified in the source data. In practice, not all cells that reflect the possibility of an entry here should be shown separately in published accounts for each type of resource.

Figure 4: General structure of the physical asset account for environmental assets (physical units)

4 Environmental Asset Accounts and Data Sources

The Central Framework comprises the supply and use tables in physical (PSUT) and monetary terms (MSUT) showing flows of natural inputs, products and residuals, and enviromental asset accounts.

One of the main purposes of enviromental asset accounts is to capture change through natural and catastrophic events, suitable metrics for describing climate change. Other than mineral and energy resources, each of the below assets includes these change dimensions. Summing across assets groups provides an estimate of climate-change-generated loss and damage.

The SEEA-CF supply and use tables in intended to compliment the SNA supply and use: in SEEA-CF they show how changes in the environment feed “into” the changes in the SNA economy. However, SNA supply and use tables are not common throughout our pacific member country, making the enviromental asset accounts the overwhelming more useful metrics for countries.

	Industries	Households	Accumulation	Rest of the world	Environment	Total
Supply table						
Natural inputs					Flows from the environ-ment	Total supply of natural inputs
Products	Output			Imports		Total supply of products
Residuals	Residuals generated by industry	Residuals generated by final household consumption	Residuals from scrap-ping and demolition of produced assets			Total supply of residuals
Use table						
Natural inputs	Extraction of natural inputs					Total use of natural inputs
Products	Intermediate consumption	Household final consumption	Gross capital formation	Exports		Total use of products
Residuals	Collec-tion and treatment of waste and other residuals		Accumula-tion of waste in controlled landfill sites		Residual flows direct to environ-ment	Total use of residuals

Note: Dark grey cells are null by definition. Blank cells may contain relevant flows, which are explained in detail in chapter III.

Figure 5: Physical Supply and Use Table

Asset accounts for mineral and energy resource

Mineral and energy resources include deposits of oil resources, natural gas resources, coal and peat resources, non-metallic minerals and metallic minerals. A key factor in the measurement of mineral and energy resources is the concentration and quality of the minerals and energy resources in the deposit, since this will influence the likelihood and cost of extraction and the degree of confidence regarding the quantity that can be extracted in the future.

Deposits exclude potential deposits where there is no expectation of the deposits' becoming economically viable and there is a lack of information needed to determine the feasibility of extraction or to have confidence in the geologic knowledge. The location and depth of the resource in the ocean will affect the number of minerals within this group.

SEEA-CF uses the United Nations Framework Classification for Fossil Energy and Mineral Reserves and Resources.[13] to group known mineral deposits into whether those resources have been confirmed, developed or planned. Three criteria affecting their extraction: Economic and social viability (E), Field project status and feasibility (F) and, Geological knowledge (G).

Known deposits are categorized in three classes: Class A (commercially recoverable resources), Class B (potentially commercially recoverable resources), and Class C (non-commercial and other known deposits)

	Class of known deposit		
Type of mineral or energy resource	A: Commercially recoverable resources	B: Potentially commercially recoverable resources	C: Non-commercial and other known deposits
Oil resources (thousands of barrels)	800	600	400
Natural gas resources (cubic metres)	1 200	1 000	1 500
Coal and peat resources (thousands of tonnes)	600	50	50
Non-metallic mineral resources (tonnes)	150	200	100
Metallic mineral resources (thousands of tonnes)	60	40	60

Note: Different physical units (e.g., tonnes, cubic metres and barrels) will be used for different types of resources.

Figure 6: Stocks of mineral and energy resources

[13] Probably now this one: https://unece.org/info/publications/pub/2772

	Type of mineral and energy resource (Class A: Commercially recoverable resources)				
	Oil resources (thousands of barrels)	Natural gas resources (cubic metres)	Coal and peat resources (thousands of tonnes)	Non-metallic minerals (tonnes)	Metallic minerals (thousands of tonnes)
Opening stock of mineral and energy resources	800	1 200	600	150	60
Additions to stock					
Discoveries					20
Upward reappraisals		200		40	
Reclassifications					
Total additions to stock		200		40	20
Reductions in stock					
Extractions	40	50	60	10	4
Catastrophic losses					
Downward reappraisals			60		
Reclassifications					
Total reductions in stock	40	50	120	10	4
Closing stock of mineral and energy resources	760	1 350	480	180	76

Note: Different physical units (e.g., tonnes, cubic metres and barrels) will be used for different types of resources.

Figure 7: Physical asset account for mineral and energy resources

SPC's Geoscience, Energy and Marine (GEM) Division is the primary data source for information on this asset account.

Asset accounts for land

Land is a unique environmental asset that delineates the space in which economic activities and environmental processes take place and within which environmental assets and economic assets are located. While the term "land" is commonly meant to refer only to terrestrial areas, in the SEEA, the term may also apply to areas covered by water.

Land use

There are two primary aspects of land for environmental accounting purposes: land use and land cover. Land use is grouped into:

1	**Land**
1.1	Agriculture
1.2	Forestry
1.3	Land used for aquaculture
1.4	Use of built-up and related areas
1.5	Land used for maintenance and restoration of environmental functions
1.6	Other uses of land n.e.c.
1.7	Land not in use
2	**Inland waters**
2.1	Inland waters used for aquaculture or holding facilities
2.2	Inland waters used for maintenance and restoration of environmental functions
2.3	Other uses of inland waters n.e.c.
2.4	Inland waters not in use

Figure 8: Land use classification

Land cover

Land cover is the observed physical and biological cover of the Earth's surface and includes natural vegetation and abiotic (non-living) surface.

The Food and Agriculture Organization of the United Nations (FAO) has developed an international standard classification system, the Land Cover Classification System, version 3 (LCCS 3) which can be used to systematically record the biophysical characteristics of all areas of land within any territory.

	Category
1	Artificial surfaces (including urban and associated areas)
2	Herbaceous crops
3	Woody crops
4	Multiple or layered crops
5	Grassland
6	Tree-covered areas
7	Mangroves
8	Shrub-covered areas
9	Shrubs and/or herbaceous vegetation, aquatic or regularly flooded
10	Sparsely natural vegetated areas
11	Terrestrial barren land
12	Permanent snow and glaciers
13	Inland water bodies
14	Coastal water bodies and intertidal areas

Figure 9: Land cover classification

	Artificial surfaces	Crops	Grassland	Tree-covered area	Mangroves	Shrub-covered area	Regularly flooded areas	Sparse natural vegetated areas	Terrestrial barren land	Permanent snow, glaciers and inland water bodies	Coastal water and inter-tidal areas
Opening stock of resources	12 292.5	445 431.0	106 180.5	338 514.0	214.5	66 475.5	73.5	1 966.5		12 949.5	19 351.5
Additions to stock											
Managed expansion	183.0	9 357.0									
Natural expansion			64.5								1.5
Upward reappraisals			4.5								
Total additions to stock	183.0	9 357.0	69.0								1.5
Reductions in stock											
Managed regression		147.0	4 704.0	3 118.5	9.0	1 560.0	1.5				
Natural regression					1.5	64.5					
Downward reappraisals						4.5					
Total reductions in stock		147.0	4 704.0	3 118.5	10.5	1 629.0	1.5				
Closing stock	12 475.5	454 641.0	101 545.5	335 395.5	204.0	64 846.5	72.0	1 966.5		12 949.5	19 353.0

Note: Crops include herbaceous crops, woody crops, and multiple or layered crops.

Figure 10: Physical account for land cover (hectares)

Digital Earth Pacific, with their remote-sensing and geospatial capabilities, is the primary data source for information on this asset account.

Accounting for soil resources

Soil resources are a fundamental part of the environment and has many dimensions. Accounting for soil resources can provide information on the area and volume of soil resources lost due to soil erosion, or made unavailable by changes in land cover (e.g., soil covered by buildings or roads) and other causes (e.g., changes in soil structure due to compaction, acidity or salinity).

SEEA's focus is on the top layers (horizons) of soil that form a *biological system* and are defined in reference to their components and properties. Soil resources are measured through a series of inventory processes, known collectively as a soil survey. Soils are generally ranked in terms of their properties (e.g., carbon content), productive capacity (e.g., for agriculture) and/or their tendency towards degradation over time.

A first stage of accounting for soil resources entails measurement of the area of different soil types within a country.

	Type of soil resource	Total area
Opening stock of soil resources		
Additions to stock		
Due to changes in land cover		
Due to changes in soil quality		
Due to changes in soil environment		
Total additions to stock		
Reductions in stock		
Due to changes in land use		
Due to changes in soil quality		
Due to changes in soil environment		
Total reductions in stock		
Closing stock of soil resources		

Figure 11: Physical asset account for area of soil resources

In this technical scientific aspect, SEEA provides little additional guidence. The most immediate deliverable might be just identifying which aresestimating soil land-area size change.

Again, Digital Earth Pacific is probably going to be the primary data source for information on this asset account.

Asset accounts for timber resources

Timber resources are defined by the volume of trees, living or dead, and include all trees regardless of diameter, tops of stems, large branches and dead trees lying on the ground that can still be used for timber or fuel. The general principle that should be considered in determining the volume of timber resources is the volume that is commercially usable. SEEA-CF distinguishes between cultivated and natural timber resources, although this distinction will be infeasible if standarding timber is estimated via remote-sensing.

SEEA notes there is a cross-over with land assets: both the forest timber *and* the land use needs to be counted.

	Type of timber resource		
	Cultivated timber resources	Natural timber resources	
		Available for wood supply	Not available for wood supply
Opening stock of timber resources	8 400	8 000	1 600
Additions to stock			
Natural growth	1 200	1 100	20
Reclassifications	50	150	
Total additions to stock	1 250	1 250	20
Reductions in stock			
Removals	1 300	1 000	
Felling residues	170	120	
Natural losses	30	30	20
Catastrophic losses			
Reclassifications	150		150
Total reductions in stock	1 650	1 150	170
Closing stock of timber resources	8 000	8 100	1 450
Supplementary information			
Fellings	1 250	1 050	

Figure 12: Physical asset account for timber resource

Again, Digital Earth Pacific, is probably going to be the primary data source for information on this asset account.

Asset accounts for aquatic resources

Aquatic resources are an important biological resource that includes fish, crustaceans, mollusks, shellfish and other aquatic organisms such as sponges and seaweed, as well as aquatic mammals such as whales. They are harvested for commercial as well as subsistence and recreational fishing reasons. In principle, all aquatic resources are in scope of the asset accounts in the Central Framework. In practice, measurement activities is limited to those aquatic resources that are subject to commercial activity, unless subsistence and recreational fishing and fishing stocks can be measured.

Aquatic resources cover both cultivated aquatic resources and natural aquatic resources. All aquatic resources produced within aquaculture facilities are considered cultivated biological resources. All other aquatic resources harvested as part of capture production processes are considered natural biological resources.

Asset accounts for aquatic resources organize information on the stocks and changes in stocks of the quantity and value of aquatic resources within a country's economic territory, including stocks within a country's EEZ or on the high seas over which the country holds ownership rights.

The physical asset account measures the total biomass of species that are subject to harvesting activity or cultivated within the national boundary, including within the country's EEZ, and a portion of shared resources biomass to which a country has access rights either through traditional practice, international agreement or provision of part of the distribution areas. The physical asset account also shows the changes due to harvest, normal loss, growth (in size and in number) and other changes.

	Type of aquatic resource		
	Cultivated aquatic resources—fixed assets	Cultivated aquatic resources—inventories	Natural aquatic resources
Opening stock of aquatic resources	406	150	1 393
Additions to stock			
Growth in stock	19	192	457
Upward reappraisals			33
Reclassifications	40		11
Total additions to stock	59	192	501
Reductions in stock			
Gross catch/harvest		183	321
Normal losses	37	5	183
Catastrophic losses	4	2	9
Uncompensated seizure			7
Downward reappraisals	5		
Reclassifications	9		35
Total reductions in stock	55	190	555
Closing stock of aquatic resources	410	152	1 339

Figure 13: Physical asset account for aquatic resources (tonnes)

Migratory species and fishing in other EEZ

The aquatic resources for a given country comprise those resources that are considered to live within the exclusive economic zone (EEZ) of a country throughout their life cycles, in both coastal and inland fisheries. Migrating and straddling fish stocks are considered to belong to a country during the period when those stocks inhabit its EEZ.

The scope of harvesting includes commercial sea- and freshwater operations, aquaculture, and subsistence and recreational harvesting of aquatic resources. Aquatic resources that exist within other countries' EEZ but are harvested by operators that are resident in the reference country **should not** be included in the asset accounts of the reference country.

Changes in aquatic resource assets and the economic activity of fishing

Fishing is an example where the two separate SEEA-CF and SNA systems need very careful consideration.

Fishing (the *economic activity*) undertaken by non-residents within another country's EEZ follows the principles of the SNA: the location of the aquatic resource (the *environmental asset*) is **not** the key determinant of the attribution of economic production (*where* did production occur). Production (the *economic activity*) is allocated instead to the country of residence of the harvesting operation.

For example, foreign fleets fishing tuna in Pacific member country EEZ have the harvested tuna recognised in the member country SEEA accounts, but the vessel costs and fishing profits are assocaited back to the country of residence of the fleet.[14] BUT for measuring changes in the aquatic resource assets, the foreign fleet catch needs to be reflected in the harvest metrics of country where the catch was made.

Illegal fishing

Where non-residents harvest aquatic resources illegally, either without a licence or by taking catch in excess of their allocated quota, the physical removals need to be recorded as uncompensated seizures, separate from estimates of gross catch of the country in whose EEZ the fish were caught.

Preferred units of aquatic resource measure: Fish "Stocks"

Fishery biologists define a "stock" as a group of individuals from the same species that constitute a unit in breeding new offspring. If mating between members of different groups occurs to the level required to modify their gene pools in the long term, those groups should be regarded as belonging to one stock.

The resource management should be based on this concept of stock. The boundary of a stock in this sense does not correspond to national boundaries and when aquatic resources belonging to a stock move around multiple countries' boundaries, international

[14] There is disagreement whether the fishing operation country is the fishing vessel flagged country *or* whether it represents the country receiving the harvested stocks. Fishing vessel flags may have not economic connection to where the catch is ultimately sent for processing, which is where the value added for fishing is generated. The jury is out.

collaboration in management is needed and the national asset account of such stock can be defined based on the share of access to the stock.

There are several dimensions that should be considered in measuring the size of the resources. An important one is the measurement of the sexually mature part of the stock (i.e., the spawning stock or parental biomass). Another relevant measurement dimension is the exploitable stock size. This corresponds to the proportion of the stock that is subject to harvesting activity, which ignores the cohorts that are younger than those being harvested about which little is known.

Alternative aquatic resource measure: Gross Catch

When scientific assessment of the absolute stock size is not available, an alternative approach is to measure the gross catch for a certain harvesting operation in relation to the amount of effort required to obtain the catch for a given species (e.g., days at sea, number and type of fishing gear, size and power of vessel, and expenditure on catch effort, including wages and fuel).

The ratio of catch per unit effort (CPUE) may provide a good indicator of the relative change in stock size, assuming that population density and population size are closely correlated and that CPUE is higher at higher population densities. Importantly, not all species have the same ratios between population structure and the associated CPUE and this needs to be taken into account in using this technique. Further, CPUE measures may be affected by changes in quota and other administrative arrangements, and changes in technology.

For the SEEA, the measurement of discarded catch is an important contributory factor to a full understanding of the linkages between economic activity and the impact on aquatic resources. For this reason, it is recommended that the concept of “gross catch” be used to measure the extraction of fish resources. Conceptually, “gross removal” is the most appropriate concept for measuring the impact on aquatic resources and the damage to aquatic ecosystems, e.g., to coral reefs, as a result of fishing activity. However, the measurement of gross removal is not possible in practice.

Depletion of natural aquatic resources and degradation of fisheries

Depletion for natural aquatic resources is shown to be equal to gross catch less sustainable yield. Estimates would be derived from FAME’s biological models compared with indicators of stock size, such as CPUE, and also that estimation be carried out on an ongoing basis so that the dynamics of the various populations (natural growth, natural losses, etc.) can be better understood.

Degradation considers changes in the capacity of environmental assets to deliver a broad range of contributions known as ecosystem services (e.g., air filtration services from forests) and the extent to which this capacity may be reduced through the action of economic units, including households.

The measurement of degradation is complicated because the capacity of environmental assets to deliver ecosystem services is not attributable solely to individual assets, and because individual assets may deliver a number of different ecosystem services. To assess whether a body of water has been degraded, assessments might be made of the various pollutants in the water as part of a broader assessment of the overall change in condition.

This very complicated area is the realm of the Fisheries, Aquatic and Marine Environment (FAME) Division.

Accounting for other biological resources

Other biological resources are largely represented by cultivated animals and plants including livestock, annual crops such as wheat and rice, and perennial crops such as rubber plantations, orchards and vineyards.

Natural biological resources are distinguished from cultivated biological resources because their natural growth and regeneration are not under the direct control, responsibility and management of an institutional unit, and are not easily accounted for.

The structure and logic of the accounting for these resources are consistent with the accounting presented in sections 5.8 and 5.9 on timber resources and fish resources.

As natural biological resources form an important part of biodiversity and ecosystems in particular regions, SEEA-CF suggests there may be interest in compiling data on the availability and extraction of these resources at subnational spatial levels.

At the moment, this feels like a “remainder” grouping, estimated through Digital Earth Pacific once all other land-based assets are measured..

Asset accounts for water resources

Asset accounts for water resources focus on the inflows and outflows of water to and from the land surface and subsurface, and on the destination of these flows.

The asset accounts themselves present information on the stock of water at the beginning and end of an accounting period, whether it is in artificial reservoirs, lakes or rivers, or stored as groundwater or soil water. The accounts then record the flows of water as it is abstracted, consumed, added to through precipitation, or changed through flows to and from other countries and returns to the sea. The focus is on the amount of water in the environment, its abstraction, and the use of water through the economy; hence, in this case, it is the volume of water and the changes over time that are of interest.

As a component of land, it is the in situ or passive use of water that is being considered, for example, in the provision of space for transportation and recreation.

	Type of water resource						
	Surface water				Groundwater	Soil water	
	Artificial reservoirs	Lakes	Rivers and streams	Glaciers, snow and ice			Total
Opening stock of water resources	1 500	2 700	5 000		100 000	500	109 700
Additions to stock							
Returns	300		53		315		669
Precipitation	124	246	50			23 015	23 435
Inflows from other territories			17 650				17 650
Inflows from other inland water resources	1 054	339	2 487		437	0	4 317
Discoveries of water in aquifers							
Total additions to stock	1 478	585	20 240		752	23 015	46 071
Reductions in stock							
Abstraction	280	20	141		476	50	967
for hydropower generation							
for cooling water							
Evaporation and actual evapotranspiration	80	215	54			21 125	21 474
Outflows to other territores			9 430				9 430
Outflows to the sea			10 000				10 000
Outflows to other inland water resources	1 000	100	1 343		87	1 787	4 317
Total reductions in stock	1 360	335	20 968		563	22 962	46 188
Closing stock of water resources	1 618	2 950	4 272		100 189	553	109 583

Note: Dark grey cells are null by definition.

Surface water comprises all water that flows over or is stored on the ground surface regardless of its salinity levels and includes water in artificial reservoirs, which are purpose-built reservoirs used for storage, regulation and control of water resources. Other sources of water include lakes and rivers and streams.

Artificial reservoirs are not natural components of the earth's surface; however, once in place, their stocks and flows are treated in the same way as the stocks and flows associated with natural stores of water, in particular natural lakes. These will be quite significant for Pacific countries.

This main data source for this account would be Digital Earth Pacific. Estimating the number of artificial reservoirs (ie. water tanks) and the quantity of water held might be quite difficult.

5 References

[1] United Nations, European Union, Food, et al. *System of Environmental-Economic Accounting 2012 Central Framework*. New York: United Nations, 2014. ISBN: 978-92-1-055926-3. URL: https://seea.un.org/sites/seea.un.org/files/seea_cf_final_en.pdf.

[2] J. C. Villasenor-Derbez, C. Costello, and A. J. Plantinga. "A market for 30x30 in the ocean". EN. In: *Science* (Jun. 2024). Publisher: American Association for the Advancement of Science. DOI: 10.1126/science.adl4019. URL: https://www.science.org/doi/10.1126/science.adl4019 (visited on 07/17/2025).

[3] Kiribati National Statistics Office and The Pacific Community. *Kiribati Natural Disasters and Climate Change Survey Report 2023–2024*. Tech. rep. Kiribati National Statistics Office, Jun. 2025. URL: https://nso.gov.ki/download/151/2023-24-hies-reports/2167/kiribati-natural-disasters-and-climate-change-report-2023-2024.