Montserrat Ecosystem Accounting

2019 ecosystem account

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Disclaimer

Document evolution

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This report is based on eftec's Version 2 – January 2020 report template.

2019 Ecosystem account

At 102 square kilometres with a total population of 4,649 in 2018 (Statistics Department Montserrat, 2020), the island of Montserrat is largely dependent on its wealth of environmental assets. In fact, the environment contributes at least an estimated **23 million XCD** in value to Montserrat in 2019 (Table 2), which is 13% of its estimated GDP in 2019[1] (Statistics Department Montserrat et al., 2020). These environmental assets provide an abundance of benefit to the people across and visitors to the 'Emerald Isle of the Caribbean', including the: exportation of sand and aggregates (10 million XCD per year); value added to the tourism industry (5 million XCD per year); carbon sequestration by ecosystems (1 million XCD per year); and other more difficult to measure values such as protection of buildings and roads from inland flooding events. The economic prosperity and wellbeing of the people of Montserrat are fundamentally linked to the effective management of the environment, and an understanding of the value that it provides.

Ecosystem accounts provide economic evidence that supports the delivery of sustainable value from environmental assets[2]. Effective management of the environment must consider the extent and underlying condition of ecosystems over time, as well as the range of benefits they provide and the economic value of those benefits to different stakeholder groups. Specifically, the data in ecosystem accounts can help address several fundamental questions for policy and planning:

- What environmental assets are present and what state are they in? How does this change over time?
- What benefits does the environment provide? How are these received by beneficiaries?
- What is the economic value of these benefits? How is this value distributed across the population?

The environmental and socioeconomic data produced within ecosystem accounts provide a basis for answering these questions. Their importance is reflected in the development of the System of Environmental Economic Accounting – Ecosystem Accounts (SEEA-EA), by the United Nations (UN, 2021)[3]. Officially adopted by the UN as a statistical standard in March 2021, the SEEA-EA supports the implementation of ecosystem accounting as a part of National Accounts by National Statistics Offices around the world. Ecosystem accounts provide indicators that compliment national economic and social indicators (such as GDP and demographic trends) and this evidence can support policy development and decision making, such as

- Effective decision-making which impact on the environment and the benefits it provides;
- Action on climate change, including mitigation, adaptation and resilience to impact;
- Delivery of international initiatives, such as the UN Sustainable Development Goals (SDGs)[4]; and
- A green post-COVID economic recovery, and in particular a sustainable tourism sector.

For ecosystem accounts to be a valuable addition to government and organisational policy and planning strategy, they should be embedded into the decision-making process, and updated on an annual basis both to provide current data and to monitor trends over time. A partnership of eftec, the UK Joint Nature

[1] GDP at current purchase prices is estimated as 179 million XCD in 2019 (Statistics Department Montserrat et al., 2020)
[2] See Box 1 for more detail.
[3] More information is available at: https://seea.un.org/ecosystem-accounting
[4] More information is available at: https://sdgs.un.org/goals

Conservation Committee (JNCC), the New Economics Foundation, and Montserrat's Ministry of Agriculture, Trade, Housing, Land and Environment (MAHLE), with Darwin Plus funding from the UK Government, have initiated this process in Montserrat. The aim is for full ownership of the accounting process to be handed over to the Government of Montserrat by Q1 2022.

Physical flow and monetary flow

A range of benefits have been assessed within the ecosystem account, with estimated annual physical flow and monetary values given a confidence rating, as described in **Table 1**. The confidence rating is based on the robustness of the evidence and assumptions used. The summary of the ecosystem account is presented in **Table 2**. The annual physical flow and monetary flow are divided between those measured in accordance with the SEEA-EA standard, and those measured by supplementary methods. The present values (the sum over 25 years), of the benefits are also shown.

Table 1: Description of confidence

Confidence	Symbol	Description
Low	● (red)	Evidence is partial and significant assumptions are made so that the data provides only order of magnitude estimates of value to inform decisions and spending choices.
Medium	● (yellow)	Science-based assumptions and published data are used but there is some uncertainty in combining them, resulting in reasonable confidence in using the data to guide decisions and spending choices.
High	● (green)	Evidence is peer reviewed or based on published guidance so there is good confidence in using the data to support specific decisions and spending choices.
No colour	● (grey)	Not assessed

Table 2: **Summary of Montserrat ecosystem account**

	Physical flow (unit/yr.)			Monetary flow (XCDm/yr.)			Present Value 25 years (XCDm)
Produced at: March 2021	Reporting (2019/20)	Confidence	Units	Reporting (2019/20)	Confidence	Valuation metric	
Ecosystem service flow account (SEEA-EA)							
Fisheries	166,920	●	Total volume of fish landings (lbs/yr.)	1	●	Total value of fish landings	24
Agriculture	95,387	●	Total weight of agriculture production (lbs/yr.)	0.3	●	Total value of agriculture production	5
	89,197	●	Total weight of livestock production (lbs/yr.)	0.7	●	Total value of livestock production	20
	28,344	●	Total egg production (dozens/yr.)	0.3	●	Total value of egg production	7
Water supply	142,667,360	●	Total volume of water consumed (gal./yr.)	4	●	Total value of water consumed	72
Sand and aggregates	399,370	●	Total volume of sand and aggregate exports (t/yr.)	10	●	Total export customs value of sand and aggregates	152
Carbon sequestration	16,552	●	Total tonnes of CO_2e sequestered (tCO_2e/yr.)	1	●	Total value of CO_2e sequestered	33
Tourism	15,047	●	Total number of visitors (visits/yr.)	5	●	Total value added to tourism industry attributed to ecosystems	89
			Total value	**23**	●	**Mix of values**	**402**
Supplementary information							
Other exchange values							
Tourism	15,047	●	Total number of visitors (visits/yr.)	16	●	Total visitor expenditure attributed to ecosystems	268
Welfare values							
Cultural value	2,251	●	Number of households on Montserrat (no.)	0.6	●	Total willingness to pay value for cultural services	12
Non-monetised benefits							
Erosion control		●			●		
Flood hazard regulation		●			●		

Extent and condition account

Spatial analysis was conducted to assess the ecosystems present within Montserrat. The quantity (i.e., extent) and quality (i.e., condition) of the present ecosystems are recorded in the extent account (**Table 3**) and condition account (**Table 4**), respectively. Beyond the extent and condition of ecosystems, other indicators for spatial configuration and other forms of capital are also included in the assessment (**Table 5**). The accounts can be used to monitor changes in the environmental assets over time. The terrestrial and marine ecosystem of Montserrat are mapped in **Figure 1.**

Table 3: Extent account

IUCN Code	Ecosystem	Area (ha)
	Terrestrial	
Total		**11,225**
T1.1	Tropical-subtropical lowland rainforests	1,077
T1.2	Tropical-subtropical dry forests and scrubs	5,188
T1.3	Tropical-subtropical montane rainforests	456
T3.4	Young rocky pavements, lava flows and screes	2,148
T7.1	Annual croplands	31
T7.4	Urban and industrial ecosystems	389
F1	Rivers and streams	101
MT1.3	Sandy shorelines	249
MT2.1	Epipelagic ocean waters	849
	Bare ground	436
	Disturbed ground	302
	Marine	
Total area		**12,821**
M1.1	Seagrass meadows	449
M1.3	Photic coral reefs	875
M1.6	Subtidal rocky reefs	5,542
M1.7	Subtidal sand beds	5,940
	Artificial reef	14
	Sargassum forest	1

Source: See Appendix A.1 for input data sources.
Table Notes: See Appendix D for MAHLE and IUCN ecosystem typology comparison.

Two main types of information available on condition are biodiversity designations (because they reflected high biodiversity value habitats at the time of designation) and the intactness of habitat. Montserrat has extensive areas of intact forest in the Centre Hills, within a protected forest area whose boundary is estimated based on the 1,500-foot contour. The boundary of the forest area that is important for water resources was derived by Montserrat Utilities work in the 1990's and is reflected in a buffer zone around the protected area, which extends slightly below the 1,500ft contour[5].

Montserrat is in a Caribbean Islands Global Biodiversity Hotspot and part of the Lesser Antilles Endemic Bird Area. Montserrat supports a number of rare species including the endemic Montserrat Oriole, one of the rarest birds in the world. Overall, Montserrat has 3 Important Bird Areas and 2 proposed Ramsar sites, supporting 4

[5] See: https://www.protectedplanet.net/centre-hills-protected-forest-area

plant, 1 reptile, 1 amphibian, 4 bat, 4 turtle and 2 bird species of global conservation concern, several of which are endemic species (Rayment, 2007)[6]. There are 12 restricted range birds on Montserrat, present in the Centre Hills Forest, and the Important Bird Areas (IBA) identified in the rest of the island, which make up 474 ha outside the 1,500ft contour used to estimate the protected area of forest. Key species for biodiversity conservation, such as Montserrat Oriole (the national bird), turtles and Mountain Chicken, are also of high cultural importance.

Table 4: Condition account

Category	Sub-category	Value
	Land	
Total forest reserve area (ha)		1,136
Total agricultural zone (ha)		381

Source: See Appendix A.2 for input data sources.

Table 5: Other indicators

Category	Sub-category	Value
	Other forms of capital	
Total mineral zone (qualitative)		Vast

Source: See Appendix A.3 for input data sources.

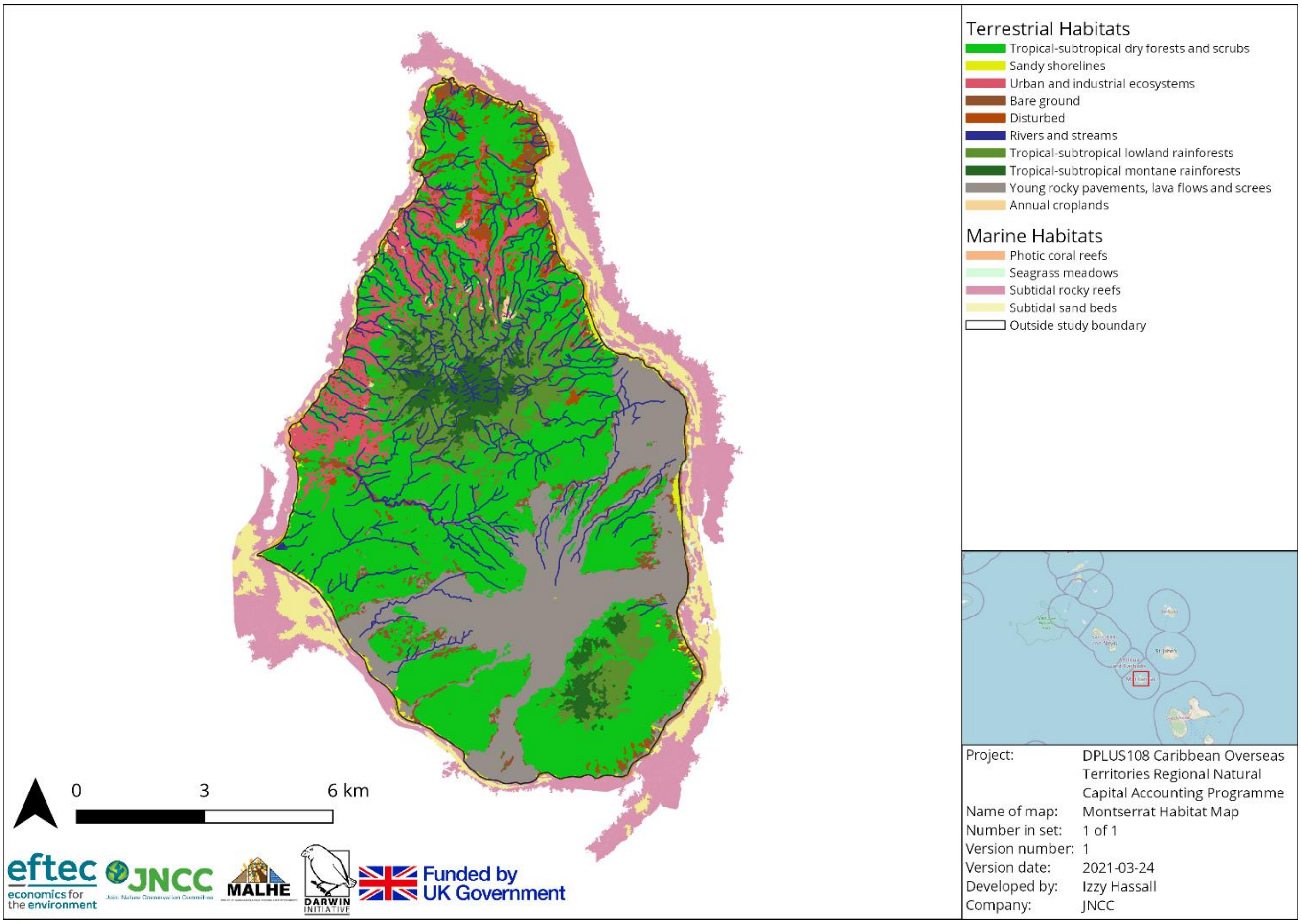

Figure 1: Montserrat terrestrial and marine ecosystems
Source: JNCC GIS analysis of JNCC Montserrat Habitat map.

[6] Rayment (2007) Costing Biodiversity Priorities in the UK Overseas Territories, RSPB. Annex 10: Montserrat.

Box 1: Ecosystem accounts

The ecosystem accounting approach helps frame the interconnection between humans and the environment in economic terms. The environment can be viewed as an asset, or natural capital, that provides a revenue of ecosystem goods and services, which benefit people. This includes provisioning services, such as agricultural produce or fisheries, regulating services, such as protection from natural hazards and carbon sequestration, and cultural services, such as tourism and local recreation. These benefits can be measured and valued in a consistent and structured manner, and compiled into an accounting framework, called ecosystem accounts. Ecosystem accounts produce environmental statistics which provide an evidence base on the benefits provided by the environment.

An ecosystem account is structured as a set of component accounts, each of which require data to be consistently collected and collated in a systematic way. The main components of an ecosystem account are:

- **Extent and condition accounts** - an inventory that holds details on the state of all ecosystem assets that are present, including their extent and condition (quality and other relevant factors). For example, the spatial area of a reef system, and its health in terms of suitable indicators.
- **Physical flow account** – contains the flow of goods and services which are dependent on the ecosystem assets that are identified in the extent and condition accounts. This includes benefits related to provisioning, regulating and cultural goods and services provided by ecosystems.
- **Monetary flow account** – calculates the annual value of the estimated flow of benefits that are captured in the physical flow account. The overall asset value is estimated based on assumptions about the values of the physical and monetary flows into the future.

This set of accounts therefore monitor the presence and state of different habitats, the benefits these provide, and the value that humans receive from them. When updated year on year they provide a useful means to monitor and evaluate growth or decline in any of these elements, while also helping to understand the relationship between the environment, the services it provides, and how humans use and value them.

Contents

1.Introduction

eftec, with project partner Joint Nature Conservation Committee (JNCC) and funding from the UK Government, have initiated *natural capital accounting* with the environment and statistics departments of the local governments of five UK Overseas Territories (OTs)[7]. The purpose is to build initial *ecosystem accounts* and to provide a foundation for data collection and processing to produce national environmental statistics in support of better decision making.

As far as possible, the ecosystem accounting work is aligned to producing UN SEEA-EA compatible accounts. The UN adopted the SEEA-EA as an internationally recognised statistical standard in March 2021. This is an important step supporting the development and integration of ecosystem accounts into national accounts, and thereby forming a basis of environmental economic evidence for policy makers. The SEEA-EA standard is new, much work is yet to be done on practical implementation. It will take time before a comprehensive and broadly applicable guidance is developed and consistently put into practice. Therefore, the accounts can be expected to evolve over time, becoming more robust and complete through subsequent iterations. The current project establishes the groundwork from which this can occur.

Ecosystem accounts are a structured way to measure and monitor the benefits provided by the natural environment. They can be produced alongside other national accounts as a basis for understanding human dependence and impact on the environment, and to inform policy and planning decisions. They should be updated annually to build up the available evidence base, to demonstrate change over time, and to improve on the methods applied.

This report gives an overview of the concepts, process and structure of ecosystem accounts, and current progress on their implementation. It provides additional context for the ecosystem account summarised above. The remaining sections are structured as follows:

- **Section 1:** Introduction
- **Section 2:** Background on Natural capital and ecosystem accounts
- **Section 3:** Implementation of ecosystem accounting
- **Section 4:** Conclusion

[7] The OTs included in this project are Anguilla, British Virgin Islands, Cayman Island, Montserrat and Turks and Caicos Islands.

2. Natural capital and ecosystem accounts

This section presents the background and concepts of natural capital and ecosystem services, also describing the process which produces ecosystem accounts and the structure of the accounts. As the SEEA-EA is recently published, the relationship with natural capital accounting is still evolving. As applied in this report, the SEEA-EA standard for ecosystem accounting can be thought of as a subset of the broader process of natural capital accounting. They generally apply the same concepts and methods. SEEA-EA does so in a more specific way to align with the System of National Accounts (which is the internationally agreed standard set of recommendations on how to compile measures of economic activity, such as GDP).

2.1 Concepts

Natural capital is defined by the UK Natural Capital Committee as: "the elements of nature that directly and indirectly produce value or benefits to people, including ecosystems, species, freshwater, land, minerals, the air and oceans, as well as natural processes and functions". Natural capital, or ecosystem assets, provide benefits to people, through ecosystem services. The focus of ecosystem accounting is to measure and value the benefits from ecosystem services and the underlying ecosystem assets, and to present this evidence in a structured format called ecosystem accounts.

In the Common International Classification of Ecosystem Services (CICES), ecosystem services are defined as 'the contributions that ecosystems make to human well-being'. They are seen as arising from the interaction of biotic and abiotic processes and refer specifically to the 'final' outputs or products from ecological systems, specifically the things directly consumed or used by people. Ecosystem services are therefore the flows of benefits which people gain from natural ecosystems, and natural capital is the stock of ecosystems from which these benefits flow (**Figure 2.1**). Ecosystem services can be subdivided into provisioning, regulating, cultural and supporting services (**Box 2.1**).

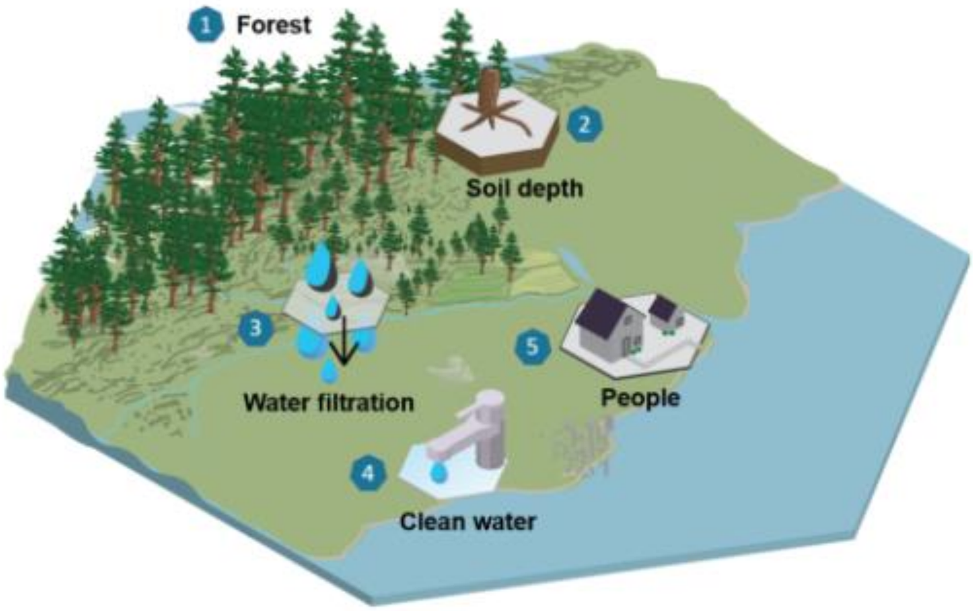

Figure 2.1: How ecosystem assets generate ecosystem services to beneficiaries in a spatial relationship
Source: UN (2021)

Viewing the environment through the lens of natural capital is an effective means to consider its value in the language of economics. Using the concept of capital and expressing the value of ecosystem services in monetary terms helps to integrate the natural environment into decision-making, in which it can otherwise be invisible.

Box 2.1: Types of ecosystem services

The most widely used definition of ecosystem services is from the Millennium Ecosystem Assessment: "the benefits people obtain from ecosystems". It further categorised ecosystem services into four types:

- **Provisioning services**: material outputs from nature (e.g., seafood, water, fibre, genetic material).
- **Regulating services:** indirect benefits from nature generated through regulation of ecosystem processes (e.g., mitigation of climate change through carbon sequestration, water filtration by wetlands, erosion control and protection from storm surges by vegetation, crop pollination by insects).
- **Cultural services:** non-material benefits from nature (e.g., spiritual, aesthetic, recreational, and others)
- Provisioning, regulating and cultural services are referred to as final ecosystem services and are underpinned by **Supporting services**. These are the fundamental ecological processes that support the delivery of other ecosystem services (e.g., nutrient cycling, primary production, soil formation).
- Analysis of benefits from natural capital also includes **abiotic services**, the benefits arising from fundamental geological processes (e.g., the supply of minerals, metals, oil and gas, geothermal heat, wind, tides, and the annual seasons).

2.2 The ecosystem accounting process

Ecosystem accounting is a process of compiling and linking data on the quantity and quality of ecosystem assets and physical and monetary data on the benefits they provide. The data are presented in a consistent framework, which should as far as possible align with the SEEA-EA standards for producing ecosystem accounts. These accounts present evidence to measure and monitor benefits from ecosystems consistently over time to inform policy and planning decisions. In the same way that the structured recording of other national statistics in conventional national accounts informs and improves a country's economic and social decisions, ecosystem accounts can inform better management of a country's ecosystem assets.

Ecosystem accounts are structured as a set of interrelated component accounts that record the value that is provided by a country's ecosystem assets. The aim of these accounts is to answer the following key questions:

- What ecosystem assets do we have? -> An ecosystem extent and condition account (together sometimes referred to as an *asset register)* is an inventory that holds details of the stocks of ecosystem assets that are present within the geographical boundary of the country. For example, a coral reef may contain a variety of species and the quality of this diversity may be measured by the number of species recorded on the site for a few selected taxa (e.g., fish, coral). The asset register helps track trends in the quantity and quality of ecosystems.

- What benefits do these assets provide? -> A *physical* account contains the flow of goods and services which are dependent on the ecosystems that are identified in the extent and condition accounts. This account provides information on the benefits provided by ecosystems, with the flows measured in different physical units (e.g., number of recreational visits or visitors, weight of produce).
- What is the value of these benefits? -> A *monetary* account calculates the annual value of the estimated flow of goods and services that are captured in the physical account. The ecosystem asset account measures the aggregate value of flows of goods and services into the future.

2.2.1 Data collection

Some relevant data will already exist, such as economic data for natural resources, the tourism sector, and utilities and infrastructure data. Additional data can be collected through social research including surveying, economic and econometric analysis, and monitoring of environmental outputs and levels of usage. Geo-referenced socio-economic data along with infrastructure maps can be compared with habitat maps to help identify and measure location specific use.

In practice, secondary data in a readily useable format may be limited, especially with regards to regulating services. Resource and time constraints can further limit primary data collection. This may require an innovative approach with what is available, clearly caveated with assumptions and further inferences to fill remaining gaps and making use of modelling where possible. In such cases, it is important to prioritise the most material benefits in the given context and to focus on where the most value is being provided.

2.3 Structure of ecosystem accounts

This section provides more detail on the component accounts which together make up the ecosystem account. Figure 2.2 presents the links between the components of ecosystem accounts.

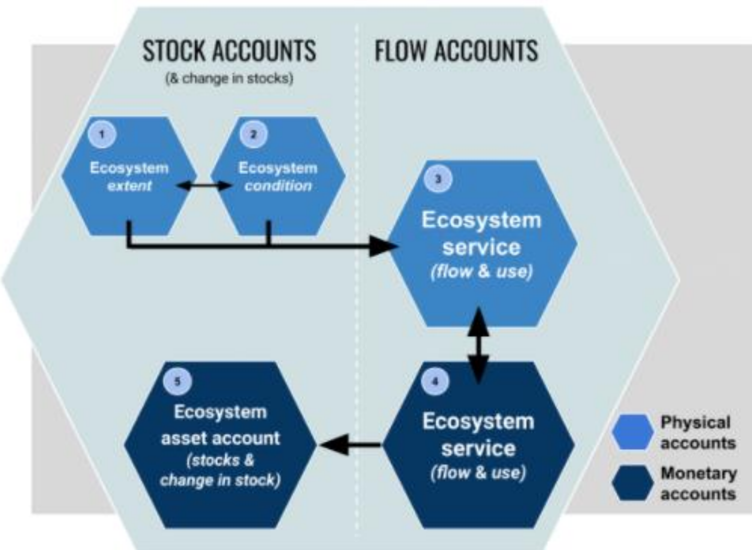

Figure 2.2: Ecosystem accounts and how they relate to each other
Source: UN (2021)

2.3.1 Ecosystem extent and condition accounts

The extent and condition accounts (or asset register) record the quantity and quality of all of the ecosystem assets in a given area. The asset register therefore acts as an inventory that holds details of the stocks of ecosystem assets that are relevant to the accounts, along with information on their quality, functionality, and other relevant factors.

The foundation for an asset register is the distribution and condition of ecosystems which are present within the accounting area. Ecosystem extent can be determined and mapped by desk-based analysis, such as with data available from existing surveys and obtained through existing remote sensing techniques such as Earth Observation (EO) and processed using Geographic Information Systems (GIS). The combination of remote sensing and on-the-ground techniques provides a strong evidence base from which to build the spatial basis for an asset register.

2.3.2 Physical flow accounts

The physical flow account records the flow of goods and services from ecosystems in the asset register. They provide a physical measure of the quantity of benefits provided on an annual basis and include information on the variety of ways that the environment provides value to people. These benefits include the provisioning, regulating and cultural services provided by ecosystems, such as fisheries, sea surge protection and locations for tourism.

Not all physical flows from ecosystems will be significant or material for evaluating. The most relevant flows of benefits should be identified and prioritised for inclusion in an account. Once the prioritised benefits that are possible to quantify are identified, the annual flows should be measured. The approach to measuring the benefits provided within the OTs will vary between territories by type of ecosystem service and benefit.

2.3.3 Monetary flow accounts

The monetary account measures the monetary value of the flows of benefits that are captured in the physical flow account. It aims to measure the exchange value of both market and non-market ecosystem services through different economic valuation techniques. This applies to both the annual value of ecosystem services and the ecosystem asset value, measured as the aggregate value of the expected annual stream of benefits over the defined assessment period.

As the monetary account measures value in a common metric, money, it allows for comparison between different benefits within the accounts, and between different accounts. Importantly, it also allows for comparison across many other factors which may act as inputs to decision making, such as: national economic accounts; the financial cost of an intervention; replacement costs for critical infrastructure; the price paid for public provision of alternative services; and income revenue streams from traditional capital assets. Monetary values help assess trade-offs across these factors, and to justify allocation of resources to environmental management and protection.

2.3.4 Account summary

Physical flows and monetary flows should be recorded separately, and then reported together. This creates added value by showing the links between ecosystems, ecosystem services and the value of benefits to people. Where monetary valuations are uncertain, but suggest certain benefits are important, physical flow indicators might be the best measure. In the context of the OTs, it may be likely in some cases that producing physical flow accounts is more feasible than monetary valuations, but even so the aim should be to build monetary accounts to guide the collection of the most important data for the physical account. Results should always be expressed with appropriate caveats to ensure that the monetary units applied reflect the value as accurately as possible. A traffic light system can be used to indicate uncertainties in data or methods applied in the ecosystem account (see **Table 2.1**).

Table 2.1: Presenting uncertainty in the physical and monetary flow of ecosystem services

Level of confidence	Symbol	Description of confidence
High	●	Evidence is peer reviewed or based on published guidance so there is good confidence in using the data to support specific decisions.
Medium	●	Science-based assumptions and published data are used but there is some uncertainty in combining them, reasonable confidence in using the data to guide decision.
Low	●	Evidence is partial and significant expert judgement-based assumptions are made so that the data provides only order of magnitude estimates of physical quantity or monetary value.

3. Implementation of ecosystem accounting

This section outlines the implementation of the ecosystem accounts, covering progress and next steps of the current ecosystem accounting activities, and areas to explore for applying the ecosystem accounts to policy and planning.

3.1 Current progress and next steps

The current project has initiated and developed ecosystem accounts in the five Caribbean UK OTs. Further embedding them involves engagement with government departments and other stakeholders to gain an understanding of key issues, discuss the concepts and uses of the accounts, and identify and collect available data.

Ideally, the process should be embedded in national statistical outputs through annual updates of the accounts, building more reliable data systems and methodologies with each iteration. Data collection and management systems will need to be developed further to ensure the quality of outputs is of an appropriate level to inform policy and planning. This may involve the use of standardised protocols and knowledge about data handling and processing; however, adoption of these broader protocols must also be applicable to the specific local context. These data collation processes should be led by the statistical departments of each OT, who have expertise in generating accurate and consistent data sets and can align to the SEEA-EA statistical guidance.

While progress needs to be made, it does not necessarily have to be resource intensive once accounting systems are set up, which can then evolve over time rather than requiring significant investment in any one time period. Updates can be streamlined so that as new data is generated, it is fed into the ecosystem accounting system as a matter of routine. While the accounts should be produced on an annual basis, it is not necessary to update every element of them every year – so long as it is transparent what is updated and what is not.

The frequency of updates needs to take into account how sensitive different variables are to change, and aspects of the accounts which would not be expected to change much year on year, or for which resource intensive primary research is needed, may be updated less regularly. However, a significant benefit of the accounts is their ability to monitor trends and provide up to date information to decision makers, and as such they should be reproduced regularly. Any progress or improvement, even if incomplete, will add value to the overall process, and its ability to effectively feed into decision making. As the accounts become increasingly complete records of the value that ecosystems provide, they should become further embedded in the OTs policy and planning systems and a vital component of government statistics and public record.

In the context of sustained pressure to develop, and focus on economic growth in the OTs, it is especially critical to understand what impacts development has on the environment and its ability to provide ecosystem services which benefit people. By initiating and building on the ecosystem accounts in the OTs, it is hoped that additional information will be generated that will directly contribute to this understanding and improved management of the economy and environment for the sustainable prosperity and well-being of the people of the OTs.

3.2 Use of ecosystem accounts

The ultimate purpose of ecosystem accounts is to facilitate improved management of the economy and environment. Better evidence leads to better informed decisions, but those decisions are reliant on understanding and interpretation of the evidence. A considerable advancement of ecosystem accounts is their ability to compile ecological, biophysical, socioeconomic, economic, and other diverse data and produce evidence in a readily useable format. The structure of ecosystem accounts provides a consistent means to present this evidence, but it can also be adapted to specific uses, producing indicators and other information fit for purpose.

There are many areas that the evidence from ecosystem accounts can contribute to, such as:

- **Link to progress on the SDGs**
- **Link to progress on domestic policy**
- **Inform on land use planning**
- **Monitor progress (growth) / deterioration (decline) over time**
- **Engage with the private sector**
- **Understand distribution of benefits (sectoral, individuals)**
- **Understand proportion of economy dependent / at risk**
- **Understand scale of potential economic impact in from specific decisions**
- **Identify priority areas for value provision and maintenance**
- **Identify targets for investment and enhancement**
- **Information for public awareness campaigns**
- **Inform industrial and economic strategy**
- **Understand tax base effects**
- **Understand resident use and benefit of environment**
- **Investigate future impact and sustainability**
- **Conduct economic planning through scenario analysis**
- **Consider potential climate change impacts**
- **Target spending for a green economic recovery**
- **Create indicators to track success management / highlight areas for improvement**
- **Improve data management and flow across departments and sectors creating efficiencies**
- ***Many other specific uses are possible**

Future work should aim to link the ecosystem accounts to relevant policy aims and initiatives. The next phase of the current project will begin to explore this by working with the local government departments to establish priority areas for further development.

4. Conclusion

The 2019 ecosystem accounts represent progress towards establishing an evidence base on the value that the environment provides. However, it should not be considered a one-off assessment, but rather a part of an ongoing process of data collection, methodological improvement and policy and planning implementation that should occur annually. As the SEEA-EA becomes more widely adopted, ecosystem accounts will increasingly inform government policy and planning internationally. The OTs are at the forefront of this process with the current set of accounts but will need to commit to their ongoing development and uptake to maintain this position as the practice evolves.

Specifically, the current project will continue this process over the next year (April 2021 through March 2022) via:

- **Stakeholder engagement** – presenting the approach and results to a wide range of stakeholders to build awareness and support.
- **Training** – build capacity for the development and use of ecosystem accounts by practitioners within the OTs.
- **National Statistics Offices** – working with government statisticians to embed the SEEA-EA in National Accounts.
- **Policy and planning implementation** – develop and promote the use of ecosystem accounts to support policy and planning aims and objectives.
- **Dedicated coordinator** – placement of a dedicated coordinator to support the adoption of ecosystem accounting.
- **Regional practitioners' network** – establishment of a Caribbean regional practitioners' network linking government practitioners across OTs.
- **Aggregate Caribbean OTs account** – compile the 5 OTs ecosystem accounts in to one Caribbean ecosystem account.
- **Link with regional organsiation and initiatives** – make connections with Caribbean region international organisations with an environmental mandate.
- **Caribbean OTs ecosystem accounting conference** – bring together practitioners and experts from across the OTs and other Caribbean nations to learn and network with each other.

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Appendix A - Methodology

This annex sets out the input data and methods used to develop the Montserrat 2019 ecosystem account (Montserrat-NCA-2019_July2021.xls) and provides guidance on how to update each component of the account.

For each component, a description of the input data, its source and a workbook reference for where it is applied are provided, along with how often the data should be updated (definitions for frequency are described in **Table A.1**).

Table A.1: Definitions of frequency assessment for input data updates

Frequency	Definition
Annually	The underlying source should be updated on an annual basis and the accounts should reflect the most up to date data
As source is updated	The underlying source is expected to be updated in the future (i.e., sources that are not updated annually). The accounts should be updated when new data from the same source is available.
As new evidence becomes available	The underlying source is not expected to be updated; a new source would be required to update this input

The remainder of this section is structured as follows:

- Extent account (Section A.1);
- Condition account (Section A.2);
- Physical and monetary accounts (Section A.3); and,
- Input tabs (Section A.4).

A.1 Extent account

The extent account records information on the area of terrestrial and marine ecosystems within the ecosystem accounting area, i.e., Montserrat's terrestrial and marine boundary. **Table A.2** sets out the data sources used to estimate the terrestrial and marine ecosystem extent, which have been applied by GIS specialists at JNCC using GIS modelling software QGIS. The extent account should be updated when the source GIS layers are updated. The extent account is within the tab: '**A1. Asset Register**' of the ecosystem accounting workbook.

Table A.2: Input data for the extent account

Description	Source	Frequency	Workbook reference
Terrestrial habitat map		As source is updated	A1. Asset register tab
Benthic habitat map		As source is updated	A1. Asset register tab
Ghaut area		As source is updated	A1. Asset register tab

A.2 Condition account

The condition account records information on the quality of ecosystems within the ecosystem accounting area. Condition indicators can be associated with ecological communities and species, freshwater, land or soil elements of ecosystems. **Table A.3** provides an overview of the data used within the condition account for Montserrat. The condition account is set within the tab: '**A1. Asset Register**'.

Table A.3: Input data for the condition account

Description	Source	Frequency	Workbook reference
Ecological communities and species			
Forest canopy density	Viridian GIS analysis for eftec and Viridian (2017)	As source is updated	A1. Asset register tab
Land			
Forest reserve area		As source is updated	A1. Asset register tab
Agricultural zone		As source is updated	A1. Asset register tab

A.1.1 Other indicators

Beyond extent and condition of ecosystems, other details on environmental assets have been included in the Montserrat 2019 ecosystem account. These reflect details of spatial configuration (e.g., indicators of connectivity), as well as other forms of capital such as renewable energy generation sites, areas of accessible greenspace as well as mineral zones. **Table A.4** provides an overview of the data sources used to generate these other indicators for Montserrat, which are set within the tab: **'A1. Asset Register'**.

Table A.4: Input data for other indicators

Description	Source	Frequency	Workbook reference
Other forms of capital			
Mineral zone		As source is updated	A1. Asset register tab

A.3 Physical and monetary flow accounts

This section sets out the ten benefits included in the 2019 ecosystem account. For quantified and monetised benefits, it outlines the methods used to value each benefit and the input data that needs to be updated for future accounts. For unquantified or non-monetised benefits, a summary of the existing data, sources and next steps are outlined.

A scope and materiality[8] assessment was conducted to show which benefits are likely to be provided by these ecosystems, and which have been possible to include in this account and which not. The scope and materiality assessment should be updated as new benefits are added or when new ecosystems are included in the ecosystem account. This assessment is set within the tab: **'Scope & materiality assessment.'**

Within the accompanying Excel workbook (Montserrat-NCA-2019_July2021.xls), each benefit has a separate calculation tab, with all estimates of annual flows summarised within the physical account (tab **'A2. Physical account'**) and the monetary account (tab **'A3. Monetary account'**). The monetary account tab also

[8] An impact or dependency on natural capital is material if considering it, as part of the set of information used for decision making, has the potential to alter that decision.

presents an estimate of the ecosystem asset value[9] expressed as a present value of the estimated flow of benefits over the accounting period (25 years).

This section starts with an overview of the flow metrics, monetary valuation metrics and the trend assumptions used for each benefit.

A.1.2 Overview

An overview of the flow and monetary valuation metrics and methods are provided in **Table A.5**. The benefits are split into the following sections:

- **Ecosystem service flow account –** This component contains the physical flow and monetary value accounts. The approach to monetary valuation aligns with the System of Environmental Economic Accounting- Ecosystem Accounting (SEEA-EA) standard which applies exchange values[10] to be comparable to other national accounts (e.g.as applied in the System of National Accounts (SNA)).
- Monetary values based on data from previous years have been inflated to 2019 prices (Economics and Statistics Office, 2020a; U.S. BEA, 2021; HM Treasury, 2021). The monetary values of benefits are calculated per year and summed and discounted over time to estimate present value of benefits using a declining discount rate (starting at 3.5%) (HM Treasury, 2020) and a 25-year study period. **Table A.6** describes the assumptions used to estimate the future flows of benefits over this assessment period. These assumptions should be revisited as new evidence becomes available.
- **Supplementary information** – The SEEA-EA guidance recognises that exchange values do not capture all information useful for decision makers. This section includes additional information outside the scope of the ecosystem account, under the following categories:
    - **Other monetised benefits –** Additional monetary benefits based on exchange values but are outside the scope of the Ecosystem account, e.g., remaining visitor expenditure attributed to ecosystems. This includes economic values, which is dependent on ecosystems, but which might not be entirely attributable to ecosystems within the SEEA-EA framework. For example, expenditure on some activities may not be feasible without the support of ecosystem assets, but only a subset of this expenditure would be attributable to ecosystems within SEEA-EA, as labour and other capitals might also contribute to the production of the good or service.
    - **Welfare values –** Monetary benefits that are based on welfare value metrics such as willingness to pay values. Note that this value includes the consumer surplus that is additional to the exchange value as adopted in the SEEA-EA framework, which also makes it an extension of the value reported with the SNA.
    - **Non-monetised benefit –** There are two types of non-monetised benefits. Firstly, where data for quantifying the physical flow is available and is useful to monitor over time, but there is currently insufficient data nor an appropriate methodological approach to conduct monetary valuation. Secondly, where material benefits exist that are not feasible or not desirable to monetise (e.g., biodiversity, spiritual value, iconic species.

[9] One of the five core accounts in SEEA EA, this account records information on stocks and changes in stocks (additions and reductions) of ecosystem assets, as well as accounting for ecosystem degradation and enhancement (UN, 2021).

[10] Exchange values are equivalent to the price as set by a market (i.e., the price at which supply equals demand) or the price at which an exchange would occur in a hypothetical market. Notably this differs from welfare values which include the surplus value created in addition to the exchange value (i.e., the consumer surplus).

Table A.5: Overview of benefits

Benefit	Flow metric	Monetary valuation metric and method
Ecosystem service flow account		
Fisheries	Volume of output	Market prices
Agriculture	Volume of output	Market prices
Wate supply	Volume of output	Market prices
Sand and aggregates	Volume of output	Market prices
Carbon sequestration	Tonnes of CO_2e sequestered	Non-traded central carbon value BEIS (2018), £/tCO_2e
Tourism	Tourist visits	Tourist expenditure (value added to tourism industry attributed to ecosystems)
Supplementary information		
Other exchange values		
Tourism	Tourist visits	Remaining tourist expenditure (i.e., not value added but attributed to ecosystems)
Welfare values		
Cultural value	Montserrat households	Willingness to pay for cultural services
Non-monetised benefits		
Run-off regulation	-	-
Flood hazard regulation	Number of buildings and length of roads at risk from inland flooding	-
	Number of buildings south of the River Belham	-

Table A.6: Benefit profile assumptions over time

Benefit	Physical flow	Monetary value
Ecosystem account		
Fisheries	No change in volume of fish caught compared to the baseline year.	Assumed constant economic value of benefit over time.
Agriculture	Average weight of arable production (2015-2019)	Assumed constant economic value of benefit over time.
	Average weight of livestock production (2015-2019)	
	Average egg production (2015-2019)	
Water supply	Average volume of water consumed (2015-2019)	Assumed constant economic value of benefit over time.
Sand and aggregates	Average volume of sand and aggregate exports (2015-2019)	Average unit customs value (XCD/tonne, 2015-2018)
Carbon sequestration	No change in sequestration rates over time	Value of carbon emissions increase over time in line with BEIS (2019)
Tourism	Average number of visitors (2015-2019)	Assumed constant economic value of benefit over time.
Supplementary information		
Other exchange values		
Tourism	Average number of visitors (2015-2019)	Assumed constant economic value of benefit over time.
Welfare values		
Cultural value	No change in household numbers from 2019.	Assumed constant economic value of benefit over time.

Non-monetised benefits		
Erosion control	-	-
Flood hazard regulation	-	-

A.1.3 Fisheries

Local fisheries provide sustenance for the people of Montserrat. The fishing fleet provides fish both for consumption by others on the island (providing income for the fishermen), and subsistence for the fishermen themselves. Fishing occurs along the reefs as well as on the coastal and open ocean pelagic zones, with reef fishing being the most common type due to the reef's proximity and also the higher value of some of the fish. The assessment of the value of fishing to Montserrat covers both the subsistence value of the fish kept for consumption by the fishermen, and the volume and value of fish sold on the island (i.e., market value).

Method overview

Montserrat fisheries have been valued in several studies, most notably by a student thesis supervised by the Wolf's Company (Fraga Coiro, 2017; Wolfs Company, 2017) and research undertaken by JNCC (2017)[11]. The literature identifies fish species groupings, the local price of fish and the volume of fish landings by species group. Fraga (2017) identified three main groups of fish species: reef, coastal pelagic and ocean pelagic. The field study conducted by JNCC (2017) surveyed the volume of fish sold and consumed, as well as market prices paid for fish by local restaurants. This data source is thought to be the most robust and is used as the basis for the fishery ecosystem service within this account.

Based on the JNCC field survey, the average volume of fish sold and consumed by fishermen (lb/week) is estimated based on the number of fishing days per week, the volume of catch and the percentage of catch either sold or kept by each vessel in the study sample. It is estimated that approximately 3,700 lbs of fish are sold each week and 600 lbs of fish each week are landed for subsistence. The estimates of weekly landings are extrapolated to annual values based on an assumption of 39 fishing weeks per year, to account for the lack of activity as a result of weather conditions and other factors.

As part of the JNCC field study, restaurants in Montserrat were surveyed to determine how many pounds of local fish per week they purchase, the main local species and the average price they paid per pound. Taking the average across the prices paid per pound by each restaurant leads to an average[12] price of fish of XCD 11 per lb (2019 prices). As the JNCC field study forms the basis of the fisheries analysis presented, this average price is used to value the market value of fisheries in Montserrat. The average market price of fish is assumed to remain constant over time[13].

[11] JNCC, 2017. Field study – data provided by JNCC including transcripts from fishermen and restaurant surveys.

[12] This average is based on 10 respondents and is an average price for all species of fish bought from local sellers (i.e., there is no differentiation between reef fish species or lobster and lionfish, wahoo or snapper).

[13] Fraga (2017) notes that the market prices have remained stable over time. The price of fish has not changed over a decade remaining constant at around XCD 10 per lb, however some of the divers and spear fishers do sell certain species (e.g., lionfish) at up to XCD 14 per lb.

Regarding the value of the subsistence catch, a methodology produced by the World Bank[14] suggests that the value of subsistence catch can be estimated by the market price of a substitute which would provide the same calorific and nutritional content. As a high-level estimate, in this case it is reasonable to assume that the replacement for fish caught for personal consumption would be with fish bought at the market rate, thus the same valuation approach can be applied to both landings that are sold and kept for subsistence.

How to update the account

The benefits are estimated in the tab: **'S1. Fisheries'**. **Table A.7** provides an overview of the input data for the benefit, including the frequency data should be updated and the workbook reference in the account.

Table A.7: Input data for the fisheries benefits

Description	Source	Frequency	Workbook reference
Physical flow			
Data collected on fishing effort and catch per vessel per trip	JNCC field study (2017)	As new evidence becomes available	1.1a
Assumed fishing weeks per year	Pers comm., Montserrat Fisheries Department	As new evidence becomes available	1.1d
Monetary flow			
Average price of fish paid by restaurants	JNCC field study (2017)	As new evidence becomes available	1.2a
Montserrat CPI inflator	ECCB (2021)	Annually	1.2e; Montserrat CPI Index tab

To reproduce these figures, data are needed on quantity of landings, consumption patterns (to estimate subsistence), and prices. Landings figures and price paid to fishermen should be updated annually, while consumption data should be updated as new survey information is produced (at least every five years to account for shifting preferences in sea food consumption). Finally, accurate data and approaches to estimation of the contribution of other factors of production (e.g., physical capital and labour) to the overall economic value would allow for a more refined estimation of the contribution that is directly attributable to ecosystems.

A.1.4 Agriculture

Natural capital on Montserrat includes the fertile soils and hydrology systems which provide sustenance to plant life. With human input these services provide the benefit of agricultural food production. Agricultural activities in Montserrat include fruit and vegetable crop production, livestock production (goat, sheep, and pig rearing), poultry production (broiler and eggs), animal slaughtering/processing, and agro-processing (e.g., cassava, jams, jellies, hot pepper sauce, and wines).

Method overview

The benefit of agriculture is estimated by the weight of agricultural produce by crop type, livestock production by type and the number of eggs by the dozen produced (Statistics Department Montserrat,

[14] World Bank. Economic Valuation of Subsistence Fisheries. Retrieved from: http://siteresources.worldbank.org/INTPACIFICISLANDS/Resources/3-Annexes.pdf

2020). The quantities in the accounting year (2019) are multiplied by the associated farm gate price for each product (Ministry of Agriculture, 2021). After 2019 (i.e., reporting year) the future flows of agricultural production are estimated as a five-year average (2015-2019) of each output type (Statistics Department Montserrat, 2020), however the unit monetary value remains constant over the assessment period.

How to update the account

The benefits are estimated in the tab: **'S2. Agriculture'**. **Table A.8** provides an overview of the input data for the benefit, including the frequency data should be updated and the workbook reference in the account.

Table A.8: Input data for agricultural benefits

Description	Source	Frequency	Workbook reference
Physical flow			
Agricultural production by crop type	Statistics Department Montserrat (2020)	Annually	2.1a
Livestock production by type	Statistics Department Montserrat (2020)	Annually	2.1b
Monetary flow			
Farm gate prices for agricultural products	Ministry of Agriculture (2021)	Annually	2.2a
Farm gate prices for livestock production	Ministry of Agriculture (2021)	Annually	2.2b

Future iterations of the account could estimate the contribution of other factors of production (e.g., physical capital and labour) to the overall economic value to allow for a more refined estimation of the contribution that is directly attributable to ecosystems.

Part of food production in Montserrat is also from fruiting trees. Fruiting trees are clustered in plantations and can be found scattered across the island in the forest and in private gardens – nearly every garden has fruit trees and a patch to grow a few vegetables. Fruits harvested include, but are not limited to, coconuts, mangoes, papaya, breadfruit and breadnut[15]. Certain fruits are also used to make jams and jellies[16]. These products are covered in the Environmental Statistics Compendium (Statistics Department Montserrat, 2020) data, but it is not known whether these capture production from back yard or other scattered trees for households' own consumption.

The harvest from the forest and private gardens that produce fruits and other foods (e.g., breadfruit, coconut) are probably quite an important source of sustenance and income for some people on the island. Produce is often sold through an informal roadside economy. An example of their value is that each forest coconut tree might be harvested twice per year, producing 25 coconuts each time, i.e., 50 coconuts per year. Each coconut is sold for 2-5 XCD, giving a value of 100 – 250 XCD per tree per year. There are estimated to potentially be thousands of accessible coconut trees on the island, with the capacity to support 20 - 30 livelihoods. Trees in private gardens have been bolstered by the distribution of over 1,000 fruit trees per year for more than two decades. Along with forest trees they can be an important food source when conditions for agricultural crops are poor, contributing to the resilience of the island.

[15] Source: Montserrat National Trust.
[16] Source: Montserrat Department of Agriculture.

A.1.5 Water supply

Freshwater springs are a source of water that is abstracted for both use by domestic households, commercial operations and buildings. There are a total of seven springs located in or adjacent to the Centre Hills. The benefit of water supply can be measured in terms of volume produced (i.e., gallons abstracted) or volume consumed (i.e., gallons abstracted that is used by consumers). In this account, data for both production and consumption are collated however, the main reporting value is the volume of consumption and the associated market price based on Montserrat water charge rates.

Method overview

The volume of water consumed and produced is recorded by Montserrat Utilities Limited (MUL) and has been collated in the Environmental Statistics Compendium (Statistics Department, 2020). Annual production levels are recorded at each spring. Water consumption (residential and non-residential users) volumes[17] are recorded monthly, the total of which provides an annual figure. Based on what is reported in the Environmental Statistics Compendium, the latest data year (i.e., 2019) is set as the reporting year value, after which a five-year average (2015-2019) of the volume of water produced or consumed is profiled over time.

The volume of water consumed has been valued using MUL's latest water rates. The MUL charge rates are likely to capture some added value from the underlying infrastructure to supply consumers (e.g., pipes and other equipment). MUL charge rates differentiate between commercial/building and domestic (i.e., residential) properties and by the volume of water consumed (on an escalating scale). The commercial and building price of water consumption (28 XCD/thousand gallons) is applied the volume of water consumed in each year. Note that this is a flat rate set in January 2004, and therefore remains constant over time. In the present value calculation, the annual monetary value in each year will vary in line with the physical flow.

Water supply has also been valued by van Beukering, et al. (2008) study on the Centre Hills protected area of forest. The study based this value on the annual volume of water produced by springs in the Centre Hills which was recorded at 146 million gallons. However, it noted that the actual volume used was around 117 million gallons. This was valued using an annual replacement cost which is lower than the MUL charge rate. This results in differing physical flow estimates and monetary values when compared to the approach used in this account. Discrepancies in volumes are likely to be due to differing supply source boundaries (e.g., van Beukering et al. only assesses what lies within the Centre Hills).

How to update the account

The benefits are estimated in the tab: **'S3. Water supply'**. **Table A.9** provides an overview of the input data for the benefit, including the frequency data should be updated and the workbook reference in the account.

Table A.9: Input data for water supply benefits

Description	Source	Frequency	Workbook reference
Physical flow			
Volume of water produced by each spring	Statistics Department Montserrat (2020)	Annually	3.1a

[17] Previously this data has not reflected local water supplies such as sources used for irrigation by farmers.

Volume of water consumed	Statistics Department Montserrat (2020)	Annually	3.1b
Annual water consumption by type of consumer	Statistics Department Montserrat (2020)	Annually	3.1c
Monetary flow			
Water rates effective 1st January 2004	Montserrat Utilities Limited	As source is updated	3.2a

To further refine the water supply benefit method applied additional information on the relationship between production and consumption volumes (e.g., to account for differences in reported volumes). Water consumption by user type (e.g., public supply, private supply, agricultural use) can also be incorporated into the calculation to identify beneficiaries more clearly across Montserrat. Future iterations of the account could estimate the contribution of other factors of production (e.g., physical capital and labour) to the overall economic value to allow for a more refined estimation of the contribution that is directly attributable to ecosystems.

A.1.6 Sand and aggregates

Sand and gravel are extracted in the south of island and are used for construction on-island or exported. Total extraction is not known, but the majority is exported, and the Montserrat Port Authority collects monthly data on the net weight of sand and aggregate exports (tonnes) and their corresponding customs value (XCD).

Method overview

The most recent figures on total sand and gravel exports (tonnes) are reported in the Environmental Statistics Compendium (Statistics Department Montserrat, 2020). The latest data represents the reporting year value for total sand and aggregate exports. The future flow of sand and aggregate exports is assumed to be equal to the estimated five-year (2015-2019) average export volumes for the remainder of the assessment period. This assumption is made based on historic data, rather than using an approach based on remaining sand and aggregate reserves on the Island and therefore implicitly assumes that sand and aggregates are extracted sustainably into the future.

The value of sand and aggregate exports is based on the recorded export customs value for both sand and aggregates, which is collected by the Montserrat Port Authority. The most recent dataset provides monthly sand and aggregate export customs value between 2013-2018 (Montserrat Port Authority, 2018). As the physical flow data represents a combined total volume for sand and aggregates, the average unit customs values for sand and aggregate exports for each year from 2015-2018 is estimated by dividing the sum of the sand and aggregate customs volume (Montserrat Port Authority, 2018) by the total volume of sand and gravel exports (Statistics Department Montserrat, 2020). The unit customs value for sand and aggregate exports based on 2018 data is applied to the current reporting year, which is approximately 25 XCD/tonne of sand and aggregate exports in 2019 prices. This is multiplied by the 2019 volume of sand and aggregate exports. After 2019, the four-year average (2015-2018) unit exports value (approximately 30 XCD/tonne) is applied to the subsequent physical flow.

How to update the account

The benefits are estimated in the tab: **'S4. Sand and aggregates**. **Table A.10** provides an overview of the input data for the benefit, including the frequency data should be updated and the workbook reference in the account.

Table A.10: Input data for sand and aggregates benefit

Description	Source	Frequency	Workbook reference
Physical flow			
Sand exports, net weight	Montserrat Port Authority (2018)	Annually	4.1a
Aggregate exports, net weight	Montserrat Port Authority (2018)	Annually	4.1b
Sand and aggregate exports	Statistics Department Montserrat (2020)	Annually	4.1c
Monetary flow			
Sand export customs value	Montserrat Port Authority (2018)	Annually	4.2a
Aggregate export customs value	Montserrat Port Authority (2018)	Annually	4.2b
Montserrat CPI inflator	ECCB (2021)	Annually	4.2c

In this iteration of the Montserrat ecosystem account, the 2019 export customs values were requested as part of the data collection process, but they were unable to be sourced and therefore not included in the account. In the future, it is recommended that this data be included to reflect the reporting year value more accurately and to track trends in export values.

A.1.7 Carbon sequestration

Carbon sequestration refers to the ability of the natural environment (both terrestrial and marine) to remove carbon from the atmosphere. This benefit contributes towards global climate regulation. This benefit is estimated using the sequestration rates for each habitat (tonnes CO_2 equivalent per hectare) and the UK non-traded price of carbon.

Method overview

Table A.11 shows the global average per hectare carbon sequestration rates for terrestrial and marine habitats. Two main sources are used as the basis of the carbon sequestration rate estimates – Murray et al. (2011); as cited in IUCN (2017) and Alongi (2014). The midpoint sequestration rates between the two sources are used in the analysis.

Table A.11: Carbon sequestration rates by habitat type (tCO_2e/ha/yr)

Habitat	Murray et al. (2011); IUCN (2017)	Alongi (2014)[1]	Midpoint
Terrestrial			
Mature tropical forest	2.3	-	2.3
Marine			
Seagrass	4.4	2.0	3.2
Saltmarsh	8.0	5.5	6.8
Mangroves	6.3	6.4	6.3
Estuaries	-	1.7	1.7
Shelves	-	0.6	0.6

Table Notes:
[1] The values reported were converted from $gC/m^2/yr$ to $tCO_2e/ha/yr$ using the IPCC (2018) tC to tCO2e conversion factor of 3.67, gram to tonne and m2 to ha conversion factors.

The total amount of CO_2 equivalent sequestered is estimated by multiplying these per hectare rates with the total hectare area of the respective habitat type, as recorded in the ecosystem extent account. **Table A.12** summarises the assumed carbon sequestration rate for each ecosystem type. The carbon sequestration rates are assumed to remain constant over time.

Table A.12: Assumed carbon sequestration rate for each ecosystem type

Extent account ecosystems	Applied sequestration rate
Dry forest	Mature tropical forest
Wet woodland	Mature tropical forest
Seagrass	Seagrass

The amount of CO_2e sequestered is then valued following the BEIS (2019) guidance. The economic value of carbon sequestration is estimated using the non-traded central price, £70 per tonne of CO_2e in 2019**.** The economic value of carbon sequestration is estimated using the non-traded central price, £70 per tonne of CO_2e in 2019**.** The UK carbon prices were multiplied by the relative GDP per capita in Montserrat[18] as compared to the UK (Statistics Department Montserrat et al., 2020; Statistics Department Montserrat, 2020; ONS, 2020) and then converted to Eastern Caribbean dollars (HMRC, 2020). The carbon price is then multiplied by the estimated tonnes of CO_2e sequestered. Future monetary values of carbon sequestration change in line with the UK carbon price series (BEIS, 2019).

How to update the account

The benefits are estimated in the tab: '**S5. Carbon sequestration**'. **Table A.13** provides an overview of the input data for the benefit, including the frequency data should be updated and the workbook reference in the account.

Table A.13: Input data for carbon sequestration benefits

Description	Source	Frequency	Workbook reference
Physical flow			
Ecosystem extent		As new evidence becomes available	5.1a
Terrestrial and marine carbon sequestration rates	Murray et al. (2011); Alongi (2014)	As new evidence becomes available	5.1b, 5.1c
Monetary flow			
Montserrat GDP by economic activity in current prices	Statistics Department et al. (2020)	Annually	5.2a
Montserrat population	2018 Intercensal Count & Labour force Census in Statistics Department Montserrat (2020)	As new evidence becomes available	5.2b
UK GDP per capita at current prices	ONS (2020).	Annually	5.2c

[18] This has been estimated by dividing Montserrat GDP at current prices in 2019 (Statistics Department et al., 2020) by the population of Montserrat recorded in 2018 (Statistics Department Montserrat, 2020).

UK Carbon prices	BEIS (2019)	As source is updated	5.2d; UK Carbon prices full tab
GBP to XCD exchange rate	HMRC (2020)	Annually	5.2g
UK GDP deflator	HM Treasury (2021)	As source is updated	5.2e; UK GDP deflators tab

Data inputs for the physical flow can be updated as science and understanding of carbon sequestration rates of ecosystems improves. All data for the monetary flow can be updated annually.

A.1.8 Erosion control

Habitats on Montserrat regulate hydrology in several ways. Assessment of these services on Montserrat has modelled runoff regulation, which mitigates flood and erosion risk, taking into account slope and vegetation cover[19.], to give analysis of:

- Flow accumulation;
- Areas liable to flood, which reflects both runoff modelling, and further modelling of the role of reefs is absorbing wave energy during storms;
- Flooding mitigation; and
- Erosion control.

The modelling produces maps of both the 'provision' of these services, and the 'solution' which represents the optimal areas to increase them. There are also maps showing overall provision and solution, which combines assessment of flood mitigation and erosion control. This has resulted in 22 maps of these services.

Method overview

The mapped results have been generated for the whole island. However, as the results are relative across Montserrat (comparing different areas to each other), the volcanic deposits in the south distort the results, for example due to the very high erosion risk on poorly consolidated ash.

Therefore, the analysis has also been re-run on the northern half of the island, which covers the Centre Hills forests and developed areas where these regulating services have more direct effects on human welfare[20]. The modelling shows areas which are most liable to flooding. This includes some areas on the coast where during storms water will pool behind existing flood defences, which could also coincide with areas inundated with sea surge flooding during an extreme event.

The modelling of erosion control shows similar patterns to flow accumulation. However, erosion risks arise when there is greater build-up of overland water flow. Therefore, the area identified as at risk of soil erosion is not as extensive at the area at risk from surface flow accumulation. This can be observed in the more extensive areas indicated in white around the centre hills. This reflects the soil protection function of the forest cover, both with the forest and to down-slope areas.

The modelling presented in the maps illustrates the following patterns in hydrological regulating services

[19] The modelling uses habitat properties gathered by the Natural Capital Project, Stanford University, and island land cover data.

[20] The boundary of these maps is defined through the island's districts with a resident population.

on Montserrat:

- The forests of the Centre Hills have highest value in terms of erosion mitigation service and overall hydrological regulation.
- The area at risk of soil erosion is lower than the area of surface flow accumulation risk. However, the consequences of soil erosion, including loss of fertile agricultural soils and soil destabilisation (potential risk of landslides) may be more severe than for flow accumulation.
- There are opportunities for habitat creation on the coastline to buffer sediment runoff into the sea. This could help protect the reef and seagrass areas in Montserrat's waters from sedimentation.
- There is generally lower service provision on the coast as there is less property and land that is protected downstream.

The 'solution' areas in the erosion risk model identify different types of intervention, as show on the map key: *Slow flows* (e.g., through woodland planting); *Retain water* to prevent flow accumulation in soil (e.g., through wetland habitats); and *Protect soil* by binding it (e.g., through establishing grassland).

Figure A.1shows the accumulation of erosion risk for the north of Montserrat, and Figure A.2 shows the relative provision of erosion control services to the landscape by each map pixel ranked relative to all other pixels. The flow accumulation map (Figure A.1) is a generalisation of the number of up-slope areas flowing into each pixel. It is simply a guide to where the main flow paths exist for any surface flow, so judgments on risks of erosion are indicated, but need further work to be conclusively identified. These maps form a basis to develop understanding of how development decisions and run-off will impact on infrastructure, water supplies and the wider environment during storm events.

Although monetary valuation cannot be made, indicators for these services can be quantified. Risk to infrastructure can be quantified with respect to the roads network, which is key infrastructure and common to all developed areas. The erosion risk modelling has been analysed across 1 ha pixels for the north of Montserrat. Approximately 1,050 pixels that contain part of the road network have been identified. Of these, 223 pixels (21.2%) that have at least a 10-times higher than average erosion risk are shown in Figure A.3. Most of the cells identified have 10 – 100 times higher risk (yellow), but a handful of cells have 100 – 400 times higher risk (orange), and 400 – 1,000 times higher risk (red) respectively.

This mapped information provides an important input to future land use planning on Montserrat, including identification of the highest-risk areas for flow accumulation and soil erosion. In these areas further development should be carefully scrutinised for resilience for these risks, and mitigating actions (e.g., appropriate tree planting) should be considered to protect existing or future developments.

The data that can be produced from the modelling have limitations due to lack of soils data for the island. These limitations mean there is a moderate level of uncertainty with the results, and also prevents detailed modelling of the marginal impact of the presence of vegetation on flood and soil erosion risk. This means that the results cannot be connected to specific impacts on property or infrastructure, or any economic valuation in monetary terms. Those using the data should be aware of the limitations of the modelling and use the results in combination with local knowledge.

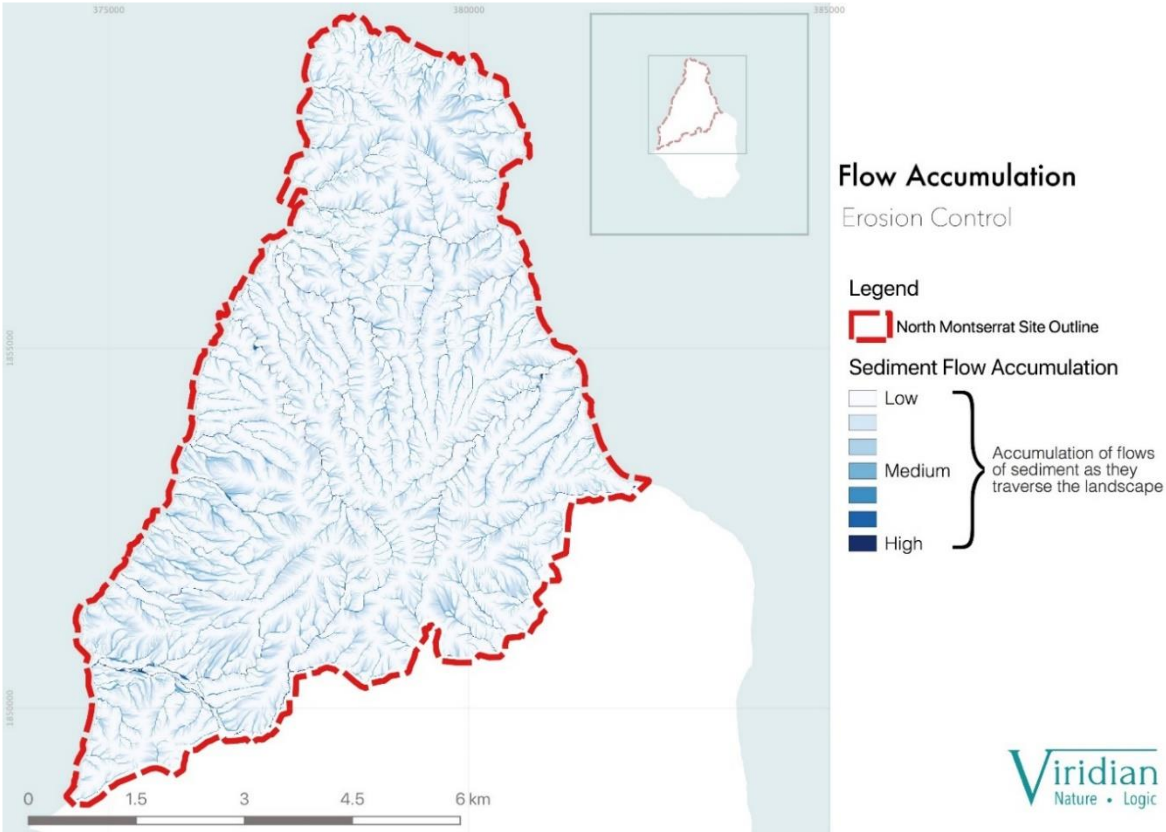

Figure A.1: **Erosion risk accumulation on the north of Montserrat**

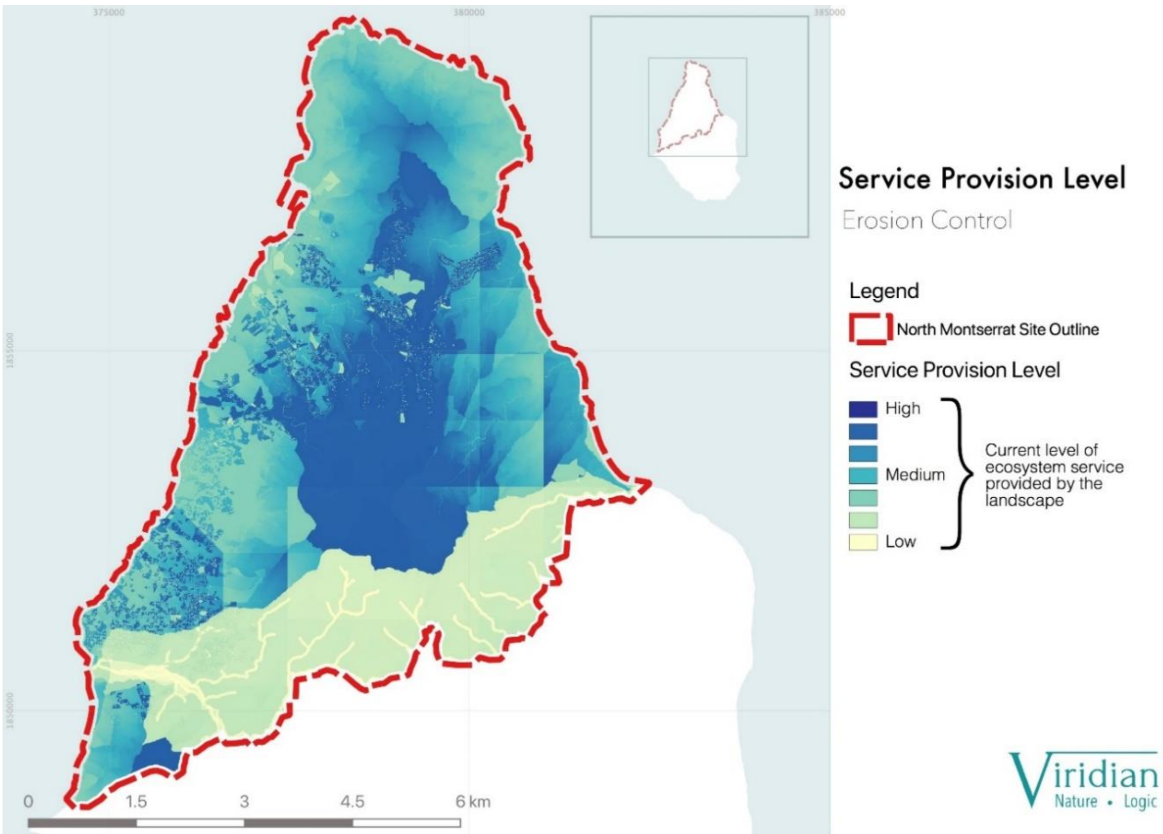

Figure A.2: **Erosion control service provision on the north of Montserrat**

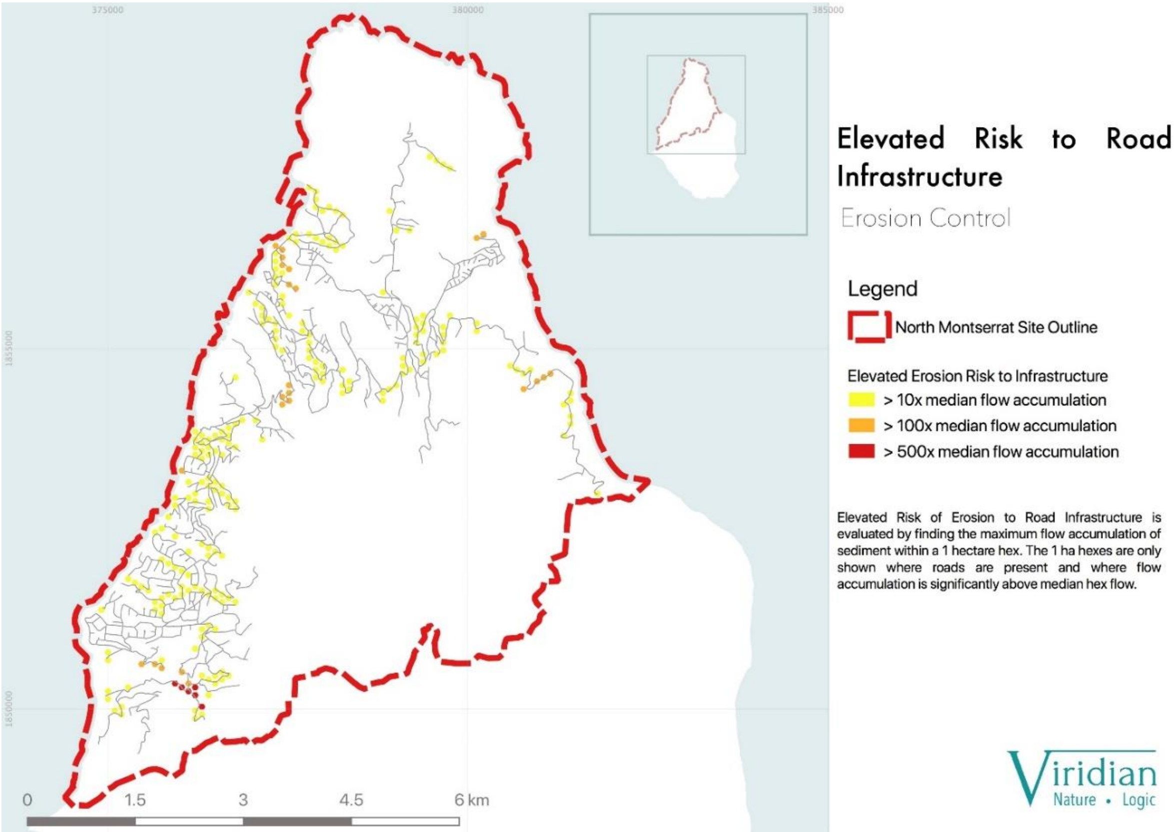

Figure A.3: Erosion risk to roads on Montserrat

How to update the account

The approach requires GIS analysis and the specified data inputs with which to model the impact. The modelling can be updated with the most up to date infrastructure and habitat maps as they are produced. Doing so on a regular basis will track changes in development and vegetative cover which can help monitor the change in the risk to road infrastructure with changing land use, as well as to identify high risk erosion areas for future development planning. Note that there is potential overlap between this benefit and the benefits of agriculture and fishing, whereby a portion of the value of agricultural and fisheries produce may be double counted as avoided losses due to protection from erosion which may negatively impact these sectors. This could be further assessed with additional data and research but is not material in this iteration of the account. There is potential overlap with other benefits, as well as additional value would be expected due to avoided property loss and sedimentation clean-up costs. Changing weather patterns should also be incorporated into any future modelling of this benefit.

A.1.9 Flood hazard regulation

Extreme rainfall has caused severe inland flooding in recent years across Montserrat. As a result of this extreme weather main roads on the Island are flooded resulting in connectivity impact as well as lost business days. The existing natural capital in Montserrat provides protection to the Islands infrastructure (road networks and buildings) from damage and flooding due to storm events. This benefit is focused on the avoidance of physical damage to infrastructure from surface flooding events as well as community severance due to flooded access routes.

Method overview

Based on the modelling approach set out in Jones et al. (2020), GIS analysis undertaken by JNCC (2020) produced the number of buildings and length of roads at risk of flooding in Montserrat were identified. The modelling output identifies the total buildings/road lengths at risk by storm type (i.e., Tropical Storm or Category 1 to 5) and by flood risk zone (scale 1 to 5). This data is within the non-monetised benefit section of the reporting table.

The modelling from JNCC (2020) also provides estimates for the changes in flood risk areas under two different natural capital scenarios for a Category 3 storm event: (i) removed all roads, where the roads were converted to dry scrub, simulating a scenario where these were all removed; and (ii) low roads, where roads above 100m elevation were removed and converted to dry scrub. The modelling output includes the number of buildings and road lengths at risk in each scenario and by flood risk zone (scale 1 to 5). This modelling will provide the basis for valuation for the next iteration of the account.

In addition, the main impact of inland flooding from the flooded road network is a loss of business days and connectivity. The number of buildings south of the River Belham provide an indication of the number of households impact by loss of connectivity (i.e., unable to travel to work) due to the flooded road network. The appropriate valuation method for this impact will be invested as part of the next iteration of the account.

How to update the account

The benefits are estimated in the tab: **'S7. Flood hazard regulation'**. **Table A.14** provides an overview of the input data for the benefit, including the frequency data should be updated and the workbook reference in the account. Note that estimated number of buildings and roads at risk of flooding will be estimated as part of the next iteration of the account.

Table A.14: Input data for flood hazard regulation

Description	Source	Frequency	Workbook reference
	Physical flow		
Number of buildings at, by storm type and risk category	JNCC (2020); Jones et al. (2020); World DEM © DLR e.V 2019, Distribution: Airbus DS/Airbus DS Geo GmbH	As source is updated	7.1a
Length of road at risk, by storm type and risk category	JNCC (2020); Jones et al. (2020); World DEM © DLR e.V 2019, Distribution: Airbus DS/Airbus DS Geo GmbH	As source is updated	7.1b
Total number of buildings south of River Belham	JNCC (2020); World DEM © DLR e.V 2019, Distribution: Airbus DS/Airbus DS Geo GmbH	As new evidence becomes available	7.1d

A.1.10 Tourism

Montserrat attracts tourists through its culture and natural environment. Within this, the single biggest attraction is the Soufriere Hills volcano. Other key features of Montserrat are the Centre Hills Forest (e.g., hiking and tours) and the sea (e.g., beach, diving, fishing). When people stay for several days, they usually do a combination of these things. Visitors provide important trade for restaurants on the island, which offer the opportunity to eat fresh, locally caught fish.

Method overview

The Montserrat Tourism Division records visitor arrivals by visitor type: tourists, excursionists, cruise passengers and yacht arrivals, annual figures by mode of travel (air or sea) are reported in the Environmental Statistics Compendium (Statistics Department Montserrat, 2020). Visitor arrivals are adjusted to exclude arrivals visiting the Island for business, this is approximated using the latest accessible data on visitor arrivals by purpose from 2016 and estimating the proportion of tourists and excursionist arriving for business as a proportion of total arrivals in each visitor group. This proportion is applied to the current year's recorded tourist and excursionist arrivals, with the product subtracted from the 2019 total tourist and excursionist arrivals (Statistics Department Montserrat, 2020). Cruise passengers and yacht arrivals are set equal to the latest total figure (i.e., 2019) (Statistics Department Montserrat, 2020). The estimated proportions of arrivals by purpose remain constant, however the future number of arrivals are estimated as a five-year average (2015-2019) for each visitor type (Statistics Department Montserrat, 2020).

The value of arrivals in the account is estimated using visitor expenditure, where average expenditure per visitor is estimated by dividing total expenditure by total visitor arrivals (i.e., no distinction between visitor types). Following the approach set out in Guzman et al. (2017) for the Cayman Islands, the average expenditure per visitor is multiplied by the assumed proportion (25%) of total spend that corresponds to added value of the tourism industry (Schep et al., 2012). The value added is then multiplied by an assumed factor of ecosystem dependence, which for Montserrat is 100%[21]. The resulting value added per visitor adjusted for ecosystem dependence is then multiplied by the estimated number of total visitors to Montserrat. The monetary unit value is assumed to remain constant over time.

The remaining annual visitor expenditure (i.e., remaining 75% of total expenditure) is adjusted for ecosystem dependence and multiplied by the number of total visitors to the Island as well. In the absence of projection data, the attributable expenditure is assumed to remain constant over future time periods. This additional ecosystem dependent[22] value is reported as supplementary information to the ecosystem account.

How to update the account

The benefits are estimated in the tab: **'S8. Tourism'**. **Table A.15** provides an overview of the input data for the benefit, including the frequency data should be updated and the workbook reference in the account.

Table A.15: Input data for tourism benefits

Description	Source	Frequency	Workbook reference
Physical flow			
Tourist arrivals by purpose of visits	Montserrat Tourism Division, 2015-2016	As new evidence becomes available	8.1b
Excursionist arrivals by purpose of visit	Montserrat Tourism Division, 2015-2016	As new evidence becomes available	8.1c

[21] Although, note that further research is required to understand the relationship between ecosystems and visitor expenditure based on activities and/or spending categories.

[22] See A.1.1 on ecosystem dependent expenditure versus ecosystem attributable expenditure.

Visitor arrivals by purpose of visit	Montserrat Tourism Division, 2015-2016	As new evidence becomes available	8.1d
Visitor arrivals by type of visitor	Statistics Department Montserrat (2020)	Annually	8.1e
Monetary flow			
Visitor expenditure over time	Pers comm, Montserrat Tourism Division	Annually	8.2a
Proportion of total spend that corresponds to added value of the tourism industry	Schep et al. (2012) as cited in Guzman et al. (2017)	As new evidence becomes available	8.2b
Factor of ecosystem dependence	Expert judgment	As new evidence becomes available	8.2c

Tourism data should be updated annually in regard to tourist numbers for each type of visit, while average expenditure data should be updated when relevant survey data is published in order to capture trends, and no more than every five years to capture changing patterns of use and perceived value. Future work should investigate the appropriate monetary valuation approach for this benefit.

There are several specific services provided to tourists in Montserrat, such as nature-guiding, volcano helicopter tours, and diving/snorkelling. For example, Scuba Montserrat makes about 100 boat trips, for approximately 375-400 people, each year (pers comm.). Data on visitor activities would be a necessary addition to refine the valuation approach included in the account. The Montserrat Tourism Division were in the process of collecting data on activities by cruise passengers in February 2020, with a view to extending it to the overnight stay visitors shortly after but this was stopped due to Covid-19 (pers comm, Montserrat Tourism Division).

A.1.11 Cultural value

Cultural values in this account include recreational activities, aesthetic value and knowledge of species conservation. Cultural values for visitors are partly reflected in tourism values (above). While there is limited research on Montserrat regarding cultural services, Van Beukering et al. (2008) do specifically attempt to value them for the Centre Hills, which are a prominent feature of Montserrat's natural capital.

Method overview

The Van Beukering et al. (2008) monetary values are determined on a per household basis, therefore, to determine the cultural value supported by the Centre Hills the users need to be identified. The values are applied to the total number of households in Montserrat, which in 2018 was 2,251 (Statistics Department Montserrat, 2020). This is assumed to be representative of current and future years, and it is assumed all households in Montserrat are users of the Centre Hills.

Van Beukering et al. (2008) adopted a choice experiment[23] approach to evaluate cultural services from the Centre Hills. A choice modelling exercise, whereby relative values are assigned based on stated preferences for various packages of attributes, was developed and administered to 342 islanders. The exercise used attributes for forest cover, wildlife abundance (biodiversity), control of invasive species, trail maintenance and income tax. Various scenarios were tested for respondent's preferences, and the relative importance

[23] Van Beukering et al. (2008) describes choice experiments as a survey-based method that asks respondents their willingness to pay for environmental goods that are not traded in markets.

of the attributes was statistically determined.

As impact on income tax was included within the choice experiment as a numerical value, the relative preference amongst the attributes can be compared with the financial value of the change in income tax to assign a relative financial value to the different attributes weighted by respondent's preferences. The values are determined on a per household basis.

The study uses the attribute of trail maintenance as a proxy for recreational value, and values it as the willingness to pay (WTP) to increase trail quality from medium to high. The attribute for quality of forest cover is used as proxy for aesthetic value, and the value relates to the WTP to avoid a decline in forest cover quality from high to medium. The attribute of mean species abundance is used to measure biodiversity, with the value applied as the WTP to improve from a situation in which unique wildlife species are endangered to a situation with abundant species populations. The ecosystem accounting framework uses exchange values for valuation; however, the use of WTP, a welfare value, provides useful evidence on this benefit and is included in the supplementary evidence to the account. The household willingness to pay values per year, adjusted to 2018 prices, are presented in **Table A.16**.

Table A.16: Willingness to pay of Montserratians for cultural services, XCD 2019 prices

Benefit	WTP	Unit
Recreation	97	Household WTP per year to increase trail maintenance from medium to high
Aesthetic quality	43	Household WTP per year to avoid decline from high quality forest cover to medium quality of forest cover
Species abundance	114	Household WTP per year to improve from unique wildlife species endangered to abundant species populations

How to update the account

The benefits are estimated in the tab: **'S9. Cultural value'**. **Table A.17** provides an overview of the input data for the benefit, including the frequency data should be updated and the workbook reference in the account.

Table A.17: Input data for cultural value benefits

Description	Source	Frequency	Workbook reference
Physical flow			
Total population of Montserrat	Statistics Department Montserrat (2020)	As source is updated	9.1a
Montserrat average household size	Statistics Department Montserrat (2020)	As source is updated	9.1b
Monetary flow			
WTP value of recreation access to the Centre Hills by households	van Beukering et al. (2008)	As new evidence becomes available	9.2a
WTP value of aesthetic quality of the Centre Hills by households	van Beukering et al. (2008)	As new evidence becomes available	9.2b

WTP value of species abundance of the Centre Hills by households	van Beukering et al. (2008)	As new evidence becomes available	9.2c
Montserrat CPI inflator	ECCB (2021)	Annually	9.2d

The WTP value could be updated with a more direct study of Montserratians value of the local environment for cultural purposes, as well as complemented by understanding the local recreation expenditure habits and patterns to add as an exchange value to the ecosystem account.

A.4 Input data tabs

There are several input tabs that are linked throughout the workbook as background information (e.g., ecosystem classification) and as inputs to calculations (e.g., CPI index, discount factors) across multiple benefits. **Table A.18** provides an overview of these input tabs and the frequency that these data sources should be updated.

Table A.18: Input data tabs

Tab name	Description	Source	Frequency
Montserrat ecosystem classification	Ecosystem classification alignment between Montserrat extent layers and IUCN Global Ecosystem typology	Extent account data (Table A.2); IUCN GET (v1.01)	As account is updated
UK Discount Factors	UK discount factors used throughout the workbook.	HM Treasury (2020)	As source is updated
Montserrat CPI Index	Montserrat annual CPI used throughout workbook	ECCB (2021)	Annually
UK GDP deflators	UK GDP deflators used throughout the workbook.	HM Treasury (2021)	As source is updated[1]
UK Carbon prices full	BEIS modelled carbon prices (£) used throughout the workbook.	BEIS (2019)	As source is updated[2]

Table notes:

[1] The HM Treasury released updated UK GDP deflators every quarter as well as part of the Spring or Autumn budget.

[2] UK carbon prices are currently under review, with an update due to be released soon.

Appendix B - Changes in account values

Table B.1 sets out the value estimated in the previous Montserrat ecosystem accounts and notes key reasons for the changes in values. All monetary values are presented in the reporting year price year, e.g., 2019/20 account values are reported in 2019. Sources GDP deflators in Montserrat and the UK have been updated, which impacts the monetary value across all benefits.

The previous Montserrat ecosystem accounts are available online and can be found at JNCC (eftec and Viridian, 2017; eftec and Viridian, 2019).

Table B.1: Changes in account values

	Initial account: 2017/18			Latest account: 2019/20			
Produced at: March 2021	**Physical flow**	**Monetary value (XCDm)**	**PV 60 (XCDm)**	**Physical flow**	**Monetary value (XCDm)**	**PV 25 (XCDm)**	**Notes on changes**
Ecosystem assessment							
Fisheries	166,920	2	48	166,920	1	24	Physical flow has stayed the same. **Input data change:** 2019/20 monetary value reflect use of average reef and pelagic fish price (XCD/lb) (Ministry of Agriculture, 2021). This is a decrease in the unit value to 9 XCD/lb in 2019 prices rather than the average fish price based on JNCC (2017) study which would be 11 XCD/lb in 2019 prices. Change in present value also reflects shorter PV time horizon.
Agriculture	168	0.03	1	95,387	0.3	5	2017/18 refers to total area of cultivated land (acres) valued using land rents. **Method change:** 2019/20 reflects arable, livestock and egg production reported in the Montserrat Environmental Statistics Compendium (2020) and has been valued using latest farm gate prices (Ministry of Agriculture, 2021).
				89,197	1	20	
				28,344	0.3	7	
Water supply	99,083,000	3	73	142,667,360	4	72	Unit price has stayed the same across the accounts. **Input data change:** 2019/20 account reflects volume of water consumed reported in the Montserrat Environmental Statistics Compendium (2020).
Sand and aggregates	1,007,300	9	232	399,370	10	152	**Input data change:** 2019/20 account reflects figures (both physical flow and monetary value) reported in the Montserrat Environmental Statistics Compendium (2020).
Carbon sequestration				16,552	1	33	Carbon sequestration was not assessed in 2017/18 account. **Method change:** 2019/20 account builds on approach set out in 2018/19 account but uses different carbon sequestration rates.
Erosion control							

	Initial account: 2017/18			Latest account: 2019/20			
Produced at: March 2021	**Physical flow**	**Monetary value (XCDm)**	**PV 60 (XCDm)**	**Physical flow**	**Monetary value (XCDm)**	**PV 25 (XCDm)**	**Notes on changes**
Inland flooding				3,165			Inland flooding was not assessed in 2017/18 account. **Method change:** 2019/20 account reflects the total number of buildings (count) and total length of roads (km) at risk from inland flooding. As well as the number of buildings south of the River Belham that may be disconnected from the main part of the Island during an inland flooding event.
				132			
				41			
Tourism	9,293	23	601	15,047	5	89	**Method change:** 2019/20 account only excludes business travellers. Monetary values in 2019/20 have been adjusted to reflect value added to the tourism industry (assumed to be 25% of total expenditure).
Total value		**36**	**955**		**23**	**402**	
Supplementary information							
Other monetary values							
Tourism				15,047	16	268	**Method change:** 2019/20 account only excludes business travellers. Monetary values in 2019/20 have been adjusted to reflects the remaining 75% of total expenditure that is not value added to the industry.
Hunting	450,000	5	119				**Removed from account:** The value could not be accurately substantiated.
Welfare values							
Cultural value	2,576	1	18	2,251	1	12	**Input data change:** 2019/20 account uses number of households in 2018 reported in the Montserrat Environmental Statistics Compendium (2020). Previous account estimated number of households using Worldometer population statistics and UN average household size in Montserrat. Change in monetary values reflect a) inflation and b) different PV time horizon.

Appendix C - Ecosystem service classification comparison

The Common International Classification of Ecosystem Services (CICES) was chosen as a reference point for ecosystem service typology to enable comparison of ecosystem services between accounts (EEA, 2018). CICES is a globally recognised classification of ecosystem services and referenced within the SEEA EA guidance (UN, 2021). The typology structure consists of four levels – section, division, group and class. See EEA (2018) for more guidance on using CICES.

Table C.1 compares the benefit typology used in this account with the CICES class.

Table C.1: Ecosystem services typology comparison

Shorthand	CICES Class
Fisheries	Animals reared by in-situ aquaculture for nutritional purposes
Agriculture	Animals reared for nutritional purposes; Cultivated terrestrial plants (including fungi, algae) grown for nutritional purposes
Water supply	Surface water for drinking
Sand and aggregates	Sand and aggregate substances used for material purposes
Carbon sequestration	Regulation of temperature and humidity, including ventilation and transpiration
Erosion control	Hydrological cycle and water flow regulation (Including flood control, and coastal protection)
Flood hazard regulation	Hydrological cycle and water flow regulation (Including flood control, and coastal protection)
Tourism	Characteristics of living systems that that enable activities promoting health, recuperation, or enjoyment through active or immersive interactions
Cultural value	Characteristics of living systems that are resonant in terms of culture or heritage

Appendix D - Ecosystem classification comparison

To allow the national accounts to be aggregated with other Overseas Territory accounts and compared between countries, the International Union for Conservation of Nature (IUCN) Global Ecosystem Typology (GET) Ecosystem Functional Groups (EFG) was cross-referenced with the terrestrial and marine ecosystem typology used within the Ministry of Agriculture, Trade, Housing, Land and Environment (MAHLE). The IUCN GET is a global typological framework that applies an ecosystem process-based approach to ecosystem classification for all ecosystems around the world. The typology structure consists of six levels. The top three levels – realm, biome and ecosystem functional group - are aligned with the System of Environmental Economic Accounting (SEEA) Ecosystem Type reference (UN, 2021, *see Section 3.4 – Classifying ecosystem assets for more guidance*).

Table D.1 sets out the alignment between the habitat classifications completed by eftec and JNCC.

Table D.1: Ecosystem classification comparison

Terrestrial/ benthic	Montserrat classification	IUCN - GET			Notes on alignment
		Realm	Biome	Ecosystem function group	
Terrestrial	Ash / mud	Terrestrial	T3 Shrublands & shrubby woodlands	T3.4 Young rocky pavements, lava flows and screes	Land covered with volcanic ash/mud
Terrestrial	Bare ground	n/a	n/a	Bare ground	Same as Montserrat classification - IUCN does not have a group that refers to bare ground. Include rock near coast and disturbed ground in urban areas.
Terrestrial	Beach	Marine-Terrestrial	MT1 Shorelines biome	MT1.3 Sandy shorelines	
Terrestrial	Buildings	Terrestrial	T7 Intensive land-use	T7.4 Urban and industrial ecosystems	
Terrestrial	Cultivated area	Terrestrial	T7 Intensive land-use	T7.1 Annual croplands	Refers to land currently under cultivation
Terrestrial	Disturbed ground/ Cultivated area	n/a	n/a	Disturbed ground	Same as Montserrat classification.
Terrestrial	Dry forest	Terrestrial	T1 Tropical–subtropical forests	T1.2 Tropical-subtropical dry forests and scrubs	
Terrestrial	Dry scrub	Terrestrial	T1 Tropical–subtropical forests	T1.2 Tropical-subtropical dry forests and scrubs	Represents shrubby veg (0.5-2.5m tall) at low elevation and low rain
Terrestrial	Dry thicket	Terrestrial	T1 Tropical–subtropical forests	T1.2 Tropical-subtropical dry forests and scrubs	Represents large shurb/small tree at low elevation and low rain

Terrestrial/ benthic	Montserrat classification	IUCN - GET			Notes on alignment
		Realm	Biome	Ecosystem function group	
Terrestrial	Elfin woodland	Terrestrial	T1 Tropical–subtropical forests	T1.3 Tropical-subtropical montane rainforests	Represents shrubby veg at high elevations and high rain
Terrestrial	Mesic forest	Terrestrial	T1 Tropical–subtropical forests	T1.1 Tropical-subtropical lowland rainforests	Represents medium/large tree at mid elevation and mid rain
Terrestrial	Open water	Marine	M2 Pelagic Ocean waters biome	M2.1 Epipelagic Ocean waters	Represents coastal waters
Terrestrial	Rivers and ghauts	Freshwater	F1 Rivers and streams	F1 Rivers and streams	
Terrestrial	Roads	Terrestrial	T7 Intensive land-use	T7.4 Urban and industrial ecosystems	
Terrestrial	Urban	Terrestrial	T7 Intensive land-use	T7.4 Urban and industrial ecosystems	
Terrestrial	Wet forest	Terrestrial	T1 Tropical–subtropical forests	T1.3 Tropical-subtropical montane rainforests	Represents medium/large tree at high elevation and high rain
Benthic	Algal Reef (Hard Bottom)	Marine	M1 Marine Shelfs	M1.6 Subtidal rocky reefs	
Benthic	Algal Reef (Mixed Bottom)	Marine	M1 Marine Shelfs	M1.6 Subtidal rocky reefs	
Benthic	Artificial Reef	n/a	n/a	Artificial Reef	Same as Montserrat classification. Under IUCN habitat classification, this contains both M4.1 Submerged artificial structures and M1.3 Photic coral reefs.
Benthic	Colonized Volcanic Boulders	Marine	M1 Marine Shelfs	M1.6 Subtidal rocky reefs	
Benthic	Coral Reef	Marine	M1 Marine Shelfs	M1.3 Photic coral reefs	
Benthic	Hard Bottom and Sand	Marine	M1 Marine Shelfs	M1.7 Subtidal sand beds	
Benthic	Sand	Marine	M1 Marine Shelfs	M1.7 Subtidal sand beds	
Benthic	Sargassum Forest	n/a	n/a	Sargassum Forest	Same as Montserrat classification - IUCN does not have a group that refers to sargassum forest.
Benthic	Seagrass	Marine	M1 Marine Shelfs	M1.1 Seagrass meadows	

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