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Manual on the Basic Set of Environment Statistics of the FDES 2013

1.1.3 Geological and geographical information

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Statistics in subcomponents 1.1.3 Geological and geographical information

Code and location in the FDES 2013			
Component	**Sub-Component**	**Topic**	**Code and Environment Statistic**
1. Environmental Conditions and Quality	1.1 Physical Conditions	1.1.3. Geological and geographical information	a. Geological, geographical and geomorphological conditions of terrestrial areas and islands
			1. Length of border
			2. Area of country or region
			3. Number of islands
			4. Area of islands
			5. Main geomorphological characteristics of islands
			6. Spatial distribution of land relief
			7. Characteristics of landforms (e.g., plains, hills, plateaus, dunes, volcanoes, mountains, seamounts)
			8. Area by rock types
			9. Length of fault lines
			b. **Coastal waters (including area of coral reefs and mangroves)**
			c. Length of marine coastline
			d. Coastal area

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Introduction

Statistics on geographic and geological characteristics of a country comprise most common and mostly static properties. Geology and its branches have traditionally been used to develop fundamental national data, including topographic maps, geographic names and geodetic networks of reference points. During the past centuries, this data has been instrumental for the development of most national and international infrastructures, national cadastres (property registers), navigation activities, etc. and in recent decades also for monitoring sea level raise.

The production and dissemination of proper statistics on geological and geographic topics was not common in the past, but it will become of critical importance in view of expected global environmental changes, including climate change. In addition, the delimitation of geo-physical and administrative characteristics of countries' land and territorial waters serves as an input to the quantification and reporting of many other environmental topics, hence the quality and comparability of these data is also of critical importance in statistics.

The knowledge of the geological environment is an inexhaustible source of information their interaction with endogenous and exogenous processes shapes the land where people live and perpetrate their activities. Geology is present in our daily life, however, it is uncommon for the population to have a clear perception of this importance and dependence.

The field of sciences and disciplines which include the prefix ‘geo’ is very broad and diverse, therefore the scope of this chapter is narrowed down to address selected subjects from geology and geography: namely the physical characteristics of countries (mostly used in an international comparability context) such as land with area and boundaries and territorial waters; and also rather dynamic features such as coast lines and coastal areas. On the other hand, the related, but separate areas of statistics on land cover and land use, soils and mineral resources are covered in specific chapters.

Definitions and description of the statistics

Definitions and description of the statistics

The main statistical variables in this methodology sheet is the geological, geographical and geomorphological conditions of terrestrial and coastal areas and islands. The following generic definitions apply:

- Geology is the science that pursues the understanding of planet Earth. The science of geology has been divided into two major areas: physical and historical geology.
- Geomorphology is the scientific discipline concerned with the description and classification of the Earth's topographic features.
- Geodesy is 'scientific discipline concerned with the precise figure of the Earth and its determination and significance.

- Geography according to UNESCO is a “science that locates, describes and compares all the geographical phenomena that happen on Earth and the influence they cause on the life of man. The following generic terms and specifications apply: UNESCO (1950).

  - Territory: In the FDES when the term territory is used it means the territory or area of reference, which can be a country, other administrative area below national level, or a natural area such as a watershed or river basin, depending on the context.

  - Toponymy or geographic names is the ‘taxonomic study of place-names, based on etymological, historical, and geographical information.

3.A Definition of the statistics

Topic 1.1.3 Geological and geographical information

The following topics include descriptive information and statistics on the relatively permanent country characteristics, and relatively dynamic changes of the characteristics of coastal areas.

1.1.3.a. Geological, geographical and geomorphological conditions of terrestrial areas and islands.

1.1.3.a.1 Length of border

Length of border is defined by the border line that divides two countries. Total length of the country border and length of segments bordering other countries or entities are relevant. ("Border concept it is define on international right, as the line that indicates their exterior border of a one State territory, it means, line that define spatial context where a State exercises its sovereignty with exclusion of others".

1.1.3.a.2 Area of country or region

It refers to continental area of a country or geographically defined area by some criteria.

1.1.3.a.3 Number of islands

States the approximate number of islands of an island group or island state

1.1.3.a.4 Area of islands

Surface area of the island, island group, or island state in square kilometers

1.1.3.a.5 Main geomorphological characteristics of islands

According to morphological characteristics, three generic terms can be defined:

Island: Any area of land smaller than a continent and entirely surrounded by water. Islands may occur in oceans, seas, lakes, or rivers. Islands may be classified as either continental or oceanic. Oceanic islands are those that rise to the surface from the floors of the ocean basins. Continental islands are simply unsubmerged parts of the continental shelf that are entirely surrounded by water

Reef: A mass of rock or coral (coral reef) which either reaches close to the sea surface or is exposed at low tide and may constitute a hazard to surface navigation

Cay: A small, low island, usually sandy, situated on a coral reef platform. A cay is often elongated perpendicular to the prevailing winds, but its shape may change considerably with deposition in calm weather and erosion during storms. Even fairly large cays are vulnerable to complete destruction by severe hurricanes or typhoons.

1.1.3.a.6 Spatial distribution of land relief

Relief is the physical shape, configuration or general unevenness of a part of the Earth's surface, considered with reference to variation of height and slope or to irregularities of the land surface; the elevation or difference in elevation, considered collectively, of a land surface

A landform is defined as "Any physical feature of the Earth's surface having a characteristic, recognizable shape and produced by natural causes" (Cindy, 2006). Countries may have nationally defined landform descriptions and classifications, depending on their particular relied characteristics.

Typical landforms are mountain slopes and valleys, plateaus, flood-plains, streams, beach, dunes, estuaries, etc. These may be presented in statistical tables with their total area, and where relevant changes or other characteristics.

1.1.3.a.7 Characteristics of landforms

Refers to diverse forms that earth crust acquire, as consequence of tectonic plates movements or external modelling agents as the rain, wind and waves of the sea

- Abyssal plain: Any terrain portion with a flat surface or with mild undulations. Flat region, with smooth slope or almost horizontal of the bottom of the sea:
- Hills: Little isolated elevation smaller than a mountain
- Plateaus: Area of considerable extension flat or almost flat, that falls abruptly in one or more of their sides

1.1.3.a.8 Area by rock types

It refers to an occupied surface for a rocky material type, not included those that are covered by urban infrastructure and water bodies. While not commonly reported in official statistics, this topic is an important input for developing other environmental and integrated assessments, including for defining areas under risks of natural disasters, such as landslides; also, for defining ecosystem types/units for the purposes of SEEA-EEA.

According to the international classification the following broad categories can be distinguished

- Igneous rocks: rock resulting from the solidification of meting rock or magma.
- Sedimentary rock is formed (by the accumulation of sediment in water or from the air
- Metamorphic rock is a rock that has undergone chemical or structural changes produced by increase in heat or pressure, or by replacement of elements by hot, chemically active fluids
- Alluvial deposit is transported by rivers, it consists of silt, sand, clay, and gravel, as well as much organic matter. Alluvial deposits are usually most extensive in the lower part of a rivers course, forming floodplains and deltas, but they may form at any point where the river overflows its banks or where the flow of a river is checked

1.1.3.a.9 Length of fault lines

A fault is a fracture or zone of fractures between two blocks of rock. Faults allow the blocks to move relative to each other. This movement may occur rapidly, in the form of an earthquake - or may occur slowly, in the form of a creep. The fault surface can be horizontal or vertical or some arbitrary.

- Normal fault: a dip-slip fault in which the block above the fault has moved downward relative to the block below. This type of faulting occurs in response to extension efforts and along oceanic ridge systems.
- Reverse fault: thrust fault - a dip-slip fault in which the upper block, above the fault plane, moves up and over the lower block. This type of faulting is common in areas of compression, such as regions where one plate is being subducted under another.
- Strike-slip fault: a fault on which the two blocks slide past one another.
- A left-lateral strike-slip fault is one on which the displacement of the far block is to the left when viewed from either side.
- A right-lateral strike-slip fault is one on which the displacement of the far block is to the right when viewed from either side.

1.1.3.b. Coastal waters (including area of coral reefs and mangroves)

As the interface between terrestrial environments and open oceans, coastal waters encompass many unique habitats and serve important human needs. Coastal habitats include estuaries, coastal wetlands, seagrass meadows, coral reefs, mangroves, kelp forests, and upwelling areas. Coastal waters support a wide range of human activities such as tourism, recreation, transportation, and fisheries.

Coral reef: are one of the most diverse ecosystems on earth. They also protect shorelines and create land by dissipating wave energy and continue to be a potential source of new medicines. Yet coral reefs are threatened by a combination of impacts that include ocean warming and acidification, as well as local pollution, overfishing and sedimentation.

Artificial reef: Is a submerged (or partly exposed to tides) structure deliberately placed on the seabed to mimic some functions of a natural reef, such as protecting, regenerating, concentrating and/or enhancing populations of living marine resources.

Mangroves: Mangroves are the characteristic littoral plant formations of tropical and subtropical sheltered coastlines. They are variously described as coastal woodland, tidal forest and mangrove forest.

1.1.3.c. Length of marine coastline

Coastline is not a uniformly defined concept, because of complexities such as fractal dimensions. Coast is generally defined as ‘broad area of land that borders the sea’. Coastal countries may have more specific definitions and official estimates of its length. Because of the many natural and engineering construction impacts affecting the coastline, its length and shape varies substantially.

1.1.3.d. Coastal area

Coastal areas are commonly defined as the interface or transition areas between land and sea, including large inland lakes. Coastal areas are diverse in function and form, dynamic and do not lend themselves well to definition by strict spatial boundaries.

Related terms:

Territorial sea: According to Part II, Articles 2 and 3 of the United Nations Convention on the Law of the Sea, the territorial sea is a marine space where a coastal State extends its sovereignty, beyond its land territory and internal waters and, in the case of an archipelagic State, its archipelagic waters, to an adjacent belt of sea. And every State has the right to establish the breadth of its territorial sea up to a limit not exceeding 12 nautical miles, measured from baselines determined in accordance with this Convention.

Exclusive Economic Zone: According to Article 55 of the United Nations Convention on the Law of the Sea, the exclusive economic zone is an area beyond and adjacent to the territorial sea, subject to the specific legal regime established in this Part, under which the rights and jurisdiction of the coastal State and the rights and freedoms of other States are governed by the relevant provisions of this Convention.

International sources and recommendations

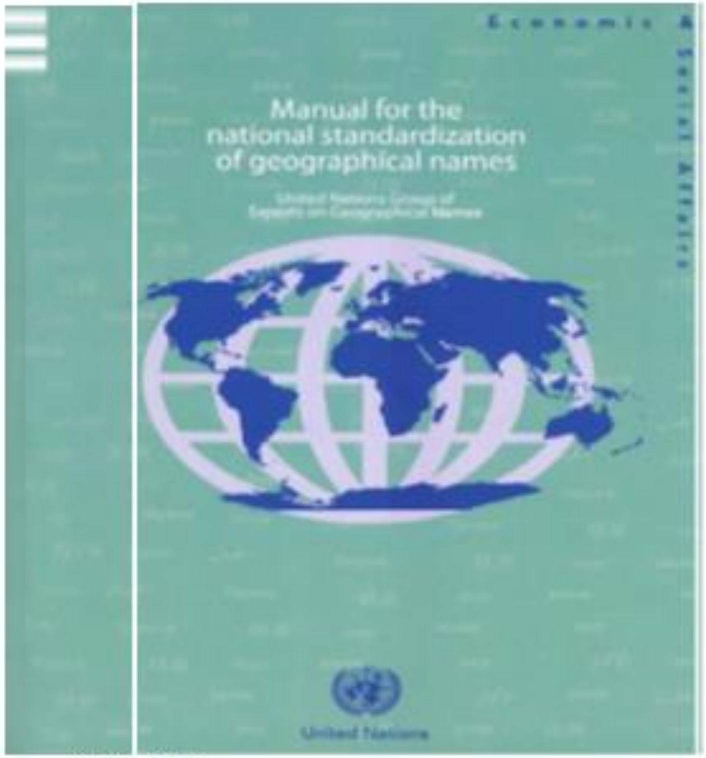
4 A. Classification and grouping

On geographic names

United Nations Group of Experts on Geographical Names (UNGEGN) is one of the seven standing expert bodies of ECOSOC, with over 400 members from over 100 countries. UNGEGN functions through 24 geographical/linguistic divisions and through working groups, currently addressing issues of training courses, digital data files and gazetteers, romanization systems, country names, terminology, publicity and funding, and toponymic guidelines.

UNGEGN's goal is for every country to decide on its own nationally standardized names through the creation of national names authorities or recognized administrative processes.

At the global level, there is a manual for the standardization of the geographical names of the group of experts of the United Nations in geographical names, which makes it possible to give certainty of the sources to be consulted in geographical matters.



Source: United Nations
https://unstats.un.org/unsd/publication/seriesm/seriesm_88e.pdf

Classification and grouping of Rock types

According to the international classification the rocks are classified into.

1. Igneous rocks surface covered by rocks generated by magmatic events that intrude and when cooled form an intrusive igneous rock and by erosion they appear on the surface and when the magma is spread on the surface (lava) and on cooling it forms an igneous extrusive rock.
2. Sedimentary rock surface covered by rocks that by erosion-transport-sedimentation and consolidation processes surface on the surface.
3. Metamorphic rocks covered by rocks that, due to high pressure or temperature processes, modify their mineral composition.
4. Recent Deposit Disintegrated or altered rock material that covers rocks, may be "in situ" or transported by water or air and deposited away from parent material.

The International Stratigraphic Guide indicates that the rock units can be classified based on different properties:

- Lithostratigraphic units. Units based on lithological characteristics of rocky bodies.
- Units limited by discontinuities. Rocky bodies limited superiorly and inferiorly by significant discontinuities in the stratigraphic succession.
- Biostratigraphic units. Units based on the fossil content of rock bodies.
- Magnetostratigraphic polarity units. Units based on the orientation changes of the remaining magnetism of the rocky bodies.
- Chronostratigraphic units. Units based on the age of formation of the rocky bodies.

Rocks are affected by tectonic events, and responds in a fragile or ductile manner.

A fragile structure is considered a discontinuity in the rock in which there is an opening and displacement.

1. Normal failure, when the blocks of a rock mass move, one downwards with respect to the other. The surface on which the movement occurs (fault plane), indicates the relative direction of the movement and is from vertical to inclined.
2. Reverse failure, when one of the blocks moves in an ascending way, with respect to the other along the fault plane, which tends to have a low inclination (< 45 °), it is classified as thrusts "if the inclination is less than 10° they obtain the name of landslides, when the displacement is usually of great magnitude.
3. Lateral failure (of heading), the movement manifests horizontal displacements that cause the lateral sliding of one block with respect to the other, the plane of failure is usually close to the vertical. Depending on the direction of this displacement, we can distinguish the dextral tear, in which, situating ourselves on one of the blocks, we would see the other moving towards our right, and the sinistral, the movement is opposite to the previous one. They are also called transverse failures.
4. Fracture separation of a land surface, without relative displacement of the blocks, on both sides of the plane of the fracture.

4B. Reference to international statistical recommendations, frameworks and standards

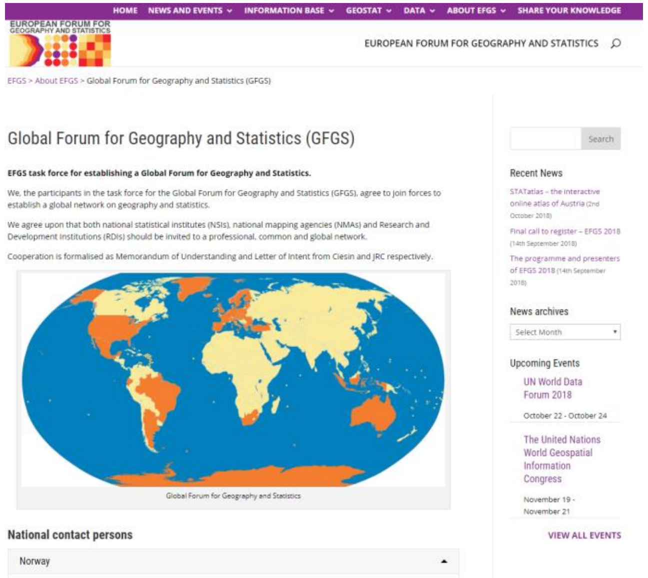
The following international sources provide statistical recommendations and guidance for the production of geological and geographic information statistics and for compiling environment indicators.

- UNESCO
- UNITED NATIONS. Oceans and the Law of the Sea[40]
- USGS. Geological Survey[41]
- IUGS. Earth Science for the Global Community[42]
- UGI. International Geographic Union[43]
- EUROGEO. European Associations of Geographer[44]
- IGS. International Geoscience Services[45]
- BGS. British Geological Survey[46]

[40]UN. https://www.un.org/en/sections/issues-depth/oceans-and-law-sea/
[41]USGS. https://www.usgs.gov/
[42]IUGS. http://iugs.org/uploads/images/PDF/IUGS%20booklet%20print.pdf
[43]UGI. https://igu-online.org/
[44]EUROGEO. http://www.eurogeography.eu/
[45]IGS. https://www.igsint.com/
[46]BGS. https://www.bgs.ac.uk/

4C. Sources of global and regional environment statistics and indicators series

A global statistical information source on geographic information is the Global Forum on Geography and Statistics (GFGS) aims to join forces for the establishment of a global network of geography and statistics, adding to national statistical institutes (INE), as well as the national cartographic agencies (ANM), as institutions and research and development (RDI) should be invited to a professional network, common and global.[47]



A source for geospatial information consultation of the United Nations is the following[48]

[47]GFGS. Global Forum for Geography and Statistics. https://www.efgs.info/about-efgs/global-forum-for-geography-and-statistics/ (accesed on Octubre 23,2018).

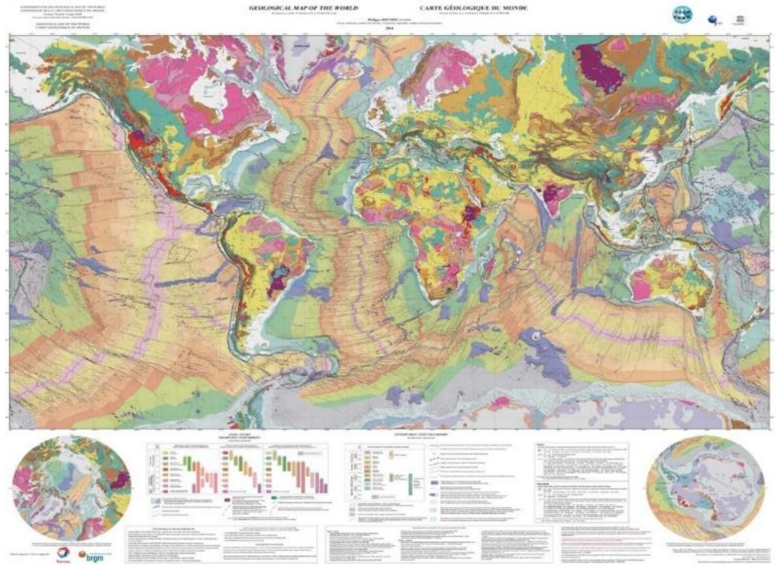
[48]Geospatial Information Section. http://www.un.org/Depts/Cartographic/english/htmain.htm

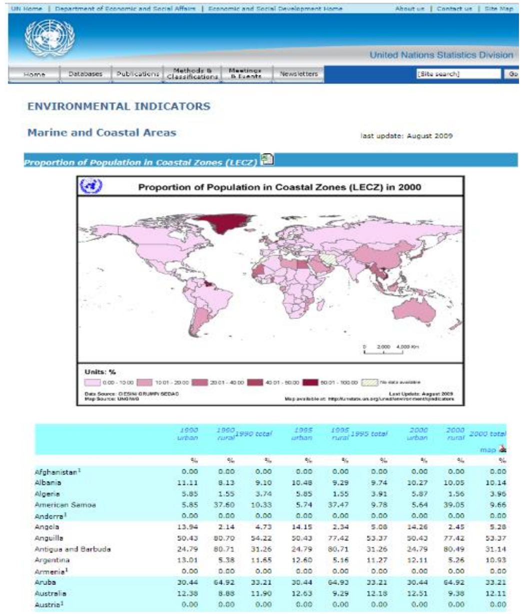
Among some examples of information in the geological part there are several sources of data that can be consulted at a global level, one of which is the European geological data infrastructure (EGDI) providing access to geological datasets of geological survey organizations in Europe. This source of information can be consulted both by the general public and specialized users to exploit the entire database available in a map viewer.[49]

The most important initiative is the one that shows the Commission of the Geological Map of the World (CGMW); that comes from the old organization created in the International Geological Congress (IGC) in 1978 and in 1910 proposed the formation of the Commission and formed in 1913. Since 2014 UNESCO recognizes it as a non-governmental organization of rank A (NGO).[50]

[49]EGDI. European Geological Data Infrastructure. http://www.europe-geology.eu/ (October 23, 2018).
[50]CCGM. Commission for the Geological Map of the World. https://ccgm.org/en/home/164-carte-geologique-du-monde-a-l-echelle-de-135-000-000-9782917310243.html (October 23, 2018).

It has been responsible for publishing geological issues at small scales: Geological, tectonic, mineral deposits, natural resources, etcetera. It also plans to have a leading role in the development of international standards. The CGMW actively participates in the One Geology initiative. Of the Geological and Lithological maps made by the CGMW, they include explanatory notes in which the characteristics are broken down. In the case of the geological map, it is explained that it is a compilation with the pedagogical objective, trying to represent in a simple way the geology of the world, including the oceanic funds.





	1990 urban	1990 rural	1990 total	1995 urban	1995 rural	1995 total	2000 urban	2000 rural	2000 total map
	%	%	%	%	%	%	%	%	%
Afghanistan[1]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Albania	11.11	8.13	9.10	10.48	9.29	9.74	10.27	10.05	10.14
Algeria	5.85	1.55	3.74	5.85	1.55	3.91	5.87	1.56	3.96
American Samoa	5.85	37.60	10.33	5.74	37.47	9.78	5.64	39.05	9.66
Andorra[1]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Angola	13.94	2.14	4.73	14.15	2.34	5.08	14.26	2.45	5.28
Anguilla	50.43	80.70	54.22	50.43	77.42	53.37	50.43	77.42	53.37
Antigua and Barbuda	24.79	80.71	31.26	24.79	80.71	31.26	24.79	80.49	31.14
Argentina	13.01	5.38	11.65	12.60	5.16	11.27	12.11	5.26	10.93
Armenia[1]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Aruba	30.44	64.92	33.21	30.44	64.93	33.21	30.44	64.92	33.21
Australia	12.38	8.88	11.90	12.63	9.29	12.18	12.51	9.38	12.11
Austria[1]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

There is a consultable source related to the information of environmental indicators for the marine environment and coastal area at an international level.[51]

[51]United Nations. Statistical division https://unstats.un.org/unsd/environment/proportion_population_coastalzones.htm

Data collection and sources of data

5. Data collection and sources of data

5A. Sources of data

This section identifies international and national sources and types of data collection for each group of statistics related with geological and geographical conditions of terrestrial areas and islands.

In an international context, the UN Standard of Country names and area codes for statistical use (M49)[52] is relevant. Besides the official country names and codes, it includes also macro-geographic regions denominations. These names are based on the United Nations Terminology Database (UNTERM).[53]

The wide range of geological and geographical statistics contained in this MS originates from sources of primary national data including geological and geographical institutions, universities and research institutes. These institutional partners generally collaborate to produce information and statistics on many related topics, such as boundaries and areas of administrative entities, land forms, rocks, etc. In case a country wishes to consult international data sources, it is advisable to consider global statistics and existing UN sources.

52Country names and area codes for statistical use (M49): https://unstats.un.org/unsd/methodology/m49/ (accessed 20-03-2019)
53UNTERM website: http://unterm.un.org (accessed 20/03/2019)

The types of sources by which the basic data of the statistics contained in this methodological sheet are collected include:

- Remote sensing products (for example: on identification of minerals and rocks; geological structures and their changes/impacts, such as landslides)
- Thematic maps (types of bedrocks and their history, topographic maps)
- Surveys (including geodetic data)
- Scientific research

Typically, most countries have a National agency engaged in fundamental geographic and geodetic data production, such as topographic maps, geographic names and geodetic references. This data supports multitude of activities among which maintaining cadastral registers, civil engineering and navigation. Historically such data were produced by, or in cooperation with military authorities. Therefore, in view of developing statistical time-series, data may be sought from such agencies and related research institutes.

Table 5.1. Geological and geographical statistics, institutional participants and types of sources.

FDES Topic	Environment statistics	Type of data source	Institutional source
1.1.3 Geological and geographical information	*a. Geological, geographical and geomorphological conditions of terrestrial areas and islands.*	*Remote sensing, thematic maps, scientific research and administrative records.*	*Government institutes/National geological/Statistics Office/Universities, research agencies and other organizations.*
	b. Coastal water (Including area of coral reefs and mangroves).	*Remote Sensors, Thematic Maps and Scientific research.*	International organizations/*government institutes/National Forest/universities/ research agencies and other organizations.*
	c. Length of marine coastline.	*Remote sensing, thematic maps, Scientific research.*	*Government institutes/Universities, research agencies and other organizations.*
	d. Coastal area.	*Remote sensing, thematic maps, Scientific research.*	*Government institutes/Universities, research agencies and other organizations.*

Many countries build geological and geographical inventories. But because they are expensive, they usually do it at infrequent intervals, in most countries with limited resources. On the other hand, facilitating access to remote sensing images has allowed recent assessments of the geological and geographical cover. As mentioned above, in developing countries it would facilitate the inventories and produce data on geological coverage every 10 years and in some countries even less frequently.

5B. Data compilation (procedures and instruments) and transformation into environment statistics series

The construction of time series of statistical information of geological and geographic data on the above topics is relevant for the ones that are subject to relatively frequent changes, such as coastal areas and sea level raise. On the other hand, most of the topics comprise relatively permanent land structures and delimitations, which if not meaningful as statistical time series, are still needed as underlying data input to the quantification of other environmental statistics. Such underlying data can be generated using observation points in the field in order to define the characteristics of continental elements such as marine, main types of bedrocks, deposits and linear structures, such as faults affecting the ground, in addition to knowing the characteristics of coastal areas. This information is often needed prior to establishing monitoring networks

Where relevant, producing time series is not simple, since in most countries the primary data is scarce in terms of observation points that cover the continuum of time and space. Most likely, very detailed series can be added to the relevant variables sought to produce the statistical time series on topics such as coastal erosion and accretion. The environmental statistician will compile, validate, describe and structure these data points and produce statistical series for dissemination.

Data quality and validation

The quality of the data of the geological and geographical inventories, should be evaluated taking into account criteria such as the methodologies used, as well as the analysis of the comparability between different inventories produced at specific times or periods and / or covering different territories, as necessary. In addition, the quality of the data from remote sensing should be evaluated taking into account criteria such as image interpretation procedures and validation processes involving field sampling or field verification.

Spatial considerations should take into account the spatial coverage of inventories over time for the assessment of comparability, as they may not cover the entire national and / or relevant territory, often due to insufficient resources.

Aggregation and disaggregation

If basic data on island, continental relief, rock, mangrove and coastal areas are produced by remote sensing these series can generally be aggregated nationally and disaggregated by region. A possible breakdown of the statistical series relevant to the rocky area by subtype, for example, in sedimentary rocks in clastic or calcareous.

Transformation into environment statistics series

The situation of each country is very unique in terms of data availability and periodicity of the production of primary data around geological and geographical statistics. However, the following considerations could be useful since they synthesize the general attributes of the most important and common environmental statistics in the FDES.
Main considerations for transforming the primary geological and geographical data into some examples of statistics.

FDES Topic	Environment Statistic	Category of Measurement	Unit of measure	Recommended periodicity	Potential aggregations and disaggregations
1.1.3	Main geomorphological characteristics of islands	Area	Square Kilometer (Km^2) and percentage (%)	Five years	By marina, political division.
1.1.3	Characteristics of plain landforms	Area	Square Kilometer (Km2) and percentage (%)	Five years	By type, coastal plain, erosion plain, eolian plain, delta plain, alluvial plain.
1.1.3	Characteristics of plateau landforms	Area	Square Kilometer (Km2) and percentage (%)	Five years	By volcanic plateau
1.1.3	Characteristics of dune landforms	Area	Square Kilometer (Km2) and percentage (%)	Five years	By type frontal dunes, hollow dunes, parabolic dunes, barjan dunes, transgressive dunes, fossil dunes.
1.1.3	Characteristics of volcanic landforms	---	----	Ten years	By assets or inactive.
1.1.3	Area by rock types	Area	Square Kilometer (Km2) and percentage (%)	Ten years	By type of rock, geological age and distribution.
1.1.3	Fault lines	Length	Kilometer (Km)	Two years	By type normal fault, reverse and slip.

Source: own source

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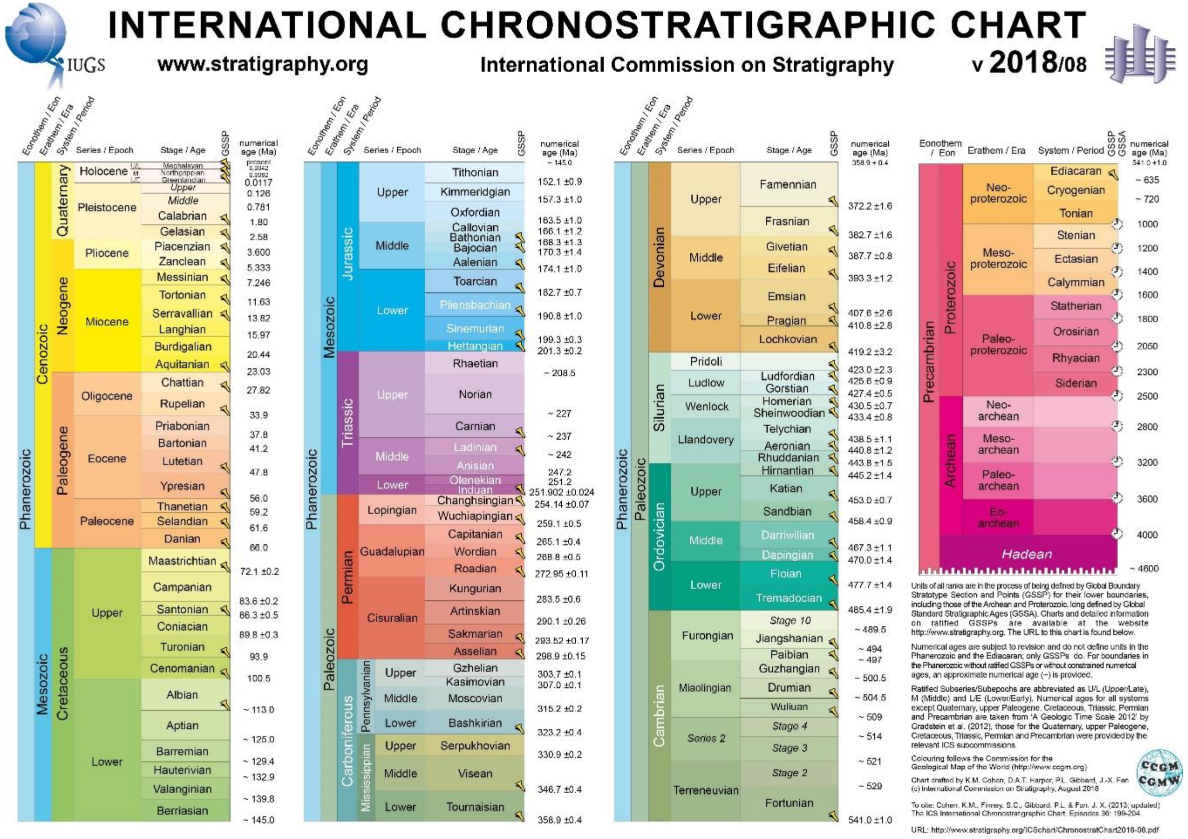
Uses and dissemination

6A. Potential presentation/dissemination formats

This section presents examples of countries and international organizations to show how geological and geographical statistics and indicators can be disseminated. Examples of tables, graphs and maps of selected countries and regions are included

Tables

Table 5.1. Example international chronostratigraphic chart



Source: International Commission of stratigraphy; http://www.stratigraphy.org/ICSchart/ChronostratChart2018-08.jpg

Table 5.2. Explanation of island indicators

UNEP Islands Web Site

EXPLANATION OF ISLAND INDICATORS

CONTENTS:

General comments on indicators

One aim of this island directory is to classify islands by various criteria, and to make comparisons between different islands or areas as a basis for facilitating inter-island cooperation and sharing of solutions, and identifying conservation importance. Given the large number of islands, the diversity of their characteristics, and the inadequacies in the data, it seems important to show as clearly as possible the bases on which indicators have been calculated, and the weightings that are given to different objective and subjective factors. To do this, the series of simple numerical indicators developed for the Review of the Protected Areas System in Oceania (Dahl, 1986) have been refined and expanded to adapt them to the needs of a world island list. These include indicators for the nature and isolation of the island, for features of conservation interest, for risks to that conservation interest, and for the feasibility of conservation action, and are incorporated in the island entries and the various tables. They make it possible to reduce, or at least to make more consistent and explicit, the subjectivity of judgements as to relative island significance and conservation importance. They also can help to identify islands with particular characteristics.

While this approach using numerical values reduces the chances of personal bias or the drift in judgement that can occur between the beginning and the end of a long analysis, it does have its weaknesses. First among these is the tendency to see the numbers as having more accuracy or weight than is actually the case. The indicators only reflect present information, and can be expected to change as more data become available. A low overall indicator including a low reliability of data rating can easily reflect a lack of information rather than a lack of conservation interest. At the same time, the system of indicators can be updated rapidly when appropriate.

Users of this directory are cautioned not to place too much weight on these indicators without first studying their derivation to ensure that they are appropriate to the intended use of the information. Small differences between indicators should not be considered important, since there are too many uncertainties in the database, and some indicators are derived from what are essentially subjective judgements. Where particular uses require other selection criteria, it is not difficult to modify the content and weighting of the indicators for such other uses.

The indicators of conservation importance are explained in broad catagories, since the numerical ratings in the island entries are based on data that are still too incomplete for fair inter-island comparisons. Rankings in the tables, however, are based on the calculated numerical values.

Despite these weaknesses in detail, the indicators do give a good overall picture of conservation needs and relative importance of islands, and should prove a useful tool in sustainable development planning if used wisely.

Coastal Index

A coastal index as one measure of insularity is calculated by dividing the length of the shoreline by the land area.

Sea level rise risk

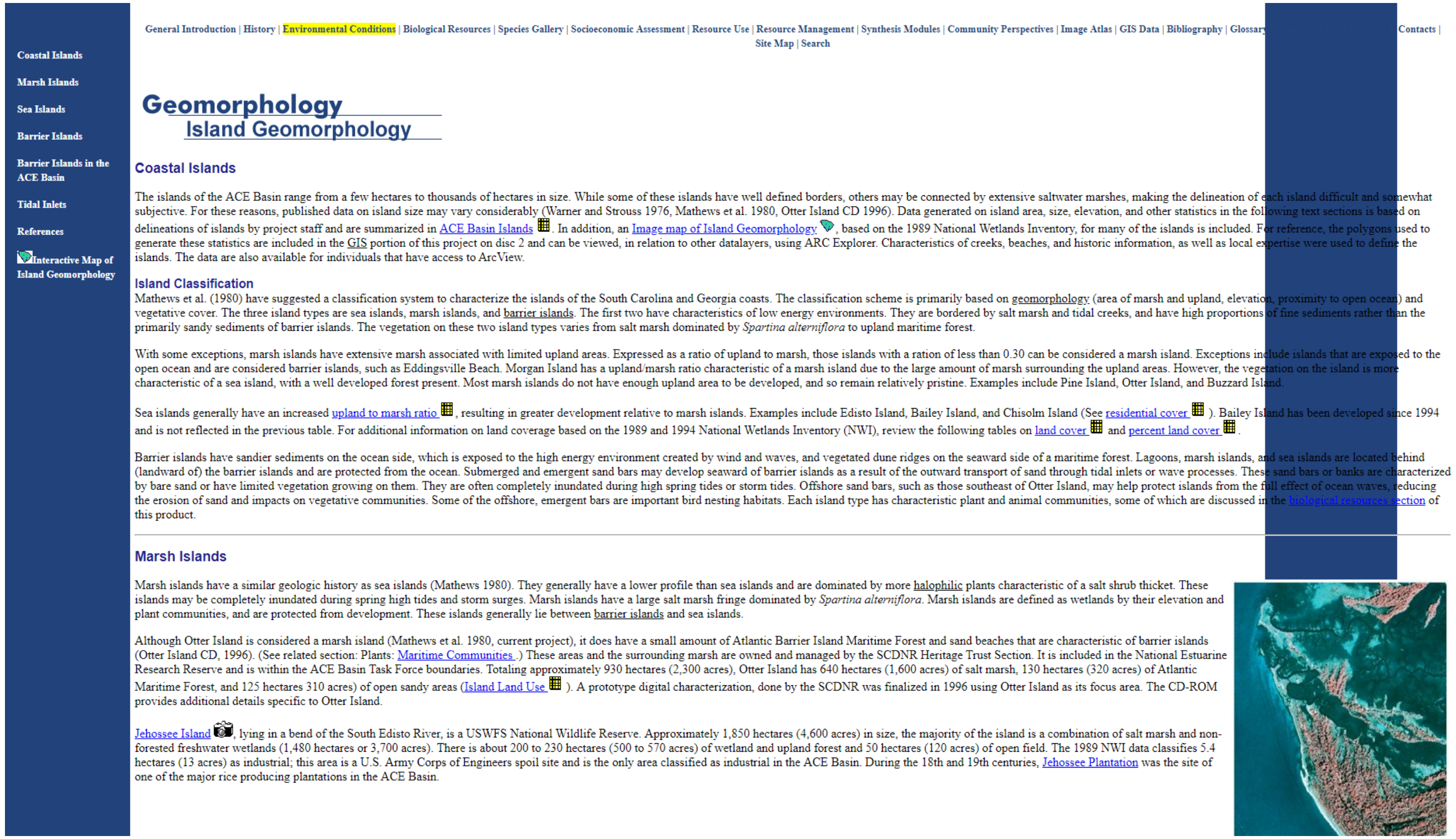
The risk to the island from sea level rise due to climate change is evaluated as the percentage of the land area less than 5 metres above sea level, divided by 10 to give a single digit.

Isolation

Source: UNEP. Island Web Site. http://islands.unep.ch/indicat.htm (Accessed on February 13, 2019).

Graphs

Example of the description of the islands geomorphology



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- Interactive Map of Island Geomorphology

Geomorphology
Island Geomorphology

Coastal Islands

The islands of the ACE Basin range from a few hectares to thousands of hectares in size. While some of these islands have well defined borders, others may be connected by extensive saltwater marshes, making the delineation of each island difficult and somewhat subjective. For these reasons, published data on island size may vary considerably (Warner and Strouss 1976, Mathews et al. 1980, Otter Island CD 1996). Data generated on island area, size, elevation, and other statistics in the following text sections is based on delineations of islands by project staff and are summarized in ACE Basin Islands. In addition, an Image map of Island Geomorphology, based on the 1989 National Wetlands Inventory, for many of the islands is included. For reference, the polygons used to generate these statistics are included in the GIS portion of this project on disc 2 and can be viewed, in relation to other datalayers, using ARC Explorer. Characteristics of creeks, beaches, and historic information, as well as local expertise were used to define the islands. The data are also available for individuals that have access to ArcView.

Island Classification

Mathews et al. (1980) have suggested a classification system to characterize the islands of the South Carolina and Georgia coasts. The classification scheme is primarily based on geomorphology (area of marsh and upland, elevation, proximity to open ocean) and vegetative cover. The three island types are sea islands, marsh islands, and barrier islands. The first two have characteristics of low energy environments. They are bordered by salt marsh and tidal creeks, and have high proportions of fine sediments rather than the primarily sandy sediments of barrier islands. The vegetation on these two island types varies from salt marsh dominated by *Spartina alterniflora* to upland maritime forest.

With some exceptions, marsh islands have extensive marsh associated with limited upland areas. Expressed as a ratio of upland to marsh, those islands with a ration of less than 0.30 can be considered a marsh island. Exceptions include islands that are exposed to the open ocean and are considered barrier islands, such as Eddingsville Beach. Morgan Island has a upland/marsh ratio characteristic of a marsh island due to the large amount of marsh surrounding the upland areas. However, the vegetation on the island is more characteristic of a sea island, with a well developed forest present. Most marsh islands do not have enough upland area to be developed, and so remain relatively pristine. Examples include Pine Island, Otter Island, and Buzzard Island.

Sea islands generally have an increased upland to marsh ratio, resulting in greater development relative to marsh islands. Examples include Edisto Island, Bailey Island, and Chisolm Island (See residential cover). Bailey Island has been developed since 1994 and is not reflected in the previous table. For additional information on land coverage based on the 1989 and 1994 National Wetlands Inventory (NWI), review the following tables on land cover and percent land cover.

Barrier islands have sandier sediments on the ocean side, which is exposed to the high energy environment created by wind and waves, and vegetated dune ridges on the seaward side of a maritime forest. Lagoons, marsh islands, and sea islands are located behind (landward of) the barrier islands and are protected from the ocean. Submerged and emergent sand bars may develop seaward of barrier islands as a result of the outward transport of sand through tidal inlets or wave processes. These sand bars or banks are characterized by bare sand or have limited vegetation growing on them. They are often completely inundated during high spring tides or storm tides. Offshore sand bars, such as those southeast of Otter Island, may help protect islands from the full effect of ocean waves, reducing the erosion of sand and impacts on vegetative communities. Some of the offshore, emergent bars are important bird nesting habitats. Each island type has characteristic plant and animal communities, some of which are discussed in the biological resources section of this product.

Marsh Islands

Marsh islands have a similar geologic history as sea islands (Mathews 1980). They generally have a lower profile than sea islands and are dominated by more halophilic plants characteristic of a salt shrub thicket. These islands may be completely inundated during spring high tides and storm surges. Marsh islands have a large salt marsh fringe dominated by *Spartina alterniflora*. Marsh islands are defined as wetlands by their elevation and plant communities, and are protected from development. These islands generally lie between barrier islands and sea islands.

Although Otter Island is considered a marsh island (Mathews et al. 1980, current project), it does have a small amount of Atlantic Barrier Island Maritime Forest and sand beaches that are characteristic of barrier islands (Otter Island CD, 1996). (See related section: Plants: Maritime Communities .) These areas and the surrounding marsh are owned and managed by the SCDNR Heritage Trust Section. It is included in the National Estuarine Research Reserve and is within the ACE Basin Task Force boundaries. Totaling approximately 930 hectares (2,300 acres), Otter Island has 640 hectares (1,600 acres) of salt marsh, 130 hectares (320 acres) of Atlantic Maritime Forest, and 125 hectares 310 acres) of open sandy areas (Island Land Use). A prototype digital characterization, done by the SCDNR was finalized in 1996 using Otter Island as its focus area. The CD-ROM provides additional details specific to Otter Island.

Jehossee Island, lying in a bend of the South Edisto River, is a USWFS National Wildlife Reserve. Approximately 1,850 hectares (4,600 acres) in size, the majority of the island is a combination of salt marsh and non-forested freshwater wetlands (1,480 hectares or 3,700 acres). There is about 200 to 230 hectares (500 to 570 acres) of wetland and upland forest and 50 hectares (120 acres) of open field. The 1989 NWI data classifies 5.4 hectares (13 acres) as industrial; this area is a U.S. Army Corps of Engineers spoil site and is the only area classified as industrial in the ACE Basin. During the 18th and 19th centuries, Jehossee Plantation was the site of one of the major rice producing plantations in the ACE Basin.

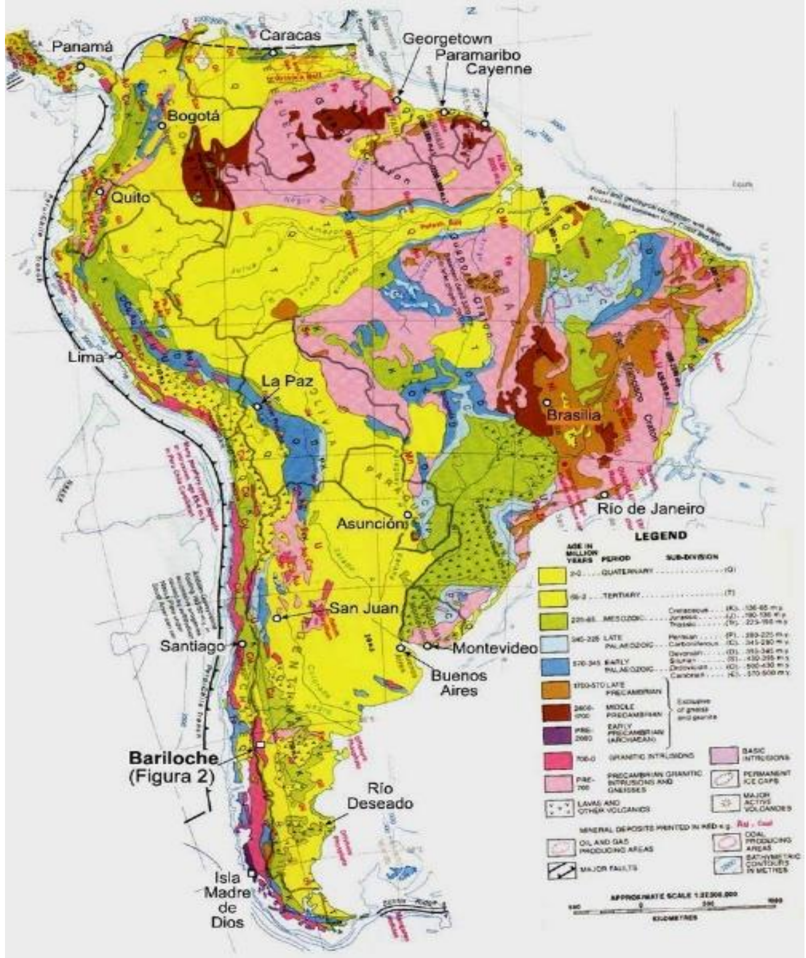
Source:Geomorphology. https://webapp1.dlib.indiana.edu/virtual_disk_library/index.cgi/4928836/FID1596/html/envicond/geomorph/gmisland.htm (Accessed on February 13, 2019)

Maps

Example of map of characteristics landforms of United States

Source: NATGEO. Mapping Landforms
https://www.nationalgeographic.org/activity/mapping-landforms/
(Accessed on February 13, 2019).

Example of geologic map and faults of South America



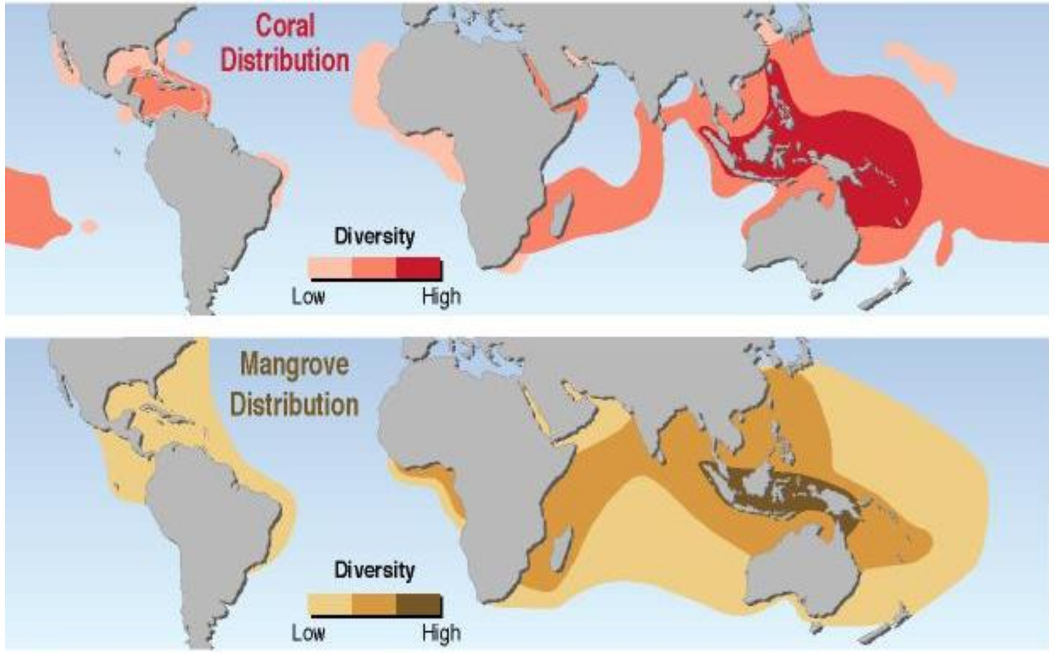
Source: GIFEX. Maps and satellite photos of the World. https://www.gifex.com/
(Accessed on February 13, 2019)

The coral reefs are largely animal-occupied, there are a few plant species that exist in conjunction with reefs. The two types most associated with reefs are seagrasses and mangroves.

In places where mangroves occur close to a coral reef, they mutually benefit from the association. The plants stabilize the soft substrate near the reef which reduces sedimentation, thereby improving water quality. While The reef acts as a breaker which reduces wave energy to create the calm waters on the other side, where the seagrasses and mangroves can grow. These plant communities also serve as excellent nursery habitat for animal species that will eventually live on the coral reef.[56]

Global distribution of coral and Mangroves diversity

Source: REEFNATION. http://reefnation.com/wp-content/uploads/2015/11/39-global-distribution.jpg (accessed on February 13, 2019)



[56]REEFNATION. https://reefnation.com/can-imagine-world-without-coral-reefs/ (accessed on February 13, 2019).

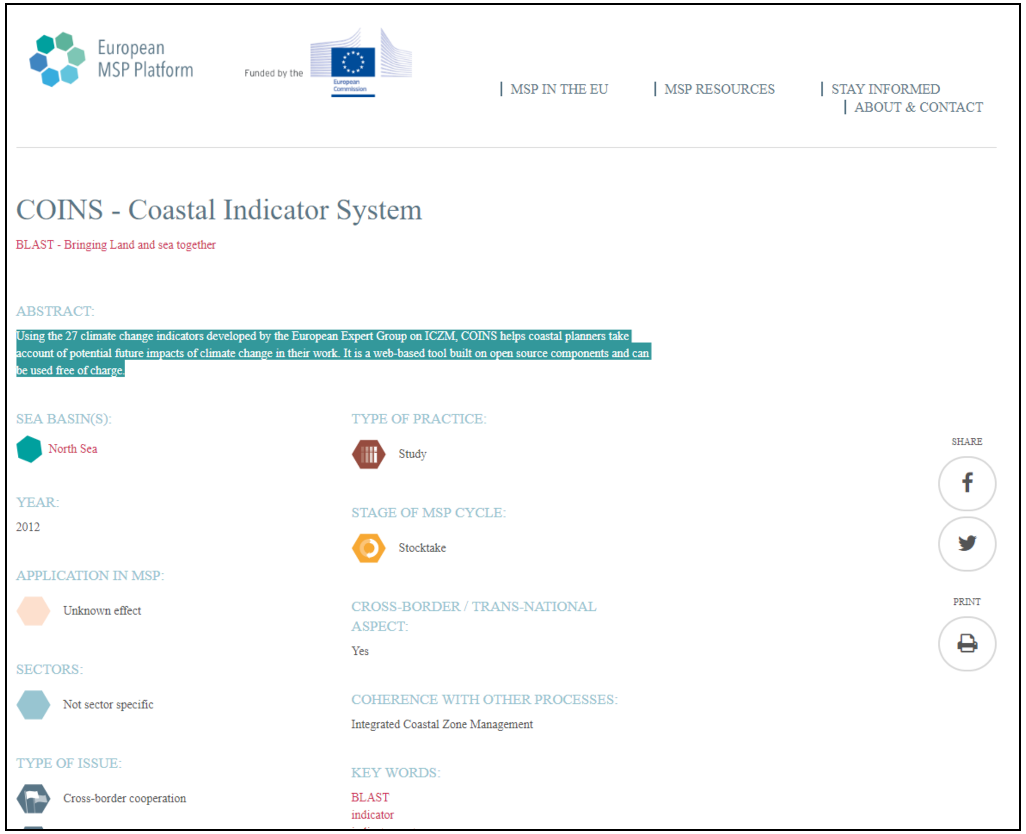
This is an example of Coastal Mapping within an EMODnet activity, initiated in 2015 at the end of the second EMODnet development phase (Phase II) and finalized in June 2018. It was not part of the preparatory action which ran from 2009-2013. Main objectives of the EMODnet Coastal Mapping project were to assess the availability of digital coastal maps in the EU, to disseminate this information by EMODnet, to share experience of coastal mapping in the EU, to develop standards for best practices and to propose how a future Joint European Coastal Mapping Programme (JECMAP) could operate.[57]

Source: EMODnet. Central Portal. http://www.emodnet.eu/sites/emodnet.eu/files/public/CM_panel_pic.png (Accessed on February 13, 2019).

[57]EMODnet. Central Portal. http://www.emodnet.eu/coastal-mapping (Accessed on February 13, 2019)

The COINS (Coastal Indicator System) an example the use of the 27 climate change indicators developed by the European Expert Group on ICZM, COINS helps coastal planners take account of potential future impacts of climate change in their work. It is a web-based tool built on open source components and can be used free of charge.

Source: European MSP Platform. COINS. https://www.msp-platform.eu/practices/coins-coastal-indicator-system (Accessed on February 13, 2019).



6B. SEEA accounts/tables that use this statistic

Geographical and geological data and statistics are an important tool to know the physical characteristics of the territory in order to be able to carry out some environmental, ecotourism and civil works projects for the benefit of the population. As we have seen throughout this document, geological and geographic statistics are an important input that supports the knowledge of the characteristics of the land, so, according to the FDES, they are important to develop policies and make decisions about the need to conserve and maintain natural resources, that is, to reinforce knowledge and the needs to evaluate these resources.

SEEA-EEA is developing guidelines[58] for defining and delineating ecosystems as spatial units which supply ecosystem services, termed 'Ecosystem extent account'. Geological and topographic data are among the sources listed as potential inputs to defining the ecosystem types of a country, while wider administrative or physical delimitations are recommended for aggregation and reporting purposes

6C. Commonly used indicators that incorporate this statistic

The situation of each country is very unique in terms of data availability and periodicity of the production of primary data around geological and geographical statistics. However, the following considerations could be useful since they synthesize the general attributes of the most important and common environmental geological statistics in the FDES.

[58]SEEA Experimental Ecosystem Accounting: Technical Recommendations: https://unstats.un.org/unsd/envaccounting/eea_project/TR_consultation/SEEA_EEA_Tech_Rec_Consultation_Draft_II_v4.1_March2017.pdf (accessed 20/03/2019)

6D. SDG indicators that incorporate this statistic

This indicator framework for the Sustainable Development Goals and targets of the 2030 Agenda for Sustainable Development was developed by the Inter-Agency and Expert Group on SDG Indicators (IAEG-SDGs) and agreed upon, including refinements on several indicators, at the 48th session of the United Nations Statistical Commission held in March 2017.

Advancing the sustainable use and conservation of the oceans continues to require effective strategies and management to combat the adverse effects of overfishing, growing ocean acidification and worsening coastal eutrophication. The expansion of protected areas for marine biodiversity, intensification of research capacity and increases in ocean science funding remain critically important to preserve marine resources.[59]

The situation of each country is very unique in terms of data availability and periodicity of the production of primary data around geological and geographical statistics. However, the following considerations could be useful since they synthesize the general attributes of the most important and common environmental geological statistics in the FDES.

[59]SDG. https://sustainabledevelopment.un.org/sdg14 (accessed 27/03/2019)

The SDG goal, target and indicators pertaining to forest are depicted in the following table

Goal	Target	Indicators	Metadata
Objective 14. Conserve and sustainably use oceans, seas and marine resources for sustainable development.	*14.2* *By 2020, manage and protect in a sustainable way the marine and coastal ecosystems to avoid effects important adversities, including strengthening their resilience, and measures to restore them to improve the health and productivity of the oceans.*	*14.2.1* *Proportion of national exclusive economic zones managed through ecosystem-based approaches.*	https://unstats.un.org/sdgs/tierIII-indicators/files/Tier3-14-02-01.pdf

Source: self made

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