Environmental and ecosystem-related disaster losses

Issue Paper

Table of Contents

Summary

This paper supports the development of a global framework for disaster-related statistics (DRS) being undertaken by the United Nations (UN) through the Office of Disaster Risk Reduction (UNDRR) and the UN Statistical Commission (UNSC) by:

- Reviewing the documents developed in relation to disaster risk reduction (DRR) and determine how they relate to the environment and ecosystems;
- Identifying and developing issues that need attention in the development of statistics for disaster-related environment and ecosystem losses.

The issues identified and developed for statistics for disaster-related environment and ecosystem losses are considered in the context of the development of a common statistical framework for DRS and with reference to existing environmental statistical frameworks, namely the Framework for Development of Environment Statistics (FDES) and the System of Environmental-Economic Accounting (SEEA).

This paper supports the development of such a framework by:

- Reviewing the documents developed in relation to DRS and DRR and determine how they relate to statistics for environment and ecosystem losses;
- Identifying and developing issues that need attention in DRS related to statistics for environmental and ecosystem losses.

It is expected that the common framework for DRS will:

- Provide guidance on the production, dissemination, and use of DRS to inform national policies and plans. The framework should enable comparison over time and between administrative regions (including nations).
- Facilitate national reporting to internationally agreed development goals and agendas as they relate to disaster risk reduction.
- Make recommendations to enable compilation of statistics consistent with agreed definitions and existing guidelines for international reporting.[1]

Key issues identified in the documents reviewed are the need to:

1. Determine the scope of environment and ecosystem losses in DRS. Is this, is the scope could be:
    a) The losses to the environment and ecosystems themselves
    b) The losses to the environment and ecosystems that impact on socio-economic systems. The key aspect of this is that loss of the value of ecosystem services (both final and intermediate) from ecosystems losses not in scope of traditional economic statistics
    c) Both (a) and (b). Including both aspects in DRS is probably best
        - If (c) is decided, that it is both (a) and (b), then a secondary issue is how should the loss of ecosystem services be divided between

[1] Towards a common statistical framework on disaster-related statistics, IAEG Core Group for consideration, May 2021

environment and ecosystem losses and the economic losses components of DRS.

d) The losses to *and risk of* losses to the environment and ecosystems

2. While not part of DRS environment and ecosystem-related losses, the environment itself poses risks to the economy and society, therefore measurement of the environment and ecosystems is needed for DRS to quantify risks. This aspect is noted in various documents (e.g., the UNDRR Hazard Definition & Classification Review - Technical Report 2020 lists "declining ecosystems" as an underlying risk driver). Statistics for this aspect of DRS do not seem to have been explicitly considered to date. Going forward DRS for environmental and ecosystem losses could be linked other aspects of DRS that are related to the calculation of the risks posed by the environment to the economy and society more generally (related to the question of scope raised in 1(e)
3. Agreement on the definition of the key terms in the DRS framework as a whole. Consistent definition and use of terms are essential for producing coherent statistics and standardized reporting against environment-related goals. For example, “disaster risk reduction” and “assets” (and related terminology). For “assets” a key question for environment and ecosystem-related losses is; do assets include natural capital assets?
4. Other key terms for definition of DRS component for environment and ecosystem losses are “environment” and “ecosystems”. The usage of these terms in the documents reviewed indicates a view of these as “natural” environments and ecosystems. Clarification of this is needed to determine how human dominated environments and ecosystems, such as agricultural and human settlements, are included in DRS. Human dominated environments could be included in economic-related disaster statistics or the DRS for environmental and ecosystem-related losses or both (with the overlap clearly explained).
5. Decide on treatment of climate change and climate change risks in DRS for environment and ecosystem losses. Climate change is referred to in a variety of ways, including as a single risk in and of itself, a collection risks that can be aggregated under the banner “climate change” and as factor exacerbating other risks. The UNDRR says “*climate change is an example of an underlying disaster risk driver*." In addition, climate change could also be treated as a current disaster, future risk or both
6. Determine the extent to which currently used environmental and ecosystem statistical frameworks, namely, the FDES and SEEA, can be used to support DRS for environment and ecosystem losses.
7. Physical environmental and ecosystem statistics are usually spatially referenced requiring the use of geographic information systems (GIS). Other spatially referenced information (e.g. population and economic DRS) could also be included GIS. Those responsible for DRS will need to ensure that if different GIS are used for environment, economic and population DRS that they can be integrated. Ideally, all DRS would all be included in a single GIS or at least interoperable GIS and and could be achieved through the implementation of the Strategic Framework on Geospatial Information and Services for Disasters
8. Recognize that National Statistical Offices (NSOs) are not usually the collectors or custodians of the primary data on the environment and ecosystems and that populating these aspects of the DRR Statistics framework, as it does for FDES and SEEA, requires cooperation and collaboration with other scientific and information agencies.

9. Understand that because NSOs are not usually the collectors or custodians of the primary data on the environment and ecosystems, additional resources, formal agreements for data sharing and even legal mandates of NSOs are likely to be needed, if they are to be the organizations primarily responsible for the production of DRS.
10. While outside the scope of DRS for environmental and ecosystem losses, it is noted that overlap between environment protection and resource management expenditure accounts of the SEEA with the proposed Disaster Risk Expenditure Satellite (DRES) Account. In this, countries already with such accounts could have a ready starting point for a DRES Account.

There is a *prime facie* case that the existing environment and ecosystem statistical frameworks, the FDES and SEEA, which are interrelated, provide information relevant to DRS for environmental and ecosystem-related disaster losses for all phases of disaster risk management – response, recovery, risk assessment, prevention and mitigation, and preparedness. Both systems would need elaboration for DRS, but such elaboration seems feasible.

If it is agreed that the FDES and SEEA provide a starting point for DRS for environmental and ecosystem-related disaster losses, then a way forward would be for the statistics from each of these frameworks to be mapped to the categories of hazard event and disaster. The statistics from FDES and SEEA could then be ranked according to their importance for DRS and DRR.

The mapping of hazard and disaster classifications to DRS for environmental and ecosystem-related disaster losses, and agreement on ranking, are likely to take some time. In this, the ranking could be done by level of risk which would require the weighting of pure environment and ecosystem values (reducing risk to environment and ecosystem losses for its own sake) or for human-related considerations (the degree to which the environment and ecosystem losses reduce benefits to people). The relative importance of the environment and the ecosystems and species that are part of the environment, could be assessed in a number of ways. For example, through the IUCN Red List or the UNESCO World Heritage Listings, and their national equivalents.

In the short-term, the production of a “SEEA for environmental and ecosystem-related disaster losses” or “SEEA for Disaster Risk Reduction” could be a useful interim step for providing integrated environmental and economic disaster loss statistics. In the medium-term the update of System of National Accounts (SNA) and the proposed update of FDES provides an opportunity for the DRS for environmental and ecosystem-related disaster losses to be embedded in existing statistical frameworks. Such an approach would build on existing and planned work and reduce the risk of duplication of effort and confusion due to use of different, concepts, classifications and terms used in internationally agreed statistical frameworks.

The final point returns to the scope of DRS for environment and ecosystem-related losses. The inclusion of “losses” in the name and framing of the Issue Paper is a restriction of the scope the environmental and ecosystem statistics that would be useful for DRR and DRM. Future work could more broadly consider the role of environment and ecosystem statistics in the DRS global framework.

Consolidated list of issues

Issues are identified within the full text of the document and are listed below for ease of reference. Some issues are raised in more than one place in the document but are only include one in the list below.

Issues of scope

1. Determine the scope of DRS for environment and ecosystem-related losses. Is this, is it:
   - The losses to, or risk of losses to, the environment and ecosystems themselves?
   - The losses to, or risk of losses to, the environment and ecosystems that impact on socio-economic systems? The key aspect of this is that loss of the value of ecosystem services from ecosystems losses is not is scope of traditional economic statistics
   - Both (1) and (2)?
   - If both aspects should be included in DRS, the secondary issue is how should they divided between environment and ecosystem losses and the economic losses in the DRS?
2. Are ecosystem services within the scope of DRS for environment and ecosystem-related losses?
3. To what extent, if any, should DRS for environmental and ecosystem-related disaster losses consider the information needed for disaster risk reduction or disaster risk management?
4. Does the scope of DRS for environment and ecosystem-related losses includes climate change statistics and indicators?
5. Should goods and services from ecosystems not counted in economic statistics be included in direct economic losses in DRS?
6. What is the scope of hazardous events and disasters (HED) to be included in DRS for environmental and ecosystem-related losses?

Issues of definition and classification

7. How will the terms and definitions related to DRS be standardized?
8. Are the definitions of environment and ecosystem assets in the SEEA appropriate for DRS for environment and ecosystem-related losses
9. Are the classifications of environment and ecosystem assets in the SEEA appropriate for DRS for environment and ecosystem-related losses?

Issues of existing environmental statistics frameworks

10. To what extent can existing environmental and ecosystem statistics frameworks be used to as the basis for minimum standards and to provide the indicators and methodologies needed for DRS for environmental and ecosystem related losses?
11. To what extent could a possible revision of the FDES address the needs of DRS for environment and ecosystem-related losses?
12. To what extent could environmental and ecosystem asset accounts from SEEA be used as the basis for DRS for environment and ecosystem-related losses?
13. To what extent do the SEEA accounts provide information of relevance to the phases of disaster risk management?
14. Would coordination with the UNCEEA be useful for the development of DRS for environment and ecosystem-related losses?

Issues of implementation

15. Will resources be made available to NSOs and other organisations to enable development of DRS for environmental and ecosystem-related losses?

16. What coordination mechanisms are needed by NSOs to enable development of DRS for environmental and ecosystem-related losses?
17. To what extent should countries be expected to report against the UNDRR hazard list and hazard definitions to ensure internationally comparability of results for DRS for environmental and ecosystem-related losses?

Other issues

18. To what extent, if any, could the SEEA environment protection expenditure accounts be used in the DRRE satellite account?
19. While not part of DRS environment and ecosystem-related losses, the environment itself poses risks to the economy and society, therefore measurement of the environment is needed for DRS to quantify risks.

1. Introduction

The need for disaster-related statistics to support the Sendai Framework was recognized at the 49th session of the UN Statistical Commission (UNSC). To support the development of disaster-related statistics, an Inter-Agency and Expert Group (IAEG) on Disaster-related Statistics, involving UNSD, UNESCAP, UNECE, UNECLAC and UNDRR, was established in 2019. Progress on the development of disaster-related statistics has been reported to subsequent meetings of the UNSC.

The UNSC made explicit reference to the technical guidance contained in the Disaster-related Statistics Framework (DRSF) noting:

> "*. . .these serve as a good starting point for a universally applicable tool with global relevance, building upon the principles and priorities of the Sendai Framework for Disaster Risk Reduction 2015–2030.*"

The UNECE Task Force on Measuring Hazardous Events and Disasters and the IAEG held an Expert Forum on disaster-related statistics in June 2021. Emerging from this was a proposal to establish a Technical Working Groups and to produce Issue Papers on selected topics contained in the research agenda. The three topics selected for the production of Issue Papers were:

- Economic losses attributed to disasters,
- Disaster Risk Reduction Expenditure (DRRE) satellite accounting; and
- Environmental and ecosystem-related disaster losses.

This Issue Paper for Environmental and ecosystem-related disaster losses had the objectives to:

- Review past efforts to advance guidance on disaster-related statistics as per the decision of the UN Statistical Commission.
- Review documents developed by statistics divisions of DESA, UN regional commissions and UNDRR as related to the topic Environmental and ecosystem-related disaster losses. These include, but are not limited to, the documentation related to Disaster-related statistics Framework supported by ESCAP, Task Force on Measuring Hazardous Events and Disasters supported by ECE, the Latin American and Caribbean Disaster Risk Reduction Statistics Working Group supported by ECLAC and UNDRR-ISC report on Hazard Classification and Definitions.
- Develop issues related to guidelines and statistical standards for the above-mentioned topic, in consultation with the respective Technical Working Group.
- Coordinate with the Chief Technical Advisor and Technical Working Group on the above-mentioned research topic to ensure that the issue papers are aligned with the overall structure of the common statistical framework.
- Consult key practitioners and other experts in the field of disaster-related statistics represented in the Technical Working Group, especially coming from the Core Group of the IAEG and National Statistical Organizations and disaster risk reduction organizations as required for the research topic.
- Prepare a draft of the proposed Issue Paper on the above-mentioned topic under the research agenda, which will feed into the overall common statistical framework

The remained of this document represents the last dot point, a Draft of the Issue Paper.

2. Review existing work on Disaster and Disaster Risk Reduction Statistics

The documents reviewed:

- Technical Guidance for Monitoring and Reporting on Progress in Achieving the Global Targets of the Sendai Framework for Disaster Risk Reduction (UNISDR 2017)[2]
- Disaster Related Statistics Framework (ESCAP 2018)[3]
- Recommendations on the Role of Official Statistics in Measuring Hazardous Events and Disasters (ECE 2019)[4]
- Hazard, Identification and Classification Review, Technical Report (UNDRR 2020)[5]

The review of these documents considers the development of DRS in the broader context of Sendai Framework, the UNSC mandate for development to develop a statistical framework to support Disaster Risk Reduction (DRR), and existing environment and ecosystem statistical frameworks (FDES and SEEA, discussed later).

2.1 Sendai Framework (SF)

A disaster is:

> "*A serious disruption of the functioning of a community or a society due to hazardous events interacting with conditions of exposure, vulnerability and capacity, leading to one or more of the following: human, material, economic and environmental losses and impacts*."[6]

The SF provides explanatory guidance and describes the scope of reporting requirements for inputs into indicators and aggregated analyses of disaster impacts at the national and international level. Four priorities for action are identified:

1. Understanding disaster risk.
2. Strengthening disaster risk governance to manage disaster risk.
3. Investing in disaster risk reduction for resilience; and
4. Enhancing disaster preparedness for effective response and to "build back better" in recovery, rehabilitation, and reconstruction.

Environment and ecosystem statistics are relevant to all four priority actions. Some environments and ecosystems are more susceptible to risks, some ecosystems mitigate risk,

[2] Technical Guidance for Monitoring and Reporting on Progress in Achieving the Global Targets of the Sendai Framework for Disaster Risk Reduction – Collection of Technical Notes on Data and Methodology, UN Office for Disaster Risk Reduction (UNISDR), 2017

[3] Disaster Related Statistics Framework, Expert Group on Disaster-related Statistics in Asia and the Pacific, UN Economic and Social Commission for Asia and the Pacific (ESCAP), 2018

[4] Recommendations on the Role of Official Statistics in Measuring Hazardous Events and Disasters, United Nations Economic Commission for Europe (ECE), 2019

[5] Hazard, Identification and Classification Review, Technical Report, United Nations Office for Disaster Risk Reduction (UNDRR), 2020

[6] The Sendai Framework Monitor and associated Technical Guidance (UNISDR, 2017), adopted by the UN General Assembly via the Report of the OEIWG (2016)

and the environment and ecosystems are themselves a source of risk. Risks can be to the environment itself, to the benefits derived from the environment by people or both.

The SF recognizes many hazards that emanate from the environment and ecosystems, for example: fire, geophysical hazards, hydrological hazards, meteorological hazards, climatological hazards, extra-terrestrial hazards, environment degradation, and biological hazards. It is not clear if statistics to measure the risk of disasters emanating from the environment should be included in DRS or if the areas at risk of such hazards should be included in DRS..

ISSUE: To what extent, if any, should DRS for environmental and ecosystem-related disaster losses consider the information needed for disaster risk reduction or disaster risk management?

The SF provides technical guidance to:

- Develop minimum standards and metadata for disaster-related data, statistics, and analysis with the engagement of national government focal points, national disaster risk reduction offices, national statistical offices, the UN Department of Economic and Social Affairs and other relevant partners.
- Develop methodologies for the measurement of indicators and the processing of statistical data with relevant technical partners.

ISSUE: To what extent can existing environmental and ecosystem statistics frameworks be used to as the basis for minimum standards and to provide the indicators and methodologies needed for DRS for environmental and ecosystem-related losses?

Targets identified in Sendai included developing technical notes and data methodology across seven defined areas:

1. Estimating global disaster mortality
2. Number of effected people
3. Estimate direct economic loss
4. Estimate damages to infrastructure and disruptions to basic services
5. Estimate the global progress in the number of countries with national and local DRR strategies
6. Estimate the enhancement of international cooperation to developing countries to complement national actions
7. Estimate the availability of and access to multi-hazard early warning systems and disaster risk information and assessments

The identified targets in the SF do not directly relate to the environment and ecosystem-related losses, except if the definition of the environment and ecosystems includes natural resources (e.g. timber, fish, minerals) and human dominated ecosystems (e.g. agricultural and urban areas) included within the economy.

Target 3 would also be relevant if use of natural resources (such as firewood, food or water) not within the formal economy are included. This would extend to the of loss ecosystem services which is discussed later in Section 3.2.4.

ISSUE: Should goods and services from ecosystems not counted in economic statistics be included in direct economic losses in DRS?

2.2 Disaster Related Statistics Framework (DRSF)

While the focus of the Sendai Framework is on 'disaster,' the Disaster Related Statistics Framework (DRSF) emphasises 'disaster risk.' Disaster risk is:

> "*the potential loss of life, injury, or destroyed or damaged assets which could occur to a system, society or a community in a specific period, determined probabilistically as a function of hazard, exposure, vulnerability and capacity*" (UNISDR, 2017), and "*The focus in the DRSF is to clarify the role of official statistics and how they can be made as accessible as possible for risk assessments*."[7]

The DRSF further noted:

> "*Whereas core concepts and indicators for disaster risk reduction (DRR) for international monitoring have been defined in the Sendai Framework and SDGs, there is a need to translate the agreed concepts and definitions into specific instructions and technical recommendations for production and dissemination of statistics."*

The range of disaster impact statistics proposed in the DRSF includes:

1. Human impacts
2. Demographic and social disaggregation
3. Deaths or missing persons
4. Injured and ill
5. Displacement
6. Impacts to livelihood
7. Material impacts
8. Impacts to agriculture
9. Economic loss
10. Economic loss and poverty
11. Disruptions to basic services

Impacts on environmental and ecosystem will have knock-on effects to points 6, 7, 8, 9, 10 and 11. In some cases ecosystem services (Section 3.2.4) may be a large contributor to livelihoods (6), while impacts to agricultural ecosystems will have impacts on agricultural production (8). Some agriculture production relies on ecosystem services (e.g. soil retention, pollination) or natural resources (e.g. water).

Economic values (costs) can be attributed to several of these impacts – livelihood, material impacts, agriculture, economic loss, and disruptions to basic services. Economic costs associated with direct impacts of disasters - preparation, mitigation, and replacement are already incorporated explicitly within a countries' national accounts (SNA) as productive activities. Losses to the environment and ecosystem assets are recorded in the System of Environmental-Economic Accounting (SEEA), which is discussed later. In this, the economic value of ecosystem assets would decline with the loss of future ecosystems services.

Indirect impacts will implicitly affect gross domestic product (GDP) in the year of the disaster (and often subsequent years) but may be in the form of foregone income rather than direct costs or asset losses so will not be recorded in the SNA. Indirect income losses may occur during the accounting period, for example lost income in industries that rely on intermediate inputs from directly impacted industries to produce their output. Many indirect impacts will

[7] DRSF 3.1

extend beyond the disaster accounting period. The SEEA would account economic losses not included in the SNA.

2.3 Recommendations on the Role of Official Statistics in Measuring Hazardous Events and Disasters (RROS)

The RROS aims to clarify the role of NSOs and other members of the NSS in providing information related to hazardous events and disasters. It also aims to identify the practical steps needed for these organisations, in coordination with Disaster Risk Management Agencies (DRMAs), to better support disaster risk management efforts (RROS).

The leading roles that NSOs and the NSS would ideally assume in providing statistics relating to Hazardous Events and Disasters (HED) that would conform with the recommendations of the Sendai Framework are described in the RROS. The publication acknowledges that this will take some time to occur.

Strengths that NSOs can bring to HED related information are noted in the RROS:

> "*NSOs are often seen solely as providers of statistics. However, they also have other unique strengths and competencies that would be useful in measuring hazardous events and disasters and their impacts. As coordinators of NSS, NSOs have a strong network and experience in coordinating multiple information producers, including ensuring the use of common standards, classifications, and terminology. They have a mandate to provide information based on professional independence, strict quality criteria, use of sound, transparent, and commonly agreed methodologies, and a commitment to accessibility. NSOs also have established procedures for communicating and disseminating information and are well suited to providing a platform for regular dissemination of HED-related information*."[8]

Several challenges facing the NSS increased involvement in HED statistics were noted, including:

a) Although NSS has information at its disposal that can be used in disaster risk management, this information is often not sufficiently used. NSOs are often unaware of the related requirements, and DRMAs are frequently unaware that this information is available.
b) The NSS is often not involved in producing HED-related statistics.
c) Roles of NSOs and other organisations within NSS related to HED are not clear. HED-related information needs are complex. Addressing these needs typically involves different agencies. While some needs can be met by NSS, others require quite distinct types of information which cannot be provided by official statistics. Therefore, it is important to clarify the roles of NSOs and the other organisations within NSS in providing HED-related information.
d) Official statistics are not fit-for-purpose. Official statistics are often not fit for measuring HED-related issues. For example, the time lag may be too long, or the required spatial disaggregation may not be available. Special approaches are needed to provide more timely statistics and to deal with confidentiality issues in cases of emergency. As production of these types of statistics often is of low priority,

[8] Recommendations on the Role of Official Statistics in Measuring Hazardous Events and Disasters, 1.3.d

there is a lack of funding to make existing official statistics more suitable for disaster risk management, and to develop new statistics in this area.

In terms of fit-for-purpose, official statistics usually provide information on events or transactions occurring in a reference period (e.g. 3-monthly, annually, or 5-yearly), depending on the data needed, which is relatively predicable. The information is usually collected during or after the reference period has ended and published sometime after the references period. HED are sporadic and less predictable posing additional challenges. Official statistics are collected to meet defined national and international reporting obligations in respect of the economy and society. Environmental and ecosystem statistics are usually collected by a range of government information agencies and NSOs rely on the cooperation of other information agencies for information. Adding responsibilities to an NSO for the production of DRS for environment and ecosystem-related losses will require on-going collaboration between NSOs, and other information agencies in NSS, and will likely require additional administrative arrangements and may even require changes to laws.

An important challenge associated with data collection for DRS for environmental and ecosystem-related losses is the timeliness of data. UNISDR recommends countries report disaster data by event, so that complementary analysis can be undertaken to obtain trends and patterns in which such catastrophic events can be included or excluded. Impacts may occur close to the time of initial onset of the event, in which case finalizing data collection and declaring the data collected as final is straightforward. However, disaster related impacts will often extend over several months or years such that collecting final data extends beyond the period in which the disaster occurred, and other disasters may follow either as a consequence of the first event, or as a new independent event or events. The impacts of multiple disasters may interact is such a way as the impact of each disaster is magnified. For the environment and ecosystems some impacts, like high-intensity fires in forests, may have impacts lasting decades.

Official environment and ecosystem statistics are compiled and presented as per the FDES and SEEA to facilitate national environmental and ecosystem management policy and planning as well as international comparison. Ideally environment and ecosystem statistics would be collected and published annually. In practice, this does not always occur and hence the impact of disasters may not be reflected in official statistics until sometime well after the disaster.

In the absence of a commonly agreed framework for production of HED statistics, NSOs may regard development of DRS as a low priority. Based on the development of the FDES and SEEA, prioritisation of particular disaster-related statistics for environment and ecosystem-related losses should follow the development of the DRS framework, as well as assess the funding appropriate for the production of the statistics.

It is noted in the preface of the RROS that disaster-risk management on the national level is usually a task of specialised agencies or line ministries, with only limited or no involvement of NSOs or other members of the national statistical system (NSS). However, the work of Disaster Risk Management Agencies (DRMAs) is largely dependent on data produced by NSS, such as statistics on population, economy, agriculture and the environment.

NSOs are usually not the primary collectors or custodians of the data used in production of environment and ecosystem statistics. Environment and ecosystem data can come from ministries responsible for environmental, agriculture, forests and water, mapping agencies, hydro-meteorological institutes and environment protection agencies and sub-national administrative bodies. Research institutions and NGOs can also contribute environment and ecosystem data to NSOs.

The RROS publication raises critical issues for developing DRS for environmental and ecosystem-related losses, especially regarding the role of the NSO and NSS. The RROS does not provide any guidance for the development of statistics related to environment and ecosystems. It may be that the need for DRS will raise the priority of both disaster-related and environmental statistics within NSOs and the NSS, and provide a reason for greater coordination within countries on environment and ecosystems statistics.

ISSUE: Will resources be made available to NSOs to enable the development of DRS for environmental and ecosystem-related losses?

ISSUE: What coordination mechanisms are need by NSOs to enable development of DRS for environmental and ecosystem-related losses?

2.4 Hazard, Definition and Classification Review, Technical Report

In May 2019, the UN Office for Disaster Risk Reduction (UNDRR) and the International Science Council jointly established a technical working group to identify the full scope of hazards relevant to the Sendai Framework. This was to be the basis for countries to review and strengthen their risk reduction policies and operational risk management practices. The report from the technical working group recognized that multiple hazard lists are used by many organizations at various levels of government. As such, a single reference list delineating the full scope of hazards to inform and support all parts of DRR and DRM was not available.

As a scientific undertaking, the technical working group was guided by the definition of 'hazard' adopted by the United Nations General Assembly in February 2017; namely:

> "*a process, phenomenon or human activity that may cause loss of life, injury or other health impacts, property damage, social and economic disruption or environmental degradation*".

This definition covers a broader scope of hazards than has traditionally been the case in the field of disaster risk reduction and expands the definition of hazard to include processes and activities.[9] This is important as the fundamental basis of DRM uses hazard information combined with exposure, vulnerability (or resilience) and capacity. Therefore, standardization of terminology, common consensus and usage of terms, will support the consistency of DRM approach and results. Section 5 provides a list of terms and their definition from the various documents.

The implication of this report and of *Recommendations on the Role of Official Statistics in Measuring Hazardous Events and Disasters*, is that a clear definition of 'disaster' in relation to 'hazard' and 'hazardous events' needs to be agreed so that it can be integrated into the development of the DRS framework.

ISSUE: What is the scope of hazardous events and disasters (HED) to be included in DRS for environmental and ecosystem-related losses?

[9] Hazard, Definition and Classification Review, Technical Report, United Nations Office for Disaster Risk Reduction (UNDRR), 2020

The compilation of hazards from existing documents was limited during the development of the UNDRR hazards list at it was recognized that the full scope of what is considered a 'hazard' was potentially infinite. The hazard list excluded hazards that did not have the potential to impact a community (small-scale or potentially lower priority hazards), whose components were not able to be spatially or temporally measured, and those for which proactive and reactive measures were unavailable. The report also notes the exclusion of:

> "*complex human activities and processes where it was difficult to identify a single or limited set of hazards, compound and cascading hazards, and underlying disaster risk drivers (such as climate change)".*[10]

It is implied that future development of the hazard list will consider complex, compound and cascading hazards and risk. The issue of how the list of hazards would be related to DRS for environmental and ecosystem-related losses was not considered.

A total of 302 hazards were listed and grouped into eight 'clusters ', without a hierarchy. This was deliberate to allow countries and communities to develop their own priorities driven by own risk management objectives and context. The technical working group developed common templates to be applied to all hazards called 'Hazard Information Profiles (HIP)' which are available to support prioritization of hazards by countries. The report recognized that "*countries have their own terminology and definitions embedded in institutional, policy, legal and fiscal documents*"[11] and does not suggest alignment with internationally agreed terminology and definitions contained within the developed list of hazards. The defined eight clusters which are the only structural components of the UNDRR hazard list are:

1. Meteorological and hydrological hazards
2. Extra-terrestrial hazards
3. Geohazards
4. Environmental hazards
5. Chemical hazards
6. Biological hazards
7. Technological hazards
8. Societal hazards

If the compiled list of hazard definitions and terminology are aligned to existing environmental statistics frameworks (examined in Section 3), a more uniform understanding and approach to DRR and DRM to environment and ecosystem-related losses could be supported. This would probably go beyond the implied scope of DRS for environment and ecosystem-related losses but would provide additional information useful for both DRR and DRM.

Clear definitions of underlying hazards are essential for monitoring and measuring of the environment and ecosystems and determining the needs for information for the DRS framework, and for DRR and DRM. Standardized reporting using clearly defined terminology, would support and common understanding of relationships between the components of disaster risk (hazard, exposure, vulnerability and capacity), and provides

[10] Hazard, Definition and Classification Review, Technical Report, United Nations Office for Disaster Risk Reduction (UNDRR), 2020

[11] Hazard, Definition and Classification Review, Technical Report, United Nations Office for Disaster Risk Reduction (UNDRR), 2020

crucial evidence of effectiveness of DRR and DRM actions and approaches to reduce environmental and ecosystem losses.

ISSUE: To what extent should countries be expected to report against the UNDRR hazard list and hazard definitions to ensure internationally comparability of results for DRS for environmental and ecosystem-related losses?

ISSUE: To what extent, if any, should DRS for environmental and ecosystem-related disaster losses consider the information needed for disaster risk reduction or disaster risk management?

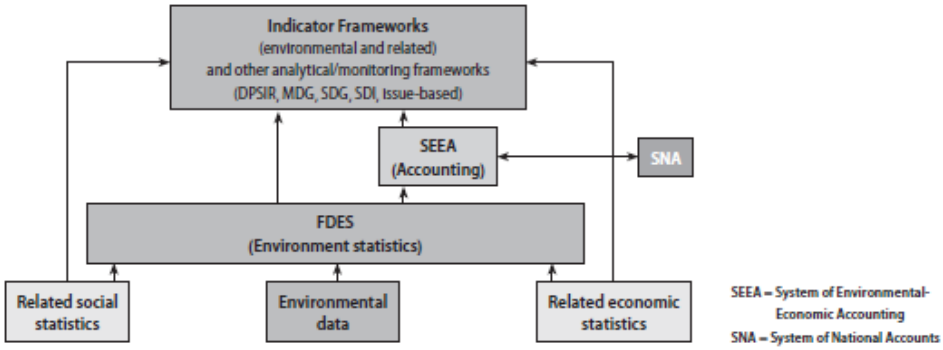
3. Review of existing environment and ecosystem statistical frameworks

The Sendai Framework explicitly identifies the environment in its definition of disasters:

> *"a serious disruption of the functioning of a community or a society at any scale due to hazardous events interacting with conditions of exposure, vulnerability and capacity, leading to one or more of the following: human, material, economic and environmental losses and impacts."* (UNGA, 2016).

Two existing statistical frameworks are available to measure the environment and ecosystems. These are the FDES and SEEA and both of these frameworks include statistics that measure "environmental losses and impacts" mentioned in the Sendai Framework. The SEEA, because of links to economic information and the identification use of ecosystem services of benefit to people not identified in standard economic information (i.e., the SNA), can also be used to assess secondary impacts on the economy, from environmental and ecosystem losses. The relationship between the FDES and SEEA framework and international indicators is shown in Figure 2.4 of FDES and is shown below.

Figure 2.4
Relationship of the FDES to other frameworks, systems and indicator sets

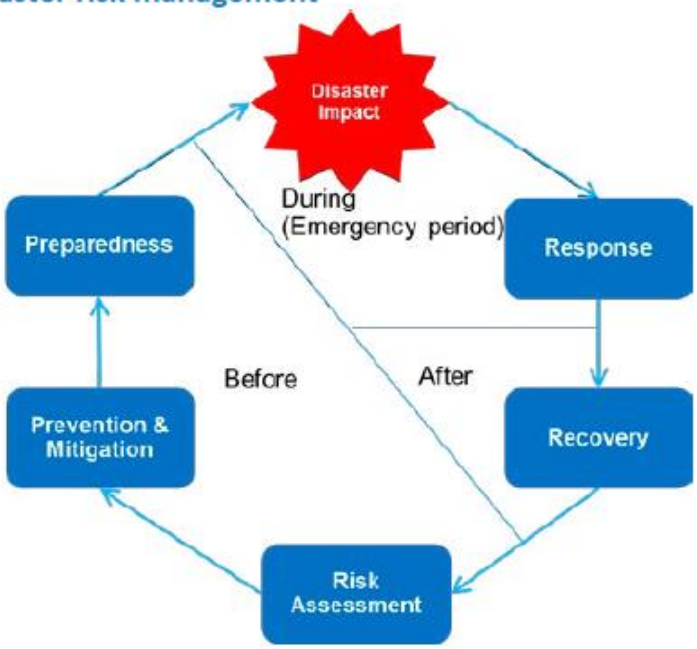


The phases of disaster risk management are shown below in Figure 2 of the paper of the UNESCAP Expert Group (2018). How statistics from the FDES and SEEA relate to these phases are outlined in the sections below.

In addition to these two environmental and ecosystem statistical frameworks there is also Framework on Geospatial Information and Services for Disasters[12]. This framework provides the basis for storing and accessing all types of data – social, economic and environmental – relevant to DRS. This framework should guide the design and use of statistical infrastructure underpinning the spatially referenced environmental and ecological information needed for DRS.

[12] UN-GGIM (2017) https://ggim.un.org/documents/UN-GGIM_Strategic_Framework_Disasters_final.pdf

Figure 2: Phases of disaster risk management



Source: ESCAP Expert Group, 2018

3.1 The Framework for the Development of Environment Statistics (FDES)

The FDES outlines the scope of environmental statistics and provides a conceptual framework for synthesising and categorising environmental statistics and data from a variety of sources "*covering relevant issues and aspects of the environment to support multiple objectives such as analysis, policy and decision-making*"[13]. It also provides a tiered mechanism for countries to prioritise both environmental data collection and methodological development in ways appropriate to individual country circumstances at the national, regional and local levels.

The UNSC endorsed the FDES in 2013. The 2013 FDES was a revision of the 1984 version, updated to account for developments in science, politics, technology, statistics and experience. Another update is planned, and is discussed below in the context of coordination of the development of DRS. The FDES update is planned to begin in 2023.

FDES was developed to support the development of the SEEA development and Driving Forces-Pressure-State-Impact-Response (DPSIR) model of environmental reporting. FDES is compatible with the MDG and subsequent SDG indicators. The FDES is now partially superseded by the UN ECE CECESSTAT[14], but it continues to provide a practical basis for countries to organise environmental statistics that could support DRS for environmental and ecosystem-related disaster losses.

The FDES structures environmental statistics using six components and 21 sub-components (Table 1) to which multiple underlying environment variables can be ascribed. This grouping of statistics can support multiple indicators to assist the monitoring of environmental change over time at a range of scales (e.g. national, regional and local).

[13] Framework for the Development of Environmental Statistical (FDES 2013)

[14] Recommendations on the Role of Official Statistics in Measuring Hazardous Events and Disasters, 2019, United Nations Economic Commission for Europe (UNECE)

The FDES could provide a basis for DRS for environmental and ecosystem-related disaster losses as well as for the allocation of resources and application of DRR and DRM actions to minimise environmental and ecosystem-related disaster losses. In the this, the FDES components, sub-components and topics consider both natural and human processes and activities.

Hazardous event and Disaster (HED) related statistics predominantly are attributable to Component 4 (Extreme Events and Disasters) and 6 (Environmental Protection, Management and Engagement), with additional application (albeit not as connected to DRR) to components 1, 2, 3. The flexibility of FDES allows users to group subcomponents and their underlying topics to form bespoke environmental indicators related to their own needs, which could include DRS for environment and ecosystem-related losses. However, the FDES notes that indicators are not standardized and lack evidence of effectiveness.

Table. 1. Components and subcomponents of the FDES

Table 2.2
Components and subcomponents of the FDES

Component 1: Environmental Conditions and Quality	Subcomponent 1.1: Physical Conditions Subcomponent 1.2: Land Cover, Ecosystems and Biodiversity Subcomponent 1.3: Environmental Quality
Component 2: Environmental Resources and their Use	Subcomponent 2.1: Mineral Resources Subcomponent 2.2: Energy Resources Subcomponent 2.3: Land Subcomponent 2.4: Soil Resources Subcomponent 2.5: Biological Resources Subcomponent 2.6: Water Resources
Component 3: Residuals	Subcomponent 3.1: Emissions to Air Subcomponent 3.2: Generation and Management of Wastewater Subcomponent 3.3: Generation and Management of Waste Subcomponent 3.4: Release of Chemical Substances
Component 4: Extreme Events and Disasters	Subcomponent 4.1: Natural Extreme Events and Disasters Subcomponent 4.2: Technological Disasters
Component 5: Human Settlements and Environmental Health	Subcomponent 5.1: Human Settlements Subcomponent 5.2: Environmental Health
Component 6: Environmental Protection, Management and Engagement	Subcomponent 6.1: Environmental Protection and Resource Management Expenditure Subcomponent 6.2: Environmental Governance and Regulation Subcomponent 6.3: Extreme Event Preparedness and Disaster Management Subcomponent 6.4: Environmental Information and Awareness

ISSUE: To what extent are the components of FDES aligned with DRS for environment and ecosystem related losses?

DRS for environment and ecosystem related losses can be allocated to various levels of each component, however, the FDES is structured in a way that DRS are connected with socio-economic considerations and direct or indirect impacts on humans, human settlements and assets, rather than ecosystems and the environment itself. As such, the framework would need to be updated to be applicable to DRS for environment and ecosystem-related losses. The FDES could play a broader role in DRS and support DRR and the related DRM processes. The planned update of FDES in 2023 could allow identification and prioritization of collection requirements and application of resources to support DRS for environment and ecosystem-related losses.

ISSUE: Could the planned FDES update be used to address the needs of DRS for environment and ecosystem-related losses?
Including DRS for environment and ecosystem-related losses in the planned update of the FDES would help minimize the burden on the producers of statistics.

3.2 SEEA and DRS for environment and ecosystem-related losses

The System of Environmental Economic Accounting (SEEA) organizes and integrates statistics on the environment and the economy. It measures the condition of the environment, the contribution of the environment to the economy and the impact of the economy on the environment. The SEEA Central Framework was adopted by the UN Statistical Commission in 2012 and SEEA Ecosystem Accounting in 202. Around 100 countries have or are developing SEEA-based information. A feature of the SEEA is its link to the System of National Accounts (SNA). This enables the integration of environmental and economic statistics and a range of indicators about the economy and environment to be produced.

A key feature of SEEA Ecosystem Accounting is that the data are spatially referenced. This allows ecosystem information to be overlaid with other spatially referenced information, such as topographic maps, enabling other factors contributing to risk assessment to be added (e.g. low-lying areas are more at risk of flooding).

The SEEA Central Framework and SEEA Ecosystem Accounting both recognize the potential of the frameworks to assess risk and account for disasters. The very first paragraph (para 1.1) of SEEA-EA mentions risks:

> "*1.1 It is well established that healthy ecosystems and biodiversity are fundamental to supporting and sustaining our wellbeing, our communities and our economies. However, our environment is under pressure and there are consequential risks that we face in securing and improving our livelihoods. These challenges have been recognized at local, national and global levels. Global responses have been articulated clearly in the Sustainable Development Goals and other global agreements such as the Paris Agreement on limiting the effects of climate change and the Global Biodiversity Framework6 to conserve biodiversity*." (SEEA-EA, p. 2)

Risk and disasters are mentioned in several places, and SEEA Ecosystem Accounting application to DRR is recognized, most explicitly in Chapter 10:

> "*Decreases in the value of ecosystem assets due to catastrophic losses are identified separately to provide scope for compilers to record decreases due to large scale, discrete and recognizable events that cause a significant decline in the condition of an ecosystem asset, i.e., significant losses in structure, function or composition, and hence affect the future flows of ecosystem services in physical terms. Examples include earthquakes, bushfires, cyclones and industrial disasters. While these events may be anticipated in general terms, the precise timing, location and magnitude cannot be foreseen in the same way as expectations may be formed about patterns of ecosystem use by people. The effects on future flows of ecosystem services may be temporary if the ecosystem quickly recovers to its previous condition or permanent if the changes are such that some ecosystem services can no longer be supplied or accessed (e.g., due to changes in regulations). Where the effects of the large-scale events is significant enough such that it is considered that the ecosystem has changed ecosystem type, this should be recorded as an ecosystem conversion."* (para 10.37, p. 214)

The words are backed by the example of the standard asset account of the SEEA Central Framework, which is discussed below in more detail, that includes a line for recording "catastrophic losses". The line item "catastrophic losses" in the asset account could be expanded to include all applicable classes of HEDs.

DRS could adopt the SEEA, concepts, definitions, classification and basic reporting format for DRS for environment and ecosystem-related losses. The advantages of doing this are that the system already exists and is being implemented by NSOs around the world. This would lessen the resources needed for the development of the overall DRS framework and mean it is more likely to be able to be implemented in countries as there is existing capacity in NSO for SEEA implementation.

The remainder of this section examines how the SEEA can be related to the DRS for environment and ecosystem-related losses.

3.2.1 Defining the environment and ecosystems for DRS using SEEA

The SEEA Central Framework accounts for environmental assets ("natural capital") and the natural resources (e.g. minerals, timber, water, fish) that contribute to the economy more generally. Environmental assets are defined as:

> "*the naturally occurring living and non-living components of the Earth, together constituting the biophysical environment, which may provide benefits to humanity*"(para 2.17).

The SEEA Ecosystem Accounting defines ecosystem assets (EAs) as:

> "*contiguous spaces of a specific ecosystem type characterized by a distinct set of biotic and abiotic components and their interactions."* (para. 2.11)

Ecosystem types as defined in the SEEA include agricultural ecosystems (e.g. T7.1 annual cropland) and human settlements (T7.4 urban land and industrial ecosystems).

Both environment and ecosystem assets can be measured in physical (e.g. hectares, tonnes, litres) and monetary terms (e.g. US$).

ISSUE: Are the definitions of environment and ecosystem assets in the SEEA appropriate for DRS for environment and ecosystem-related losses?

The SEEA Central Framework and SEEA Ecosystem Accounting both have classifications of the environment, natural resources and ecosystems. The SEEA Central Framework asset classification is found in Annex 1, while the global ecosystem classification developed by IUCN, which is the suggested classification of ecosystem assets in the SEEA Ecosystem Accounting is presented in Annex 2. These classifications could be used for DRS.

ISSUE: Are the classifications of environment and ecosystem assets in the SEEA appropriate for DRS for environment and ecosystem-related losses?

3.2.2 Recording of environment and ecosystem-related disaster losses using SEEA asset accounts

The SEEA asset accounts record changes in the stock and condition of environmental and ecosystem assets. The general structure of the environmental asset account is shown

below. This is Table 2.3 of the SEEA Central Framework. Note the stock reductions part of the table includes a row for “Catastrophic losses”.

Basic form of an asset account

Opening stock of environmental assets
Additions to stock
Growth in stock
Discoveries of new stock
Upward reappraisals
Reclassifications
Total additions of stock
Reductions of stock
Extractions
Normal loss of stock
Catastrophic losses
Downward reappraisals
Reclassifications
Total reductions in stock
Revaluation of the stock[a]
Closing stock of environmental assets

.

For DRS for environment and ecosystem-related losses the row “Catastrophic losses” could be renamed “Hazardous events and disasters”. This row could then be disaggregated by every type of hazardous events and disaster (HED). The HED could be split between human or natural causes. For example, for a forest fire the land cover accounts would record the area burnt, while a timber account would show the tonnes and value of timber in the forest lost. The fire would be catastrophic loss from natural causes. If the loss of forest was due to human factors, e.g. a chemical spill, then this would be a human caused loss.

In this way the environment assets, the type of hazardous event or disaster and impact of the disaster on environmental assets would be recorded, which is completely aligned with DRS for environment and ecosystem-related losses. Overtime this approach would also allow the frequency of each type of disaster and the magnitude of impacts to be revealed, providing a solid foundation for the calculation of risk, which can be described in physical and monetary terms supporting DRR and DRM. As the environmental accounts are linked to national economic and ecosystem information the knock-on effects can also be seen and estimated.

The ecosystem extent account (SEEA Ecosystem Accounting Table 4.1, shown below) does not include a row for “Catastrophic losses” as in the SEEA Central Framework asset account. The rows shown are for managed (human caused) and unmanaged (natural) additions and reductions. Disasters and hazardous events can be both human-caused or natural. Like the SEEA Central Framework asset account, losses due to hazardous events disasters could be recorded within the existing structure of the ecosystem extent account by disaster type.

Table 4.1: Ecosystem extent account (units of area)*

	Selected ecosystem types (based on Level 3 - EFG of the IUCN Global Ecosystem Typology)																		
Realm	Terrestrial												Freshwater			Marine			
Biome	T1 Tropical-subtropical forests				T2 Temperate-boreal forests and woodlands				...		T7		F1	...	FM1	M1	...	MFT1	
Selected Ecosystem Functional Group (EFG)	Tropical-subtropical lowland rainforests	Tropical-subtropical dry forests and scrubs	Tropical-subtropical montane rainforests	Tropical heath forests	Boreal and temperate high montane forests and woodlands	Deciduous temperate forests	...	Temperate pyric sclerophyll forests and woodlands	...	...	...	Derivied semi-natural pastures and old fields	Permanent upland streams	...	Intermittently closed and open lakes and lagoons	Seagrass meadows	...	Coastal saltmarshes and reedbeds	TOTAL
	T1.1	T1.2	T1.3	T1.4	T2.1	T2.2	...	T2.6	...	...	...	T7.5	F1.1	...	FM1.3	M1.1	...	MFT1.3	
Opening extent																			
Additions to extent																			
Managed expansion																			
Unmanaged expansion																			
Reductions in extent																			
Managed reductions																			
Unmanaged reductions																			
Net change in extent																			
Closing extent																			

* This table provides an indicative structure with respect to the set of ecosystem types. Compilation will require the use of nationally selected ecosystem types.

The stylized ecosystem condition accounts (SEEA Ecosystem Accounting, Table 5.4, 5.5 and 5.6) do not record the reasons for change in ways immediately compatible with disaster-related statistics. The tables could, however, be adapted to reveal the impact of disasters.

ISSUE: To what extent could environmental and ecosystem asset accounts be used as the basis for DRS for environment and ecosystem-related losses?

3.2.3 Recording of environment and ecosystem-related disaster losses using SEEA ecosystem service accounts

Ecosystem assets are linked to ecosystem services accounts. Ecosystem services may contribute directly to economic production (as measured in the SNA) or to human wellbeing more generally (not included in the SNA).

Ecosystem services are defined as:

> " *the contributions of ecosystems to the benefits that are used in economic and other human activity."* (SEEA-EA, para 6.9)

In the SEEA- Ecosystem Accounting the definition of an ecosystem service is something that is used by people.

Several types of ecosystem service are listed in SEEA-EA Table 6.3 (presented in Annex 3 of this report). Some of these ecosystem services are directly applicable to DRS for environment and ecosystem-related losses and DRR and DRM. These ecosystem services include:

- Air filtration services, which reduce concentrations of air pollutants providing improved health outcomes and reduced damage to buildings

- Global climate regulation services that reduce concentrations of GHG in the atmosphere through the removal (sequestration) of carbon from the atmosphere and the retention (storage) of carbon
- Soil erosion control services that reduce the loss of soil (and sediment) and support use of the environment (e.g., agricultural activity, water supply)
- Landslide mitigation services that mitigate, or prevents damage to human health and damaging effects to buildings and infrastructure that arise from the mass movement (wasting) of soil, rock and snow
- Solid waste remediation services transform organic or inorganic substances, through the action of micro-organisms, algae, plants and animals that mitigates harmful effects.
- Water purification services maintain the chemical condition of surface water and groundwater bodies through the breakdown or removal of nutrients and other pollutants and mitigate the harmful effects of the pollutants on human use or health
- Water regulation services regulate mitigate the effects of flood and other extreme water-related events
- Coastal protection services are the ecosystem like coral reefs, sand banks, dunes or mangrove ecosystems along the shore that mitigate the impacts of tidal surges or storms on local communities
- River flood mitigation services are provided by riparian vegetation and provide a physical barrier to high water levels and mitigates the impacts of floods on local communities
- Storm mitigation services mitigate the impacts of wind, sand and other storms (other than water related events) on local communities
- Biological control services reduce the incidence of species that may prevent or reduce the effects of pests on biomass production processes or other economic and human activity.
- Disease control services reduce the incidence of species that may prevent or reduce the effects of species on human health.

All of these ecosystem services are benefits to people from ecosystems. Damage to the ecosystem are recorded in the ecosystem asset accounts and the resulting losses of ecosystems services to the economy and human wellbeing could be identified from changes in the flows of ecosystem ecosystems; i.e. before and after the disaster. Loss of ecosystem services from losses to ecosystem assets do not seem to have been explicitly considered in the discussions to date of DRS. Reporting on losses of ecosystem services would be of benefit to the overall DRS global framework

ISSUE: Are ecosystem services within the scope of DRS for environment and ecosystem-related losses?

3.2.4 SEEA and the Disaster Risk Reduction Expenditure (DRRE) satellite account.

Note: this section is included as it is relevant to the development of the DRS global framework, but it is not within the scope of DRS for environment and ecosystem-related losses.

As part of the development of disaster-related statistics a Disaster Risk Reduction Expenditure (DRRE) satellite account is being considered. Disaster Risk Reduction (DRR)

activities are activities that boost coping capacities of society where a disaster occurs or may occur. The costs of investment in DRR are expenditures or transfers for activities with a DRR purpose. The size of DRR expenditure can be compared with other activities and with total GDP.[15]

The SEEA includes accounts for environmental protection expenditure (EPE) and resource management (RME). EPE accounts record expenditures related to disaster-related statistics and the DRRE satellite account. Environmental protection expenditure enables identification and measurement of society's response to environmental concerns through the supply of environmental protection services and through the adoption of production and consumption behaviour aimed at preventing environmental degradation. The scope of the EPE accounts is:

> "…… *the expenditures undertaken by economic units for environmental protection purposes*" (SEEA Central Framework, para 4.39)

Resource management expenditure accounts are not commonly produced, but would, in practice, expand the coverage of the EPE accounts by encompassing resource management activities that could be part of disaster-related statistics. Resource management expenditure accounts would include, for example, the expenditure on the management of water supply and forests used for timber production.

There is an overlap between the scope of environment protection and resource management expenditure accounts of the SEEA with the proposed DRRE satellite account. In this, countries already with EPE and RME accounts have a starting point for DRRE satellite accounting. Regardless of the extent to which they are useful, the overlap between the DRRE, EPE and RME accounts needs to be understood and explained in the disaster-related statistics.

ISSUE: To what extent, if any, could the SEEA environment protection expenditure accounts be used in the DRRE satellite account?

3.2.5 DRS for environment and ecosystem-related disaster losses, SEEA and phases of disaster risk management

The SEEA could support all five of the disaster risk management phases and to measure the impact of individual disasters.

The ecosystem assets accounts could be used in conjunction with other data for response, recovery, risk assessment, and prevention and mitigation. For example, to set priorities for the intrinsic values of the environment and ecosystems accounts. In this, the response, recovery and prevention and mitigation of damage ecosystems could be prioritized through reference to rare or endangered ecosystems or the species occurring within ecosystems. The importance of particular ecosystem or species could be assessed by their status as determined by the IUCN Red List (and their national equivalents). The risks to different ecosystems can be assesses based on location of ecosystem assets and the frequency and severity of possible impacts. For example, freshwater ecosystems close to coastal areas that could affected by tsunamis, tidal surge or sea-level rise.

For the people dependent on the environment for day-to-day living (e.g. drinking water from lakes, streams or wells, forest for fuelwood, seas for fish) the SEEA asset accounts would

[15] DRSF 5.1, 5.2

show the location of critical environmental assets (e.g. freshwater, forests or seas). Communities affected by changes in water quality (e.g. increased to salinity due to a tsunami making water used for dinking undrinkable) or seas used for local food provision (e.g. not entering markets) can be prioritized for assistance.

The ecosystem services accounts can show which ecosystem assets are most important for human benefits. For risk management prevention and mitigation, many ecosystems services are directly relevant – coastal protection, flood mitigation and air filtration. The ecosystems delivering these services can be maintained. In some cases, increasing ecosystem assets, would provide "nature-based solutions" as an alternative to "grey" infrastructure (e.g. restoring mangroves, rather than concrete sea walls).

The SEEA- Ecosystem Accounting notes:

> "….. *it may not be necessary to measure ecosystem capacity for all ecosystem services" and "from a risk management perspective, this might be appropriate and it certainly provides a basis for prioritization of ecosystem services for measurement*."(para 6.156, p. 153)
>
> "*Other monetary indicators can be derived by comparing [SEEA] aggregates with other economic data such as the total value of other assets, expected ecosystem restoration costs, or the value added of industries dependent on ecosystem services or at risk if ecosystem services are lost*." (para, p. 317)
>
> "*In considering both the future supply and demand of ecosystem services it will be helpful to frame the future flows differently depending on the type of service" and "future flows of regulating and maintenance services are more likely to be functions of changes in exposure to risks over time, for example from pollution and emissions, floods and the effects of climate change" and "the information provided in the logic chains for ecosystem services in annex 6.1 may provide a useful starting point in framing the relevant factors by type of ecosystem service*." (para 10.67 p. 219)

The ecosystem services logic chain in SEEA Ecosystem Accounting Annex 6.1 is also of interest as it provides examples of several services of direct relevance the phases of disaster risk management:

- Risk to loss of Soil and sediment retention services (p. 155)
- Coastal protection services and River flood mitigation services, both measured by "Number of properties in a lower risk category" (p.156)
- Table 14.3: Potential indicators on physical ecosystem services flows
- "Number of properties/ km of coast/shoreline/riparian zone protected; change in degree of risk" for "Flood mitigation services" (p. 317)

ISSUE: To what extent do the SEEA accounts provide information of relevance to the phases of disaster risk management?

4. Coordination of the development of DRS for environment and ecosystem-related disaster losses with FDES and SEEA

If the FDES and SEEA are considered a useful starting point for DRS for environment and ecosystem-related losses, then coordination with the bodies governing these frameworks needs to be considered. The bodies are the Expert Group on Environment Statistics (EGES) for the FDES and Committee of Experts on Environmental-Economic Accounting (UNCEEA) for the SEEA.

To this end, two documents were reviewed:

- The Minutes of Sixteenth Meeting of the UN Committee of Experts on Environmental-Economic Accounting (UNCEEA 2021)[16]
- The Final Repot of the Eighth Meeting of the Expert Group on Environment Statistics (EGES 2021)[17]

The minutes of the 16th Meeting of UNCEEA held in 2021 considered the role of communication and coordination but do not expressly refer to disaster risk statistics. However, the benefit of using the SEEA as the basis for the relevant indicator frameworks climate change was emphasized to promote harmonized indicators on the environment-economy nexus. Also emphasized was the importance of NSOs to actively engaging with policy makers "to provide relevant, high quality data that meets their monitoring and reporting needs." Disaster risk management would be an area for policy engagement.

ISSUE: Would coordination with the UNCEEA be useful for the development of DRS for environment and ecosystem-related losses?

The Eighth Meeting of the Expert Group on Environment Statistics held in 2021 addressed climate change statistics and indicators related directly to DRS. The meeting aimed to make progress on a Draft Global Set of Climate Change Statistics and Indicators. The UNDRR were represented at the meeting and it was noted the work of DRR and climate change statistics needed to align as it "*reduces reporting fatigue of Member States*", and UNDRR noted that "*a common statistical framework on disaster-related statistics could provide a common methodological reporting framework*." (para 47 of Final Report). The meeting also identified the 2013 FDES provides guidance on statistics related to climate change and that a possible revision to the FDES could simultaneously address climate change statistics.

ISSUE: Does the scope of DRS for environment and ecosystem-related losses includes climate change statistics and indicators?

ISSUE: To what extent could a possible revision of the FDES address the needs of DRS for environment and ecosystem-related losses?

[16] Minutes of the 16th Meeting of the United Nations Committee of Experts on Environmental-Economic Accounting (UNCEEA 2021)

[17] Final Report Eighth Meeting of the Expert Group on Environment Statistics, 2021

5. Terminology

The definition of terms cuts the across social, economic and environmental aspects of DRS.

A ranged of terms are used in the various documents examined as part of this review. Some of the terms are listed below with a reference to the source of each term. The list is not exhaustive and is provided as an indication of the terms that need to be defined and consistently used in the development of DRS framework for disaster risk reduction and disaster risk management.

Term	Definition
Assets	Store of value representing a benefit or series of benefits accruing to the economic owner by holding or using the entity over a period of time. It is a means of carrying forward value from one accounting period to another[18]Capacity The combination of all the strengths, attributes and resources available within an organization, community or society to manage and reduce disaster risks and strengthen resilience (UNGA, 2016)
Compound hazard	When one hazard event triggers another (e.g. heavy rainfall leading to a landslide, or a volcanic eruption leading to a landslide that triggers a tsunami with limited observation and no early warning for such a case in place)[19]
Disaster	A serious disruption of the functioning of a community or a society at any scale due to hazardous events interacting with conditions of exposure, vulnerability and capacity, leading to one or more of the following: human, material, economic and environmental losses and impacts.[20]
Disaster damage	Occurs during and immediately after the disaster. This is usually measured in physical units and describes the total or partial destruction of physical assets, the disruption of basic services and damages to sources of livelihood in the affected area.[21]
Disaster impact	The total effect, including negative effects (e.g. economic losses) and positive effects (e.g. economic gains), of a hazardous event or a disaster. The term includes economic, human and environmental impacts, and may include death, injuries, disease and other negative effects on human physical, mental and social well-being.[22]

[18] SNA 2008

[19] Hazard, Definition and Classification Review, Technical Report, United Nations Office for Disaster Risk Reduction (UNDRR), 2020

[20] UNDRR / ISC Sendai Hazard Definition and Classification Review 2020

[21] Hazard, Definition and Classification Review, Technical Report, United Nations Office for Disaster Risk Reduction (UNDRR), 2020

[22] Hazard, Definition and Classification Review, Technical Report, United Nations Office for Disaster Risk Reduction (UNDRR), 2020

Disaster recovery	The restoring or improving of livelihoods and health, as well as economic, physical, social, cultural and environmental assets, systems and activities, of a disaster-affected community or society, in accordance with the principles of sustainable development and "build back better," to avoid or reduce future disaster risk.[23]
Disaster response	The provision of emergency services and public assistance during or immediately after a disaster to save lives, reduce health impacts, ensure public safety, and meet basic subsistence needs of those affected.[24]
Disaster risk	The potential loss of life, injury, or destroyed or damaged assets, which could occur to a system, society, or a community in a specific time period, determined probabilistically as a function of[25]: • Hazard (the existence of a hazard) • Exposure • Vulnerability (or resilience, included here as opposite of vulnerability) • Capacity
Disaster risk assessment	A qualitative or quantitative approach to determine the nature and extent of disaster risk by analysing potential hazards and evaluating existing conditions of exposure and vulnerability that together could harm people, property, services, livelihoods and the environment on which they depend[26]
Disaster risk reduction	No definition found

[23] Both sources:
- Recommendations on the Role of Official Statistics in Measuring Hazardous Events and Disasters, 2019, United Nations Economic Commission for Europe (UNECE)
- Hazard, Definition and Classification Review, Technical Report, United Nations Office for Disaster Risk Reduction (UNDRR), 2020

[24] Recommendations on the Role of Official Statistics in Measuring Hazardous Events and Disasters, 2019, United Nations Economic Commission for Europe (UNECE)

[25] Recommendations on the Role of Official Statistics in Measuring Hazardous Events and Disasters, 2019, United Nations Economic Commission for Europe (UNECE)

[26] 2016 Report of the open-ended intergovernmental expert working group on indicators and terminology relating to disaster risk reduction (UNGA)

Disaster risk management	A continuous process that occurs before, during and after a disaster impact. It is a task typically assigned to DRMA or a line ministry (e.g. the Ministry of Interior). Includes the following phases which occur in parallel before, during and after a disaster[27]: • Assessment • Prevention and mitigation • Preparedness • Response • Recovery
Early warning system	An integrated system of hazard monitoring, forecasting and prediction, disaster risk assessment, communication and preparedness activities systems and processes that enables individuals, communities governments, businesses and others to take timely action to reduce disaster risks in advance of hazardous events (UNGA, 2016: p 17)[28]
Ecosystem	A dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit.[29]
	Ecosystem assets Contiguous spaces of a specific ecosystem type characterized by a distinct set of biotic and abiotic components and their interactions[30]
Ecosystem services	The contributions of ecosystems to the benefits that are used in economic and other human activity[31]
Environment	To be added from SEEA No definition in FDES No definition in disaster statistics documents
Environmental asset	The naturally occurring living and non-living components of the Earth, together constituting the biophysical environment, which may provide benefits to humanity[32]

[27] Recommendations on the Role of Official Statistics in Measuring Hazardous Events and Disasters, 2019, United Nations Economic Commission for Europe (UNECE)
[28] Hazard, Definition and Classification Review, Technical Report, United Nations Office for Disaster Risk Reduction (UNDRR), 2020
[29] Methodology Sheet 1.2.2: Ecosystems and Biodiversity Statistics, Manual for the Basic Set of Environment statistics (derived from Framework for the Development of Environmental Statistics, 2013, United Nations Statistics Division) https://unstats.un.org/unsd/envstats/fdes/manual_bses.cshtml
[30] SEEA -Ecosystem Accounting
[31] SEEA- Ecosystem Accounting
[32] SEEA – Central framework

Environment accounts	Reorganize the relevant environment statistics according to stocks and flows within and between the environment and the economy.[33]
Environmental degradation	Loss of utility (of the environment). Degradation can be a very gradual process and be hard to discern on a day-to-day basis. This includes biodiversity loss, land salination, loss of permafrost and the marine equivalents – including loss of sea ice.[34]
Environmental hazards	Arise through degradation of the natural systems and ecosystem services upon which humanity depends. Ecosystem services including air, water, land, biodiversity, and some key earth processes are threatened by environmental degradation.[35]
Environment indicators	Environment statistics that have been selected for their ability to depict important phenomena or dynamics.[36]
Environment statistics	Environmental data that have been structured, synthesized and aggregated according to statistical methods, standards and procedures.[37]
Environmental data	Large amounts of unprocessed observations and measurements about the environment and related processes.[38]
Environmental indices	Composite or more complex measures that combine and synthesize more than one environmental indicator or statistic and are weighted according to different methods.[39]
Exposure	Constitutes the assets of interest and at risk (such as the environment, the economy, buildings, or people)[40] The situation of people, infrastructure, housing, production capacities and other tangible human assets located in hazard-prone areas.[41]
Hazard	The process, phenomenon or human activity that may cause loss of life, injury or other health impacts, property damage, social and economic disruption or environmental degradation.

[33] Framework for the Development of Environmental Statistics, 2013, United Nations Statistics Division
[34] Hazard, Definition and Classification Review, Technical Report, United Nations Office for Disaster Risk Reduction (UNDRR), 2020
[35] Hazard, Definition and Classification Review, Technical Report, United Nations Office for Disaster Risk Reduction (UNDRR), 2020
[36] Framework for the Development of Environmental Statistics, 2013, United Nations Statistics Division
[37] Framework for the Development of Environmental Statistics, 2013, United Nations Statistics Division
[38] Framework for the Development of Environmental Statistics, 2013, United Nations Statistics Division
[39] Framework for the Development of Environmental Statistics, 2013, United Nations Statistics Division
[40] Hazard, Definition and Classification Review, Technical Report, United Nations Office for Disaster Risk Reduction (UNDRR), 2020
[41] Hazard, Definition and Classification Review, Technical Report, United Nations Office for Disaster Risk Reduction (UNDRR), 2020

	• **Natural hazards** are predominantly associated with natural processes and phenomena. • **Environmental hazards** may include chemical, natural and biological hazards. They arise from degradation of the natural systems and ecosystem services upon which humanity depend and can be created by environmental degradation or physical or chemical pollution in the air, water and soil. However, many of the processes and phenomena that fall into this category may be termed drivers of hazard and risk rather than hazards in themselves, such as soil degradation, deforestation, loss of biodiversity, salinization and sea-level rise.[42]
Hazard(ous) event	The manifestation of a hazard in a particular place during a particular period of time (UNGA, 2016)[43]
Impact information	Refers to hazard warning messages that address the possible impacts of hazard events on lives and livelihoods. [44]
Meteorological and Hydrological hazards	Meteorological and Hydrological hazards are those resulting from the state and behavior of the Earth's atmosphere, its interaction with the land and oceans, the weather and climate it produces, and the resulting distribution of water resources[45]
Multi-hazard	Means: • The selection of multiple major hazards that the country faces, and • The specific contexts where hazardous events may occur simultaneously, cascadingly or cumulatively over time, and taking into account the potential interrelated effects.[46]
Preparedness	The knowledge and capacities developed by governments, response and recovery organizations, communities and individuals to effectively anticipate, respond to and recover from the impacts of likely, imminent or current disasters. It comprises activities undertaken prior to a disaster to prevent or mitigate the impact of the disaster.[47]

[42] Multiple sources:
- UNDRR / ISC Sendai Hazard Definition and Classification Review 2020
- Recommendations on the Role of Official Statistics in Measuring Hazardous Events and Disasters, 2019, United Nations Economic Commission for Europe (UNECE)

[43] Hazard, Definition and Classification Review, Technical Report, United Nations Office for Disaster Risk Reduction (UNDRR), 2020

[44] Hazard, Definition and Classification Review, Technical Report, United Nations Office for Disaster Risk Reduction (UNDRR), 2020

[45] Hazard, Definition and Classification Review, Technical Report, United Nations Office for Disaster Risk Reduction (UNDRR), 2020

[46] Hazard, Definition and Classification Review, Technical Report, United Nations Office for Disaster Risk Reduction (UNDRR), 2020

[47] Recommendations on the Role of Official Statistics in Measuring Hazardous Events and Disasters, 2019, United Nations Economic Commission for Europe (UNECE)

Prevention/Mitigation	Activities and measures to avoid existing and new disaster risks.[48]
Risk assessment	A qualitative or quantitative approach to determine the nature and extent of disaster risk by analyzing potential hazards and evaluating existing conditions of exposure and vulnerability that together could harm people, property, services, livelihoods and the environment on which they depend.[49]
Risk information	Refers to information that is derived from risk assessment(s)[50]
Vulnerability	The susceptibility of those assets to damage or impact to a hazard[51] The conditions determined by physical social, economic and environmental factors or processes which increase the susceptibility of an individual, a community, assets or systems to the impacts of hazards.[52]

ISSUE: How will the terms and definitions related to DRS be standardized?

6. A way forward for the development DRS for environment and ecosystem-related disaster losses

The Disaster-Related Statistics Framework[53] (DRSF) notes:

> *'Basic requirements for the international indicator monitoring systems include comparability of concepts and methods for measurement across disaster occurrences. Thus, these systems depend heavily on coordination and consistency at the national and local levels, which can be accomplished via the adoption and application of a commonly agreed measurement framework.'*

The existing FDES and SEEA provide a range of statistics that can be used for DRS for environment and ecosystem-related disaster losses. Identifying and selecting the environment and ecosystem statistics most relevant to this is dependent on the definition of the environment and ecosystems and the scope DRS for environment and ecosystem-related disaster losses. Whatever the definitions and scope, the FDES and SEEA are existing frameworks that address many aspects of DRS for environment and ecosystem-related disaster losses. The FDES and SEEA also appear to address all phases of DRM and would assist with DRR.

[48] Recommendations on the Role of Official Statistics in Measuring Hazardous Events and Disasters, 2019, United Nations Economic Commission for Europe (UNECE)
[49] Recommendations on the Role of Official Statistics in Measuring Hazardous Events and Disasters, 2019, United Nations Economic Commission for Europe (UNECE)
[50] Hazard, Definition and Classification Review, Technical Report, United Nations Office for Disaster Risk Reduction (UNDRR), 2020
[51] Hazard, Definition and Classification Review, Technical Report, United Nations Office for Disaster Risk Reduction (UNDRR), 2020
[52] Hazard, Definition and Classification Review, Technical Report, United Nations Office for Disaster Risk Reduction (UNDRR), 2020
[53] Disaster Related Statistics Framework, Demands for a statistical framework

Using the statistics from FDES and SEEA would ensure that DRS are aligned with existing standards. This has several benefits:

- Environment-related statistics are consistent across the DRS, FDES and SEEA
- The systems already in place for FDES and SEEA can be used by NSOs, and the NSS more generally, for DRS. Because of this, DRS are more likely to be available sooner than if DRS for environment and ecosystem-related disaster losses are built from scratch.
- By using the SEEA, the ecosystem services relevant to disaster risk reduction and management (e.g., flood mitigation, climate regulation, water filtration) can be explicitly incorporated as well as the services that contribute to economic production (e.g. food and water provisioning, pollination, recreational services). The SEEA can assess the current value of these services and value of loss of these services caused by any hazardous events and disasters. The inclusion of ecosystem services requires a reconsideration of the scope of DRS for environment and ecosystem-related disaster losses.

There is a *prime facie* case that these existing environment and ecosystem statistical frameworks, the FDES and SEEA, provide information relevant to DRS for environment and ecosystem-related disaster losses and to DRS more generally.

A way forward would be for the metrics in each of these frameworks be mapped to category of hazardous events and disasters and then for each metric to ranked according to its importance for DRS for environment and ecosystem-related disaster losses, DRR and DRM. The mapping and agreement on ranking are likely to take some time. In the short-term, the production of a “SEEA for DRS for environment and ecosystem-related disaster losses” or “SEEA for Disaster Risk Reduction and Management” could be a useful interim step for providing integrated environmental and economic statistics for DRS, DRR and DRM. Such an approach would build on existing work and reduce the risk of duplication of effort and confusion due to use of different, concepts, classifications and terms used in internationally agreed statistical frameworks

Annexes

Annex 1 SEEA – Central Framework Asset Classes

Table 5.1
Classification of environmental assets in the SEEA Central Framework

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

Annex 2 SEEA-Ecosystem Accounting Asset Classes (= ecosystem types)

IUCN Global Ecosystem Typology recommended by SEEA-Ecosystem accounting in A3.29

Realm Biome Ecosystem Functional Group
Terrestrial T1 Tropical–subtropical forests
T1.1 Tropical-subtropical lowland rainforests
T1.2 Tropical-subtropical dry forests and scrubs
T1.3 Tropical-subtropical montane rainforests
T1.4 Tropical heath forests
T2 Temperate–boreal forests & woodlands
T2.1 Boreal and temperate montane forests and woodlands
T2.2 Deciduous temperate forests
T2.3 Oceanic cool temperate rainforests
T2.4 Warm temperate laurophyll forests
T2.5 Temperate pyric humid forests
T2.6 Temperate pyric sclerophyll forests and woodlands
T3 Shrublands & shrubby woodlands T3.1 Seasonally dry tropical shrublands
T3.2 Seasonally dry temperate heaths and shrublands
T3.3 Cool temperate heathlands
T3.4 Rocky pavements, lava flows and screes
T4 Savannas and grasslands T4.1 Trophic savannas
T4.2 Pyric tussock savannas
T4.3 Hummock savannas
T4.4 Temperate woodlands
T4.5 Temperate subhumid grasslands
.T5 Deserts and semi-deserts T5.1 Semi-desert steppes
T5.2 Thorny deserts and semi-deserts
T5.3 Sclerophyll deserts and semi-deserts
T5.4 Cool deserts and semi-deserts
T5.5 Hyper-arid deserts
.T6 Polar-alpine (cryogenic) T6.1 Ice sheets, glaciers and perennial snowfields
T6.2 Polar-alpine rocky outcrops
T6.3 Polar tundra and deserts
T6.4 Temperate alpine grasslands and shrublands
T6.5 Tropical alpine grasslands and shrublands
T7 Intensive land-use
T7.1 Annual croplands
T7.2 Sown pastures and fields
T7.3 Plantations
T7.4 Urban and industrial ecosystems
T7.5 Derived semi-natural pastures and old fields
Freshwater
F1 Rivers and streams
F1.1 Permanent upland streams
F1.2 Permanent lowland rivers
F1.3 Freeze-thaw rivers and streams
F1.4 Seasonal upland stream
F1.5 Seasonal lowland rivers
F1.6 Arid episodic arid rivers

F1.7 Large lowland rivers
F2 Lakes
F2.1 Large permanent freshwater lakes
F2.2 Small permanent freshwater lakes
F2.3 Seasonal freshwater lakes
F2.4 Freeze-thaw freshwater lakes
F2.5 Ephemeral freshwater lakes F2.6 Permanent salt and soda lakes F2.7 Ephemeral salt lakes

F3 Artificial fresh waters
TF1 Palustrine wetlands
FM1 Semi-confined transitional waters
M1 Marine shelfs
M2 Pelagic ocean waters
M3 Deep sea floors
M4 Anthropogenic marine systems MT1 Shoreline systems
MT2 Supralittoral coastal systems
MT3 Anthropogenic shorelines MFT1 Brackish tidal
S1 Subterranean lithic
S2 Anthropogenic subterranean voids
F2.8 Artesian springs and oases F2.9 Geothermal pools and wetlands F2.10 Subglacial lakes F3.1 Large reservoirs F3.2 Constructed lacustrine wetlands F3.3 Rice paddies F3.4 Freshwater aquafarms F3.5 Canals, ditches and drains TF1.1 Tropical flooded forests and peat forests
TF1.2 Subtropical-temperate forested wetlands TF1.3 Permanent marshes TF1.4 Seasonal floodplain marshes TF1.5 Episodic arid floodplains
TF1.6 Boreal, temperate and montane peat bogs
TF1.7 Boreal and temperate fens
FM1.1 Deepwater coastal inlets
FM1.2 Permanently open riverine estuaries and bays
FM1.3 Intermittently closed and open lakes and lagoons
Marine-Terrestrial
M1.1 Seagrass meadows M1.2 Kelp forests M1.3 Photic coral reefs M1.4 Shellfish beds and reefs M1.5 Photo-limited marine animal forests M1.6 Subtidal rocky reefs
M1.7 Subtidal sand beds M1.8 Subtidal mud plains M1.9 Upwelling zones M2.1 Epipelagic ocean waters
M2.2 Mesopelagic ocean waters
M2.3 Bathypelagic ocean waters
M2.4 Abyssopelagic ocean waters
M2.5 Sea ice
M3.1 Continental and island slopes
M3.2 Submarine canyons M3.3 Abyssal plains M3.4 Seamounts, ridges and plateaus
M3.5 Deepwater biogenic beds
M3.6 Hadal trenches and troughs
M3.7 Chemosynthetically-based ecosystems

M4.1 Submerged artificial structures M4.2 Marine aquafarms MT 1.1 Rocky shorelines MT 1.2 Muddy shorelines MT 1.3 Sandy shorelines MT 1.4 Boulder and cobble shorelines MT 2.1 Coastal shrublands and grasslands
MT 3.1 Artificial shorelines
Marine-Freshwater- Terrestrial
MFT1.1 Coastal river deltas
MFT1.2 Intertidal forests and shrublands
MFT1.3 Coastal saltmarshes and reedbeds
Subterranean
S1.1 Aerobic caves S1.2 Endolithic systems S2.1 Anthropogenic subterranean voids

Subterranean- Freshwater
SF1 Subterranean freshwaters
SF1.1 Underground streams and pools
SF1.2 Groundwater ecosystems
SF2 Anthropogenic subterranean SF2.1 Water pipes and subterranean canals freshwaters
SF2.2 Flooded mines and other voids
Subterranean-Marine SM1 Subterranean tidal SM1.1 Anchialine caves SM1.2 Anchialine pools
SM1.3 Sea caves

Source: D. A. Keith et al. (2020).

Annex 3 SEEA-Ecosystem Accounting Ecosystem Services

Table 6.3: Reference list of selected ecosystem services

ECOSYSTEM SERVICE		DESCRIPTION
Provisioning services		
Biomass provisioning services	Crop provisioning services*	Crop provisioning services are the ecosystem contributions to the growth of cultivated plants that are harvested by economic units for various uses including food and fibre production, fodder and energy. This is a final ecosystem service.
	Grazed biomass provisioning services*	Grazed biomass provisioning services are the ecosystem contributions to the growth of grazed biomass that is an input to the growth of cultivated livestock. This service excludes the ecosystem contributions to the growth of crops used to produce fodder for livestock (e.g., hay, soybean meal). These contributions are included under crop provisioning services. This is a final ecosystem service but may be intermediate to livestock provisioning services.
	Livestock provisioning services*	Livestock provisioning services are the ecosystem contributions to the growth of cultivated livestock and livestock products (e.g., meat, milk, eggs, wool, leather), that are used by economic units for various uses, primarily food production. This is a final ecosystem service. No distinct livestock provisioning services to be recorded if grazed biomass provisioning services are recorded as a final ecosystem service.
	Aquaculture provisioning services	Aquaculture provisioning services are the ecosystem contributions to the growth of animals and plants (e.g., fish, shellfish, seaweed) in aquaculture facilities that are harvested by economic units for various uses. This is a final ecosystem service.
	Wood provisioning services	Wood provisioning services are the ecosystem contributions to the growth of trees and other woody biomass in both cultivated (plantation) and uncultivated production contexts that are harvested by economic units for various uses including timber production and energy. This service excludes contributions to non-wood forest products. This is a final ecosystem service.
	Wild fish and other natural aquatic biomass provisioning services	Wild fish and other natural aquatic biomass provisioning services are the ecosystem contributions to the growth of fish and other aquatic biomass that are captured in uncultivated production contexts by economic units for various uses, primarily food production. This is a final ecosystem service
	Wild animals, plants and other biomass provisioning services	Wild animals, plants and other biomass provisioning services are the ecosystem contributions to the growth of wild animals, plants and other biomass that are captured and harvested in uncultivated production contexts by economic units for various uses. The scope includes non-wood forest products (NWFP)[69] and services related to hunting, trapping and bio-prospecting activities; but excludes wild fish and other natural aquatic biomass (included in previous class). This is a final ecosystem service
Genetic material services		Genetic material services are the ecosystem contributions from all biota (including seed, spore or gamete production) that are used by economic units, for example (i) to develop new animal and plant breeds; (ii) in gene synthesis; or (iii) in product development directly using genetic material. This is most commonly recorded as an intermediate service to biomass provisioning.
Water supply*		Water supply services reflect the combined ecosystem contributions of water flow regulation, water purification, and other ecosystem services to the supply of water of appropriate quality to users for various uses including household consumption. This is a final ecosystem service.
Other provisioning services		

ECOSYSTEM SERVICE		DESCRIPTION
Regulating and maintenance services		
Global climate regulation services		Global climate regulation services are the ecosystem contributions to reducing concentrations of GHG in the atmosphere through the removal (sequestration) of carbon from the atmosphere and the retention (storage) of carbon in ecosystems. These services support the regulation of the chemical composition of the atmosphere and oceans. This is a final ecosystem service.
Rainfall pattern regulation services (at sub-continental scale)		Rainfall pattern regulation services are the ecosystem contributions of vegetation, in particular forests, in maintaining rainfall patterns through evapotranspiration at the sub-continental scale. Forests and other vegetation recycle moisture back to the atmosphere where it is available for the generation of rainfall. Rainfall in interior parts of continents fully depends upon this recycling. This may be a final or intermediate service.
Local (micro and meso) climate regulation services		Local climate regulation services are the ecosystem contributions to the regulation of ambient atmospheric conditions (including micro and mesoscale climates) through the presence of vegetation that improves the living conditions for people and supports economic production. Examples include the evaporative cooling provided by urban trees ('green space'), the role of urban water bodies ('blue space') and the contribution of trees in providing shade for humans and livestock. This may be a final or intermediate service.
Air filtration services		Air filtration services are the ecosystem contributions to the filtering of air-borne pollutants through the deposition, uptake, fixing and storage of pollutants by ecosystem components, particularly plants, that mitigates the harmful effects of the pollutants. This is most commonly a final ecosystem service.
Soil quality regulation services		Soil quality regulation services are the ecosystem contributions to the decomposition of organic and inorganic materials and to the fertility and characteristics of soils, e.g., for input to biomass production. This is most commonly recorded as an intermediate service.
Soil and sediment retention services	Soil erosion control services	Soil erosion control services are the ecosystem contributions, particularly the stabilising effects of vegetation, that reduce the loss of soil (and sediment) and support use of the environment (e.g., agricultural activity, water supply). This is may be recorded as a final or intermediate service.
	Landslide mitigation services	Landslide mitigation services are the ecosystem contributions, particularly the stabilising effects of vegetation, that mitigates or prevents potential damage to human health and safety and damaging effects to buildings and infrastructure that arise from the mass movement (wasting) of soil, rock and snow. This is a final ecosystem service.
Solid waste remediation services		Solid waste remediation services are the ecosystem contributions to the transformation of organic or inorganic substances, through the action of micro-organisms, algae, plants and animals that mitigates their harmful effects. This is may be recorded as a final or intermediate service.
Water purification services (water quality regulation)	Retention and breakdown of nutrients	Water purification services are the ecosystem contributions to the restoration and maintenance of the chemical condition of surface water and groundwater bodies through the breakdown or removal of nutrients and other pollutants by ecosystem components that mitigate the harmful effects of the pollutants on human use or health. This may be recorded as a final or intermediate ecosystem service.
	Retention and breakdown of other pollutants	
Water flow regulation services	Baseline flow maintenance services	Water regulation services are the ecosystem contributions to the regulation of river flows and groundwater and lake water tables. They are derived from the ability of ecosystems to absorb and store water, and gradually release water during dry seasons or periods through evapotranspiration and hence secure a regular flow of water. This may be recorded as a final or intermediate ecosystem service.
	Peak flow mitigation services	Water regulation services are the ecosystem contributions to the regulation of river flows and groundwater and lake water tables. They are derived from the ability of ecosystems to absorb and store water, and

ECOSYSTEM SERVICE		DESCRIPTION
		hence mitigate the effects of flood and other extreme water-related events. Peak flow mitigation services will be supplied together with river flood mitigation services in providing the benefit of flood protection. This is a final ecosystem service.
Flood control services	Coastal protection services	Coastal protection services are the ecosystem contributions of linear elements in the seascape, for instance coral reefs, sand banks, dunes or mangrove ecosystems along the shore, in protecting the shore and thus mitigating the impacts of tidal surges or storms on local communities. This is a final ecosystem service.
	River flood mitigation services	River flood mitigation services are the ecosystem contributions of riparian vegetation which provides structure and a physical barrier to high water levels and thus mitigates the impacts of floods on local communities. River flood mitigation services will be supplied together with peak flow mitigation services in providing the benefit of flood protection. This is a final ecosystem service.
Storm mitigation services		Storm mitigation services are the ecosystem contributions of vegetation including linear elements, in mitigating the impacts of wind, sand and other storms (other than water related events) on local communities. This is a final ecosystem service.
Noise attenuation services		Noise attenuation services are the ecosystem contributions to the reduction in the impact of noise on people that mitigates its harmful or stressful effects. This is most commonly a final ecosystem service.
Pollination services		Pollination services are the ecosystem contributions by wild pollinators to the fertilization of crops that maintains or increases the abundance and/or diversity of other species that economic units use or enjoy. This may be recorded as a final or intermediate service.
Biological control services	Pest control services	Biological control services are the ecosystem contributions to the reduction in the incidence of species that may prevent or reduce the effects of pests on biomass production processes or other economic and human activity. This is may be recorded as a final or intermediate service.
	Disease control services	Disease control services are the ecosystem contributions to the reduction in the incidence of species that may prevent or reduce the effects of species on human health. This is most commonly a final ecosystem service.
Nursery population and habitat maintenance services		Nursery population and habitat maintenance services are the ecosystem contributions necessary for sustaining populations of species that economic units ultimately use or enjoy either through the maintenance of habitats (e.g., for nurseries or migration) or the protection of natural gene pools. This service is an intermediate service and may input to a number of different final ecosystem services including biomass provision and recreation-related services.
Other regulating and maintenance services		
Cultural services		
Recreation-related services		Recreation-related services are the ecosystem contributions, in particular through the biophysical characteristics and qualities of ecosystems, that enable people to use and enjoy the environment through direct, in-situ, physical and experiential interactions with the environment. This includes services to both locals and non-locals (i.e., visitors, including tourists). Recreation-related services may also be supplied to those undertaking recreational fishing and hunting. This is a final ecosystem service.
Visual amenity services*		Visual amenity services are the ecosystem contributions to local living conditions, in particular through the biophysical characteristics and qualities of ecosystems that provide sensory benefits, especially visual. This service combines with other ecosystem services, including recreation-

Annex 4 SEEA-Central Framework Environment Protection Expenditure Account

		Providers of disaster risk reduction services (SNA institutional sectors)											Rest of the World (RoW)
		Non-financial corporations	Financial corporations	General government (incl. non-profit institutions controlled by governments and social security)				Households			Non-profit institutions serving households (NPISHs)	TOTAL Resident sectors (units with at least 1 year of activity)	
				Central government	State government	Local government	Subtotal General government	Households owners of unincorporated enterprises	Employees and recipients of property and transfer incomes	Subtotal Households			
Activity expenditure account (current plus investment)													
1	**Disaster Risk Prevention**												
1.1	Risk prevention in advance of hazardous event												
1.2	Risk prevention in or after hazardous event												
2	**Disaster Risk Mitigation**												
2.1	Structural measures												SDG 11.c.1
2.2	Non-structural measures												
2.3	Land-use planning												
2.4	Early warning systems management												
3	**Disaster Management**												
3.1	Preparedness												
3.2	Emergency management												
3.3	Other disaster responses												
3.4	Emergency supply of commodities												
4	**Disaster Recovery**												
4.1	Relocation												
4.2	Rehabilitation												
4.3	Reconstruction												
5	**General Government, Research & Development, Education Expenditure**												
5.1	General government expenditure for Disaster Risk Reduction												
5.2	Research & Development, risk assessment, and information												
5.3	Education to Disaster Risk Reduction												
A	**Subtotal current production expenditure (SUM 1 to 5)**												
1	**Disaster Risk Prevention**												
1.1	Risk prevention in advance of hazardous event												
1.2	Risk prevention in or after hazardous event												
2	**Disaster Risk Mitigation**												
2.1	Structural measures												
2.2	Non-structural measures												
2.3	Land-use planning												
2.4	Early warning systems management												
3	**Disaster Management**												
3.1	Preparedness												
3.2	Emergency management												
3.3	Other disaster responses												
3.4	Emergency supply of commodities												
4	**Disaster Recovery**												
4.1	Relocation												
4.2	Rehabilitation												
4.3	Reconstruction												
5	**General Government, Research & Development, Education Expenditure**												
5.1	General government expenditure for Disaster Risk Reduction												
5.2	Research & Development, risk assessment, and information												
5.3	Education to Disaster Risk Reduction												
B	**Subtotal Gross formation of fixed capital (SUM 1 to 5)**												
6	**Acquisition less disposals of land and other non produced non-financial assets**												
6.1	Acquisition less disposals of land												
6.2	Acquisition less disposals of non produced non-financial assets												
C	**Investment production expenditure**												
Total DRR Production Expenditure (current plus investment)													

Acronyms

DMSF	Disaster Management Statistical Framework
DRM	Disaster Risk Management
DRMA	Disaster Risk Management Agency
DRME	Disaster Risk Management Expenditure
DRR	Disaster Risk Reduction
DRRE	Disaster Risk Reduction Expenditure
DRSF	Disaster Related Statistics Framework
EER	Environment and ecosystem related
EGES	Expert Group on Environmental Statistics
FDES	Framework for the Development of Environment Statistics
GDP	Gross domestic product
HED	Hazardous Events and Disasters
NSO	National Statistics Office
NSS	National Statistical System
RROS	Recommendations on the Role of Official Statistics in Monitoring Hazardous Events and Disasters
SEEA	System of Environmental-Economic Accounting
SEEA-CF	System of Environmental-Economic Accounting Central Framework
SEEA-EA	System of Environmental-Economic Accounting Ecosystem Accounting
SF	Sendai Framework
SNA	System of National Accounts
UNCEEA	United Nations Committee of Experts on Environmental Economic Accounting
UNGA	United Nations General Assembly
UNSC	United Nations Statistical Commission