

Review of guidance on data standards, management, and quality

This review forms part of phase 1 of the Data Information Flow project, delivered by the UN Environment World Conservation Monitoring Centre (UNEP-WCMC), on behalf of the Natural Capital Coalition. The table below provides a summary of sources of data-related guidance identified as a result of desk-based research, a stakeholder survey, and structured interviews with 10 organizations representing different aspects of the natural capital data ecosystem. This review seeks to assist companies in dealing with the data challenges they face when carrying out natural capital assessments.

Name	Primary user	Description	Challenge(s) addressed	Impact/Dependency
Generic guidance on data standards, management and quality				
1.1 DataONE Best Practices - Data Observations Network of Earth	Researchers	A searchable database on best practices in data management aimed at the research community. It is accompanied by a primer on data management which contains hyperlinks to best practices within the database. The best practices are often brief and are aimed at researchers rather than business, but provide a good introduction to a diverse range of concepts including developing a data management plan.	Accessibility Infrastructure Quality	Relevant for all issues
1.2 INSPIRE Data Standards - European Commission	Governments	An infrastructure for environmental spatial data developed for use in the European Union, but with broader applicability to companies wishing to adopt a pre-defined set of standards for managing data. Aims to enhance interoperability and optimize data-management processes. Companies adopting it will be able to draw on a large quantity of interoperable data from EU governments. May not always be useful to a non-specialist audience.	Quality Infrastructure	Relevant for all issues
1.3 Fundamental Principles of Official Statistics, 2014 - United Nations Statistics Division	Governments	10 Principles to guide official statistics organizations in the collection, review, storage and representation of relevant data. It addresses: methods of collecting data, transparency, dealing with errors in data, data sources, confidentiality, creating a strong data ecosystem.	Quality Infrastructure	Relevant for all issues
1.4 Guidelines for the Template for a General National Quality Assurance Framework, 2012 - United Nations Stats	Governments	A document to support the template for a National Quality Assurance Framework (NQAF). It outlines quality assurance procedures as well as ways in which quality can be assessed and reported on. It covers how accessibility, accuracy, reliability, security, and confidentiality of data should be managed. It also addresses how interactions between data providers, data users, and national statistical organizations should be conducted.	Quality	Relevant for all issues

Name	Primary user	Description	Challenge(s) addressed	Impact/Dependency
1.5 The principles of good data management, 2005 - UK Ministry of Housing, Communities and Local Government	Governments	This document is intended for use by the UK government, but is also relevant to businesses. It provides guidance on the principles of geographic data management, but is potentially useful for other types of data. Additionally, the document lays out principles that touch on ownership, metadata, quality, data management plans, and data-sharing, however, it does not go into detail.	Quality Infrastructure	Relevant for all issues
1.6 Handbook on Data Quality Assessment Methods and Tools, 2007 - European Commission	Governments, Data Providers	Describes how to conduct a data quality assessment and aims to help users determine whether a decision can be made with the required confidence, and whether the sampling design is adequate to support future assessments. The document lays out five steps, including sampling design, verifying the assumptions of a selected statistical test, and drawing conclusions. It is highly technical and therefore may not be accessible to many private sector users. The DataQUEST software referred to in the document is no longer available.	Quality (dealing with uncertainty)	Relevant for all issues
1.7 Pedigree Matrix, 2007 - Swiss Centre for Life Cycle Inventories	Business	A methodology for qualitatively assessing uncertainty of data in life cycle assessments. It uses a suite of 5 indicators, reliability, completeness, temporal correlation, geographical correlation and further technical correlation to determine the uncertainty of data.	Capacity (dealing with uncertainty)	Relevant for all issues
1.8 Motivating and improving uncertainty assessment in ecosystem services modelling to inform decisions, 2016 - Natural Capital Project, Stanford	Businesses, Governments, NGOs	Presents the results of a workshop on the current state of practice on uncertainty assessment. Although parts of the workshop report will not be relevant to business users, it provides an overview of the key issues around uncertainty as it relates to ecosystem service assessments. It goes on to discuss specific techniques and tools for dealing with uncertainty.	Capacity (dealing with uncertainty)	Relevant for all issues
1.9 Uncertainty assessment in ecosystem services analyses: Seven challenges and practical responses, 2017 - Journal of Ecosystem Services	Businesses, Governments, NGOs	This article discusses approaches to dealing with uncertainty, and challenges specific to ecosystem services assessments. Table 1 lists specific challenges and concerns, and provides suggestions for practical solutions in each case.	Capacity (dealing with uncertainty)	Relevant for all issues

Name	Primary user	Description	Challenge(s) addressed	Impact/Dependency
1.10 Guidance for Uncertainty Assessment and Communication Series - Netherlands Environmental Assessment Agency	Governments	<p>Guidance in multiple volumes:</p> <ul style="list-style-type: none"> Guidance for uncertainty assessment and communication, 2013 Guide for uncertainty communication, 2013 Guidance for uncertainty assessment and communication: detailed guidance, 2003 Guidance for uncertainty assessment and communication: tool catalogue for uncertainty assessment, 2004 Guidance for uncertainty assessment and communication: checklist for uncertainty in spatial information and visualizing spatial uncertainty, 2006 <p>It covers how to take uncertainty into account when drawing conclusions and how to communicate it to users. Included are tools for in-depth assessments of uncertainty, as well as methods for identifying intended audiences and tailoring communication to them.</p>	Capacity (dealing with uncertainty)	Relevant for all issues
1.11 Monte Carlo Simulation - Palisade	Multiple	Outlines application of Monte Carlo simulations for understanding the uncertainty within a model based on the data used. Using the minimum and maximum estimated values the data, the methodology helps identify the most likely output of a model.	Capacity (dealing with uncertainty)	Relevant for all issues
1.12 Open Data Institute (ODI) - Open Data Institute	Businesses, Governments	ODI provides resources and services to help users manage their data, including guidance on data infrastructure, ethics, and publishing. Guidance on mapping the data ecosystem to determine flows of information and how best to manage them.	Infrastructure	Relevant for all issues
1.13 Open Geospatial Consortium (OGC) standards and supporting documents - OpenGeospatial	Businesses	This is a series of technical documents detailing interfaces and encodings. When implemented, the standards improve interoperability between products and/or online services. The standards are accompanied by a set of best practice documents which can be found here. The use of these standards requires specialist knowledge hence they will be useful primarily for data providers.	Infrastructure	Relevant for all issues but focus on spatial data

Name	Primary user	Description	Challenge(s) addressed	Impact/Dependency
Guidance on data directly relevant to natural capital assessments				
2.1 Improving EIA practice: Best practice guide for publishing primary biodiversity data, 2011 - Global Biodiversity Information Facility	Businesses	Guide promoting standards and data publishing tools which can be used by those undertaking Environmental Impact Assessments to discover, capture and publish biodiversity data in a standardized format. This includes developing a set of best practices and standards; developing data-transformation tools; and promoting the use of local and global information systems and networks	Accessibility Infrastructure	Relevant for all issues
2.2 Toolkit for Ecosystem Service Site-based Assessment (TESSA)	Businesses, Governments, NGOs	Provides practical guidance on how to assess and monitor the flows of ecosystem services and some of the stocks of natural capital at a site scale. The toolkit uses a step-by-step framework to guide users with identifying which services to assess, what data is needed to measure them, what methods or sources can be used to obtain the data and how to communicate the results. The toolkit focuses on site scale assessments making it useful for local decision-making and it is accessible to non-experts and conservation practitioners on the ground. However, some relevant experience or training may be necessary.	Accessibility Capacity Quality	Relevant for all issues

Name	Primary user	Description	Challenge(s) addressed	Impact/Dependency
2.3 The System of Environmental-Economic Accounting (SEEA), 2012 - United Nations Statistics Division	Governments	<p>A framework that includes internationally agreed standards and accounting rules for producing statistics on the environment and its relationship with the economy. This includes guidance on integrating economic, environmental and social data to support decision-making. Important resources include:</p> <ul style="list-style-type: none"> • Central Framework providing a comprehensive set of accounts and guidance on understanding the interactions between economy and environment. • Applications and Extensions (building on the Central Framework to provide examples of possible uses of SEEA data for policy and research) • E-learning courses including on water accounts, with other impact areas in development (requiring enrolment) <p>The SEEA has specific sub-systems on: Energy, Water, Land and Ecosystems and Agriculture, forestry and fisheries. The SEEA for water is the most developed and is supported by the International Recommendations for Water Statistics (see 2.24). The SEEA for energy and the SEEA for agriculture, forestry and fisheries are in draft form, and up-to-date information is not available on the website.</p> <p>The SEEA Experimental Ecosystem Accounts deal with land and ecosystems. This is not an official standard but more a conceptual framework informed by the current state of the art. There is an ongoing revision process to achieve an official statistical standard for the SEEA EEA by 2020.</p> <p>The SEEA EEA is a rather broad conceptual framework and does not go into detail on the data issues. However, data is addressed in the form of advice on spatial data infrastructures in the technical recommendations for the SEEA EEA.</p>	<p>Accessibility</p> <p>Capacity</p> <p>Infrastructure</p>	Relevant for all issues
2.4 Technical Recommendations in support of the System of Environmental-Economic Accounting, 2012 - United Nations Committee of Experts on Environmental-Economic Accounting	Businesses	<p>A document providing support for the testing of ecosystem accounting in the light of the publication of SEEA (2.3). There are resources for collating and managing the data needed to carry out ecosystem accounting. It also provides information on a range of data sources as well as methods for carrying out ecosystem accounting.</p>	<p>Accessibility</p> <p>Capacity</p> <p>Infrastructure</p>	Relevant for all issues

Name	Primary user	Description	Challenge(s) addressed	Impact/Dependency
2.5 Natural Capital Assessments at the National and Sub-national level. A guide for environmental practitioners, 2016 - United Nations Environment	Governments	Presents eight steps to completing natural Capital Assessments. The third step is to 'Gather and review data'. This outlines key principles and practices for collection, processing and using data to ensure that they are accepted by stakeholders and decision makers and that they can be updated and further synthesized in a standard format.	Accessibility Capacity Quality	Relevant for all issues
2.6 Natural Capital Protocol, 2016 - Natural Capital Coalition	Businesses	Guides businesses through the process of undertaking a natural capital assessment. It includes basic guidance on dealing with uncertainty around outcomes, including probability-based analysis, multi-criteria analysis, expert opinion and/or multi-stakeholder assessment. Section 7 describes how to use value transfer while minimizing limitations and sources of error. Section 8 includes information on testing assumptions. The protocol further discusses how to verify whether the results of an assessment are robust enough to base decisions on, and/or to be communicated externally.	Capacity	Relevant for all issues
2.7 Developing Corporate Natural Capital Accounts, 2015 - Natural Capital Committee, EFTEC, RSPB, PWC	Businesses	This document provides a framework to develop natural capital accounts. It aims to produce an easily understandable Natural Capital Balance Sheet for an organization. It also details pilot studies with varying levels of data from a range of sources. Can assist companies in determining the sorts of data required in natural capital assessments.	Capacity	Relevant for all issues
2.8 Guidelines for Environmental & Social Impact Assessment, 2016 - The Cement Sustainability Initiative	Businesses	This document provides guidelines on how to identify impacts and dependencies, as well as measure changes in natural capital. It outlines what data should be collected in order to assess impacts.	Capacity	Relevant for all issues

Name	Primary user	Description	Challenge(s) addressed	Impact/Dependency
2.9 International Organization for Standardization Standards - International Organizations for Standardization	Businesses, Data Providers, Governments, NGOs	<p>Provides guidance on data standards applicable to a wide range of sectors. Many of these standards are relevant to environmental data. An ISO standard for the valuation of natural capital is in development, and will be published in 2019. Further information can be found here. Although globally accepted, much of the guidance is behind a paywall and were therefore not reviewed in detail.</p> <p>Relevant introductory pages include:</p> <ul style="list-style-type: none"> • Environmental management • Environmental management: quantitative environmental information: guidelines and examples • Environmental management: life cycle assessment: principles and framework • Environmental management: material flow cost accounting: guidance for practical implementation in a supply chain https://www.iso.org/standard/54811.html • Environmental management: water footprint: principles, requirements and guidelines • Protecting our planet: https://www.iso.org/protecting-our-planet.html • Geographic information: metadata: part 1: fundamentals 	Quality Infrastructure	Relevant for all issues
2.10 Data Quality Assessment: A Reviewer's Guide, 2006 - US Environmental Protection Agency	Governments	<p>Contains guidance on determining whether environmental data are suitable for a given purpose. It helps address questions around sampling design, uncertainty and whether a decision can be made given the quality of the data. It includes sections on aligning data-sampling design with objectives, conducting a data-review, selecting statistical methods, drawing conclusions and interpreting the results.</p>	Quality (gaps and uncertainty)	Relevant for all issues

Name	Primary user	Description	Challenge(s) addressed	Impact/Dependency
2.11 Biodiversity Conservation Information System (BCIS) Framework for information sharing, 2000 – United Nations Environment Programme World Conservation Monitoring Centre	Businesses, Data Providers, Governments, NGOs	This series of documents aims to promote understanding of key data-management principles and the process of implementing an organizational data policy. The series includes guidance on quality assurance, principles of maintaining metadata, data standards and data management tools including a subsection on database design. Volume 7 on core datasets is no longer up-to-date and therefore, doesn't remain useful. Volume 4 on data access does not discuss more recent developments in this field, but does address data approaches and principles that remain relevant and useful. If used, the series should be referred to in combination with more recent guidance.	Quality Infrastructure	Relevant for all but with a focus on biodiversity
2.12 Approaches to mapping ecosystem services, 2016 – United Nations Environment Programme World Conservation Monitoring Centre	Businesses, Governments	Provides guidance on different types of input data, mapping methods, mapping at different scales and mapping tools. It also discusses key challenges in mapping projects, and how to go from mapping to decision-making, although this section does not go into detail.	Capacity	Relevant for all issues–spatial data
2.13 Environmental Impact Assessment Biodiversity Data Publishing Framework, 2012 – Journal of Impact Assessment and Project Appraisal	Businesses, Governments	Scientific paper highlighting the lack of accessibility to biodiversity information obtained during environmental impact assessments and sets out an EIA Biodiversity Data Publishing framework, based on the Global Biodiversity Information Facility (GBIF) global standards.	Accessibility	Biodiversity
2.14 Principles of Data Quality, 2005 – Global Biodiversity Information Facility	Data providers	This document deals primarily with the quality of species occurrence data, but has broader applicability, dealing with general principles of data accuracy and precision, quality-assurance, quality-control, uncertainty and error.	Quality	Biodiversity
2.15 Principles and methods of data cleaning, 2005 – Global Biodiversity Information Facility	Data providers	Although focused on species occurrence data, this document contains relevant sections on error-prevention and cleaning of spatial and descriptive data. It includes a section on documentation of error and error-checking, enabling users to determine the 'fitness of use' of the data. Lastly, it provides a list of software packages that can aid in enhancing data quality and addressing error.	Quality	Biodiversity

Name	Primary user	Description	Challenge(s) addressed	Impact/Dependency
2.16 National Biodiversity Network guidance documents - National Biodiversity Network	Data providers	Provide flexible standards on collecting wildlife data. They include guidance on planning surveys, recording data, managing data, and making use of data. Some details are UK-specific, but much of the content has broader applicability.	Infrastructure	Biodiversity
2.17 Data sharing for sustainable assessments: Using functional databases for interoperating multiple building information structures, 2012 - Conference Paper	Businesses, Data Providers	This study investigates the development and implementation of an automatic sustainable assessment prototype using functional databases. They translate rules from the Leadership in Energy and Environmental Design (LEED) standard into computable formulas and develop a prototype application to produce templates for LEED submission. It provides useful information on the use of computer systems or software to exchange and make use of information and create semi-automated evaluation for use in assessments.	Infrastructure	Energy Greenhouse gas Water Waste
2.18 Global Logistics Emissions Council Framework, 2016 - Smart Freight Centre	Businesses	A framework for assessing the greenhouse gas footprint of businesses in the freight sector. Enables the identification of impacts related to GHG emissions and energy dependencies but does not attempt to value these. There is guidance on how to address data needs and manage computer systems to handle the most accurate emissions data.	Capacity	Greenhouse gas emissions
2.19 Uncertainty in greenhouse gas inventories, 2007 - International Institute of Applied Systems Analysis	Government	This brief introduces the concept of uncertainty in inventories of greenhouse gas emissions and removals. It discusses uncertainty analysis and the possibility of pricing uncertainty, and provides links to further information.	Capacity (dealing with uncertainty)	Greenhouse gas emissions
2.20 Sub-national consumption statistics: Methodology and Guidance, 2018 - Department for Business, Energy & Industrial Strategy, UK	Businesses Government	Guidance provided on the use and interpretation of energy consumption statistics. It provides information on limitations and comparability of statistics for gas, electricity, road transport fuels and residual fuels.	Capacity	Greenhouse gas emissions

Name	Primary user	Description	Challenge(s) addressed	Impact/Dependency
2.21 Guidance on how to measure and report your greenhouse gas emissions, 2009 - Department for Environment, Food and Rural Affairs, UK	Businesses	Guidance on measuring organizational greenhouse gas emissions. Includes data requirements for calculations, methods for conducting assessment and how to verify emissions data.	Capacity	Greenhouse gas emissions
2.22 Valuing corporate environmental impacts: PwC methodology document, 2015 - PriceWaterhouseCooper	Businesses	A series of seven papers present the approach taken by PricewaterhouseCoopers to the valuation of environmental impacts for Environmental Profit and Loss Accounts. Topics covered include pollution (air and water), solid waste, greenhouse gases, land use, and water consumption. The third paper describes impacts of land use change and the data needed to estimate the consequences in terms of lost ecosystem services. Guidance is provided on the types of data that might be available, potential sources of data and coefficients and provides guidance on sensitivity analysis.	Capacity Quality	Greenhouse gas emissions Land use Waste Water
2.23 Economics of Land Degradation Initiative: User Guide, 2015 - Economics of Land Degradation Initiative	Businesses, NGOs, Governments	The document outlines a 7 step process for the implementation of cost benefit analysis for land use change scenarios. There is a breakdown of suggested approaches (and the required data collection) for assessing different ecosystem services, as well as the ease with which this can be done.	Capacity	Land use
2.24 Economics of Land Degradation Initiative: Practitioners Guide, 2014 - Economics of Land Degradation Initiative	Businesses, NGOs, Governments.	Based on the principles set out in the 2.23. This document guides users through the process of conducting a cost-benefit analysis with regards to the avoidance of land degradation. It summarizes a range of methods for collecting data in order to value ecosystem services associated with changes in land use.	Capacity	Land use
2.25 Corporate water accounting: an analysis of methods and tools for measuring water use and its impacts, 2010 - United Nations Environment	Businesses	Includes descriptions of a range of water accounting methods and tools, including the type of data required. It also has a section on data limitations, describing the implications of the limitations on a business's ability to arrive at meaningful conclusions.	Capacity Quality	Water

Name	Primary user	Description	Challenge(s) addressed	Impact/Dependency
2.26 International Recommendations for Water Statistics (IRWS), 2012 - Knowledge Base on Economic Statistics	Governments	Principles to ensure that water data is collected and compiled on a comparable basis. This guidance aligns with the SEEA (2.3) for water. Can be used by businesses, researchers, compilers of water accounts, and the public. Includes guidance on physical and monetary data types relating to stocks and flows; inland waters; and population using improved water sources and sanitation facilities. Guidance is provided on statistical units and classifications, types of water-related data, data collection strategies, data sources and methods, metadata and data quality, and data dissemination. It does not include guidance on surface water and groundwater quality, drinking water quality, environmental flows or social aspects of water. Marine water resources are considered only when they relate to the extraction of saltwater from the sea.	Quality Infrastructure	Water
2.27 ISO and water, 2017 - International Organization for Standardizations	Businesses, Data Providers, Governments, NGOs	This document provides an inventory of the ISO standards relating to water.	Infrastructure	Water
2.28 The Greenhouse Gas Protocol Corporate Accounting and Reporting Standard, 2015 - World Business Council for Sustainable Development	Businesses	Provides standards and guidance to businesses and others preparing a greenhouse gas inventory, including accounting and reporting processes. This Standard is accompanied by: Greenhouse Gas Protocol Scope 2 Guidance, 2015: this amendment to the Standard adds information on new requirements.	Infrastructure Quality	Greenhouse gas emissions

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2.29 GRI Standards - Global Reporting Initiative	Businesses	<p>Provides standards for reporting on impacts and how they are managed. Each of the following documents should be used alongside the three universal Global Reporting Initiative Standards available at the same link:</p> <p>Standards 301 - Materials (2016)</p> <p>Standards 302 - Energy (2016)</p> <p>Standards 303 - Water and Effluents (2018)</p> <p>Standards 304 - Biodiversity (2016)</p> <p>Standards 305 - Emissions (2016)</p> <p>Standards 306 - Effluents and Waste (2016)</p> <p>Standards 307 - Environmental Compliance (2016)</p> <p>Standards 308 - Supplier Environmental Assessment (2016)</p>	Infrastructure	<p>Biodiversity</p> <p>Energy</p> <p>Greenhouse gas emissions</p> <p>Waste</p> <p>Water</p>