Draft recommendations on climate change related statistics

Prepared by the Conference of European Statisticians’ Task Force on Climate Change Related Statistics

8 January 2014

The Bureau is invited to comment on these recommendations and to decide whether the draft can be circulated to all CES members for electronic consultation with a view of presenting it to the CES 2014 plenary session for endorsement.

The recommendations were developed in several rounds of consultation. The Task Force started its work by analysing the results of a survey on the involvement of national statistical offices in the area. The Bureau reviewed the Task Force’s initial findings in February 2013. The first draft recommendations were consulted with the Conference in June-July 2013. The Task Force regularly informed the United Nations Committee of Experts on Environmental-Economic Accounting (UNCEEA) and the United Nations Statistics Division (UNSD) of the progress achieved. Two expert meetings were organised, in November 2012 and October 2013, with the participation of several major players that are active in measuring climate change. The feedback received is reflected in the recommendations.
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EXECUTIVE SUMMARY

This report presents recommendations for improving the statistics related to climate change collected by national statistical systems and enhancing their utility for the compilation of greenhouse gas inventories. The recommendations were developed by the Task Force on Climate Change Statistics at the request of the heads of the national statistical offices of the member states of the United Nations Economic Commission for Europe and other countries that participate actively in the work of the Conference of European Statisticians. The Bureau of the Conference of European Statisticians established the Task Force in November 2011. The report primarily addresses data that are already collected as part of official statistics and that can support analysis or research related to climate change. The report also serves as a tool for discussion with producers of climate information outside the national statistical system. The report does not focus on scientific or meteorological data on changes in weather and climate.

In June 2012, the Rio+20 Conference on Sustainable Development emphasized climate change as an immediate and urgent global priority. This has increased the pressure to provide new information to support analysis of climate change and improve existing statistics. The Task Force organised two expert meetings to explore user needs and existing practices within national statistical systems and to review its draft recommendations.

In drafting its recommendations, the Task Force analysed the results of an earlier survey of the involvement of national statistical offices in climate change related statistics and carried out interviews of users of climate information, including the Intergovernmental Panel on Climate Change, the United Nations Framework Convention on Climate Change, research agencies, non-governmental organizations and universities.

The Task Force defined climate change related statistics as:

- *environmental, social and economic data that measure the human causes of climate change, the impacts of climate change on human and natural systems, the efforts of humans to avoid the consequences as well as their efforts to adapt to these consequences.*

To narrow the focus of work for official statistics, the report presents recommendations in areas where the national statistical offices and other members of national statistical systems can contribute with concrete actions.

National governments in most developed countries have for many years published information on greenhouse gas emissions through a well-established reporting process guided by the United Nations Framework Convention on Climate Change. Statistical offices often provide source data for the inventories, whereas the compiler is usually outside the national statistical system. Official statistics on climate change are less well developed, though several statistical offices have started to work in this direction. Climate change related data are scattered across a variety of organisations and are largely unstructured. The wide range of existing official environmental, social and economic statistics could be much better utilized for climate change policy and analysis.

The report recommends that national statistical offices work more closely with greenhouse gas inventory producers to ensure that official statistics meet the needs of greenhouse gas inventories. Given the considerable amount of statistical data required for the inventories, it is recommended that national statistical offices be recognized as formal entities in the greenhouse gas inventory systems in all countries. This could be done simply by explicitly noting the role of the national statistical office in the inventory documentation submitted to the United Nations or via a Memorandum of Understanding between the national statistical office and the national entity responsible for the inventory. It would be beneficial as well to create national working groups around greenhouse gas inventory compilation and other climate change related statistics.
It is recommended that national statistical offices start improving climate change related statistics gradually and based on their key competencies. First, existing environmental, social and economic statistics should be better organised for the purposes of climate change analysis; for example, official statistical dissemination channels could be better used to provide climate change researchers and decision makers with access to them. As a second step, the usefulness of the existing statistics for climate change analysis should be improved by reviewing existing data collection systems. In this context, the Task Force underlines the importance of linking existing datasets to improve their coherence and maximize their potential for climate change analysis. Third, development of new statistics may be considered; for example, on the underlying driving forces of climate change, on its social and economic impacts, on mitigation efforts and on vulnerability and adaptation.

National statistical offices should act as the facilitator for inventory compilers within the national statistical system; for example, by assessing the usefulness of existing official statistics for inventory compilers, by reviewing the statistical requirements related to the Kyoto protocol and other global or regional climate change agreements and by preparing themselves to meet new data requirements. International statistical organizations should also contribute by engaging in processes around international climate accords and the global greenhouse gas inventory system.

The Task Force realizes that taking action on the points above will challenge the infrastructure of national statistical systems. Reviews of standard classification systems, registers, definitions and survey methods will all be required to ensure the usefulness of official statistics for climate change analysis. So too will be finding new ways to ensure confidentiality of official statistics while providing climate change analysts with increased access to microdata.

Statistical systems will need to acquire new kinds of expertise through training, recruitment and, especially, through partnerships with other producers and experts. In the longer run, organizational changes may be required in national statistical offices to support the production of these statistics that cut across the statistical system.

The Task Force’s recommendations are the first ever developed to help national statistical offices improve climate change related statistics and enhance their support to greenhouse gas inventories. While the recommendations represent useful first steps, further international work will be required to support their implementation. To this end, an international forum could be established to share good practices, improve collaboration, discuss priority data needs, discuss a key set of climate change related statistics and identify areas for further methodological work. The global nature of climate change calls for wider cooperation among users and producers of statistics to better respond to the growing information needs. Statistical standards and guidelines need to be agreed at the international level to ensure comparability and efficient use of resources. International statistical organizations (for example, the Conference of European Statisticians and its secretariat) should ensure cooperation with the United Nations Framework Convention on Climate Change, the International Panel on Climate Change, the World Meteorological Organisation and others.
# LIST OF ABBREVIATIONS

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Full Form</th>
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<tbody>
<tr>
<td>ABS</td>
<td>Australian Bureau of Statistics</td>
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<tr>
<td>CES</td>
<td>Conference of European Statisticians</td>
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<td>CIS</td>
<td>Commonwealth of Independent States</td>
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<td>CO₂</td>
<td>Carbon dioxide</td>
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<td>COP</td>
<td>Conference of the Parties</td>
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<tr>
<td>CPC</td>
<td>Central Product Classification</td>
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<td>CRF</td>
<td>Common Reporting Format</td>
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<td>CSA</td>
<td>Classification of Statistical Activities</td>
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<tr>
<td>DECC</td>
<td>Department of Energy and Climate Change of the United Kingdom</td>
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<tr>
<td>DG-CLIMA</td>
<td>Directorate-General on Climate Action of the European Commission</td>
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<tr>
<td>DPSIR</td>
<td>Driving forces – Pressure – State – Impacts – Response</td>
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<tr>
<td>ECLAC</td>
<td>Economic Commission for Latin America and the Caribbean</td>
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<td>EU</td>
<td>European Union</td>
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<td>EEA</td>
<td>European Environment Agency</td>
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<td>ETS</td>
<td>European Union Emissions Trading System</td>
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<td>FDES</td>
<td>Framework for the Development of Environment Statistics</td>
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<td>GDP</td>
<td>Gross Domestic Product</td>
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<td>GHG</td>
<td>Greenhouse Gas</td>
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<td>GNI</td>
<td>Gross National Income</td>
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<td>GVA</td>
<td>Gross Value Added</td>
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<td>IEA</td>
<td>International Energy Agency</td>
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<td>IMA</td>
<td>Impact, Mitigation and Adaptation</td>
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<td>IPCC</td>
<td>Intergovernmental Panel on Climate Change</td>
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<td>ISIC</td>
<td>International Standard Industrial Classification of all economic activities</td>
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<td>ITL</td>
<td>International Transactions Log</td>
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<tr>
<td>LULUCF</td>
<td>Land Use, Land-Use Change and Forestry</td>
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<tr>
<td>NACE</td>
<td>Nomenclature statistique des activités économiques dans la Communauté européenne / Statistical classification of economic activities in the European Community</td>
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<tr>
<td>NASA</td>
<td>National Aeronautics and Space Administration of the United States</td>
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<td>NOAA</td>
<td>National Oceanic and Atmospheric Administration of the United States</td>
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<td>NSO</td>
<td>National Statistical Office</td>
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<td>NSS</td>
<td>National Statistical System</td>
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<tr>
<td>Acronym</td>
<td>Description</td>
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<tr>
<td>OECD</td>
<td>Organisation for Economic Co-operation and Development</td>
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<td>PRTRs</td>
<td>Pollutant Release and Transfer Registers</td>
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<tr>
<td>QA/QC</td>
<td>Quality Assurance/Quality Control</td>
</tr>
<tr>
<td>SEEA-CF</td>
<td>System of Environmental-Economic Accounting Central Framework</td>
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<tr>
<td>SIEC</td>
<td>Standard International Energy Product Classification</td>
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<tr>
<td>SNA</td>
<td>System of National Accounts</td>
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<tr>
<td>SNAP97</td>
<td>Selected Nomenclature for Air Pollution</td>
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<tr>
<td>UNCEEA</td>
<td>United Nations Committee of Experts on Environmental-Economic Accounting</td>
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<td>UNECE</td>
<td>United Nations Economic Commission for Europe</td>
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<td>UNEP</td>
<td>United Nations Environment Programme</td>
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<tr>
<td>UNFCCC</td>
<td>United Nations Framework Convention on Climate Change</td>
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<td>UNSC</td>
<td>United Nations Statistical Commission</td>
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<td>UNSD</td>
<td>United Nations Statistics Division (in New York, secretariat to UNSC)</td>
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<tr>
<td>WHO</td>
<td>World Health Organization</td>
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<tr>
<td>WMO</td>
<td>World Meteorological Organization</td>
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INTRODUCTION

This report presents recommendations for improving the statistics related to climate change collected by national statistical systems and enhancing their utility for the compilation of greenhouse gas emission inventories (GHG inventories). While this report is aimed primarily at official statisticians, it also serves as a tool for discussions with those outside national statistical systems who are producers and users of climate change related statistics.

The recommendations were developed by the Task Force on Climate Change Statistics at the request of the heads of the national statistical offices of the member states of the United Nations Economic Commission for Europe (UNECE) and several other countries that participate actively in the work of the UNECE Conference of European Statisticians (CES). The Bureau of the Conference of European Statisticians established the Task Force in November 2011. The Task Force consisted of experts from the statistical offices of Canada (Chair), Finland, Italy, Mexico, Norway, Qatar and the United Kingdom, as well as the European Environment Agency (EEA), Eurostat, the Directorate-General on Climate Action of the European Commission (DG-CLIMA) and UNECE who provided secretariat support for the Task Force. The following experts participated on the Task Force: Robert Smith (Canada, Chair), Leo Kolttola (Finland, Vice Chair), Martin Adams (EEA), Enrique de Alba (Mexico), Julio Cabeca (Eurostat), Helen Champion (United Kingdom), Ricardo Fernandez (EEA), Angela Ferruza (Italy), Julie Hass (Norway), Jesarela Lopez (Mexico), Tiina Luige (UNECE), John Mackintosh (United Kingdom), Michael Nagy (Qatar), Brian Newson (Eurostat), Rolando Ocampo (Mexico), Adriana Oropeza (Mexico), Anu Peltola (UNECE), Velina Pendolovska (DG-CLIMA), Giovanna Tagliacozzo (Italy), Stefano Tersigni (Italy) and Angelica Tudini (Italy).

The work is a step towards taking data needs related to climate change more fully into account in national statistical systems and improving the contribution of official statistics to analysing climate change related phenomena.

The United Nations Statistical Commission (UNSC) carried out a programme review on climate change and official statistics in 2009. The review was based on a paper by the Australian Bureau of Statistics and the outcome of two conferences on this topic held in 2008. As an outcome of the review, the UNSC recognised there is an important role for national statistical systems in filling data gaps related to climate change and emphasized the need for better understanding of the data requirements of stakeholders.

In view of these developments, the CES Bureau decided in 2011 to take stock of the current state of work on climate change related statistics in national statistical offices (NSOs) and asked UNECE to conduct a survey among member countries of the UNECE and the OECD. The survey was carried out with the support of the United Nations Committee of Experts on Environmental-Economic Accounting (UNCEEA) and the United Nations Statistical Division (UNSD) in New York. The purpose was to find out the extent to which the NSOs are involved in producing climate change related statistics and to identify issues of common concern for further work at international level. The survey covered 69 countries reaching beyond the UNECE region. Of the 48 countries that replied, 37

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1 This includes member countries of UNECE and OECD plus some other countries that participate in the work, such as Brazil, China, Colombia, Mexico and South Africa.
3 Conference on Climate Change and Official Statistics, Oslo: unstats. un. org/unsd/climate_change/default.htm and Conference on Climate Change, Seoul: unstats. un. org/unsd/climate_change/korea/
4 Armenia, Australia, Austria, Azerbaijan, Belarus, Bosnia and Herzegovina, Brazil, Bulgaria, Canada, Chile, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Georgia, Germany, Hungary, Ireland, Israel, Italy, the Republic of Korea, Kyrgyzstan, Latvia, Lithuania, Luxembourg, Mexico, Moldova,
reported involvement in work related to greenhouse gas inventories and 18 compiled other statistics related to climate change. The survey respondents called for international efforts to consider how the data available in national statistical systems could be made more useful for the purposes of climate change analysis and policy making. They also noted that analysis of climate change across all its dimensions would benefit from the linkage of climate change data, often produced outside of the national statistical system, with official statistics on the environment, society and economy. While the survey provided evidence that such linkages are already being made, it showed that there is clearly room for improvement.

Most national statistical offices reported currently providing data on economic activities to the compilers of greenhouse gas emission inventories. These so-called “activity data” include energy, industry, agriculture, forestry, transport, international trade, land use and land cover, wastewater and waste statistics. About one quarter of statistical offices also reported taking part somehow in the emissions calculations in addition to providing data.

To identify practical steps to support future development of climate change related statistics and enhance the role of official statistics in greenhouse gas inventories, the CES Bureau established the Task Force on Climate Change Related Statistics in November 2011 (terms of reference for the Task Force are provided in Annex 1). The Task Force was asked to start its work by assessing the gaps between user needs and available statistics and defining the scope of climate change related statistics. It was asked to collaborate with other bodies involved in related international work, including the United Nations Framework Convention on Climate Change (UNFCCC), the Intergovernmental Panel on Climate Change (IPCC), the European Commission’s Directorate General for Climate Action (DG-CLIMA), Eurostat, the European Environmental Agency and the United Nations Statistics Division (UNSD). Regular progress reports were submitted by the Task Force to the United Nations Committee of Experts on Environmental-Economic Accounting (UNCEEA).

The Task Force aimed to identify areas where improvements are most needed and where national statistical systems can best contribute with concrete actions. The Task Force paid special attention to recommendations related to making existing statistics more easily available to users and to identifying the highest priority statistical gaps that must be filled. Its work focused on six topics:

1. Defining the scope of “climate change related statistics” and testing different frameworks and models for this purpose.
2. Analysing user needs for climate change related statistics in both the policy and scientific domains to determine where the most pressing needs exist. This was done by conducting stakeholder interviews\(^5\) and by carrying out desk studies on the data needs for emission inventories and climate policies.
3. Reviewing existing statistics of relevance to climate change and comparing those against the needs. The results of the survey of statistical offices was analysed to identify existing statistics and gaps.
4. Analysing the relationships between NSOs and agencies responsible for greenhouse gas inventories to find opportunities for strengthening their cooperation.
5. Reviewing the statistical infrastructure, such as standards, classifications and methods, used to report on climate change related statistics. The Task Force examined the existing

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\(^5\) In total, 11 organizations were interviewed about their views on using official statistics in climate change analysis and how national statistical systems could improve their contribution: IPCC, UNFCCC, World Health Organization (WHO), World Meteorological Organization (WMO), DG-CLIMA and researchers and NGOs, such as the University of Bologna, Fondazione Eni Enrico Mattei (FEEM), the Finnish Environment Institute, the Carbon Brief and the World Wildlife Fund.
infrastructure in NSOs in order to identify gaps and recommend priorities for improving this infrastructure.

6. Identifying practical steps and priorities for future development of climate change related statistics so that they would better meet user needs.

The Task Force organized two expert meetings on climate change related statistics for producers and users. The first meeting was held on 19-20 November 2012 in Geneva. The meeting explored user needs for climate change related statistics and took stock of what statistical offices are doing in the area. It also discussed the definition of the scope of climate change related statistics. The conclusions of the meeting provided valuable input to the Task Force’s work.

The Task Force organised a second meeting on 8-9 October 2013, again in Geneva, to discuss a draft version of this report and its recommendations. The meeting brought various producers and users of climate change information together in order to take into account their views and expectations with regard to official statistics and climate change.

The Task Force was asked by the CES to prepare a report to review the current state of climate change related statistics and the possibilities to develop and streamline the work, with a proposal for:

(a) Developing climate change related statistics for evidence-based climate change policies: concrete steps and priorities for further work
(b) Harmonising and streamlining the work of NSOs on the greenhouse gas inventories.

This report presents the results of that effort. Chapter 1 begins by discussing the definition and scope of climate change related statistics that the Task Force used in its work. The particular competencies of NSOs in measuring climate change related phenomena are also assessed.

Chapter 2 focuses on the relationship between official statistics and GHG inventories. The chapter reviews the data required for the compilation of GHG inventories with a focus on the data that can be provided by national statistical systems. The gaps between the needs of inventory compilers in ideal terms and what national statistical systems are currently able to provide are discussed.

Chapter 3 focuses on climate change related statistics other than those required for GHG inventories. The chapter considers especially needs related to climate policies and climate change analysis, and looks at existing statistics and gaps in those statistics.

Chapter 4 addresses challenges of the statistical infrastructure of NSOs as coordinators of the development work to be done in the national statistical systems for climate change related statistics. National statistical systems are organised in different ways across countries. Therefore, the analysis is based on the most common roles, practices and data of national statistical systems in the UNECE countries.

The report concludes in Chapter 5 with the Task Force’s recommendations for the improvement of climate change related statistics. Practical examples and priorities for the implementation of these recommendations at the national and international levels are also considered.

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6 The following countries and organizations attended the expert meeting on 19-20 November 2012: Albania, Armenia, Belgium, Canada, Egypt, Finland, France, Georgia, Germany, Ireland, Italy, Japan, Kyrgyzstan, Luxembourg, Mexico, Netherlands, Norway, Poland, Republic of Moldova, Slovakia, Ukraine, United Kingdom, Sweden, Switzerland, DG CLIMA, EEA, Eurostat, International Labour Organization (ILO), UNFCCC, United Nations Industrial Development Organization (UNIDO), World Bank, World Meteorological Organization (WMO), World Health Organization (WHO), the Carbon Brief and UNECE.

7 The following countries and organizations attended the expert meeting on 8-9 October 2013: Canada, China, Finland, France, Germany, Ireland, Italy, Luxembourg, Mexico, Netherlands, Norway, Poland, Qatar, Romania, Switzerland, United Kingdom, DG CLIMA, Eurostat, Intergovernmental Panel on Climate Change, UNFCCC, United Nations Industrial Development Organization (UNIDO), World Bank, World Meteorological Organization (WMO), World Health Organization (WHO) and UNECE.
1 SCOPE OF CLIMATE CHANGE RELATED STATISTICS

1.1 Defining climate change

To define the scope of climate change related statistics, this chapter starts by first defining change, climate and climate change.

Change from a statistical perspective is a difference between two observations – usually between two or more points in time. Measuring change well requires consistent and comparable data collected over long time series.

When defining climate, it is necessary to bear in mind the distinction between weather, which we experience daily, and climate, which reflects expected weather patterns over time:

“...the difference between weather and climate is a measure of time. Weather is what conditions of the atmosphere are over a short period of time, and climate is how the atmosphere "behaves" over relatively long periods of time... In short, climate is the description of the long-term pattern of weather in a particular area. Some scientists define climate as the average weather for a particular region and time period, usually taken over 30-years. It's really an average pattern of weather for a particular region... An easy way to remember the difference is that climate is what you expect, like a very hot summer, and weather is what you get, like a hot day with thunderstorms.”

Climate change is defined in the United Nations Framework Convention on Climate Change (UNFCCC) Article 1 as "a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is, in addition to natural climate variability, observed over comparable time periods". In addition, the same article also defines the term climate system, which means "the totality of the atmosphere, hydrosphere, biosphere and geosphere and their interactions."

In addition, UNFCCC defines the term adverse effects of climate change as "changes in the physical environment or biota resulting from climate change which have significant deleterious effects on the composition, resilience or productivity of natural and managed ecosystems or on the operation of socio-economic systems or on human health and welfare".

Climate change is a global challenge which requires substantial and diverse information. As described by NASA, climate change

“will affect people around the world. Rising global temperatures are expected to raise sea levels, and change precipitation and other local climate conditions. Changing regional climate could alter forests, crop yields, and water supplies. It could also affect human health, animals, and many types of ecosystems. Deserts may expand into existing rangelands, and features of some of our National Parks and National Forests may be permanently altered.”

Key elements in these definitions are: the human-induced causes of climate change (notwithstanding other natural causes), the fact that the climate is a system comprising several components (atmosphere, hydrosphere, etc.) and their interactions, and the consideration that

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8 Source: www.nasa.gov/mission_pages/noaa-n/climate/climate_weather.html
9 Article 1 of the Full text of the Convention: unfccc.int/essential_background/convention/background/items/1349.php
10 IPCC defines resilience as “the ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity for self-organization, and the capacity to adapt to stress and change.”
11 Source: www.nasa.gov/mission_pages/noaa-n/climate/climate_weather.html
climate change ultimately affects both the natural environment and the socio-economic aspects of life.

The main cause of human-induced climate change cited in the definition is the release of greenhouse gases in the atmosphere. Thus, Article 2 of the UNFCCC, codifying the core objective of the Convention, explicitly addresses this cause:

“The ultimate objective of this Convention... is to achieve stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time-frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner.”

Greenhouse gas emissions are released as a result of a number of human activities that underpin development and technological progress, such as, for example, industry, agriculture, transport and the combustion of fossil fuels for electricity production.

1.2 What the statistical system can contribute to measuring climate change

Competencies

The statistical system\textsuperscript{12} has a lot of features that are important in relation to climate change. Official statistics\textsuperscript{13} adhere to international principles that bring a number of important attributes to the discourse on climate change. Given the sometimes controversial nature of the discourse on climate change, professional independence is one such attribute. Other attributes include a commitment to well-defined quality standards, the use of sound and transparent methodologies, a focus on publishing data in long and consistent time series and a commitment to data accessibility. Official statistics are an important source of reliable information because of the strict conditions and quality criteria under which they are produced.

The main focus of the statistical system is on human systems and on how they interact with natural systems. Official statistics typically measure the activities of enterprises, individuals, households, institutional and government sectors and regions. Therefore, environmental data that are related to industries and households – as well as climate change – can be covered by the statistical system. Official statistics often also include a link to the geographic region and, in some countries, exact coordinates are attributed to statistics through geo-referencing. This is valuable, as the spatial dimension is important in the context of climate change.

Research studies often provide a picture of a particular issue at a particular point in time. Such studies are, of course, essential in understanding the issue in question and how it might be

\textsuperscript{12} National statistical offices in most countries are part of a broader \textit{national statistical system} comprising all the organisations and units within the country that jointly collect, process and disseminate official statistics on behalf of the government. The national statistical system also includes the mechanisms of interaction between suppliers, producers, users and other stakeholders. Usually the national statistical office has a coordination role in the national statistical system. In addition, there are international statistical systems that focus on the production of official statistics at the regional or global level. The term “statistical system” used in this report refers generically to all national and international statistical systems.

\textsuperscript{13} \textit{Official statistics} comprise any statistical activity carried out within a national statistical system or under the statistical programme of an intergovernmental organization (\url{www.sdmx.org/}). They are, by definition, compiled in accordance with the United Nations \textit{Fundamental Principles for Official Statistics} (\url{unstats.un.org/unsd/methods/statorg/FP-English.htm}), the \textit{European Statistics Code of Practice} (\url{epp.eurostat.ec.europa.eu/cache/ITY_OFFPUB/KS-32-11-955/EN/KS-32-11-955-EN.PDF}) or a similar authoritative international framework ensuring professional standards.
addressed. But they are not necessarily helpful in understanding how it evolves over time. This is where official statistics can be of particular value, given that the development of consistent, comparable time series is a core competence of the statistical system. Official statistics include well-developed methods to adjust data so they are made comparable over time; for example, by accounting for seasonal variation, changes in prices, temperature, etc. When such adjustments are made, the effect of a known source of influence on the variation in the data is eliminated so that only the changes caused by unknown sources of influence and natural variation are left. This type of data treatment can be important when trying to investigate climate change. It is, by definition, an issue that demands evaluation over time and is, therefore, an issue that will benefit from using the long time series available in national statistical systems.

The statistical system also has routines for developing statistics that are internationally comparable – with a global institutional infrastructure to ensure that the definitions, classifications and data collection are harmonized across countries. Furthermore, a core goal of the statistical system is the production of timely statistics, so statistical offices can help in responding to the demand for timely climate change information.

Research has underlined the importance of “assessing the socio-economic aspects of climate change and implications for sustainable development”\(^\text{14}\). These are areas where the statistical system could provide existing data to link with climate information in order to provide a broader and more informed picture of changes in the future.

Recently, the focus of official statistics on environmental and climate issues has broadened with many offices offering data on natural resource assets, energy, waste, water and air emissions as well as environmental protection expenditures. The United Nations Statistical Commission (UNSC) recently adopted the System of Environmental-Economic Accounting Central Framework\(^\text{15}\) as an international standard for environmental-economic accounts. It will support development of climate change related statistics by enhancing work on environmental accounts, but the implementation of SEEA will also be a challenge for the statistical system. The SEEA contains internationally agreed concepts, definitions, classifications, accounting rules and tables for producing comparable statistics on the environment and its relationship with the economy.

**Challenges**

In spite of the many competencies the statistical system brings to the measurement of climate change, it is true that existing official statistics are not always as useful for climate change analysis as they might be. Existing statistics were not, in general, developed for analysing climate change. Thus, the statistical system must make changes to allow it to better respond to the need for climate change related statistics. This will certainly require changes to the official statistics that are collected and may also require organizational changes within the statistical system.

The statistical system offers a lot of data on different subject-areas. However, it often does not put much emphasis on cross-cutting data and measuring the interactions between the subject areas. Identifying and modelling interactions is often the work of economists, academics, government ministries and others often working outside of the statistical system.

In many countries, NSOs are not responsible for much of environmental statistics even though they are mainly produced within the national statistical system. For example, state of the environment reports and measures of biodiversity are typically the responsibilities of environment ministries or specialized agencies. One of the challenges of developing climate change related statistics is,

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\(^{14}\) Source: Climate change 1995, Economic and Social Dimensions of Climate Change: www.ipcc.ch/ipccreports/sar/wg_IIii/ipcc_sar_wg_IIii_full_report.pdf

\(^{15}\) unstats.un.org/unsd/envaccounting/seea.asp
therefore, to establish an efficient coordination and division of work between various national bodies.

Moreover, new statistics to be incorporated into the statistical system to support climate change analysis, such as monitoring the move towards greener consumption and production patterns, will be a challenge for the system. The competences and challenges of the statistical system are discussed in more detail in Chapter 4 on statistical infrastructure.

1.3 Frameworks that can be used to structure climate change related statistics

Since the climate change related statistics cover a wide range of topics, the Task Force used different frameworks to delineate the scope of climate change related statistics and to provide a structure to organise the statistics that fall within the scope.

Examining the frameworks helped with identifying the statistical subject areas that are related to climate change, and ensuring that all relevant topics are covered. Examples of variables under each statistical area are provided in Annex 2. The exercise did not intend to identify which is the “best”, or most suitable framework for structuring climate change related statistics: each framework has its own purpose and advantages. The following frameworks were analysed:

1. Driving forces – Pressure – State – Impacts – Response (DPSIR)
2. UN System of Environmental-Economic Accounting (SEEA, 2013)
4. Natural capital approach
5. Impact, mitigation and adaptation

1. DRIVING FORCES – PRESSURE – STATE – IMPACT – RESPONSES (DPSIR) FRAMEWORK

Climate change related statistics could be examined and structured according to the so called Driving forces-Pressure-State-Impact-Responses (DPSIR) model (see figure 1). The DPSIR model is used by the European Environment Agency (EEA) to “structure thinking about the interplay between the environment and socio-economic activities.”

DPSIR uses a systems analysis view towards assessing environmental phenomena. Although the model appears to be fairly simple, it can also represent a more complex system.

Organizing statistics relevant to climate change according to the DPSIR model can help to structure the different statistical areas that inform the various aspects of the climate change phenomenon, including broad socio-economic developments, specific sources of greenhouse gas emissions, measures related to adaptation or curative action, etc.

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17 The DPSIR framework used by the EEA: ia2dec.ew.eea.europa.eu/knowledge_base/Frameworks/doc101182/
The DPSIR model can be examined in closer detail by looking at each of the five components separately. Examples of variables relevant to climate change for each area of the DPSIR model are given in Annex 2.

DRIVING FORCES
Driving forces encompass information on socio-economic developments, changes in life styles, levels of consumption and production that influence the pressure on the environment and that are particularly relevant to climate change. These include, for example, data on population structure and movement, urbanization; changes in wealth and consumption and their impact on the demand for energy, transport, housing and food; changes in economic activity; internationalisation of the economy and tourism. Statistics on these topics are produced by most national statistical systems.

PRESSURE
Pressures concern the actual greenhouse gas emissions, land use changes, resource consumption, direct damage to resources, and the underlying activities that produce the emissions; for example, technology. The data relevant to the latter are referred to as "activity data" that statistical offices usually provide to emission inventory calculation. The emissions are estimated based on activity data and emission factors. The data required for calculating the emissions cover, for example, combustion and production of fossil fuels in different industrial sectors, industrial processes, livestock, soil, land use and forestry, ozone depleting substances, waste and emission factors.

STATE
This component is interpreted to encompass the state of the climate system and the environment as affected by climate change. Information on the state of climate change includes data on atmosphere and climate, cryosphere (glaciers, arctic sea ice, snow cover) and marine biodiversity and its ecosystems. A good example of the state variables is the so called set of Essential Climate Variables (ECVs) of the Global Climate Observing System (GCOS)\(^\text{18}\).

\(^{18}\) GCOS Essential Climate Variables: www.wmo.int/pages/prog/gcos/index.php?name=EssentialClimateVariables
The main authorities responsible for these data are typically national meteorological institutes, and at the international level, the climate observation networks coordinated by World Meteorological Organization (WMO) and United Nations Environment Programme (UNEP). Currently, in most countries the NSOs do not collect data on the state of the climate. They may, however, be involved in dissemination of these data alongside with data produced within the statistical system.

**IMPACT**

Impact of climate change can be viewed in two ways: the direct or indirect impact. First, the impact can be seen in terms of natural phenomena, for which data on water, air, soil, biodiversity, and ecosystems are relevant. Second, we can look at the socio-economic impacts of these physical changes: such as on agriculture and forestry, human health and the economy. The role of NSOs here is stronger when it comes to the latter type of data as the environmental data are often provided not by NSOs but by environmental agencies.

**RESPONSES**

The responses include actions to mitigate the effects and adapt to climate change. These can be expressed as official targets; for example, as quantified emission limitations or reduction objectives under the Kyoto Protocol to the UNFCCC. Responses concern also economic opportunities generated as a result of climate change like eco-industries, technology exchange, “green” jobs and “green” growth. The International Labour Organization’s 19th International Conference of Labour Statisticians discussed a proposal for the statistical definition and measurement of green jobs. Methodology and sets of indicators are developed for some related issues such as "green" growth (for example, under the “Green” Growth Initiative of the Organisation for Economic Co-operation and Development (OECD)

Several statistics currently produced by the statistical system are relevant for responses; for example, statistics on environmental protection, investment, energy, prices, waste, employment, government finance and education.

2. **THE SYSTEM OF ENVIRONMENTAL-ECONOMIC ACCOUNTING**

The United Nations *System of Environmental-Economic Accounting Central Framework (SEEA-CF)*\(^\text{20}\) is a multipurpose system for measuring the contribution of the environment to the economy and the impact of the economy and human activity on the environment. It provides an integrated set of basic statistics that can be re-grouped into a variety of indicators that are useful for the analysis of climate change, among other issues. The system is flexible in that its implementation can be adapted to countries’ priorities and policy needs while at the same time providing a common framework across countries and ensuring consistency with the concepts, structures, rules and principles of the *System of National Accounts (SNA)*.

While the SEEA-CF is not intended explicitly for climate change analysis, it includes a number of components that are relevant to different aspects of climate change: 1) accounts for physical flows of materials and energy; 2) accounts for stocks of environmental assets and changes in them; and 3) accounts for economic activity and transactions related to the environment. Examples of variables relevant to climate change for each area of the SEEA-CF are given in Annex 2.

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\(^\text{19}\) [www.oecd.org/document/10/0,3746,en_2649_37465_44076170_1_1_1_37465,00.html](http://www.oecd.org/document/10/0,3746,en_2649_37465_44076170_1_1_1_37465,00.html)

ACCOUNTS FOR PHYSICAL FLOW OF MATERIALS AND ENERGY

The physical flow accounts of the SEEA-CF record flows of materials and energy that enter and leave the economy and flows of materials and energy within the economy itself. The physical supply and use tables cover natural inputs, products and residuals. Natural inputs are flows from the environment to the economy; for example, minerals, timber, fish, water. Product flows take place within the economy and residuals refer to the flows from the economy to the environment; for example, solid waste and air emissions. The physical supply and use tables can be linked with economic data through the monetary supply and use tables that record products in the same way as the SNA.

From the perspective of climate change, the SEEA-CF air emission accounts provide data on the origin and destination of air emissions, including greenhouse gasses. Energy flow accounts provide relevant data on the supply and use of energy, both renewable and non-renewable. Water flow accounts are particularly relevant in understanding of the impacts of climate change with respect to changes in water availability and use. Solid waste flow accounts provide data on sources of waste, incineration and landfill emissions of methane, a potent greenhouse gas. Currently, those modules are still in stages of development, with most countries not yet in a position to provide statistics and time series, useful for policy purposes.

By implementing the SEEA-CF, NSOs would create the basis for climate change related indicators such as energy use and GHG emissions per unit of GDP by industry; measures of “consumption based” GHG emissions21; and measures of “decoupling” between the economy and the environment.22

GHG inventories are important data sources for air emission accounts, although adjustments are needed to align with the SEEA-CF accounting concepts. For example, transportation emissions are grouped together in GHG inventories regardless of the sector responsible. In contrast, transportation emissions are attributed to the specific sectors (industries, governments and households) responsible for them in the air emission accounts. When compiling air emission accounts, it is essential that their distinctions with respect to GHG inventories be clearly explained to users, including clear descriptions of the conceptual and methodological reasons for the distinctions (see the Canadian case study in section 2.3).23

ACCOUNTS FOR STOCKS OF ENVIRONMENTAL ASSETS

The SEEA-CF stock accounts measure the size of environmental assets (ecosystems24, land and natural resources) and the annual changes in these stocks. The accounts are measured in both physical and, where possible, monetary terms.

Asset accounting is relevant to quantifying the impacts that climate change may have on different environmental assets. Asset accounts can be compiled for energy, land, soil, timber, and water

21 Consumption based emissions are those that are associated with a country’s consumption activities regardless of where the emissions occur. Thus, emissions associated with the production of imported goods are counted in consumption based estimates. In contrast, production based emissions include those related to production activity of units legally registered in the country.

22 Decoupling indicators show the extent to which economic output over time is associated with use of the environment. They are derived by dividing an economic aggregate (for example, household consumption or GDP) by a physical flow (for example, GHG emissions). When shown together, the trends in the economic indicator, the physical flow indicator and the decoupling indicator show whether or not the economy is developing such that it makes less use of the environment, both in absolute and in relative terms.


24 The SEEA-CF treatment of ecosystems is limited. Accounting for ecosystems is still in its infancy, so the detailed treatment of it is given in a separate SEEA volume called Experimental Ecosystem Accounting.
resources, all of which are subject to change as a result of climate change. For example, as precipitation regimes change, the availability of water resources and their geographic distribution will change. Water stock accounts are well suited to measuring these changes.

Some countries have tested the compilation of experimental ecosystem accounts. Canada, in particular, has published a major study on ecosystem accounting in which ecosystem stocks are evaluated from a number of perspectives, including that of climate change. Australia has developed an experimental framework for a carbon asset account following the SEEA approach. Using existing data, a partial carbon asset account has been prepared but more research is required to provide robust estimates of carbon in terrestrial and marine ecosystems.

ACCOUNTS FOR ECONOMIC ACTIVITIES AND TRANSACTIONS RELATED TO THE ENVIRONMENT

The SEEA-CF accounts for economic activities and transactions related to the environment record the monetary transactions between economic units that may be considered “environmental” in nature. Generally, these transactions concern activity undertaken to preserve and protect the environment. As well, there are a range of transactions, such as taxes and subsidies that reflect efforts by governments, on behalf of society, to influence the behaviour of producers and consumers with respect to the environment. The accounts measure activities and transactions whose primary purpose is 1) the prevention, reduction and elimination of pollution and other forms of degradation of the environment; 2) preserving and maintaining the stock of natural resources and hence safeguarding against depletion; and 3) influencing the behavior of producers and consumers with respect to the environment.

The accounts cover a number of activities and transactions that are either directly or indirectly related climate change; including:

- the prevention, reduction or elimination of air emissions
- the prevention, reduction or treatment of solid waste
- the protection of biodiversity and landscapes, including ecological functions
- monitoring of the quality of the natural environment
- restoring natural resource stocks

A related set of information in the SEEA-CF focuses on the supply of environmental goods and services in the economy. These statistics include information on the production of the range of environmental goods and services, some of which are related to climate change; for example, goods that are designed to improve energy efficiency or otherwise reduce GHG emissions. They are useful for measuring the economic benefits in the form of innovation, job creation and trade that might be associated with climate change.

The SEEA-CF also provides guidance on the measurement of environmental taxes, subsidies, permits and licences that relate to energy production and use, GHG emissions and environmental innovation. These data provide a basis for analysing the relationship between GHG emissions, energy use and emission permits and for monitoring trading of GHG emissions.

The SEEA-CF limits the scope of activities considered “environmental” to environmental protection and resource management activities. However, it is recognised that there are a number of other economic activities that are related to the environment that may be of particular interest for policy and analytical purposes. These include efforts to adapt to the effects of climate change. At this stage, there has been little development of accounts relating to these activities and the SEEA-CF offers no recommendations regarding accounts for climate change adaptation activities. The SEEA-CF handbook recommends that work in this area be considered within the SEEA research agenda.

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26 unstats.un.org/unsd/envaccounting/ceea/archive/Framework/eap_Aus.pdf
Finally, the System of Environmental Economic Accounting should not be confused with the issue of accounting of emissions and assigned amount units under the Kyoto Protocol. The use of the term “accounting” in GHG inventory communities has a very different meaning that relates to the emission reduction or limitation commitments (or targets) under the Kyoto Protocol. Those commitments can be met by reducing emissions domestically, by enhancing emission sinks or by trading emission units under the carbon market (Kyoto flexible mechanisms). The accounting concerns the rules and procedures for settling all these elements at the end of the commitment period.  

3. **FRAMEWORK FOR THE DEVELOPMENT OF ENVIRONMENTAL STATISTICS (FDES, 2013) AND IPCC SCHEMATIC FRAMEWORK**

The primary objective of the Framework for the Development of Environmental Statistics (FDES) is to guide the formulation of environmental statistics programs. The concepts, terms and definitions used in the FDES are largely consistent with the SEEA-CF. FDES also facilitates the description of climate change related statistics in all of its six main components: environmental conditions and quality; environmental resources and their use; residuals; extreme events and disasters; human settlements and environmental health; and environment protection, management and engagement. These are explained in more detail below. Examples of possible variables from FDES to measure climate change related phenomena are listed in Annex 2.

**ENVIRONMENTAL CONDITIONS AND QUALITY**

This component organizes information on environmental conditions and processes describing the foundations of ecosystems. It relates to the state element of DPSIR. The data relevant to climate change includes data on physical conditions (state of atmosphere, temperature, precipitation, sea level and sea ice, water system and desertification), soil and land cover, biodiversity, state of and changes in ecosystems, flora, fauna and terrestrial and marine biodiversity, as well as trends and vulnerabilities of ecosystems and quality of climate etc.

The main sources for these data are meteorological and atmospheric monitoring networks and hydrological, geographical and geological institutions. Data on biodiversity and ecosystems are often collected and maintained by national environmental authorities.

**ENVIRONMENTAL RESOURCES AND THEIR USE**

Environmental resources or assets comprise the biophysical environment that provides benefits to people. The component is closely related to the asset and physical flow accounts of the SEEA-CF and to both state and pressure elements of DPSIR. It comprises data on energy resources, land, biological and water resources that may be linked with climate change. Part of these statistics is available from the statistical systems; for example, statistics on population, energy, agriculture, forestry, mining and land use.

**RESIDUALS**

This component contains statistical information on emissions of greenhouse gases and consumption of ozone depleting substances. This component mainly relates to the pressure element in DPSIR and to some of the physical flow accounts of SEEA-CF. This information is usually produced as emission inventories, for which the statistical system provides activity data. NSOs often produce air emission inventories.

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27 For more on accounting under the Kyoto Protocol, see [unfccc.int/resource/docs/publications/08_unfccc_kp_ref_manual.pdf](unfccc.int/resource/docs/publications/08_unfccc_kp_ref_manual.pdf)
accounts that allow distinguishing emissions originating from production (by economic activity) and consumption.

EXTREME EVENTS AND DISASTERS

The occurrence of climate related extreme events and disasters, the abrupt impacts of the changing climate on people, economic and physical losses and effects on ecosystems belong to this component. These elements can be found in many parts of DPSIR, and they relate to the asset accounts of SEEA-CF.

Data on natural extreme events are generally not supplied by the statistical system. The assessment of economic impact is often carried out by research institutions or insurance companies. NSOs are a limited source of information for analysing the impacts of weather events; for example, via their supply of data on causes of death. Their socio-economic data, however, could be useful if linked to location attributes to get, for example, information on population density and infrastructure in areas hit by weather events.

HUMAN SETTLEMENTS AND ENVIRONMENTAL HEALTH

Data on the environment in which humans live and work, living conditions and environmental health are part of this component. It includes data on housing vulnerable to natural disasters or extreme events; population exposed to air pollution; epidemic changes (vector borne diseases) and incidences, morbidity and mortality related to climate change.

Housing authorities, administrative records, censuses and surveys are likely sources for data on human habitat. The World Health Organization (WHO) is the global institution assessing the relationship between health and the environment, including climate change. Statistical systems typically provide useful data as part of statistics on population, health and mortality.

ENVIRONMENT PROTECTION, MANAGEMENT AND ENGAGEMENT

Information on protection, regulation and management of various climate change issues and concerns belongs to this component. It contains data on economic instruments, costs of mitigation and adaptation; governance and regulation, climate conventions; management systems to cope with extreme events; education and perception. This component relates to the response element in DPSIR and to the environmental activity accounts and related flows in SEEA-CF.

Part of this information consists of qualitative data on projects and norms related to protection of the climate system and to the management of related extreme events. Some quantitative data, however, on costs of mitigation and adaptation measures, financial flows, taxes and subsidies could be available from the statistical system. The role of statistical systems in measuring the effectiveness of economic instruments is also evolving.
The FDES report includes a section on topics in the FDES that relate to climate change. Figure 2 presents topics in the FDES that relate to climate change using the elements of the IPCC schematic framework. The IPCC framework represents anthropogenic drivers, impacts of and responses to climate change, and their linkages. An important difference between the IPCC schematic framework and the FDES is that “Socio-Economic Development” in FDES focuses on issues related to the environment, whereas the IPCC framework includes all socio-economic factors that are linked to climate change.
climate change. The FDES also provides a list of concrete climate change statistics available in environmental statistics (see FDES 2013, pages 183-185).

4. **NATURAL CAPITAL APPROACH**

Another statistical framework that facilitates defining the scope of climate change statistics is found in the body of thought around natural capital\(^3\). This approach links environmental quality and human well-being through the flows of ecological goods and services from natural assets to humans.

**NATURAL ASSETS**

The environmental goods and services are essential for human well-being. Therefore maintaining the capacity of the environment to produce these flows is of central importance. Declines in this capacity will lead to declines in ecological goods and service flows and consequent declines in well-being, other things being equal. According to the natural capital framework, the capacity of the environment to yield ecological goods and service flows arises from the numerous separately identifiable, structured groupings of living and non-living elements that constitute the environment. These “structured groupings” function as units to deliver ecological goods and service flows and have the characteristics of capital assets, similar to the assets in the economic context. These natural assets fall into three categories:

**Ecosystems**

Ecosystems are the most important and complex asset category. Ecosystems are structured groupings of living organisms and non-living matter that, given an on-going supply of solar energy, remain intact over long periods of time and yield continual flows of ecological goods and services. Ecosystems can be divided into two major groups: terrestrial and aquatic, but also the atmosphere can be seen as an ecosystem.

**Land**

Land provides space, whereas the other functions that are connected with land, such as the provision of timber, are captured in the ecosystem category. Space benefits humans in terms of the direct-use benefits associated with the occupation of space for dwellings, transportation infrastructure, agriculture, recreation etc. and these may be influenced by climate change.

**Sub-soil resources**

Sub-soil resources provide ecological goods such as minerals, metals, fossil fuels and water. Sub-soil resources represent stocks from which ecological goods are withdrawn for use in human activity. These materials provide direct-use benefits as inputs into industrial processes and home heating. Many of the resources humans require are found underground in deposits of various minerals, liquids and gases. These deposits are fundamentally different from ecosystems in that they are subject to permanent depletion as a result of use. Ecosystems, in contrast, have the ability to regenerate themselves over time if their use is kept within sustainable limits.

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\(^3\) The natural capital framework was given an early and full elaboration by Pearce and Turner (1990) in their popular textbook *Economics of Natural Resources and the Environment*. Herfindahl and Kneese (1974) drew on capital theory in an influential work on environmental economics nearly two decades earlier. The framework is today the subject of a large body of thought, much of which is found in the ecological economics literature (see Krishnan et al. [1995]). Daily (1997) offers an overview of natural capital from the perspective of ecology. Costanza et al. (1997) published a widely quoted study of the value of the world’s natural capital in the journal *Nature*. Olewiler (2007) offers a more up-to-date commentary that reflects a Canadian perspective. Critical comments on the concept can be found in Victor (1991, 2007) and Hinterberger et al. (1997).
ECOLOGICAL GOODS AND SERVICES

The natural assets – ecosystems, land and sub-soil resources – produce ecological goods and services. The relatively stable and predictable climate that has prevailed for much of modern human history is one of the most important ecological services. Possible disruptions to this service due to climate change would cause various consequences. Examples of possible variables to measure climate change related phenomena under the natural capital approach are listed in Annex 2.

Potential variables can be identified by assessing impacts of disruptions to the stable and predictable climate. These could include changes in the provision of space; flood protection service offered by forests and wetlands; spread of vector-borne diseases; transportation services offered by rivers, lakes and oceans; recreational opportunities; and aesthetic, cultural or existence value of the environment. The impact could also been seen as changed flows of ecological goods; for example, in food production, marine resources, forest products, water availability and quality.

To define statistical variables to measure climate change through capital approach, one would first identify the ecological goods and services produced by the assets that are potentially affected by climate change.

The five categories of statistical variables would be:

1. Capacity of natural assets to deliver ecological goods and services.
2. Flows of ecological goods and services from natural assets to the human sphere.
3. Flows of waste materials and energy that leave the human sphere and return to the environment.
4. Flows associated with efforts to reduce the scale of waste material and energy flows that are released to the environment.
5. Flows associated with efforts to adapt to the loss or reduction of ecological goods and services.

To summarize, the scope of climate change statistics as defined by the natural capital approach includes statistics related to the atmosphere; marine, forest, freshwater and groundwater ecosystems; agricultural ecosystems and land (as the provider of space).

5. IMPACTS, MITIGATION AND ADAPTATION (IMA)

Another way for categorizing climate change related statistics is in line with how the climate change discussions typically are structured – impacts, mitigation and adaptation. Such a framework is simpler than the ones presented above but closely linked to the DPSIR model. It provides a direct link to major strands in climate policy, but lacks a detailed structure as it allows for only three categories of information.

IMPACTS

Impacts, as considered here entail broadly the consequences of climate change. The natural impacts include heat waves, rising oceans, retreats of glaciers, droughts etc. The socio-economic impacts include reduced crop yields, changes in crop patterns, changes in disease patterns etc.

Although the statistical system provides a lot of data relevant for analysing the impact of climate change, a big challenge for it is related to causality. This concerns especially the wider socio-economic consequences of climate change. Specific changes in socio-economic phenomena (for example, crops in agriculture) may be due to other reasons than climate change (for example, changing food preferences or discontinuation of specific subsidies). Analysing the cause-effect relationship goes beyond the task of the official statisticians. This should rather be the job of specialized analysis or targeted studies but the task of official statistics is to provide data that can be used for such analysis.
MITIGATION

Mitigation is “an intervention to reduce the sources or enhance the sinks of greenhouse gases.” 31 Mitigation can be considered in broad terms to encompass efforts to control the causes of climate change, essentially to reduce greenhouse gas emissions. Relevant statistics here would include data on the emissions themselves and all the underlying activities (for example, the activities in the different inventory sectors such as energy, industrial processes, agriculture and waste) as well as the broader socio-economic phenomena such as population growth, urbanization, industrialization, etc. that have an impact on increased emissions. Statistics relevant to mitigation also include the measures taken to address these causes, i.e. any emission reduction action which can be statistically quantified; for example, energy taxes, transport taxes, data on the carbon market and trade, and on renewable energy resources.

ADAPTATION

Adaptation is “the adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities.” 32 Statistics relevant to adaptation cover the actual actions and measures taken by governments and society to adapt to the inevitable consequences of climate change as far as they are statistically quantifiable. Measures typically listed in so-called national adaptation strategies may not always be expressed in quantifiable terms.

6. FINDINGS FROM THE ANALYSIS OF DIFFERENT FRAMEWORKS

Each framework presented above provides a different viewpoint to climate change related information. Many of the statistics called for by the frameworks are already available in the statistical system, but may need to be developed further to be suitable for the purposes of analysis linked with climate change. The main question is not which framework is the best to organise climate change related information, but how all of them help to define the scope of climate change related statistics.

The Task Force used the Classification of Statistical Activities (CSA) 33 as a tool to summarise the coverage of statistical issues in the examined frameworks (Annex 3). The CSA provides a comprehensive list of the topics covered by the statistical system. The summary in Annex 3 distinguishes between statistical areas that are closely related, related and indirectly related to climate change. The Task Force used the CSA for analysing both the coverage of each framework and for defining the scope of climate change related statistics.

The challenge is deciding what variables should be measured within the scope of climate change related statistics. While both DPSIR and IMA are useful for organizing variables into categories, the frameworks say little about what variables should be collected in the first place. Both climate science and climate policy provide guidance as to what should be collected. The DPSIR and IMA are highly flexible and comprehensive and any variable that might be related to climate change can fit into the framework. Therefore, the DPSIR or IMA framework could be used to structure climate change related statistics if combined with some other approach to defining what should be measured (for example, climate policy data needs).

One challenge of the DPSIR framework is deciding which variables go into which component of the framework. For example, it is not always obvious if some element belongs to the “state” or the “impact” component. This could be solved by considering biophysical impacts part of the “state”

33 unstats.un.org/unsd/iiss/Classification-of-International-Statistical-Activities.ashx
component and by including only socio-economic impacts under the “impact” category. Furthermore, analysing causal relations and factors that contribute to change is typically done outside of the statistical system. Has the “driver” contributed to climate change and is the “impact” really a result of changing climate? The attribution of weather events to climate change or to natural climate variability is difficult. This task falls into the competence of climate science, not statistics. In this context, the DPSIR and IMA should be treated as a tool for organizing the climate change related information, not as a model for analysing causality between its parts.

SEEA-CF is a comprehensive framework for analyzing environmental issues that provides a wide range of data relevant to climate change analysis and policies. It excludes some relevant issues however; for example, economic activity associated with adaptation to climate change, population and migration issues, and health impacts that are important in connection to climate change. The strength of the framework, on the other hand, is its ability to link environmental data to economic data. The value of SEEA-CF data for climate change analysis could be increased further by linking these data with social and demographic statistics to permit their analysis in the context of, for example, vulnerable population groups. SEEA-CF data on activities aimed at minimizing the impact of natural hazards and data on resource management are of particular interest for assessing responses to climate change.

Similarly, FDES covers a number of areas relevant to climate change. It does not emphasize the causes of climate change or include all socio-economic impacts of climate change. FDES includes some of the implications to human health and well-being from the viewpoint of environment only, and does not consider economic possibilities or limitations caused by climate change nor the impact of globalization and trade to climate. FDES can be very helpful in structuring information available from environmental statistics but should be complemented with additional social and economic statistics.

The natural capital approach offers a comprehensive and rigorous means of defining the scope of climate change statistics by focusing on the links between environmental quality and human well-being. It is based on a robust scientific literature and is part of a broader effort to expand the traditional notion of capital into other domains. The approach constrains the scope of climate change statistics to those variables that are directly relevant to measuring natural assets and the flows between these assets and the human sphere. For example, it limits measures of human health issues to just those that are attributable to the loss of ecological good and service flows due to climate change. Economic measures are limited to activities that are undertaken either to mitigate the causes of climate change or to adapt to the associated loss of ecological good and service flows.

The Task Force does not advocate any particular framework. Instead, it rather proposes a pragmatic approach to divide climate change related statistics into two groups: statistics directly needed for the compilation of greenhouse gas inventories and other climate change related statistics. This approach is explained in the next section, and it is also underpinned by the Task Force's mandate (see Annex 1). The “other climate change related statistics” are further divided into statistics on the drivers of climate change, and to statistics on its consequences. The statistics on the consequences of climate change would include the impacts of climate change, mitigation, adaptation and vulnerability.

1.4 Conclusions on the scope of climate change related statistics

The need to measure climate change has spurred the development of a wide variety of data. To identify how statistical systems could better respond to the need for climate change related statistics, it is first necessary to define the scope of such statistics. The Task Force devoted considerable discussion to this issue in particular, through the above examination of different frameworks and approaches used in the compilation of environmental statistics and also through evaluation of user needs. As a common feature to all frameworks and approaches examined, they
suggest the need to measure the factors that are the cause of climate change, the consequences of climate on human and natural systems and the efforts of humans to avoid climate change and live with the consequences.

The conclusion of these discussions is that as climate change impacts the environment and society through complex interactions and cause-effect relations, the conceptually based definition of climate change related statistics would necessarily be wide and exhaustive. Climate change touches upon a broad range of human activities – from energy use to transportation, waste generation, agriculture, manufacturing and tourism etc. Indeed, few human activities are not related somehow to climate change, either as a contributing factor or via an impact. Climate change influences a wide range of natural phenomena: rainfall, temperatures, ocean and air currents and ecosystems that have an impact on human activities.

In the very broad sense, the Task Force defines the scope of climate change related statistics to include:

Environmental, social and economic data that measure the human causes of climate change, the impacts of climate change on human and natural systems, the efforts of humans to avoid the consequences as well as their efforts to adapt to these consequences.

Whereas climate change is multi-disciplinary and anchored largely in the natural sciences, the statistical system is focused largely on anthropomorphic or human systems and provides data for administrative regions within national boundaries.

A broad definition is, therefore, only a starting point for statistical offices wishing to improve climate change related statistics. A pragmatic approach is needed to narrow the scope to those areas where the statistical system’s involvement is most valuable. These are areas where the links between human and natural systems are most important in terms of understanding climate change – both from the point of view of its causes and its impacts. Evaluation of impacts requires interpretation and judgement in some cases. The focus of official statisticians is therefore on what can be measured in support of analysts’ efforts to identify and assess the impacts of climate change. It is not the task of NSOs to assess the impacts but to provide the data for doing so.

To narrow the scope in the context of the statistical system, the Task Force decided to distinguish between climate change related statistics and climate change statistics in general. The latter would include data that measure climate and weather directly; for example, temperature and precipitation. These data are frequently, but not always, collected and analysed by agencies outside of the statistical system; for example, by meteorological organizations. The focus of the Task Force was on climate change related statistics. That is, environmental, social and economic statistics that measure climate change related:

1. **Emissions**: GHG emissions and their human causes
2. **Drivers**: human causes of climate change that deal with sources of emissions
3. **Impacts**: impacts of climate change on human and natural systems
4. **Mitigation**: efforts of humans to avoid the consequences
5. **Adaptation**: efforts to adapt to these consequences

The first two groups, greenhouse gas emissions and drivers, describe causes of climate change. The latter three – impacts, mitigation and adaptation – describe the consequences of climate change. The first two groups, GHG emissions and their drivers, are discussed in Chapter 2 while the others are discussed in Chapter 3.
2 GREENHOUSE GAS INVENTORIES AND OFFICIAL STATISTICS

This chapter discusses the role of the statistical system – especially national statistical offices – in support of compiling national greenhouse gas inventories. All Annex I countries to the United Nations Framework Convention on Climate Change are required to compile a national greenhouse gas emissions inventory and submit it to the UNFCCC annually.\(^{34}\) This chapter considers the current and potential role of NSOs in the national statistical systems\(^ {35} \) that produce these inventories. The chapter aims to:

- assess the user needs of GHG inventory producers for statistical data
- examine the current involvement of NSOs and use of existing statistics with respect to the inventories
- identify major gaps and areas where NSOs could make an improved contribution

Inventory compilation incorporates various activities. These include collecting “activity data” on a variety of economic activities and making them available to inventory compilers; selecting appropriate methods and emission factors; estimating GHG emission sources and sinks;\(^{36}\) implementing quality assurance/quality control (QA/QC) procedures; and verification of national data. Inventories consist of standardised tables based on a common reporting format (CRF) and are accompanied by a national inventory report documenting the methodologies and data sources that have been used.

This chapter focuses on the role of NSOs as the coordinators of national statistical systems and on the usefulness of data from national statistical systems for inventory compilation. The role of NSOs in national inventory systems varies from country to country. In some countries, the NSO is not even the source of activity data. In others, the NSO acts as the inventory compiling authority, coordinating the whole process. Most NSOs fall between these extremes. Typically, their role is to ensure that relevant activity data and other statistics are collected and shared with national GHG inventory compilers.

2.1 User needs

Each national GHG inventory provides information on emission trends that is relevant to policymakers in designing climate mitigation policies and assessing the impact of those policies. Moreover, all national inventories undergo a thorough and independent review by international experts on an annual basis. In both these compilation and review processes, more and better-quality activity data are demanded.

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\(^{34}\) Annex I countries include the industrialised countries that are members of OECD and countries with economies in transition, such as the Baltic States, and several Central and Eastern European States. For example, most European countries, Australia, Canada, Japan, Russian Federation, New Zealand and United States are part of Annex I countries. In addition to Annex I countries, a number of other countries compile greenhouse gas inventories for their own purposes. Furthermore, the 17th UNFCCC Conference of the Parties in Durban (in November 2011) agreed to put in place by 2015 a global protocol to be implemented from 2020 which will requires all countries (not only Annex I) to submit annual inventories. The full list of Parties is provided at: [unfccc.int/parties_and_observers/parties/annex_i/items/2774.php](http://unfccc.int/parties_and_observers/parties/annex_i/items/2774.php)

\(^{35}\) Article 5.1 of the Kyoto Protocol (Read: Guidelines for national systems under Article 5, paragraph 1, of the Kyoto Protocol) requires that Annex I Parties to the Convention have a “national system” in place for estimating anthropogenic GHG emissions and removals and for reporting and archiving the results. National systems are defined to include all institutional, legal and procedural arrangements made for estimating anthropogenic emissions and removals, and for reporting and archiving inventory information.

\(^{36}\) The source/sink sectors defined by the IPCC are: 1. Energy; 2. Industrial processes; 3. Solvent and other product use; 4. Agriculture; 5. Land use change and forestry; 6. Waste; and 7. Other ([www.ipcc-nggip.iges.or.jp/public/gl/invs1.html](http://www.ipcc-nggip.iges.or.jp/public/gl/invs1.html)). A sink is a natural or artificial reservoir, physical unit or process that stores greenhouse gases; for example, forests and underground or deep sea reservoirs of CO₂.
The users of data with respect to GHG inventories can be classified as: 1) the inventory compilers themselves; 2) the inventory reviewers; and 3) climate change analysts. Each of these groups has different needs and each potentially looks to NSOs to help address these needs with official statistics. Whereas the first group are mostly interested in the availability of good quality activity data, the focus of the second group is on the review and assessment of the quality of the emission estimates. The third group has become increasingly prominent in recent years. Their task is to interpret the inventory information for the policy makers, the media and the general public.

From the perspective of inventory compilers, the most obvious role of national statistical systems is to provide high quality activity data. The reported GHG emissions are heavily dependent on these data; the better the quality of the activity data, the higher quality the GHG emissions inventory.

From the inventory reviewer perspective, it is often difficult for reviewers to ascertain the quality of the underpinning activity data. Greater involvement of NSOs in explaining the quality of official statistics could improve GHG inventories and ensure greater consistency between inventories and other statistics.

A risk of insufficient involvement of NSOs in the inventory compilation and review processes is that additional, and even duplicate, data collection systems may be established. The costs of these systems are high, they increase the reporting burden of respondents and may yield data that are inconsistent with official statistics. In many cases, inventory data needs can be better met by incorporating additional questions into existing statistical collections. This limits additional cost and respondent burden and has the benefit of full consistency with official statistics.

Considering analysts of climate change and inventories, they look for detailed data to find factors that are key to understanding the reasons behind increases and decreases in greenhouse gas emissions. Analysts may need answers to questions such as: Why have emissions increased or decreased? For example, emissions can decrease as a result of “fuel switching” in the power supply sector (for example, from coal to gas). This information can be derived from the activity data reported in GHG inventories. Emissions can also decrease if renewable energy resources, such as wind or solar power or energy, replace fossil fuels to cover part of the final electricity consumption. This activity data cannot be found in GHG inventories since renewable resources are not a source of emissions.

Similarly, linking emissions to socio-economic data, explanatory variables and other data produced by national statistical systems, will help to provide a more complete picture of the underlying reasons for increasing or decreasing trends in emissions. Analysts may wish to know: Who is emitting and how does consumption contribute to emissions? Which industries are among the most energy- or carbon-intensive? They may be interested in, for example, the contribution of energy-intensive economic sectors to GDP, exports and imports.

Analysts are also seeking timelier information, to meet the growing demands of policy makers and the public, and to raise the profile of climate change information alongside comparable economic and social information.

Based on the stakeholder interviews carried out by the Task Force, analysts are especially in need of official statistics to support analysis of GHG emissions by economic sector. The needs mentioned included:

- economic output by activity, imports, exports at national and regional levels
- emissions by sectors and products
- geo-referenced land use and land management data
- energy use by economic activity
2.2 NSO involvement today

GHG inventories require a number of different statistical inputs as the basis for their calculation. A Eurostat publication, *Using official statistics to calculate greenhouse gas emissions*\(^{37}\), provides a useful overview of the data that are available within statistical systems that may be used for estimating or analysing GHG emissions. These include, but are not limited to, activity data related to *energy production and consumption*, *agriculture*, *forestry*, *mining*, *waste generation*, *manufacturing*, *transportation and land cover*. Statistics on population, urbanization, housing, waste, globalisation and tourism are also relevant for analysing drivers of emissions.

While NSOs are usually not directly responsible for the GHG inventories, they have a crucial role to play in ensuring their quality through the provision of activity data. Indeed, most activity data needed for the GHG inventories come from official statistics and many of these data are produced as statistics in their own right by NSOs or other producers of official statistics.

A 2011 UNECE survey\(^{38}\) showed that NSOs have a considerable range of experience in supporting inventory compilation. The survey showed that more than 75 per cent of NSOs (37 countries) said they were in some way involved in the work related to greenhouse gas inventories: 20 were involved only in providing activity data, 12 participated in the calculations of emissions based on activity data, 5 were responsible for most of the inventory calculations and 4 of these actually reported their countries’ inventories. Most NSOs who participated in the process did so by collaborating with other institutions, such as ministries or research bodies, and under the auspices of special committees or expert working groups.

To classify the range of national experiences, three levels of NSO involvement can be identified:

1. provision (and/or publication) of activity data
2. inventory compilation (including calculations of emissions)
3. inventory submission (to meet international reporting obligations)

Based on the feedback received from countries and international organisations at the November 2012 and October 2013 expert meetings organized by the Task Force, the more involved NSOs are in the national inventory system, the better the results that can be achieved in streamlining the work by making use of official statistics.

In order to meet the increasing requirements for energy monitoring, all countries of the European Union (EU) and several others are producing a coherent and harmonised system of *energy statistics* that is reported to Eurostat and to the International Energy Agency (IEA). These are a source of information on energy consumption, energy dependency, energy intensity of the economy, electricity generation and statistics on renewable energy sources, and serve as an important source data for GHG inventories. The *energy balances* often serve as a basis for air emission calculations.

The most common sectors in which NSOs provide data for inventories are energy, agriculture and industrial processes. The table below illustrates the number of NSOs, among those who replied to the UNECE survey, who actively collect or calculate data for the emission inventories. Even though data on these topics are available in most statistical systems, not all NSOs actively support inventory compilation by direct involvement in the work.

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38 The UNECE survey report: [www.unece.org/stats/climate.html](www.unece.org/stats/climate.html)
Table 1: Number of NSOs, in the UNECE survey, that collect or calculate data by IPCC source/sink categories.

<table>
<thead>
<tr>
<th>DATA COLLECTION</th>
<th>EMISSIONS CALCULATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy</td>
<td>21</td>
</tr>
<tr>
<td>Agriculture</td>
<td>19</td>
</tr>
<tr>
<td>Industrial processes</td>
<td>18</td>
</tr>
<tr>
<td>Land use change and forestry</td>
<td>13</td>
</tr>
<tr>
<td>Waste</td>
<td>12</td>
</tr>
<tr>
<td>Solvent and other product use</td>
<td>7</td>
</tr>
</tbody>
</table>

As can be seen from the table, fewer NSOs are involved in emissions calculation than in data collection. Out of the 12 NSOs that were involved in GHG inventory calculations, in most cases, the NSO is responsible for the calculation of specific sectors instead of being responsible for all sectors. In some cases, the NSO has no overall responsibility for any single sector, but contributes in some way across all sectors. Sometimes the reported involvement of NSOs is rather limited.

The UNECE survey also explored the involvement of NSOs in the calculation of specific greenhouse gases. Of the NSOs that responded, 13 are involved in the calculation of at least one of the six major greenhouse gases, most commonly carbon dioxide (CO$_2$), methane (CH$_4$) or nitrous oxide (N$_2$O). The same number of NSOs is involved in calculating some of the emissions of indirect greenhouse gases, most often those of nitrogen oxides (NO$_x$) and sulphur dioxide (SO$_2$).

In respect of international reporting, of the countries who responded to the UNECE survey, more than half were involved in reporting to international organizations. These organizations included Eurostat, the UNFCCC, the European Environment Agency, the Organization for Economic Co-operation and Development (OECD), the Economic Commission for Latin America and the Caribbean (ECLAC), the United Nations Statistics Division (UNSD) and the Commonwealth of Independent States (CIS).

It should be noted that a relatively small number of NSOs is involved in some way in all three phases of the inventory process; namely, collection, compilation and reporting of the data. There are, in fact, five countries where the NSO is actually responsible for most of the inventory compilation; this applies for Finland, Israel, Norway, Turkey and partially for Sweden. In Sweden the NSO produces a large share of the results as a service commissioned by other government bodies.

It seems that in 11 countries, the NSO has no involvement in the inventory process.

A number of NSOs are also involved in other activities related to the GHG inventories. These include:

- Quality assurance of underlying datasets and final results
- National coordination of work for the greenhouse gas inventory
- Bridging the gap between classifications used in official statistics and those used for GHG
- Providing consumption based emissions estimates (for example, by end user sectors, or consumption of fuel, raw materials or products)
- Providing experts for UNFCCC reviews, international revisions and consulting
- Disseminating results via databases and thematic publications.

Some NSOs are also preparing for possible new requirements arising within the European Union in relation to the EU Climate and Energy Package, as well as from other potential international agreements (such as the second commitment period of the Kyoto Protocol or the Kiev Protocol on Pollutant Release and Transfer Registers). The majority of NSOs who responded to the UNECE survey said that they would find it useful to discuss how NSOs could contribute to the measurement, reporting and verification (MRV) approach for inventory compilation. Of the NSOs who are involved in the inventory process, a number are considering making improvements to the way the work is carried out in the national statistical system. This could potentially concern activities such as
extending the coverage to take account of new data, developing new methodologies, or improving coordination of work between the responsible organizations within the country.

The National Bureau of Statistics of China, for example, is working to strengthen its basic statistics to better measure climate change and greenhouse gas emissions. China’s energy and environment statistics have been improved during the last few years and they now provide a useful foundation for developing climate change related statistics. However, there are still gaps related to GHG emissions reporting to UNFCCC and the comprehensive measurement of climate change related issues.

The Chinese NSO’s plan for improving data sources for GHG inventories includes targeted measures for the improvement of statistics on energy, industry, agriculture and waste. It also takes into account the need to establish clear responsibilities among data producers, to provide the necessary funding and to strengthen statistical capacities through training and capacity building activities (see the following case study for details).

Case study: National Bureau of Statistics of China’s Plan for Improving Statistics for GHG Inventories

<table>
<thead>
<tr>
<th>Domain</th>
<th>Responsibility Entity</th>
<th>Statistics improvement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy</td>
<td>National Bureau of Statistics, the National Energy Board</td>
<td>Increase energy types measured in energy statistics, Refine and improve the national energy balance</td>
</tr>
<tr>
<td></td>
<td>National Bureau of Statistics</td>
<td>Refine the industrial energy statistical reporting, Improve energy consumption statistics in construction, Improve energy consumption statistics in service sector</td>
</tr>
<tr>
<td></td>
<td>Government Offices Administration of the State Council</td>
<td>Improve energy consumption statistics for public buildings</td>
</tr>
<tr>
<td></td>
<td>National Bureau of Statistics</td>
<td>Establish an energy consumption survey of selected road and river transport enterprises</td>
</tr>
<tr>
<td></td>
<td>Ministry of Transportation</td>
<td>Strengthen energy consumption statistics in selected transportation enterprises</td>
</tr>
<tr>
<td></td>
<td>National Bureau of Statistics</td>
<td>Increase selected industrial products related to GHG emissions</td>
</tr>
<tr>
<td>Industry</td>
<td>Ministry of Environmental Protection</td>
<td>Establish statistical reporting system on fluorine gas production, import, export and consumption</td>
</tr>
<tr>
<td></td>
<td>National Energy Board, the State Administration of Production Safety Supervision</td>
<td>Improve statistics on methane emissions and utilization from coal production enterprises</td>
</tr>
<tr>
<td></td>
<td>China Petroleum and Chemical Industry association</td>
<td>Improve statistics on fugitive emissions from oil and natural gas production</td>
</tr>
<tr>
<td></td>
<td>China Electricity Council</td>
<td>Improve statistics related to thermal power generation</td>
</tr>
<tr>
<td></td>
<td>China Steel Industry Association</td>
<td>Improve statistics related to steel production</td>
</tr>
<tr>
<td>Agriculture</td>
<td>National Bureau of Statistics</td>
<td>Refine the survey on seeded cropland area, Refine the survey on livestock and poultry</td>
</tr>
<tr>
<td></td>
<td>Ministry of Agriculture</td>
<td>Conduct specific investigations on crop characteristics, Conduct specific investigations on livestock characteristics, Conduct specific survey on poultry feeding and manure treatment</td>
</tr>
<tr>
<td>Forestry</td>
<td>State Forestry Administration</td>
<td>Improve forest disaster statistics, Conduct the specific survey on annual growth of forest biomass per unit area, Strengthen statistics on forest land use change, Conduct the specific survey on forest growth and carbon fixation characteristics</td>
</tr>
<tr>
<td>Waste</td>
<td>Ministry of Housing and Urban-Rural Development</td>
<td>Improve statistics on municipal solid waste</td>
</tr>
<tr>
<td></td>
<td>Ministry of Environmental Protection, Ministry of Housing and Urban-Rural Development</td>
<td>Improve statistics on sewage disposal and treatment</td>
</tr>
</tbody>
</table>
A few countries produce timelier estimates of greenhouse gas inventories. Statistics Netherlands produces a quarterly estimate of emissions only 45 days after the end of each quarter using data that exist in the national statistical system (see the following case study). This is an example of how the interrelationship between the economy and the environment can be made explicit and communicated on a regular and timely basis. Presenting the relation between economic growth and environmental pressure quarterly can help raise awareness among the general public. The Statistics Netherlands translated their quarterly press release to English and it was made available at: www.unece.org/fileadmin/DAM/stats/pr/Netherlands_press_release.pdf

Case study: Statistics Netherlands produces a quarterly estimate of greenhouse gas emissions

Statistics Netherlands compiles estimates of emissions on a quarterly basis (at T+45 days) to respond to the demand for more rapidly available environmental and emissions data. The quarterly emission estimates are released together with GDP figures to promote awareness of environmental issues alongside economic development. This type of data release also responds to the idea of broader welfare and sustainability than can be measured by economic variables only.

Though much less detailed than the Dutch GHG inventory, these statistics are much timelier – the GHG inventories become available only after a long delay. The quarterly release focuses on the changes in emissions of five key sectors of the economy: ‘agriculture, mining, manufacturing and construction’; ‘energy, water and environmental services companies’; ‘transport sector’; ‘other services’; ‘households’ and the total emissions by the Dutch economy.

Additional data collection is not needed to support the quarterly estimates, as they are derived from existing monthly energy statistics (balances for gas, oil products), quarterly national accounts and data in few other areas (for example air traffic and heating degree days).

The figures are compiled on an environmental accounts basis, meaning, for instance that the resident principle is applied. The emission estimates are thus comparable with economic statistics but differ from those in the Dutch GHG inventory. The data quality is satisfactory but clear communication is necessary to explain to end users the difference in coverage compared with data of the emission inventory (resident principle versus territory principle).

The general methodology for stationary and mobile sources is as follows: 1) Determine the annual emissions for relevant energy inputs in a particular industry (use data from Dutch Emission Inventory); 2) Determine for every quarter the emissions for the different energy inputs in a particular industry; 3) Select an indicator which is capable of estimating the emissions for the same quarter the next year for a particular energy input in a particular industry; 4) Aggregate emission to the level of publication and calculate the year to year changes; and 5) Finally, after carrying out the estimation for the four quarters, rebase the sum of the four quarters with the ‘real’ year emissions. This last step is important for two reasons. Firstly, one needs these rebased figures in order to produce figures for t+1 (new base year). Secondly, it is important to monitor the quality of the estimations done.


The above graph illustrates testing of the quality of the quarterly estimate by comparing the sum of the estimated emissions for the four quarters with both the level and the percentage change of the existing annual statistic for CO₂ emissions from the air emission accounts. For the year 2012 this has been conducted in order to test the quality of the estimations done. The adjustment of the CO₂ figures was in 2012 equal to +0.25 per cent. For more information, please see the translated press release at: www.unece.org/stats/climate.html

**Source:** Statistics Netherlands, environmental accounts

The next case studies illustrate how differently the national systems for GHG inventories are currently organised in countries. The challenges in producing emission inventories and the cooperation among institutions depend partly on the way the work has been organised in each country.

**Country case studies: Ways of organising the national systems for greenhouse gas inventories and the NSO role.**

**ALBANIA – NSO to be involved in the future**

The Albanian Ministry of Environment, Forests and Water Administration presented at the expert meeting their experience in developing their capacity for compiling emission inventories. In the previous inventory rounds, data availability and quality presented a barrier to improving the accuracy of the inventory. As a consequence, Albania is setting up official institutional arrangements for emission inventory compilation. This requires decisions on methodologies and emission factors, finding data sources, setting up networks and a framework for management and quality assurance.

In Albania the current legislation does not oblige data providers to submit their data for emission inventories, but amendments are underway. In addition, the NSO is expected to increasingly contribute to the emission inventories in the future, after development of national energy statistics and the energy balance in line with EU requirements. Albania’s experience supports the need to develop the capacity for and involvement of official statistics in emission inventory compilation.

**AUSTRALIA – NSO making quality checks to GHG as part of national statistics**

In Australia, the Department of Climate Change within the Australian Government is responsible for all aspects of GHG inventories and their submission to the UNFCCC. The department estimates emissions using the Australian Greenhouse Emissions Information System and, for the land use change and forestry sector, the National Carbon Accounting System. The department also uses a pool of consultants for specialised tasks.

The GHG inventories are primarily based on activity data published by Australia’s principal economic statistics agencies, the Australian Bureau of Statistics (ABS) and the Australian Bureau of Agricultural and Resource Economics. ABS has a prominent role in the coordination of GHG inventories as part of national statistics, and reviewing data quality. ABS provides agricultural activity data and some commodity and energy-related data.
**CANADA – NSO a partner in data provision**

In Canada, Environment Canada’s Greenhouse Gas Division is the national entity with responsibility for the preparation and submission of the GHG inventory to the UNFCCC. The Greenhouse Gas Division has defined roles and responsibilities for the preparation of the inventory, both internally and externally. Statistics Canada is one of the main providers of underlying activity data.

**FINLAND – NSO as the national entity**

The Government in Finland noted problems associated with emissions data being spread between several sources, and assigned the responsibility for coordinating the inventory compilation to Statistics Finland in 2003. Since then, Statistics Finland has been the national entity with overall responsibility for the general administration, quality management of the inventory, and of communication with the UNFCCC.

The legal framework is defined by the Resolution of the Finnish Government of 30 January 2003 on the organisation of climate policy activities of Government authorities. It is further defined by an agreement between the Ministry of the Environment and Statistics Finland.

A presentation by Statistics Finland at the expert meeting in November 2012 conveyed the lessons learned by an NSO acting as the national authority for the emissions inventory. The advantages of an NSO coordinating the work include the ability to achieve close collaboration with energy and other source statistics, well-developed quality assurance methods, and the ability to make detailed comparisons with confidential source data. A major advantage is also that no additional data collection is needed for the emission inventory in Finland. On the downside though, the NSO cannot publish company-specific information, unlike other compilers. In Finland, too, a number of areas have been identified for improvement, such as the need for energy statistics to be produced more frequently for the purposes of emission inventories.
**THE NETHERLANDS – NSO provides data to a private firm appointed as national entity**

In the Netherlands, the Ministry of Housing, Spatial Planning and the Environment (VROM) has appointed a private agency, SenterNovem, as the national entity. Most general statistical data are provided by Statistics Netherlands as part of their legal tasks. Data on agriculture, land-use change and forestry are provided by agricultural institutes and waste data are collected by the Waste Coordination Platform from SenterNovem under a longer term assignment from the Ministry. Data provision is based on agreements signed with the above organisations. In this case, the national entity has a centrally accessible archiving system with the exception of confidential data that are maintained and archived by the producer.

**NORWAY – NSO in close triangular cooperation**

The Norwegian national system for GHG inventories is based on a triangular cooperation between the Norwegian Environment Agency, Statistics Norway and the Norwegian Forest and Landscape Institute. The Norwegian Environment Agency has been appointed by the Ministry of the Environment as the national entity, and the other two agencies have signed agreements with the national entity. Statistics Norway is responsible for statistics on emissions to air. The main emission model has also been developed by Statistics Norway.

**SWEDEN – NSO provides data and calculations as a commissioned service**

The Swedish Ministry of Environment is the single national entity that has overall responsibility for the inventory, but the Swedish Environmental Protection Agency has specific responsibilities for coordinating the production of the inventory, maintaining the reporting system and quality assurance of the inventory. Statistics Sweden is part of a consortium of consultants and produces a large share of the material submitted to the UNFCCC as a commissioned service to the Swedish Environmental Protection Agency. This type of organization differs notably from most countries.

The work is regulated by a framework contract that runs for nine years. The inventory work is organised as a project run by a project management team with one person from each organization. The Meteorological and Hydrological Institute is responsible for the compilation of gridded emission data. Statistics Sweden is responsible for energy, agriculture and parts of waste sector, but is also involved in industrial processes. The University of Agricultural Sciences is responsible for the land use change and forestry sector. The Environmental Research Institute is responsible for industrial process, solvents and other products use and parts of the waste and energy sectors.
In the United Kingdom, the Department of Energy and Climate Change (DECC) is the entity with responsibility for the overall management and strategic development of the GHG inventory. DECC also produces official statistics on energy and climate change, all of DECC’s statistics as classified as National Statistics, reflecting the fact that they comply with the Code of Practise for Official Statistics and are authorised by the Chief Statistician for DECC, who has a direct reporting line to the United Kingdom’s National Statistician – this system is common for many statistics in the United Kingdom. A global, sustainability consultancy, Ricardo-AEA, is the delegated inventory agency with responsibility for compilation and reporting of the GHG inventory. The emission estimates are compiled and published as National Statistics. The key benefits of the UK system include assured independence and impartiality of the emissions reporting, quality assurance of the publication procedures, more effective public communication of the data and direct integration with the strategy and target setting for the inventories. DECC has also established an inter-departmental committee, the National Inventory Steering Committee, which ensures cross-government governance of the Inventory and prioritises inventory improvement work.

2.3 Data gaps and challenges for greenhouse gas inventories

This section considers data gaps and challenges for GHG inventories by discussing the key unmet needs of the main users identified in Section 2.1; namely, inventory compilers, inventory reviewers and analysts.

From the inventory compiler’s viewpoint, NSOs have a lot of data that are needed for GHG inventories. The challenge is that these data were collected for different purposes and may be organised in a way that makes it difficult to extract data for GHG inventories. Inventory compilers need to use these data in new ways and for new purposes.

Awareness of existing statistics is important for efficient work. As the coordinators of national statistical systems, NSOs should promote better awareness of how the data belonging to the statistical system could be used for greenhouse gas inventories. Official statistics should be the backbone of the inventories and direct data collection should be carried out only where existing sources of statistics cannot be used.

Some of the activity data are readily available from current official statistics, whereas some closely related variables are not available even if they could sometimes be easily added to data collections. For example, existing agricultural data usually include the number of animals by type and age, but not information regarding how farmers manage the manure from the animals. The emissions from animal waste are very much dependent upon that information. Similar cases exist for the other inventory sectors. Improved data are needed also on the production of heat and electricity for own use by households and enterprises and on renewable energy sources (for example, solar energy, fuel
wood, biogas, animal dung, wind, heat pumps/geothermal sources). Land-use data are also often mentioned as an area for improvement where NSOs’ support would be valuable.

The stakeholder interviews revealed that access to disaggregated source data continues to be a challenge (both the level of detail of published data and access to microdata). A question has also arisen about whether the level of detail required for inventory compilation is too excessive, and whether it would be possible to achieve a better balance between costs of data collection and accuracy of results.

Furthermore, NSOs are often not aware of the data needs of emission inventories and thus not prepared for responding to the data requirements stemming from the Kyoto Protocol. NSOs should inform themselves about the inventory data needs through closer collaboration with compilers and by reviewing their National Inventory Reports and the related Inventory Review Reports prepared by UNFCCC expert teams. To assist with this task, the United Kingdom has provided a table which sets out the key datasets against each of the inventory sectors (see Annex 4). This table can be used as a tool to find out what data NSOs could provide for emission inventories.

A good starting point for improving NSOs’ contribution to inventory compilation would be to draft, together with the inventory compilers, a list of national priorities and a road map on data gaps and development needs for inventories. Reflecting on the above mentioned inventory reports, NSOs could assess how fit existing statistics are for the purposes of inventories and consider if their usefulness could be improved.

The most obvious role of NSOs relates to national energy balances, which fall within the remit of a large number of NSOs. Typically in industrialised countries about 80 per cent of all GHG emissions are accounted for by fossil fuel combustion activities, and energy balances are, therefore, the most important input to the inventory submissions. The quality of reported GHG emissions heavily depends on the energy balance. The Task Force noted a particular interest in close cooperation among NSOs, energy agencies and inventory compilers to improve energy data and to clarify which energy data feed into inventory calculations and how. The Oslo Group on Energy Statistics, which already provides a forum for discussion among energy statisticians, offers a useful starting point for building this cooperation.39

Inventory analysts constantly request timelier estimates of emissions and several NSOs have experience in nowcasting; that is, compiling timelier statistics based on estimation methods. The Eurostat Sponsorship Group on Measuring Progress, Well-being and Sustainable Development40 identified the need to produce more timely estimates of CO2 emissions based on monthly energy statistics, thus improving timeliness of indicators.

In some cases, the length of time series is not sufficient for analysing, for instance, the drivers of emissions.

Examples of practical data gaps highlighted by the stakeholder interviews include:

- Economic statistics linked to climate change policies and measures
- Economic, social and demographic statistics with greater sector and regional detail
- Annual, geo-referenced parcel-level statistics on land use and management
- Soil carbon data
- Emissions of GHGs other than CO2 and information about “off-shored” emissions41

39 The Oslo Group (OG) on energy statistics: oslogroup.org/index.asp?page=oslogroup.html
41 Off-shored emissions are those that at some point in the past occurred in a given country but now occur in a different country because of a transfer of economic activity (usually manufacturing of some kind) from the former (usually industrialized) country to the latter (usually developing) country.
NSOs could help increase the analytical usefulness of greenhouse gas inventories by providing contextual data; for example, by providing a breakdown of emissions by ISIC industry or by developing GHG emission accounts following the guidelines in the SEEA-CF. Statistics Canada, for example, recasts official Canadian GHG emissions data into GHG emissions accounts to provide users with a tool better suited to economic analysis. They are careful to explain the differences between the SEEA-CF concepts and the inventory concepts so there is no confusion among users (see the case study).

Case study: Statistics Canada’s approach to the different emission estimates

The differences between the greenhouse gas emissions according to Environment Canada’s National Inventory Report and Statistics Canada’s Physical Flow Accounts (PFA), produced as part of the SEEA, are due to two main reasons: a) conceptual differences between the UNFCCC reporting guidelines and the SEEA, and b) different data sources or lack of data preventing an accurate allocation of some types of emissions.

The largest conceptual difference between the UNFCCC and the PFA is in the treatment of emissions stemming from solid waste. Emissions from landfill gas could be allocated to the waste management industry, but these emissions are not a result of current production: they represent releases associated with the decay of waste discarded in previous accounting periods. As such, they are not included in the Greenhouse Gas Account since they, in conjunction with the input-output tables for modelling purposes, would not vary with current period economic output and thus would not yield proper conclusions if used.

PFA are based on the residence principle which is the basis for the economic definition of a country, whereas international agreements on air emissions use a national territory principle. Thus, international aviation fuel purchases are the second largest conceptual difference. The UNFCCC requires airline emissions to be calculated based on the national territory. The SEEA requires that those emissions are based on the residence principle, meaning that the Greenhouse Gas Account must include purchases and thus emissions of aviation fuel abroad by domestic airlines and exclude those purchases and related emissions of foreign airlines in Canada. The total for emissions of the national inventory report (NIR) covers those that occur over Canadian territory regardless of the ownership of the airline, and excludes emissions of domestic aircraft abroad (although these are included elsewhere in the NIR for information purposes). These adjustments relate to all forms of international transport – land, water and air – and to tourism and fishing vessels, the relative importance of these adjustments depending on the structure of the country's economy.

Three gases are covered in Environment Canada’s NIR that are not covered in the Greenhouse Gas Account, namely hydro fluorocarbons (HFCs), per fluorocarbons (PFCs) and sulphur hexafluoride (SF₆). These are excluded from the PFA since there are no data available to allocate these emissions across industries and households. Several of these substances are refrigerants used in many industries, and attributing the leaks of the gases properly cannot be done with current data sources. The small amount of SF₆ emissions is a result of processes in several distinct industries, and the data to do this allocation properly are also not available. Emissions from solvent use suffer from the same data gap.

Another conceptual difference is the inclusion in the PFA of prescribed burns in the forestry industry as an industrial process that is part of the production function for forestry. This is allocated to the Land Use, Land-Use Change and Forestry section of the NIR. Carbon dioxide emissions from biomass combustion are also included in the PFA, but are reported separately in the NIR.

The final difference between the NIR and the greenhouse gas account relates to the consumption of motor gasoline. Environment Canada treats all transportation activity as a separate sector in the NIR. The fuel use from this activity is modelled so that it can be attributed to different vehicle types for the calculation of emissions. The modelling process allows for a discrepancy between the modelled fuel use and the fuel use totals from Statistics Canada’s energy supply and demand balances. The greenhouse gas account retains the fuel consumption amount from the energy balances, leading to the difference between the two accounting approaches.

The remaining statistical difference results from other sources including changes to source data that are required to reconcile that information with other data sources.

To account for the differences between the national emission inventory data and the air emission accounts, produced as part of the SEEA PFA, an approached called "bridging" between the two systems has been

37
developed by Eurostat. This type of bridging helps to understand the causes and the magnitude of existing gaps between two official statistics on air emissions.

Total air emissions (industry + households)

*Less National residents abroad*
- National fishing vessels operating abroad
- Land transport
- Water transport
- Air transport

*Plus non-residents on the territory*
+ Land transport
+ Water transport
+ Air transport

(+ or -) Other adjustments and statistical discrepancy

= Total emissions as reported to UNFCCC

The perspective of inventory reviewers and the challenges of GHG inventories are reflected in the *Inventory Review Reports*. Analysis of these reports helps identify areas where NSOs could contribute by, for example, improving availability and usefulness of source data for emission inventories.

Among other things, inventory reviews assess the accuracy of estimates, and frequently conclude that there is a need for quality improvements in particular sectors of inventories. The reports note that countries have made major improvements in the quality of emission inventories in recent years: better time series consistency, use of higher-tier (i.e. more complex) estimation methods, use of country-specific emission factors and more accurate activity data. Several reports refer to deficiencies in *waste data*, such as in the types of waste disposed, waste water output and handling. The quality and availability of time series data on *land use and forestry* requires further improvements in many countries. *Timeliness of activity data* was also mentioned as a problem in several countries. The general areas of improvement for emissions inventories can be summarized to the following five topics:

- **source data**: availability, access to data, accuracy and timeliness of source data
- **quality of results**: completeness, level of detail, accuracy of results and consistency
- **communication**: transparency of methods used, documentation and archiving
- **methodology**: use of comparable methods, time series consistency and quality assurance procedures
- **organization and capacity**: descriptions of institutional arrangements and capacity of the national system

### 2.4 Conclusions on greenhouse gas inventories and official statistics

1. The statistics that could be used as the basis of GHG inventories need to be examined to determine if the current statistics adequately cover the *data needs of the main users* namely, the inventory compilers, reviewers and analysts. Improving NSOs’ contribution to inventory compilation could start by drafting, with the inventory compilers, a *list of national priorities* and a road map on country-specific data gaps and development needs for inventories. According to the analysis of user needs and existing NSO data, the key gaps from inventory compilers’ viewpoint include knowledge of what data would be available from the statistical system and access to these data at the required level of disaggregation. From the inventory reviewers’ viewpoint, the quality of some source data should be improved to match inventory data requirements. Often this refers to data on waste, energy, land use and forestry. From analysts’ viewpoint, gaps exist especially in timeliness of data, length of time series, access to disaggregation data and possibilities to link emissions with other statistics.
2. NSOs should be more aware of how the data of national statistical systems are or could be used for the compilation of greenhouse gas inventories. The Task Force has, therefore, provided a table following the example of the United Kingdom that NSOs can use to track which data could be sourced from the national statistical system (see Annex 4). Information on what data are needed would help NSOs to better organize their work and optimize the availability of data from national statistical systems for the purposes of emission inventories. NSOs should inform stakeholders about how the data of national statistical systems could be used for inventories and in relation with the inventory data.

3. The statistical system needs to be involved in discussions regarding data quality so they can focus on important improvements in the activity data. The IPCC regularly analyses the quality of the countries’ inventories, and NSOs should look closely at the Inventory Review Reports to see if there are improvements needed in the basic statistics or the way they are used. The statistical data used to build the inventories should be considered part of the core of NSOs’ work on climate change related statistics. NSOs can always initiate these quality improvements for the data falling within their mandate. NSOs could also have a wider role to play in the area of quality assurance of GHG inventories even in areas where their data are not used. This could, in fact, be a natural entry point to increased involvement by NSOs in GHG inventories. In the UNECE survey, the majority of NSOs thought it would be beneficial to discuss how NSOs could contribute to the UNFCCC Measurement, Reporting and Verification (MRV) approach to inventory compilation.

4. It is unlikely that the methodological or classification differences between GHG inventories and official statistics would be changed in the short term. Yet, they increase the workload as inventory compilers need to reclassify and recompile existing data, and in some cases similar data needs to be collected twice. Data consistency problems could be overcome by describing the differences between inventory data and official statistics, developing standardized tools such as correspondence tables, and explaining the differences by using reconciliation items. This would enable analysts to undertake integrated analysis of the economic, social and environmental aspects of GHG emissions. Emission inventories have especially important links with the system of national accounts, environmental accounting, air emissions and energy statistics.

5. NSOs could also work with inventory compilers to make activity data available at an earlier stage to help develop timelier emission estimates as opposed to the current 17-18 months’ lag, or they could develop early estimates of GHG emissions using monthly and quarterly data sources that would not be comprehensive enough for actual GHG inventories. This would help more effectively inform climate change mitigation policies. Longer time series would also be needed for analysing drivers of emissions.

6. NSOs can also support the analysis of emission trends by providing background socio-economic data. Some examples of such data include population, fuel prices, GDP and gross value added (GVA) by branch/industry breakdown, national energy balances, and heating/cooling degree days. Furthermore, NSOs are well placed to contribute to analysing emissions by economic sectors, using energy statistics or developing accounts similar to air emissions for other sectors with relevance to climate change.

7. The overwhelming conclusion drawn from the evidence available to the Task Force is that there is a clear need for involvement of NSOs in emission inventory compilation. The benefits to the inventory process will be that this makes greater use of the knowledge NSOs have of the underlying datasets, whilst also benefiting from the high public trust afforded to NSOs as professionally independent producers of statistics. It would help reduce parallel and sometimes duplicating reporting systems and unnecessarily high costs of data collection and respondent burden.
8. The existing data requirements under the UNFCCC and the Kyoto Protocol are well established already and significant changes are unlikely in the short term. NSOs should, therefore, adjust their work to existing guiding frameworks for GHG inventories. At the same time, NSOs should follow up on upcoming changes in data requirements, especially concerning activity data, energy statistics and energy balances. Experts from NSOs could help to evaluate whether the needed inventory source data are available or may be developed at reasonable cost. Methodological developments need to be based on what data are realistically available and not impose unreasonably high costs on inventory compilers, statistical systems or respondents.
3 CLIMATE CHANGE RELATED STATISTICS (OTHER THAN GHG INVENTORIES)

Chapter 1 defined the scope of climate change related statistics to include environmental, social and economic data that measure:

1. **Emissions**: GHG emissions and their human causes
2. **Drivers**: human causes of climate change that deal with sources of emissions
3. **Impacts**: impacts of climate change on human and natural systems
4. **Mitigation**: efforts of humans to avoid the consequences
5. **Adaptation**: efforts to adapt to these consequences

Statistics related to greenhouse gas (GHG) inventories and drivers of emissions were discussed in Chapter 2. This chapter focuses on the remaining groups of climate change related statistics (3 to 5 of the above list). It explores users’ needs for climate change data in both the scientific and policy communities and reviews existing statistics and involvement of NSOs with the aim to identify which of those needs that are currently unmet could be met by the statistical system.

Information on other aspects of climate change than emissions, including social and economic impacts as well as mitigation and adaptation efforts, is not well developed. The statistical system has a largely unused comparative advantage in the area; namely, it capacity to access large and diverse microdata sets and combine various types of environmental, social and economic data relevant for climate change analysis.

The chapter covers data needs that users have already expressed but also considers future needs that users may not have expressed yet. User needs are first discussed without limiting the discussion to needs that can be filled by the statistical system. This is because user needs differ across countries depending on how climate change manifests itself in each region. Furthermore, countries have divergent organisational solutions for their national statistical systems and the division of work between the NSO and other producers of official statistics as well as with non-official statistics’ producers varies. Thus, the data gaps that can be filled by the statistical system vary depending on the country.

### 3.1 User needs for climate change related statistics

Climate change relates to a broad range of issues and climate policies may need to respond to new and often unforeseen developments or to address complex cross-cutting issues, such as ensuring reduction of emissions while maintaining strong economic growth. Users’ needs for climate change related statistics differ across user groups and may sometimes be highly complex.

The United Nations conferences on climate change statistics in Oslo in 2008 reflected awareness within the statistical system of the need to consider climate change as a statistical topic. The conferences called for better understanding of the data requirements of stakeholders. To this end, the Task Force carried out stakeholder interviews, analysed the outcomes of recent meetings and several policy documents related to climate change.

Figure 3 suggests groupings of users interested in climate change related data. Data needs become more complex and detailed towards the bottom of the triangle:

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42 Conference on Climate Change and Official Statistics, Oslo:
unstats.un.org/unsd/climate_change/default.htm
43 Conference on Climate Change, Seoul: unstats.un.org/unsd/climate_change/korea/
• The media and the public often require information that has been highly processed and is easy to understand. In general, users require timely, accurate and reliable information that provides a consistent picture of the developments.
• Climate policy data needs and those of international organisations are often reflected in international climate accords, protocols and monitoring mechanisms.
• Decision makers may require complex data but usually in the form of answers to specific policy questions.
• Civil society and non-governmental organisations (NGOs) require data to monitor and assess developments in their interest area.
• Other producers of climate information may wish to link their data with official statistics to provide more comprehensive climate information.
• The scientific community and analysts require access to detailed data. In some cases their data needs would be best served by access to microdata, though researchers do not always require microdata. They will, however, usually welcome help in finding answers to their research questions and NSOs should have sufficient capacity to guide researchers in their work. Since climate change is a long-term phenomenon, these users require both long time series and frequent sampling.

Figure 3: Grouping of the users of climate change related statistics, other than GHG inventories.

Generally speaking, there are users who 1) know what they want; 2) need specific data but also guidance in identifying what they need; and 3) have broad, general needs. The general public, who want basic information that is easy to use and understand, are the best example of the latter category. NSOs should take different approaches to communication with each user type. Perhaps the most difficult user needs to satisfy are those of policy makers who need answers rather than datasets.

The following section looks broadly at key data needs grouped into impacts, mitigation and adaptation following the scope of climate change related statistics defined earlier. It does not consider which data needs should be filled by NSOs or the broader statistical system. NSOs cannot and should not try to meet all users’ data requirements. Key data needs need to be defined with users before considering what is relevant and feasible to do within a national statistical system. Of course, some emerging data needs may be difficult to predict and, thus, to cope with.
IMPACTS

Climate policies are becoming more focused on the socio-economic impacts of climate change. The national communications and biennial reports to the UNFCCC require reporting on the observed and expected impacts of climate change. A great deal of scientific information about the biophysical changes in the climate exists; for example, in the assessment reports of the IPCC. These assessments make use of environmental data and statistics.

Analysis of the other impacts (economic losses and gains, access to food and water, poverty and migration, for example) is less developed. This seems to be partly because of the difficulty to define cause-effect relations and partly because of difficulties in accessing sufficiently detailed data. While NSOs should not make judgements about climate change impacts and their causes, they should improve the availability of useful data for others to make analyses that can help describe these phenomena. To do this, users generally need data on climate change impacts on:

- the state of environment, biodiversity and natural resources
- housing, social conditions and equity, poverty
- changes in access to services and resources due to weather events
- health impacts from extreme weather, reduced air quality and climate-sensitive diseases
- costs of climate change for industry and society

Decision makers are also interested in information on the possible positive impacts of climate change. They want to know, for example, if climate policies can lead to increased economic growth and creation of “green” jobs and which industries rely most on renewable energy.

Official statistics could be made more useful for analysing the impacts of climate change if linked with biophysical climate information. Researchers and producers of biophysical information outside of the statistical system should be informed of the procedures for accessing official statistics so that they might take advantage of linkage opportunities. A meeting of the Climate Observation Community, organised by the World Meteorological Organisation in December 2011, underlined the “need to establish mechanisms for connecting climate data and socio-economic data, including accessibility to the latter data. It is noted that socio-economic data exists but it is generally not known within climate communities.”

The opposite is also true for climate/meteorological data and awareness about it in statistical communities.

The following case study provides an example of actual impact indicators used to monitor climate change by decision makers in California. The lack of indicators on the costs and benefits of the impacts of climate change and on its social impacts underlines the current difficulty to link socio-economic data with climate change information.

Case study: Indicators of Climate Change Impacts in California

Indicators of Climate Change in California compiles indicators that characterize the multiple facets of climate change; specifically:

- human-induced drivers of climate change
- changes to California’s climate
- impacts of climate change on physical and biological systems in the state.

The indicators convey scientific information on the status of, and trends in, environmental conditions in California. They help the state track, evaluate and report on the climate change issues it is working to address, as well as the outcomes of these efforts. Taken collectively, the indicators

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help portray the interrelationships among climate and other physical and biological elements of the environment.

The table below provides a list of California’s indicators. They rely on monitoring and research activities carried out by state and federal agencies, universities, and other research institutions and include a lot of biophysical data that are not collected by NSOs but may be available from the broader statistical system.

<table>
<thead>
<tr>
<th>Physical systems</th>
<th>Humans</th>
<th>Vegetation</th>
<th>Animals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual Sierra Nevada snowmelt runoff Snow-water content</td>
<td>Mosquito-borne diseases</td>
<td>Tree mortality</td>
<td>Migratory bird arrivals</td>
</tr>
<tr>
<td>Glacier change</td>
<td>Heat-related mortality and morbidity</td>
<td>Large wildfires</td>
<td>Small mammal range shifts</td>
</tr>
<tr>
<td>Sea level rise</td>
<td>Exposure to urban heat islands</td>
<td>Forest vegetation patterns</td>
<td>Small mammal range shifts</td>
</tr>
<tr>
<td>Lake water, delta water and coastal ocean temperature</td>
<td>Subalpine forest density</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oxygen concentrations in the California Current</td>
<td>Vegetation distribution shifts</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Alpine and subalpine plant changes</td>
<td></td>
<td>Sacramento fall run Chinook salmon abundance</td>
</tr>
<tr>
<td></td>
<td>Wine grape bloom</td>
<td></td>
<td>Cassin’s aukllet populations, Shearwater and aukllet populations off Southern California</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Sea lion pup mortality and coastal stranding</td>
</tr>
</tbody>
</table>


**MITIGATION**

Mitigation policies aim at reducing GHG emissions, increasing carbon sinks, switching to renewable energy sources and improving energy efficiency. The quantifiable effects of policies and regulatory measures are also of interest.

For example, in the EU, policies require *inter alia* monitoring of the reduction in emissions in the Emission Trading System and the number of vehicles compliant with new standards for emission performance as well as development of air emission accounts and better data on environmental protection expenditure. The EU’s framework for energy and climate policies up to 2020 focuses on three headline targets for 20% reduction in GHG emissions, 20% of energy coming from renewable energy sources and 20% increase in energy efficiency that need to be measured by reliable statistics. These targets are part of the broader ten-year policy framework of the European Union, the *Europe 2020 Strategy on smart, sustainable and inclusive growth*. Monitoring progress under Europe 2020 requires not only keeping track of emissions but also assessing the impacts of climate policies on economic growth and vice versa. This type of policy analysis requires combining climate, energy and economic indicators, going well beyond the official targets and much deeper into sectoral trends, where often statistics are not easily available or if available, not easily comparable.

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45 Climate change and European Official Statistics, by Cesare Constantino and Angelica Tudini in Statistika Vol. 93 (2) 2013
46 Eurostat publishes information on all Europe 2020 indicators: epp.eurostat.ec.europa.eu/portal/page/portal/europe_2020_indicators/headline_indicators
47 ec.europa.eu/europe2020/index_en.htm
Furthermore, a number of mitigation indicators will be needed for monitoring effectiveness of the European Strategic Energy Technology plan which encourages a technological shift towards new and innovative technologies: e.g. second generation biofuels, smart grids, smart cities and intelligent networks, electricity storage and electro-mobility, carbon capture and storage technologies and next generation nuclear and renewable heating and cooling. The EU’s 2030 framework for climate and energy policies will put in place revised policy targets related to climate change.

Analysing the effectiveness of mitigation measures will often require combining data across statistical domains. The statistical system should, therefore, play an active role in providing the relevant data or compiling the statistics from their databases. Certainly, not all the required statistics have been collected with a sufficient level of detail to enable analysis of actions that have a particular focus on climate change mitigation. Therefore, it would be useful for researchers and other producers to study the data of national statistical systems and link it with other data sets; for instance, with information on mitigation activities.

The specific indicators and variables needed to measure mitigation vary according to the specific needs of users. In general, the following types of information may be of interest:

- Subsidies; for example, for “green” technologies or fossil fuels
- Turnover and employment in the “green” sectors; for example, the renewable energy technology industries, electric vehicles, recycling, etc.
- Research and development: financing of research and development related to “green” sectors or climate mitigation
- Energy efficiency: energy use per unit of human activity
- Fuel mix: use of renewable energy sources (solar, wind, hydro, geothermal and biomass energy)
- Ratio of emissions to turnover/gross value added for economic sectors to assess the greatest growth potential in relation to the emission abatement potential
- Environmental taxes, including energy, transport, pollution and resource taxes
- Environmental protection expenditure for climate-related activities; for example, the costs of fighting coastal erosion, costs of mitigation activities in general
- Land use management: reducing and avoiding deforestation, forest management and restoration, afforestation and reforestation
- Mitigation of the broader causes of climate change such as population growth, urbanisation, activities of industries that have an impact on increased emissions

Decision makers also require financial statistics to monitor, for example, financial support and level of technology transfer to developing countries, carbon taxes, tradable emission permits, and other financing mechanisms to mitigate climate change. “Carbon capture and storage” (that is, separating, capturing and storing carbon dioxide from industrial and energy-related sources) also needs to be monitored.

Data on emissions trading in the EU and Australia are an example of the type of mitigation data currently recorded by national governments but not necessarily compiled as part of official statistics. Reliable data on the use of economic instruments should be included as part of government finance statistics and national accounts.

ADAPTATION

National adaptation strategies aim to raise the level of preparedness regarding population, industries or regions at risk from the impacts of climate change. The strategies require a complex set of information.
Adaptation policies require data on the vulnerability of industry, infrastructure and society to climate change impacts, especially in high-risk areas and among poor communities. The IPCC defines vulnerability as “the degree to which geophysical, biological and socio-economic systems are susceptible to, and unable to cope with, adverse impacts of climate change, including climate variability and extremes.”

Depending on the types of impacts that climate change is expected to have in a country, in general, relevant information may include any of the following:

- People exposed to high risk of natural disasters, by type (for example, hurricanes, floods) or to the risk of poverty due to climate change
- Statistics on large infrastructure facilities (ports, airports, bridges, electricity/water supply networks, etc.) at the risk of damage by natural disasters
- Costs and benefits of adaptation\(^{48}\), per country or region
- Environmental protection expenditures dedicated to addressing issues of climate change in planning and policies
- Water availability and scarcity; changes in stream flow, flooding and drought risks
- Agriculture statistics (farmland area, crop productivity, water use, agricultural inputs, soil management, land-use management, crop diversification, resilience of crops and livestock.)
- National Adaptation Strategies typically list measures but all of them may not be expressed in quantifiable terms. For example, educational work is important for effective adaptation.

Besides knowing what biophysical impacts have taken place (for example, floods, droughts, heat-waves, reduced rainfall, rising sea levels, disappearing glaciers), decision makers need to have statistical information about the regions and communities affected. This means that demand for socio-economic information linked to location is quickly growing. Risk assessments require, for instance, geo-referenced data on population density, vulnerable industries, types of land-use and natural conditions.

Some of the data needs relate to infrastructure and existing structures that are well measured by the statistical system. Some of the data needs for adaptation, however, are highly specific and detailed and, therefore, should be produced by other producers or researchers. For example, information about individual enterprises and persons may be important for emergency response and disaster planning related to climate change. This type of information, however, cannot generally be sourced from the statistical system due to confidentiality constraints. Instead, NSOs should focus on providing more generalized information for adaptation analysis. An example of statistical data being used by researchers outside the statistical system to study climate change adaptation is given in the following case study.

**Case Study: Demographic Explorer for Climate Adaptation (DECA)**

The UN Population Fund has developed the Demographic Explorer for Climate Adaptation (DECA) – an automatic spatial analysis tool that makes use of official statistical data in combination with other information needed for climate adaptation. This search engine type of tool is available on the web at: nijel.org/un_popclimate/deca. It is based on the concepts, methods and case studies introduced in the publication “The Demography of Adaptation to Climate Change”\(^{49}\). The objective of the tool is to support the incorporation of population dynamics into climate change adaptation and national development strategies.

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\(^{48}\) OECD had studied the issues in the publication Economic Aspects of Adaptation to Climate Change: Costs, Benefits and Policy Instruments: www.oecd.org/env/cc/economicaspectsofadaptationtoclimatechangecostsbenefitsandpolicyinstruments.htm

\(^{49}\) The Demography of Adaptation to Climate Change: www.unfpa.org/public/home/publications/pid/13218
The online DECA tool is an innovative, free tool for automated integration and analysis of multiple kinds of spatial data. It aims to fill in knowledge gaps in social, environmental and science policy by involving stakeholders in spatial analysis and decision-making.

The DECA tool provides a simple and straightforward approach to incorporating various data, particularly census data and other social survey data, into climate change adaptation planning through spatial analytics. Unlike existing spatial analysis software, DECA assembles all the data into the tool and groups breakdown variables into detailed categories (e.g., hazard levels, land use type, housing materials, age groups, education levels, infrastructure types) so that the user can combine any categories based on specific groups of people or targeted geographic areas. All these analyses can be conducted automatically and can be learned by the user with the minimal previous analytical experience. Through the tool, the data analysis capacity of countries, especially the least-developed countries, could potentially be enhanced.

DECA will be a helpful tool to support climate-change adaptation programmes that are carried out by local and national governments with the support of other UN agencies and NGOs. It will help increase public awareness of climate change. DECA is fully accessible by the public (assuming that data providers agree). It will enhance communication among scientists, decision-makers, stakeholders and general public on the issues of population and climate change and enhance the linkage of analysis with policy formulation. The general public will benefit from the tool, as they will be able to see the level of climate-change risk, the socioeconomic status of the neighbourhood where they are located, and thus strengthen their individual awareness of the need for adaptation.

### 3.2 NSO involvement today

NSOs are not used to playing an active role in responding to the data needs of climate change analysis. Recently, several initiatives have called for closer involvement of NSOs. For example, in 2009, at the global level, the UNSC recognised the role of official statistics in closing the data gaps related to climate change.

Eurostat has produced since 2005 a monitoring report of the EU sustainable development strategy which provides statistics related to climate change and energy. The report includes indicators on GHG emission reductions and distance to official targets, GHG intensity of energy consumption, global surface average temperature, gross inland energy consumption by fuel, energy dependence, electricity from renewable sources, share of renewable energy in fuel consumption of transport, combined heat and power generation and implicit tax rate on energy.

Many existing official statistics can be important in the analysis of the impacts of climate change. For example, data on water availability and use, agricultural production, energy production from renewable sources, forest cover, timber production and health, population growth and migration patterns. As populations in cities continue to grow, the impacts of warmer temperatures can have increased health effects, especially if air quality deteriorates. Examples of the relevance of existing statistics to climate change analysis are discussed in Section 3.3 as issues that should be taken into account in disseminating these statistics.

In some cases, small adjustments to data collections may improve the value of the collected data for climate change analysis notably and lead to more efficient use of the limited resources. For instance, the Eurostat Urban Audit Survey offers more than 50 environmental variables for European cities but it does not provide information on water use, which could be important for climate change analysis.

National statistical systems rarely collect data on disasters linked to climate change and this task is not discussed in detail here. There are some exceptions, however, like the Indian statistical office that, in collaboration with the National Institute of Disaster Management in India, developed a disaster statistics database. The statistical system’s involvement in climate change related statistics thus varies depending on the urgency of climate threats in each country.
Natural hazard statistics (for example, the *International Emergency Disasters Database*<sup>50</sup>) are most often collected by research organisations or commercial enterprises (for example, the natural catastrophe database<sup>51</sup> operated by the re-insurance firm Munich RE). Only recently have public institutions engaged in similar exercises; for example, the EEA has launched the development of a European Flood Impact Database. This remains outside of official statistics for the moment, however.

The UNECE survey showed that almost 40 per cent of the responding NSOs (18 NSOs) produce some climate change related statistics or indicators. The survey was structured according to the state and impact indicators of climate change, defined by EEA. According to the results, NSOs most often produce statistics on: *water quantity, river floods and droughts* (ten countries) and *agriculture and forestry* (nine countries). *Atmosphere and climate, terrestrial ecosystems and biodiversity* and *human health* are covered by NSOs in seven countries; *Freshwater quality and biodiversity* in six countries; *marine biodiversity and ecosystems* in five countries; *economic impacts* in three countries; and *cryosphere* only in two countries. No NSO reported producing statistics under the subject of *soil*.

Table 2: Climate change related indicators produced by NSOs according to the UNECE survey.

<table>
<thead>
<tr>
<th>TYPE OF CLIMATE CHANGE INDICATORS</th>
<th>NUMBER OF NSOs</th>
<th>INDICATORS PRODUCED BY NSOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water quantity, river floods and droughts</td>
<td>10</td>
<td>Indicators on wastewater treatment, water yield, water levels, water allocation, water outflow, water use, water discharge, river floods and drought.</td>
</tr>
<tr>
<td>Agriculture and forestry</td>
<td>9</td>
<td>Indicators on crop yields, irrigated area, forest area, area under organic farming, distribution of pests and weeds.</td>
</tr>
<tr>
<td>Terrestrial ecosystems and biodiversity</td>
<td>7</td>
<td>Indicators on the extent of natural reserves, diversity of species, leaf and bloom dates, plant hardiness zones, length of growing season, bird wintering ranges, the impact of human settlements, etc.</td>
</tr>
<tr>
<td>Atmosphere and climate</td>
<td>7</td>
<td>Average monthly temperatures, precipitation, ozone concentration, number of successive dry days and cyclone intensity.</td>
</tr>
<tr>
<td>Human health</td>
<td>7</td>
<td>Indicators on mortality by types of diseases in areas of forest pests and fires compared to overall diseases and mortality as well as mortality due to heat waves. (In addition, several NSOs mention producing mortality statistics, but not in connection to climate change.)</td>
</tr>
<tr>
<td>Freshwater quality and biodiversity</td>
<td>6</td>
<td>Indicators on freshwater biodiversity according to water quality of selected rivers, lakes and drinking water, amount of nitrogen, fish observations and number of threatened species.</td>
</tr>
<tr>
<td>Marine biodiversity and ecosystems</td>
<td>4</td>
<td>Indicators describing sea levels, fish stocks, sea surface temperature, ocean heat content and acidity.</td>
</tr>
<tr>
<td>Economic impacts</td>
<td>3</td>
<td>Transport statistics, waste statistics, use of cleaner fuels and indicators for the EU monitoring mechanism for GHG emissions</td>
</tr>
</tbody>
</table>

<sup>50</sup> [www.emdat.be/](http://www.emdat.be/)

Cryosphere | 2 | Measurements of snow, ice and glaciers, arctic sea ice, snow cover, snowpack, lake ice.
Soil | 0 | No indicators mentioned as being produced by NSOs.

The below case study highlights the amount of driving force and response indicators that could be produced based on existing statistics.

**Case study: Climate change indicators for Nordic countries using existing statistical data.**

Already in 1999, a cooperation group of the energy and environmental sectors in the Nordic countries prepared an inventory of potential climate change indicators using existing data. Their report also analysed the results of the selected indicators for the Nordic countries. The below table presents their summary table of climate change indicators. It lists a number of relevant statistics for driving force and response indicators that are mainly available from national statistical systems. The response indicators are in fact mitigation indicators. At the time, the report did not yet consider monitoring of adaptive capacities and vulnerabilities. After 1999, environmental statistics have improved notably and a new inventory would probably result in a longer list of available statistical data. Many of the following indicators would, however, require re-aggregation of existing statistical data.

<table>
<thead>
<tr>
<th>Driving force indicators</th>
<th>Pressure indicators</th>
<th>State indicators</th>
<th>Response indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Climate and natural conditions: land use, annual forest growth</td>
<td>Actual emissions: Emission of all GHG (Index (GWP), per capita), of carbon dioxide (Total, per source), of methane per source, of nitrous oxide per source and of other GHG</td>
<td>Global temperature</td>
<td>Goals and agreements: GHG emissions compared to requirements of Kyoto Protocol</td>
</tr>
<tr>
<td>Population: size, density, development and share of population in major cities</td>
<td>Adjusted emissions: Energy consumption adjusted for temperature variations, Emissions of CO₂ equivalents per unit GDP</td>
<td>Atmospheric concentration of carbon dioxide</td>
<td>Response indicators for CO₂: Environmental taxes and prices of selected fuels (Gasoline prices and taxes, Indices of energy prices (industry/households), Taxes on electricity), Prices on public transport, Energy production from new renewable energy sources, Non-fossil energy use, Energy efficiency and intensity (Energy efficiency in power plants, Industrial energy use per unit production, Industry oil consumption per unit production, Residential energy intensity), Transport (Specific gasoline consumption, passenger cars, number of electric cars), Measures to increase forest growth</td>
</tr>
<tr>
<td>Natural resources: Reserves of non-renewable energy sources, renewable energy sources, annual production capacity for hydropower</td>
<td>Sinks of CO₂: Forest sinks</td>
<td>Radiative forcing</td>
<td></td>
</tr>
<tr>
<td>Transport, roads and infra: Road lengths, Road transport of goods, Domestic passenger transport by air, Personal journeys by mode of transport, Transport of oil and gas by pipelines, by tankers</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Economic conditions and production: GDP per capita, expenditures (housing and heating, transport), Consumer price index: total, housing and heating, and transport, Private consumption, Examples of &quot;industry profiles&quot;, Value added per unit emission,</td>
<td></td>
<td>Other state indicators</td>
<td></td>
</tr>
</tbody>
</table>

Inventory of Climate Change Indicators for the Nordic Countries:
In the UNECE survey, some NSOs described their current priorities for the development of climate change related statistics as follows:

- **Impacts**: Impact of climate change on human health; economic impacts of climate change
- **Mitigation**: Mitigation expenditures; “green” renewable energy; transfers and taxes
- **Adaptation**: Perceptions of climate change; adaptation expenditures.

Some NSOs reported about **plans to define a set of climate change indicators**, and to identify the needed data from the statistical system. Some do not have any plans, because they need further consultations within the country with the different institutions involved in the work; or because they are awaiting an international framework for climate change related indicators to be defined.

Some NSOs reported that they **publish climate change indicators even those that are produced by other agencies**. They may publish these data in annual statistical yearbooks; brief news releases or in their databases. However, most often these indicators are published in thematic publications dealing with sustainable development or environment.

A conclusion from the survey is that at the moment the experience of NSOs in climate change related statistics is at very different levels. It seems that the NSOs have started to collect data and study the phenomena on their own, without the possibility to use common guidelines or exchange of experience. As a consequence, there are various sets of indicators produced with a lack of standardization of definitions and methodologies. These are often developed for the monitoring of

| Industrial structure and exports of goods | Response indicators for CH₄: Taxes on waste deposition, Collection of methane from landfills, Methane from animals |     |
| Housing and building structure: Part of population in big blocks of flats, District heating of total residential heating, Energy sources for heating by types of buildings, Residential area |     |
| Energy production and trade: Primary and secondary energy production, Electricity production, Trade with energy, Net imports of electricity | Response indicators for N₂O: Agriculture (output per unit fertiliser applied), Industry |
| Production, use and trade of wood products: Production of wood products, Annual removal of forests, Use of fuelwood, Foreign trade | Response indicators for other GHG |
| Energy use: End use of energy (index, commodities, consumer groups, per capita) |     |
| Other driving force indicators: Use of nitrogen fertilisers, Number of domestic animals, Deposition of waste |     |
national climate change adaptation strategies; for example, in Finland, France, Germany, the Netherlands, the United Kingdom, Spain and others.

As noted in Chapter 2, the National Bureau of Statistics of China is working to strengthen its basic statistics to better measure climate change. To this end, the Chinese statistical bureau has collaborated with the National Development and Reform Commission (the national entity for GHG inventory reporting in China) to develop a system of 36 indicators to measure 1) climate change and its impacts; 2) adaptation to climate change; 3) greenhouse gas emissions; 4) funding for combating climate change and 5) national standard setting and management of low-carbon products (see the case study below).

**Case study: China's National Climate Change Indicator Set**

<table>
<thead>
<tr>
<th>Domain</th>
<th>Category</th>
<th>Indicator</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Climate change and its impacts</td>
<td>1. GHG concentrations</td>
<td>1. Atmospheric concentration of carbon dioxide</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Annual average temperature by region</td>
</tr>
<tr>
<td></td>
<td>2. Climate change</td>
<td>3. Annual average precipitation by region</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4. Sea level changes over the last year in coastal provinces</td>
</tr>
<tr>
<td></td>
<td>3. Impacts of climate change</td>
<td>5. Crop area affected by flood and drought</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6. Direct economic losses caused by meteorological disasters</td>
</tr>
<tr>
<td></td>
<td>1. Agriculture</td>
<td>1. Area cultivated with conservation tillage</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Increase in improved pasture area</td>
</tr>
<tr>
<td>2. Adaptation to climate change</td>
<td>2. Forestry</td>
<td>3. Increase in desertified land area</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5. Area irrigated using water efficient methods</td>
</tr>
<tr>
<td></td>
<td>4. Coastal Zone</td>
<td>6. Area of near-shore and coastal wetlands</td>
</tr>
<tr>
<td>3. Monitoring of GHG emissions</td>
<td>1. Consolidated</td>
<td>1. Rate of reduction in carbon dioxide emissions per unit of GDP</td>
</tr>
<tr>
<td></td>
<td>2. GHG emissions</td>
<td>2. National GHG emissions</td>
</tr>
<tr>
<td></td>
<td>3. Industrial structure</td>
<td>3. GHG emissions by sector and gas</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4. Proportion of tertiary industry value added in GDP</td>
</tr>
<tr>
<td></td>
<td>4. Energy conservation and energy efficiency</td>
<td>5. Proportion of the new strategic industry value added in GDP</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6. Rate of reduction of energy consumption per unit GDP</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7. Rate of reduction of energy consumption per unit of industrial added</td>
</tr>
<tr>
<td></td>
<td></td>
<td>value for enterprises above a designated size</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8. Rate of reduction of energy consumption per square metre area of</td>
</tr>
<tr>
<td></td>
<td></td>
<td>public buildings</td>
</tr>
<tr>
<td></td>
<td>5 Non-fossil energy</td>
<td>9. Proportion of non-fossil energy consumption to total energy consumption</td>
</tr>
<tr>
<td></td>
<td>6. Increase forest carbon sinks</td>
<td>10. Forest coverage</td>
</tr>
<tr>
<td></td>
<td></td>
<td>11. Volume of forest</td>
</tr>
<tr>
<td></td>
<td>7. Control of GHG emissions in industry</td>
<td>12. Change in forest area</td>
</tr>
<tr>
<td></td>
<td>agriculture and other sectors</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1. Technology</td>
<td>13. Proportion of waste substituted for raw materials in cement</td>
</tr>
<tr>
<td></td>
<td></td>
<td>14. Mass of steel scrap cost per unit raw steel in steel-clean</td>
</tr>
<tr>
<td></td>
<td></td>
<td>15. Fertilized cropland area</td>
</tr>
<tr>
<td></td>
<td></td>
<td>16. Annual biogas generation by household and enterprises in rural area</td>
</tr>
<tr>
<td>4. Funding to combat climate change</td>
<td>2. Adaptation</td>
<td>1. Funds for scientific research related to climate change</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Financing of flood control on major rivers</td>
</tr>
<tr>
<td></td>
<td>3. Mitigation</td>
<td>3. Investment in energy conservation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4. Investment in non-fossil energy development</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5. Investment in expanding forest carbon sinks</td>
</tr>
<tr>
<td></td>
<td>4. Other</td>
<td>6. Funds for the associated program on GHG emissions statistics,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>accounting and investment appraisal and capacity building</td>
</tr>
<tr>
<td>5. Climate change-related standards</td>
<td>1. Measurement, standards and certification</td>
<td>1. The number of carbon emission standards issued for industrial products</td>
</tr>
<tr>
<td>and management</td>
<td></td>
<td>2. The number of low-carbon product certifications</td>
</tr>
</tbody>
</table>
NSOs could consider providing basic statistical data users could analyse in connection with climate change. An example is the set of indicators based on existing statistics provided by the World Bank (see the case study below). The set includes, for example, an indicator of the share of urban population that the analysts can link with climate change themselves.

Case study: Climate change data in World Bank’s World Development Report, Little Data Book and Knowledge Portal

The World Bank has developed many services for distributing climate change relevant data mainly using official statistics as the starting point.

The World Bank uses over 40 indicators to create country profiles for the World Development Report in support of addressing climate change and other development issues. These indicators are mainly brought together by international organizations from existing national statistics. These World Bank data cover for example climate systems, exposure to climate impacts, resilience, greenhouse gas emissions, and energy use etc. 53

The World Bank’s Little Data Book on Climate Change includes data on climate-relevant topics, including current and projected climate conditions, exposure to climate impacts, resilience, greenhouse gas emissions, climate finance, and current national and international efforts to take action. 54

The Climate Change Knowledge Portal 55 is a hub of information, data and reports about climate change around the world. It provides possibilities to query, map, compare, chart and summarize key climate and climate-related information. The Portal contains spatially referenced environmental, disaster risk, and socio-economic datasets, as well as synthesis products, such as the Climate Adaptation Country Profiles. The portal also provides links to other resources and tools.

NSOs are currently implementing the SEEA-CF which can provide added value for climate change analysis. The SEEA-CF is a tool for integrating economic and environmental data in a way that may benefit also climate change analysis. It provides a system of components, such as material flow accounts, input-output tables, and land and water use accounts, all of which have relevance for climate change. A stepwise approach towards developing integrated environmental economic accounts linked to climate change would be an important strategic direction of work for the NSOs.

3.3 Data gaps and challenges of climate change related statistics

The improvements mentioned regarding climate change related statistics often include:

- improved timeliness
- greater regularity in collection
- longer time series (for example, extending back to 1990 to match the time series of national emission inventories) greater detail both with regard to economic sectors and geographic breakdown
- linking data across statistical domains for integrated analysis, requiring datasets using consistent structures and scopes
- improved accessibility to data currently scattered across organizations
- improved interpretability, especially for complex scientific data

The value of improving existing statistical data along the above lines, to make them more useful for climate policies, would be high in comparison to the costs of launching new work. Concerning

53 The World Bank climate change and development indicators: data.worldbank.org/topic/climate-change
55 The World Bank’s Climate Change Knowledge Portal: worldbank.org/climateportal
substantive gaps, the EU Sponsorship Group on Measuring Progress, Well-being and Sustainable Development\(^{56}\) has identified the following priorities in relation to climate change:

- indicators derived on the basis of air emission accounts
- environmentally-extended supply-use and input-output tables published on a regular basis to develop carbon footprint indicators
- indicators relevant to climate change mitigation and adaptation

Emerging data needs mentioned during the expert meeting organized by the Task Force in November 2012 included:

- economic data linked to climate change that allows to quantify the economic effects of climate policies (taxes, employment, output in “green” sectors, etc.)
- household energy consumption
- financial aid related to climate change targeted at developing countries
- data on resilience, vulnerabilities and estimates of population at risk
- mortality due to heat waves (recognizing that this involves attributing causality)

UNEP provided a general list of environmental data gaps to the November 2012 Task Force expert meeting that underlines the breadth of the gaps, many of which are relevant to climate change policies (see the case study below). A UNEP *Environmental Observing and Assessment Strategy*\(^{57}\) notes, for example, that “the global environmental conventions - climate, biodiversity, desertification - imply the need for far more detailed information on energy use patterns and greenhouse gas emissions, on the health and functioning of ecosystems, and on the pattern of human activities that contributes to land degradation.” There was also a strong finding that “all of these important data be geo-referenced so that spatial analysis could be performed”. The strategy also points out that “the majority of present global data sets suffer from the following limitations: consistently small scale and coarse spatial resolution; data derived from numerous source materials that vary in quality and time; based on variety of analysis methods; and frequently out-of-date.”

**Case study: Environmental Data Gaps Identified by UNEP**

| 1. Renewable energy                        |
| 2. Water quality, quantity and ground-water resources |
| 3. Solid waste, wastewater                 |
| 4. Land degradation                        |
| 5. Oceans and polar regions                |
| 6. Ecosystems base data (wetlands etc.)    |
| 7. Population density (urban/rural split)  |
| 8. Governance (policies, conventions & access to information) |
| 9. Air emissions, urban air quality and health impacts |
| 10. Exotic/invasive species                |
| 11. Poverty and prosperity                 |
| 12. Chemicals exposure & health            |
| 13. Glacier and ice, permafrost            |
| 14. Technology use                         |
| 15. Environment, peace and security        |
| 16. Goals, targets and reference values    |
| 17. Gender and environment (disparities)   |

\(^{57}\) A UNEP *Environmental Observing and Assessment Strategy*: www.un.org/earthwatch/about/docs/uneprstr.htm
Several global portals for climate change data exist, but these portals have been developed for specific analytical and policy purposes and they often do not include the official social or economic statistics nor all the relevant environmental data. For example, the Global Climate Observing System focuses on essential climate variables (biophysical meteorological information) but not on the related statistics. The International Renewable Energy Agency and the International Energy Agency are developing a joint Global Renewable Energy Policies and Measures Database. The Pacific Risk Information System is an example of an initiative that provides access to government data that have been geo-referenced and combined with information on infrastructure and climate change.

The European Environment Agency maintains two portals relevant to climate change. The Climate Change Data Centre provides access to data and information on greenhouse gas emissions, climate change impacts, vulnerability and adaptation in Europe. Priority is given to policy-relevant data and information for European and national policy makers, influencers (such as NGOs, business, media and scientists) and the general public. In addition, the EEA also hosts Climate-ADAPT that helps users to access and share information impacts, vulnerability and adaptation.

WMO is coordinating the development of the Global Framework for Climate Services (GFCS), whose intent is “to strengthen the production, availability, delivery and application of science-based climate prediction and services”. The aim is to bridge the gap between the climate information being developed by scientists and service providers and the practical needs of end-users. The plan was endorsed by 155 nations at the 2009 World Climate Conference. Climate services are defined as a decision aide derived from climate information, which currently refers mostly to biophysical data.

NSOs could improve service to national decision makers by developing a similar portal of climate change related statistics that exist in the statistical system, as well as statistics from outside the system. There is a question of how to select the data for the portal in a neutral and comprehensive way. NSOs would also need to tackle with issues related to the boarder of official statistics. A clear approach for providing access to non-official statistics through such a portal would need to be developed. NSOs cannot certify the quality of statistics produced outside the statistical system, though they could promote improvements in the coherence, quality and reliability of data among all producers. One option would be the approach taken by Statistics Netherlands, which provides two separate dissemination portals, one for official statistics and another containing other key data with sufficient background information for policy makers and researchers. The latter portal is owned jointly by Statistics Netherlands, Wageningen University, and PBL Netherlands Environmental Assessment Agency.

Most commonly, other producers of climate change information, such as the meteorological institutes and environmental agencies or ministries collect the information about physical environment (atmosphere, weather, hydrology, terrestrial and marine ecosystems, etc.). All environmental statistics may not follow harmonised methodologies, as they are produced by varying organisations, are not easy to find and may not be accessible from a single entry point.

NSOs should promote the use of the existing official statistics among other producers of climate change related information. If other producers do not have a clear idea of existing official statistics, duplicated data collection activities may result.

For example, national communications to the UNFCCC require reporting other information than emissions much of which is available from the statistical system. These include data on socio-economic developments, national circumstances, impact of policies and measures on emissions,

58 Pacific Catastrophe Risk Assessment and Financing Initiative (PCRAFI): pcrafi.sopac.org/
59 www.eea.europa.eu/themes/climate/dc
60 climate-adapt.eea.europa.eu/
61 The website of Statistics Netherlands: www.cbs.nl
62 The website for other than official statistics: www.compendiumvoordeleefomgeving.nl
basic data used for emission projections, data on vulnerability, financial resources and assistance, transfer of technology, education, training and public awareness. Supporting these requirements may be considered as one of the priorities for NSOs as these requirements will remain the same for a number of years.

To get a better understanding of the country-specific data gaps, it would be useful for statistical offices to review the In-depth Reviews of the National Communications. The availability of data varies a great deal across countries. However, the general issues highlighted by the reviews include the following:

- **Impacts** of climate change on key economic sectors (for example, tourism) and social issues
- **Mitigation**: Cost and effect of policies and measures across sectors (PAMs), financial resources for mitigation, technology transfer
- **Adaptation**: Measures taken to minimize adverse impacts of climate change and extreme events, vulnerability assessment (for example, of the health sector and biodiversity), financial resources for adaptation, investment etc.

Official statistics are often compiled based on samples that do not provide sufficient details and coverage for compiling small-area statistics. In some cases, small-area data could be sourced from administrative registers collected by other government organisations or producers of statistics that typically cover populations in more detail, but may only provide a limited number of variables.

Researchers and climate analysts could help improve NSOs’ contribution to climate analysis, if obstacles to linking official statistical data to other climate data could be addressed by NSOs. Linking climate change data to the related statistical data may not be the task of NSOs, but they should facilitate the use of multiple datasets and improve the possibilities for others to access official statistical data in a format that allows linking them with other data. Official statistical datasets should be made more compatible and inter-linkable. As the coordinator of the statistical systems, NSOs are also in a position to promote better coherence among the data produced by others by coordinating the development of climate change related statistics in the national statistical system. NSOs can also improve the quality of existing data that are relevant for climate change analysis and make them more easily accessible.

Easy linkage would allow analysing, for example, the impacts of climate change on human settlements, household composition, housing, health and mortality. More focused information would be needed on the risk of epidemics (air-, water- and vector-borne diseases), morbidity and mortality related to extreme climate events (for example, heat-waves, floods), and hospital admissions. Easier linking with population data would help shed light to pressures imposed to climate by changing population dynamics, migration, urbanization, transport and consumption patterns. Link to tourism statistics would enable monitoring of possible changes in tourist flows due to climate change, and to assess the related losses and gains in terms of attractiveness of the region for tourists. Link to transport statistics may be useful in finding vulnerabilities of transport infrastructure to climate extremes.

The shift in policies towards clean technologies, climate proofing and sustainable use of natural resources is expected to lead to structural changes in the labour markets. These changes will also require new skills from employees that should be monitored by using education statistics. **Employment statistics** could help document the possible shifts towards “greener” jobs, and income statistics linked with climate data would enable the analysis of climate change driven effects on households’ economic welfare or even poverty.

**Economic statistics**, especially the gross domestic product (GDP) or gross national income (GNI), linked with other statistics would help assess resource efficiency and carbon intensity of industries, as well as the contribution of different industries to GHG emissions. Better data linking would also help analyse the vulnerability of industries to climate change, as well as changes in the conditions for
farming, fisheries and forestry. A link to price statistics is important for monitoring the effectiveness of mitigation and adaptation measures, for example, through prices of oil, energy and food. Construction statistics may reflect measures taken to repair damage caused by extreme climate events. As a measure of resilience to extreme climate events banking, insurance, financial statistics may shed light on insurance coverage. Government expenditure statistics could be useful for identifying measures for financing mitigation of or adaptation to climate change. Data on science, technology and innovation are particularly useful as tools to assess the effectiveness of international goals regarding technology transfer and development of “green” technologies.

**Statistics on energy** could help reflect dependency and vulnerability of critical infrastructure to climate change, but also enable analysing the availability of energy resources (stocks and changes due to new discoveries, extraction, catastrophic losses, reappraisals, etc.) as well as renewable and non-renewable energy production and consumption.

**Environment statistics** are naturally of high relevance when studying climate change. They may provide information on environmental protection (taxes and subsidies, tradable permits, “green” certificates, etc.), water resources and use, waste, land use and land cover, soil characteristics and degradation, carbon trapped in vegetation and soils, pollutants, the state of environment and biodiversity, protected areas and species, trends and vulnerabilities of ecosystems etc. Statistics on environmental revenues and expenditure are often collected by NSOs.

NSOs cannot fill in all of the above data gaps, but making data more easily available for researchers and developing new types of services; for example, a search engine type of access to statistical microdata could be useful.

Adding the **geographic location** would notably improve the usefulness of economic, social and environmental data for the work of climate researchers and analysts. In Europe the EU Emissions Trading System provides information about installations emitting greenhouse gases, which albeit not exactly geo-referenced allows the identification of specific facilities on regional level. Furthermore, the UNECE Protocol on Pollutant Release and Transfer Registers (PRTR) provide publicly available geo-referenced data on industrial pollutants, including greenhouse gas emissions. Most of the 32 Parties to the Protocol, including the EU and Member states already provide their data through this service. Further, the US, Canada, and Mexico, as well as Chile, Japan and many other countries around the globe have comparable systems in place.

Two layers of data should be geo-referenced to enable easier linking with climate information: biophysical and socio-economic data. More work is needed in particular to provide socio-economic data with a geo-reference. Ability to link geo-referenced emissions data with economic statistics, such as national accounts variables, would increase the analytical value of data. This could enable research and analysis of “green” jobs, “green” economy, low-carbon industries, cost and price fluctuations as a consequence of climate events, sustainability of energy and resource use, impacts on population, agricultural productivity and changes in tourism flows, the vulnerability of regions to the effects of climate change as well as analysing the possible impacts of adaptation and mitigation activities. The relevant data to be geo-referenced include for example:

- Socio-economic data: drivers of climate change (production, consumption), economy (gross value added, output by industries, costs, prices), employment, population (density, household structures, health, migration, urbanisation), transport, infrastructure networks and tourism, taxation and subsidies, financial support, innovation and technology diffusion.
- Biophysical data: soil (land-use, vegetation, droughts, floods, soil quality), use of natural resources (water consumption, energy use and sources), waste generation, agriculture (crop production), extreme weather events (type, intensity, magnitude) and environmental protection.
There is also a gap in the capacity needed for the compilation of climate change related statistics in countries, and this challenges data availability. IPCC notes that there is a notable lack of geographical balance in the data on observed changes as a consequence of climate change, with marked scarcity of data in developing countries.63

3.4 Conclusions on climate change related statistics (other than GHG inventories)

1. Climate change related statistics comprise a very broad range of data that stretch across the entire statistical framework. Most official statistics are not collected specifically for climate analysis and, therefore, NSOs must better understand user needs in order to effectively direct their efforts in this domain. Data gaps must be identified together with the main users of climate change related statistics.

2. In general, the media and the public lack easy access to key climate change related statistics that are easy to understand. Policy makers’ data needs are reflected in international climate accords, protocols and monitoring mechanisms. Their focus is shifting more and more towards analysis of the socio-economic impacts of climate change and to monitoring the effectiveness of adaptation and mitigation activities. The scientific community and analysts require access to detailed data, often microdata that has been geo-referenced.

3. Producers of climate change related statistics outside of the statistical system could help serve user needs if they had easier access to and better knowledge of official statistics. Statistical systems already produce a considerable quantity of data relevant for climate change. NSOs are well positioned to collect, coordinate, harmonize and disseminate climate change related statistics. A step-by-step approach should be adopted in facing this challenge: 1) facilitating access to the existing statistics; 2) improving the quality and usefulness of existing data from different domains; and 3) developing new statistics to fill priority data gaps.

4. Facilitating access to existing statistics means bringing together and disseminating existing data that are relevant for climate change analysis. Decision makers would benefit from having a portal of key climate change related statistics at their disposal. NSOs should lead the work of developing such portals. It is not necessary to physically bring together all data. Simply facilitating access to them would be a valuable contribution; for example, a meta-database of climate change related statistics found within and outside of the statistical system could be produced. NSOs provide quality assurance for official statistics, but they cannot certify the quality of official statistics produced outside the statistical system. This does not mean that NSOs should not facilitate access to all data relevant for climate change, but they can help promote improvements in the coherence and reliability of data produced by others.

5. Improving the usefulness of existing data for climate change analysis requires reviewing data collections and improving data linking across different statistics and producers’ datasets. It entails a review of existing statistics and data collection systems to see if they can be used to identify climate change related issues, such as relevant information on renewable energy sources, green jobs, new or recurrent diseases linked to climate change etc. In some cases small adjustments to data collections may improve the value of the collected data for climate change analysis notably, and they could lead to smarter use of the limited resources. NSOs’ capacity in linking datasets produced by various organizations should also be strengthened. Data matching requires not only better technical capacity, but sufficient legislative environment for closer cooperation with other data producers and gradually a higher degree of data harmonization.

6. NSOs should determine **what additional statistics might be needed** in the longer term for climate change analysis. For example, NSOs should consider how to contribute to monitoring the impact of climate change on biodiversity and ecosystems. Reliable data on the use of economic instruments in mitigation efforts will be needed. Regular statistics should also be developed to monitor adaptation; including, resilience, risks and vulnerability of population groups and the preparedness to withstand the adverse impacts of climate change.

7. NSOs will need **further guidelines** on how to take into account the needs of climate change analysis in official statistics. For this, the links of the existing statistical frameworks to climate issues should be explored further. In the longer run, methodological guidelines for data collection and compilation on climate change related statistics should be developed.

8. A number of countries have developed national climate change adaptation strategies, based on various indicators sets to inform public environmental policies. **Development of a set of key climate change related statistics should be internationally coordinated** to achieve comparability across countries. In the longer term, high relevance areas for climate change related issues should be defined and provided as official statistics regularly.
4 CHALLENGES WITH STATISTICAL INFRASTRUCTURE

This chapter discusses the challenges with statistical infrastructure that filling the statistical gaps for greenhouse gas inventories and climate change related statistics may cause. Providing better statistical data for climate change analysis may require reviewing and partly changing the way NSOs work. On the other hand, the changes will allow current strengths of official statistics to better benefit the compilation of emission inventories and analysis of the impacts of climate change as well as the efforts to mitigate these impacts, or adapt to them.

There is no common definition of statistical infrastructure. The Australian Bureau of Statistics (ABS) defines statistical infrastructure as tools that support the operation of a statistical system. These tools can help to organize the statistical system, improve efficiency, add value, create new outputs or simply perform tasks within the system. Examples of statistical infrastructure include computer systems, metadata repositories, legislation, standards and classifications, frameworks and information development plans. Not all of these issues have specific relevance for compiling emission inventories. Therefore, the section focuses on the readiness of statistical systems in the following issues: legislation, standards and classifications, frameworks and integration, statistical methods and computer systems, organizational structures and production resources, quality assurance and guidelines, knowledge and cooperation networks.

4.1 Statistical infrastructure for greenhouse gas inventories

The advantages offered by the statistical system infrastructure to the compilation of greenhouse gas inventories could include: close collaboration with energy statistics and other source statistics; access by producers of official statistics to confidential source data; for example, on waste, industrial production and environment; experience on improving timeliness better consistency with official statistics; high level of transparency through metadata and archiving; use of internationally comparable methods; and well-developed quality assurance methods.

There are several challenges related to the shortcomings of statistical infrastructure with regard to supporting the production of GHG inventories. According to the UNECE survey, such challenges include confidentiality issues, lack of capacity and knowledge of data needs, limited database management resources in some countries, data coherence and challenges in cooperation between involved agencies.

This section analyses the parts of the infrastructure that are weakest or missing with regard to the requirements of GHG inventories, and highlights some of the important strengths too. It aims to identify the key adaptations needed in the current statistical systems to improve the ability to respond to the information needs of emission inventories.

LEGISLATION

Legislation has a crucial role in supporting the production of emission inventories. Without unambiguous legislation and clear division of work between organizations the compilation of GHG inventories may suffer from undue complications and inefficiencies. There are, however, challenges posed by the legislative frameworks involved. For one, the legislation ensuring confidentiality of official statistics limits access to some of the activity data needed by inventory compilers.

Protection of confidential data is regulated by statistical laws in almost all countries and is an important prerequisite for the production of reliable official statistics. However, confidentiality rules prevent inventory compilers outside the statistical system from having full access to detailed activity data. A concern in the opposite direction is that data submitted under the European Union Emissions Trading System is also not in all cases accessible to the producers of official statistics. Another
example is that the need to use inventory data for performance monitoring creates pressure for additional data collection outside the statistical system, since official statistics can only be used for statistical purposes.

Bearing in mind the fact that legislative changes may be difficult to achieve, when there is an opportunity to revise statistical legislation, it should be reviewed from the viewpoint of facilitating effective cooperation between agencies and permitting access to the data required by inventory compilers. Likewise, legislation related to GHG inventories should be aligned where possible with national statistical laws and with the Fundamental Principles of Official Statistics and European Statistical System Code of Practice.

As a means of dealing with the limitations on access imposed by statistical laws, some countries assign responsibility for part of the inventory calculations directly to NSOs. Another option is to treat inventory compilers as part of the official statistical system (see the United Kingdom case study in Section 2.2). This facilitates their access to official statistics but also requires their adherence to the requirements of national statistical laws and international guidelines. In general, researchers are likely to be more interested in finding answers to research questions than in access to microdata for its own sake. Therefore, interesting solutions may be found in terms of remote access where the user only receives the aggregated results of his/her queries to the data.

Ideally, national legislation providing for the right to access data needed for emission inventory compilation would exist in all countries. Such legislation would have to be aligned with the national statistical laws and principles. In the EU, for example, the recently adopted Monitoring Mechanism Regulation (EU No. 525/2013) stipulates that “Member States shall ensure that their competent inventory authorities have access to”:

- data and methods reported for activities and installations under the EU ETS
- where relevant, data collected through reporting systems on fluorinated gases
- where relevant, emissions, underlying data and methodologies reported by facilities under the European Pollutant Release and Transfer Register

**Case study: Access to information through the UNECE Protocol on Pollutant Release and Transfer Registers (PRTRs)**

The Protocol on Pollutant Release and Transfer Registers (PRTRs) to the Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters was adopted in 2003 in Kiev. Since it came into force in 2009, the Protocol requires companies to provide information on pollution from industrial sites and other sources — such as greenhouse gases and heavy metals — to national registers (PRTRs) that are publicly accessible and searchable through the Internet.

PRTRs allow free web-based access to geo-referenced data on industrial pollutants, including GHG emissions, to empower the public, decision makers in government and industry, scientists and journalists to make informed choices. While there are other initiatives promoting this type of registers, the UNECE Protocol on PRTRs is a legally binding instrument aiming at ensuring minimum standards for equal rights and transparency in the use of environmental data.

Harmonized regional PRTR databases exist e.g. in Europe (for EU countries, Norway, Iceland, Liechtenstein, Switzerland, Serbia) and in America (for Canada, United States, Mexico). In Central America, the PRTR is about to be implemented. A Global Round Table event on 19 November 2013 discussed the use of PRTRs for climate change related reporting. Norway and Japan already make use of PRTR data for reporting to UNFCCC and Finland is studying to matter in order to compare results from bottom-up calculations to top-down estimation of GHG emissions.

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64 For more information on PRTRs: [www.unece.org/prtr_grt2013.html](http://www.unece.org/prtr_grt2013.html), [www.unece.org/env/pp/welcome.html](http://www.unece.org/env/pp/welcome.html) and [prtr.net/](http://prtr.net/)
Researchers and analysts clearly need a better access to these data, and sometimes detailed analysis of drivers requires **access to microdata**. Researchers can be a useful additional resource for analysing and exploiting data held by national statistical systems. In many countries, access to microdata by researchers is limited due to confidentiality requirements. Procedures exist to permit this access, but can involve complex application procedures and require knowledge of the rules governing different datasets and producers.

It is worth noting that several NSOs are also developing tools for improved access to microdata within the context of existing statistical laws and respecting the need to safeguard confidentiality:

- Australia[^66] is developing **Remote Analysis Servers**
- the US Census Bureau[^67] has developed a **Microdata Analysis System** for researchers to perform certain statistical analysis without direct access to microdata
- Finland[^68] is working towards a national system for microdata access that would bring together datasets of different agencies via one web portal
- in Canada, access to economic microdata is being facilitated through Statistics Canada’s **Centre for Data Development and Economic Research[^69]**
- Statistics Netherlands’ **Centre for Policy Related Statistics** makes available anonymous microdata at the level of individual persons and businesses for statistical research; use of these data requires that organisations be authorised by the Central Commission for Statistics[^70]
- Eurostat has put in place rules and procedures for access to confidential data for scientific purposes, governed by Commission Regulation (EU) 557/2013[^71]

**FRAMEWORKS AND INTEGRATION**

**Reviewing links between inventories and statistical frameworks** that include data relevant for GHG inventories can help identify synergies and prevent creation of duplicate data collections. Important synergies and links exist, for example, between the GHG inventories and energy statistics, national accounts, environmental accounts, air emissions accounts and the SEEA-CF. The links to SEEA-CF and the **Framework for the Development of Environment Statistics** were discussed in Chapter 1.

International work would be needed to define how **better consistency of the inventories with the relevant statistical frameworks** could be achieved. It could increase the analytical usefulness of the inventories. The environmental accounts, for example, enable analysis of air emissions by ISIC/NACE, the amount of carbon dioxide emitted per a unit of value added in countries and environmentally related taxes by economic activity. However, the direct usability of GHG data in environmental accounts is limited because of their crucial differences e.g. in classifications as will be discussed in the following text on standards and classifications. For some countries, it is a question of two separate systems with limited synergies that are compiled by different agencies. In those countries, where the GHG inventory is compiled using national energy balances, linking between the GHG inventory, environmental accounting and energy statistics is more meaningful.

**Cross-checking the GHG inventory results with statistics produced in other frameworks** can be a key tool in the verification of emission estimates. For instance, in the energy sector is the IPCC Reference Approach, which is also an independent method for estimating CO₂ emissions, uses data

[^69]: [www.statcan.gc.ca/cder-cdre/index-eng.htm](www.statcan.gc.ca/cder-cdre/index-eng.htm)
from national energy balances\textsuperscript{72}. Ideally, there should not be significant differences between CO\textsubscript{2} emission estimates reported in the GHG inventory and estimates based on the national energy balances. If the difference between the two approaches is more than 2 per cent, parties are required to provide clear explanations in the GHG inventory report. At European level, the EU Energy Statistics Regulation explicitly requires Member States to ensure the consistency of activity data reported to UNFCCC with the energy balances reported to Eurostat.

STANDARDS AND CLASSIFICATIONS

One of the most common problems encountered by many countries is the mismatch between the reporting classifications for GHG inventories, as defined by the Intergovernmental Panel on Climate Change (IPCC) compared with international statistical classifications. This represents a major obstacle for analysing and linking the data with official statistics; for example, to facilitate better use of energy statistics in the compilation of GHG inventories. The mismatch complicates matters in two ways: to use official statistics for GHG compilation and for NSOs to reuse the GHG inventory results combination with other related data. In some areas, this leads to duplication of efforts and parallel data collection.

Comparability problems between the inventories and official statistics may be overcome by 1) describing the differences between inventory data and official statistics 2) developing standardized tools for data comparison, such as correspondence tables and 3) explaining the differences by using reconciliation items or so called “difference components”. A known reason for the differences between inventory data and official statistics is the different treatment of transportation activities. Another is the different concept used to assign emissions to countries. In official statistics, (for example, GHG emission accounts produced by NSOs) the underlying principle applied is that emissions are attributed to the country of residence of the producing or consuming unit. This so-called “residence principle” differs from the “territory principle” applied in GHG inventories. The territory principle attributes emissions to the country in which the producing or consuming unit is located at the time of the flow, regardless what relation the unit has to that country. Thus, emissions from a ship carrying the flag of Canada but operating in China are assigned to China in emission inventories even though the economic activity of the shipping company is attributed to Canada in official statistics.

The data of the GHG inventories are reported to the UNFCCC according to the Common Reporting Format (CRF) framework, which uses a classification developed by the IPCC. The CRF framework encompasses the different sources and sinks of greenhouse gas emissions arising from human activity, grouping them in sectors. Each sector generally reflects a certain type of emission source (or sink) from a technological viewpoint; for example, combustion of fossil fuels, regardless of where this combustion occurs (on the national territory) falls under the sector "energy", which includes combustion in industry, transport, energy transformation, refineries, etc. From the viewpoint of national statistics, the IPCC sectors are, in fact, a combination of what are normally considered industries (for example, electric power generation) and what are considered activities based on both economic processes (for example, transportation) and on products (for example, solvents).

\textsuperscript{72} The estimate is based on apparent consumption which refers to the balance of primary fuels produced in a country, plus imports, minus exports, minus international bunkers and the net change in stocks, adding also the apparent consumption of secondary fuels.
The current source/sink sectors\(^{73}\) in the IPCC Common Reporting Format (CRF) are the following:

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<td>Industrial processes</td>
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<td>3</td>
<td>Solvents and other products use</td>
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<td>4</td>
<td>Agriculture</td>
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<td>5</td>
<td>Land use, land use change and forestry (LULUCF)</td>
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<td>6</td>
<td>Waste management</td>
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<td>Other sector</td>
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In GHG inventories, the meaning of the energy sector is different from ISIC-class D (electricity, gas, steam and air conditioning supply) that is used in official statistics, even though they are both called the “energy sector” in everyday speech.

In GHG inventories, the sector **agriculture** includes emissions connected to agricultural processes: enteric fermentation, manure management, rice cultivation, cultivation and management of agricultural soils etc., but not emissions of the energy use in agriculture.

The sector on **land use, land use change and forestry** (LULUCF) contains the emissions caused by changes in land cover and CO\(_2\) -emissions from soil, including agricultural soil. Other greenhouse gases from agricultural soil are included in agriculture sector.

The CRF sectors do not permit easy linking of inventory data with statistics compiled by NSOs so that emissions could be allocated to industries as defined in official statistics. The CRF sectors are well suited to the scientific and technical monitoring of emissions, but they do not generally reflect social and economic considerations. Because of their differences with statistical classifications, the CRF sectors do not allow easy analysis of the role of households or industries in climate change or the costs of limiting emissions. For instance, a common question the media is asking is households’ share of total emissions. To this question, the CRF tables do not give a straightforward answer.

Although, the *Manual for Air Emissions Accounts*\(^{74}\) and SEEA handbook on energy accounts\(^{75}\) present general procedures for linking emission inventory data to economic (ISIC/NACE) and household activities there is no universal ‘correspondence key’ that can be easily applied to all cases. Linking emission inventory data to economic data is complex and country-specific work that requires detailed understanding of the two sets of data and their evolution over time.

### STATISTICAL METHODS

The UNFCCC and IPCC reporting guidelines form a framework for the GHG inventory compilation. Yet, the quality of source data for emission inventories could benefit from official statisticians having a better understanding of the concepts and methods used in inventory compilation. This would help ensure that statistics are established in such a way that they can be easily used, compared and linked with inventory data. Statisticians could develop such understanding by studying the *Common Reporting Format* tables, the IPCC inventory methodology and guidelines and the issues raised in the *inventory review reports* regarding source data.

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\(^{73}\) The source/sink sectors as defined by the Intergovernmental Panel on Climate Change (IPCC) in the *Revised 1996 Guidelines for national greenhouse gas inventories*  
[www.ipcc-nggip.iges.or.jp/public/ig/c_lntv1.html](http://www.ipcc-nggip.iges.or.jp/public/ig/c_lntv1.html)

\(^{74}\) The manual for Air Emissions Accounts:  

\(^{75}\) [unstats.un.org/unsd/envaccounting/seeae/](http://unstats.un.org/unsd/envaccounting/seeae/)
The Conference of Parties (COP) has developed standardized requirements for reporting national inventories. The UNFCCC inventory reporting guidelines are currently based on the methodologies and reporting formats of the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories. Furthermore, the IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories, complements the 1996 guidelines. In 2004, separate IPCC Good Practice Guidance for Land Use, Land Use Change and Forestry was developed.

IPCC has recently prepared the draft 2013 Revised Supplementary Methods and Good Practice Guidance Arising from the Kyoto Protocol that has been reviewed by experts. New 2006 IPCC Guidelines for National Greenhouse Gas Inventories will be adopted in November 2013 and applied as of 2015. These may require changes in the compilation of inventory data. NSOs may not yet be aware of the specific changes in methodology and data requirements. It might be beneficial to involve them to, for example, assess data availability and feasibility of requirements and to enable NSOs to prepare themselves for the new or changed requirements.

Harmonization of methods between official statistics and GHG inventories can be best ensured through the formal UNFCCC process where countries are represented. Statisticians could comment on the inventory methodologies through their national representatives delegated to the relevant UNFCCC forums. It is more difficult to directly influence the work of IPCC on methodology development, as it is performed by IPCC working groups consisting of independent experts and directed by a relatively small IPCC Secretariat.

If statistical offices were more involved in the process of compiling emission inventories, they would be more aware of the specific methodological differences and the related inconsistencies between inventory results and official statistics.

**ORGANISATIONAL STRUCTURES AND PRODUCTION RESOURCES**

The activity data for GHG inventories is normally produced in various organisational units within national statistical systems. Those offices that take part in the calculations of emission inventories have a specific organisational unit that has been assigned tasks related to emission inventories. The counterpart for inventory compilers is, however, often missing from the side of NSOs. Even though a counterpart at the NSO could help inventory compilers with the data needed from the national statistical systems and the related development needs.

As mentioned earlier, existing official statistics are not used to their full potential for emission inventories. This means that limited resources are sometimes used for duplicate reporting; for example, energy data are reported both in energy statistics and in emission inventories. This leads to unnecessarily high costs of data collection and additional burden for respondents.

**QUALITY ASSURANCE AND GUIDELINES**

Quality may be understood differently by official statisticians and inventory compilers:

- For statisticians, quality refers to adherence to quality standards in the framework of the Fundamental Principles of Official Statistics and the European Statistical System Code of Practice. Self-assessments of how the data are collected and measured are made. A system of peer reviews is also in place for EU countries and international assessments of national systems are carried out in the East Europe, Caucasus and Central Asia by UNECE, Eurostat and EFTA.

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77 The 2013 Revised Supplementary Methods and Good Practice Guidance Arising from the Kyoto Protocol: [www.ipcc-nggip.iges.or.jp/home/2013KPSupplementaryGuidance_inv.html](http://www.ipcc-nggip.iges.or.jp/home/2013KPSupplementaryGuidance_inv.html)

• Inventory compilers rely on scientific methods and external quality assurance processes. Quality assurance in this case refers to audits done by a third party who is not involved in the process of inventory compilation. These audits are often based on comparing the inventory results with independent data sources, typically available on international level (i.e. from IEA, the Food and Agriculture Organization of the United Nations (FAO) or other established data providers).

The statistical community could have a role in quality assurance of inventories and sharing good practices of data provision and compilation. NSOs could contribute to verifying the quality of activity data by comparing the inventory results to related data sources that may be available in the statistical system. These other data could be used as a verification and quality assurance tool for the GHG inventories. On the other hand, as NSOs are data providers for the inventories, they cannot carry out any external auditing tasks that should be done by an independent entity not involved in the inventory work otherwise.

Different quality reviewing procedures guide the production of GHG inventories and official statistics. The European Statistical System (ESS) Code of Practice provides practical quality assurance guidelines in line with the Fundamental Principles of Official Statistics. The Code of Practice is based on 15 Principles covering (1) the institutional environment, (2) the statistical processes and (3) the output of statistics. A set of indicators of good practice for each of the Principles provides a reference for reviewing the implementation of the Code. The quality criteria for European Statistics are also defined in European Statistical Law.

Perhaps the most important difference in the quality frameworks of official statistics and GHG inventories concerns the institutional framework for data production. For this area, the ESS Code of Practice includes standards for professional independence, mandate for data collection, adequacy of resources, quality commitment, statistical confidentiality, impartiality and objectivity. Of the above criteria, the UNFCCC reporting guidelines only mention confidentiality, but not, for example, independence or mandate for data collection. The European Union Monitoring Mechanism Regulation (EU No. 525/2013) does require member states to ensure inventory compilers’ access to the data. However, UNFCCC rules do require the establishment and maintenance of a well-functioning national system, including the institutional, legal and organisational arrangements that are needed to produce GHG inventories, including the required administrative capacity. Under the Kyoto Protocol, this obligation is also subject to the annual reviews and shortcomings in the national system can be considered as non-compliance with Kyoto obligations, including the suspension from the carbon market.

In the area of statistical processes, the Code of Practice gives recommendations on sound methodology, appropriate statistical procedures, non-excessive burden on respondents and cost-effectiveness. For the GHG inventories, the UNFCCC reporting guidelines and the IPCC Guidelines for National Greenhouse Gas Inventories do not explicitly consider the burden on respondents or cost-effectiveness.

Important differences also exist in the treatment of confidential data. The UNFCCC reporting guidelines state that “emissions and removals should be reported at the most disaggregated level of each source/sink category, taking into account that a minimum level of aggregation may be required to protect confidential business and military information.” Safeguarding the confidentiality of data is crucial for the reliability of official statistics where stricter rules are in place through national statistical laws.

There are also many similarities in the quality criteria used for the results of GHG inventories with the Fundamental Principles and the Code of Practice that deal with statistical output. The quality

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standards of statistical outputs require relevance, accuracy and reliability; timeliness; coherence and comparability; and accessibility and clarity. The UNFCCC reporting guidelines suggest similar criteria for the annual GHG inventories including transparency, consistency, comparability, completeness and accuracy80. The practice, however, differs more than the names of the quality aspects. The descriptions of the quality criteria for official statistics and GHG inventories are provided in Annex 5.

A process of peer reviews is carried out before publishing the results of GHG inventories. The reviews are guided by the UNFCCC guidelines for the technical review of GHG inventories81 and a code of practice for the treatment of confidential data82. In official statistics results are not shared with third parties before they become public to everyone. Instead, according to the principle of impartiality and objectivity, all users have equal access to statistical releases at the same time. A system of peer reviews for NSOs is in place for the EU countries. These reviews are carried out occasionally to complement NSOs’ self-assessments with an external view. For example, during 2006-2008, all NSOs and Eurostat were subject to a peer review establishing compliance with the European Statistics Code of Practice with an emphasis on the institutional environment and dissemination of statistics. The peer review reports are made publicly available83.

The most important quality aspect for the information reported to UNFCCC is transparency, as lack of it would impair the assessment of the remaining quality criteria. In the lack of quality criteria for the institutional environment, the transparency criterion becomes fundamental. Similar issues are covered under the accessibility and clarity criterion of the ESS Code of Practice. The Code of Practice underlines more clearly the need to present statistics in a clear and understandable form, but on the other hand, the UNFCCC reporting guidelines require a specific format for data reporting.

Since 2007, an approach was launched in the UNFCCC process called “measurable, reportable and verifiable” (MRV) as part of the Bali Action Plan. The term measurement refers to estimating the relevant data to measure whether the country is on track with regard to its emission targets. Reporting refers to the commitment by the parties to the UNFCCC to report progress on climate related activities via national communications (including GHG inventories). Verification aims to ensure that the reported information is correct and that confirmed methodologies have been used. All parties to the UNFCCC have agreed to enhance their national MRV systems, but many countries, especially in the developing world, have challenges in ensuring the quality of their data. Where NSOs are not the original data providers, they could contribute to verifying the quality of activity data by comparing the inventory results to related data sources that may be available in the statistical system. These other data of NSOs could be used as a quality assurance tool for the GHG inventories.

To facilitate access to the required data and promote closer cooperation in data quality issues, in some countries emission inventories are compiled in coordination with the official statistical system (see the case study of the United Kingdom in Section 2.2). Releasing individual data, however, as may be required from inventory compilers, would be problematic or impossible for organisations working as part of the statistical system. Inventory compilers may consider emission inventories already as “official” since they are called “official communications”. Consideration as “official” in the statistical system’s use of the term would, however, require adherence to somewhat different standards than the current criteria guiding the compilation of GHG inventories as discussed above.

80 Updated UNFCCC reporting guidelines on annual inventories: unfccc.int/resource/docs/2006/sbsta/eng/09.pdf
81 Review process: unfccc.int/national_reports/annex_i_ghg_inventories/review_process/items/2762.php
83 The Eurostat Code of Practice peer review reports: epp.eurostat.ec.europa.eu/portal/page/portal/quality/code_of_practice(peer_reviews)
KNOWLEDGE AND CAPACITY

Given that the statistical system holds a lot of data with relevance to emission inventory compilation, official statisticians’ knowledge of the data needs of GHG inventory compilers should be improved. That would enable reviewing and potentially reorganizing the existing data of NSOs to match the source data needs of emission inventories. If inventory compilers were to directly request the data they need from the NSOs (for instance, through formal agreements), awareness of the data requirements and changes in them would naturally improve. Lack of direct communication may lead to mistakes; for example, the case of an NSO that decided to discontinue iron and steel statistics without realizing the took away a data source that covered about 10 per cent of emissions in the country.

NSOs’ expertise in activity data could help in cases of problems in data quality, usefulness or consistency. NSOs are also in a good position to support emission inventory compilation by making use of the many detailed data sources they have, as well as by sharing their knowledge of statistical production methodology. For instance, NSOs have developed methods to allow compilation of timely estimates, such as flash estimates of gross domestic product (GDP) or short-term statistics that are published sometimes only 1 or 1.5 months after the reference period. These methods could be used to help improve timeliness of GHG emissions estimates; the quarterly emission estimate, produced by Statistics Netherlands, is a good example of the possible contribution NSOs could offer. The case study of the Dutch quarterly emissions estimates is provided in Section 2.2.

Some of the areas of greenhouse gas inventories (for example, land use) require special expertise that would not be efficient for official statisticians to acquire. The focus should be more on getting the required expertise through partnering and collaboration with the relevant agencies and experts.

The international statistical community should increase their awareness of new priorities stemming from the climate negotiations, as they not only have implications for inventories but also for statistical development. If NSOs were effectively represented at international level, they could be more efficiently informed of the implications of climate negotiations and, for example, of the UNFCCC, UNECE Protocol on PRTRs, WMO or IPCC work.

NSOs could also share experience across countries on how they take part in the emission inventory process. This could save resources, and the mutual support among countries would be helpful for capacity development. NSOs also have an international network for statistical development and sharing of experience. In this context, it is worth noting that the 17th UNFCCC Conference of the Parties in Durban launched a new negotiation (The Durban Platform on Enhanced Action) that foreshadows a single new international agreement beyond 2020 that would bring all major emitters, developed and developing, within the same legal framework. It is to be expected that this new framework should also foresee common MRV rules, allowing for the tracking of progress on emissions across all countries, including those that currently do not provide inventories. There is, therefore, an important opportunity in the next few years to make use of NSOs knowledge and experience in capacity building in new countries that will be obliged to monitor and report on GHG emissions.

COOPERATION NETWORKS

Countries and international organisations noted at the November 2012 and October 2013 expert meetings on climate change related statistics organized by the Task Force that the more involved NSOs are in the national inventory system, the better the results in terms of making use of official statistics. Furthermore, a clear distribution of responsibilities is important. Both NSOs and the inventory compiler should be efficiently engaged in each other’s work.

Closer cooperation between NSOs and inventory compilers has the potential to be mutually beneficial not only because GHG inventories rely on the data coming from the national statistical system, but also because NSOs often take the results of GHG inventories once published and adjust
them to national accounts concepts to allocate emissions to industries and households. The latter is actually a requirement in Europe through the EU Regulation No. 691/2011 on European environmental accounts that was adopted in 2011.

**Creating a national working group** consisting of inventory compilers and the organisations of the national statistical system that provide data for inventories could be helpful. The working group could share information, review existing data and data collections, and discuss related challenges. On European level, good results have been achieved by organising a joint session of already established working groups, e.g. a joint meeting to discuss energy statistics between DG CLIMA’s working group on annual inventories and Eurostat’s energy statistics working group, and with country representatives. As a result of this particular work, inventory compilers discovered the existing practices of the NSOs (for example, the existence of energy statistics manuals) and statisticians started to understand better the needs of inventory compilers.

NSOs should appoint a **contact point for greenhouse gas inventories** to collaborate with inventory compilers and know their data requirements. The same person could be the contact point for climate change related statistics in general. As the organisation of national statistical systems and NSOs varies in countries, the relevant location of such a contact point in the organisation may vary. The contact point could be located 1) in the unit that compiles environmental-economic accounts, especially if the air emissions accounts are compiled there 2) in the environmental statistics unit or 3) in the energy statistics unit.

Meeting the data needs of GHG inventories requires cooperation throughout the statistical system. For example, the role of statistical offices in the compilation of GHG inventories is not always clearly defined. **Greater interaction** between statistical offices, inventory compilers and environmental and energy agencies needs to be established in order to find synergies. The work under the UNECE Protocol on PRTRs provides support for “enhancing national capacities and capabilities for information collection, processing and dissemination, to facilitate public access to information on environmental issues”. Public participation and public access to environmental data, including GHG emissions are at the centre of the Protocol. Cooperation of NSOs and national focal points to the Protocol on PRTRs and PRTR experts at national and international level would be beneficial. Furthermore, as discussed in Chapter 2, relations with inventory compilers can be formalised whereby the NSO is officially recognised as part of the national inventory system.

The quality of emission inventories would benefit from an institutionalized data collection and compilation system and a clear division of responsibilities. In the UNECE survey, several countries mentioned having some challenges in cooperation with the GHG inventory compilers. In some countries the shortcomings of the inventory system relate to institutional arrangements of the national inventory system. NSOs are not always involved in the work, which is why their competences cannot be used to support the inventory process. This means also that the **data of national statistical systems are not used to the full extent** for GHG inventories. Low involvement of NSOs also partly explains why the **links between inventories and other statistics** are weak.

Most standards, classifications and methods of greenhouse gas inventories and official statistics are developed and agreed upon in international processes. Therefore, a **better dialogue internationally** would be mutually beneficial for all international organisations working on climate issues for instance, the UNECE (including the UNECE Protocol on PRTRs), UNFCCC, IPCC and WMO. At international level, NSOs should be represented through the Conference of European Statisticians and its UNECE Secretariat (or another body) in discussions involving the UNFCCC, IPCC, WMO, IEA, International Renewable Energy Agency (IRENA), and other relevant organisations. These organisations could discuss the way in which the data and expertise of the statistical community would best support the work of inventory compilers.

Existing official statistics might be made more useful for emission inventories if the statistical community provided their views through the national representatives to the UNFCCC process when
drafting future requirements for inventory data as well as guidelines for the inventory compilation. Involving NSOs could help reduce the costs of the global system and improve the quality of inventories.

The statistical community should follow up on the outcomes of the UNFCCC Conferences of the Parties, in particular those related to the MRV system. The statistical community could add value to the process by assessing data availability and feasibility.

4.2 Statistical infrastructure for climate change related statistics (other than GHG inventories)

Climate change related statistics are a new area for most statistical offices although relevant data are available in the statistical system. This section analyses the parts of the infrastructure that are weakest or missing with regard to compiling or providing climate change related statistics, and highlights some of the important strengths. The section provides ideas for NSOs so that they can analyse their readiness for providing climate change related statistics.

LEGISLATION

There are two main legislative issues in connection with climate change related statistics and statistical offices: confidentiality and linking data from different sources.

Climate research requires sometimes access to microdata and also detailed geo-referenced statistical data. Protection of confidential data is regulated by statistical laws in most countries, and is an important prerequisite for the production of reliable statistics. It means that identifiable information about individuals, households and businesses is not released and cannot be derived from the released data.

The growing need for microdata from national statistical systems can increase the risk of disclosure and put more pressure to developing new safe methods to access the needed data. Climate research is particularly challenging for data confidentiality due to the need to link data across several datasets and statistical topics, which may result in higher risks of disclosure especially through indirect identification of individual data.

When there is an opportunity to revise statistical legislation, it should be reviewed from the viewpoint of measuring climate change. In several countries the NSO would not get new resources for developing climate change related statistics without an explicit legal mandate. Therefore, consideration should be given to the explicit inclusion of environment, and thus climate change, in statistical laws. NSOs should also start preparing themselves for such challenging requirements (see the following case study).

Case study: The new General Law on Climate Change requires action by the NSO in Mexico

The new General Law on Climate Change of Mexico entered into force in October. The Law defines the roles of different government agencies in climate action and sets the institutional mechanisms for coordination of the work. The Law aims at regulating greenhouse gas emissions, providing direction to climate change mitigation and adaptation and thus reducing the vulnerability of the population and ecosystems to the adverse effects of climate change. The overall objective is to promote the transition to a competitive and sustainable low carbon emission economy.

The Law also assigned new tasks to the National Institute of Statistics and Geography (INEGI) in measuring climate change, namely defining indicators for planning climate policies; monitoring the progress and results of the climate policy objectives; and coordinating the development and maintenance of a new Climate Change Information System.
The new Climate Change Information System would integrate a set of key indicators to monitor the impacts of climate change, and the efficiency of climate change policies. The system should include at least the following topics:

1. Emissions as measured by the national inventory
2. Emission reduction projects
3. Atmospheric conditions including short-term climate predictions, long-term projections, and characterization of the climate variability
4. Vulnerability of human settlements, infrastructure, islands, coastal zones and river deltas, impacts on economic activities, and environment attributable to climate change
5. Average sea level
6. Costs attributable to climate change, to be included in the calculation of the environmentally adjusted Net Domestic Product
7. Soil quality, including its carbon content
8. Protection, adaptation, and management of biodiversity

The key indicators of the Climate Change Information System should be integrated into a geographic information system providing public access through a website. The website should also include some relevant descriptive material, such as inventory reports and assessments of the national climate change policy. INEGI is currently developing the System in line with the guiding principles which emphasize accessibility, transparency, objectivity and independence of data production, and aims at the provision of relevant, accurate and timely information in high quality.

Regardless the different ways of organising national statistical systems, NSO’s coordination task should extend to environmental statistics. Stronger coordination role could help improve the coherence and comparability of data, and enable easier linking of environmental data to socio-economic statistics. Some efficiency gains and simplifications could be identified, as well as synergies in development work.

Analysis of climate change related issues requires linking data from a number of sources, including registers, administrative sources, research data, etc. The ability of statistical offices to get access to these data often requires a legal basis and agreements between institutions that are responsible for keeping the data.

**FRAMEWORKS AND INTEGRATION**

Statistical frameworks help to align the information needs of users, including specific statistics and indicators, with the data sources, classifications, methods and results. Statistical frameworks also consider links between different subject areas and may incorporate data requirements from several fields. As an example, statistical business registers could be useful for producing climate change related statistics if they included a geo-reference for all relevant data. Similar benefits could be identified by reviewing the statistical production process as a whole and asking questions such as: Do we have the sampling frames that include climate issues? Do we have the methodologies and production resources to produce information at the desired level of detail? Do we have the classifications that provide sufficient disaggregation? It may be difficult to determine the exact areas where statistical production should be reviewed before NSOs start deriving the required data to develop climate change related statistics.

**Examples of statistical frameworks that are linked to climate change related statistics** include the **SEEA-CF** and the **UN Framework for the development of environmental statistics (FDES)**. SEEA-CF contains the internationally agreed standards for producing environment accounts and linking

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them with economic statistics, and FDES provides an organizing structure to guide the production of environmental statistics bringing together data from various subject areas and sources. The new version of FDES now considers the links between data needed for monitoring climate change and existing environmental statistics.

Similar developments would be needed for improving the linkage of climate change information with social and economic data, such as with the System of National Accounts (SNA). Air emissions accounts are an example of the usefulness of linking national accounts data with climate change related data. These accounts produced by all NSOs in the EU and in many other countries, and they present annual data on GHG emissions and other air pollutants in a compatible way with national accounts and assign emissions to industries and households according to the International Standard Industrial Classification (ISIC/NACE). Examining emissions with economic data helps identify sources of emissions, analyse the environmental pressure caused by economic activities, and assess the emission intensiveness of economic activities. The Inter-Secretariat Working Group on National Accounts (ISWGNA) drafted additional instructions for recording tradable emission permits in national accounts in 2011, but noted that the issue needs to be reviewed again in the future. Ways to strengthen the links between national accounts and climate data, such as emission trading data (the carbon market) should be considered.

Synergies may be found with other statistical frameworks as well. For instance, the links and inconsistencies of energy statistics with climate change related data should be reviewed. Similarly, agriculture statistics and surveys may need to be slightly adjusted to accommodate information needs for the inventories.

STANDARDS AND CLASSIFICATIONS

The statistical system has the responsibility for definitions, classifications, nomenclatures, methodologies, certified measurements, accounting standards and data quality of official statistics. These tools assist in maximising the effectiveness of statistical outputs and the efficiency of the production process in terms of comparability (over time, space, industry, etc.) and coherence (i.e. the capacity for integration) of the statistics.

While comparability and coherence are important for any dataset, they are particularly important for climate change related statistics since comprehensive analysis of climate change requires using statistical data from many different sources. The ability to combine multiple data sources is a precondition for compiling these statistics. For many indicators, samples should be geographically representative which could be difficult to achieve without combining the data with administrative registers or observation data sets that provide more detail.

The use of standard classifications helps in the production of consistent and comparable statistics over time, regions and across statistical surveys. The current statistical classifications do not fully incorporate the requirements of producing climate change related statistics.

If classifications would allow for climate change to be identified, NSOs could extract and compile the relevant statistical data from existing databases. Ideally classifications would allow extracting climate relevant data for example, on climate education, climate change research, engineering jobs related to solar panels or other “green” jobs, low-carbon industries, “green” technologies, biotechnology products, international trade flows of climate change related products and services, services on adaptation and mitigation, other environmental and climate services. It is, however, possible that the current logic of classifications would not work for measuring a crosscutting issue like climate change.

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change, and that it would require adding another dimension or layer to the existing classifications or data collections.

The statistical classifications should be adapted to include new aspects with relevance to climate change analysis. The statistical system has a structure for periodic reviews of its various sub-systems, which can be used to examine this new user need. For example, the International Standard Industrial Classification of All Economic Activities (ISIC) was revised recently to include more detail in the services sector due to the increasing importance of service activities. Same type of reviews could be undertaken for this and other classification systems with respect to aspects related to climate change during normal revisions of the classifications. The relevant classifications to be reviewed include those on education (ISCED), employment (ICSE), trade (SITC) and products (CPC). A specific group could be dedicated to assessing how each classification supports the measurement of climate change related issues.

Statistical offices typically approach new phenomena to be measured by first ensuring that common definitions can be agreed upon and then designing methodological guidelines for data collection and compilation. The statistical community should be involved in harmonizing practices of climate change related statistics and improving the standardisation of climate change related data and metadata before the number of national sets of climate variables and global portals is multiplied.

**STATISTICAL METHODS AND COMPUTER SYSTEMS**

Spatial statistics often require highly complicated and sophisticated methods, for instance spatial interpolation. Therefore, climate change related statistics might require development of new statistical methods not used in the national statistical system or NSOs otherwise. For example, statisticians are experienced in applying adjustments to make measures comparable over time and adjust them, for example, for seasonal variation. These adjustments that eliminate the effect of some known source of influence, and leave only the changes caused by unknown sources of influence and natural variation, could be useful for measuring climate change related phenomena. On the other hand, many consider that any modelling approaches, based on hypothetical assumptions, should be left outside official statistics.

To measure the impacts and vulnerability to climate change, different types of data from very different sources need to be brought together. This places major requirements for the capacity and inter-functionality of IT systems and requires wide access to different data sets thus underlying the importance of statistical systems to be involved. The data linking techniques and methods of data reconciliation require development. Furthermore, ways for facilitating research and statistical activities linking relevant data across statistical domains should be sought.

One of the challenges is that typically sample surveys do not provide detailed enough regional data for analysis of, for example, the regional economic and social impacts of extreme weather events.

Geo-referencing is a precondition for compiling small area statistics. NSOs’ capacity to provide geospatial data is not yet sufficiently developed to match the detailed data needs of climate change analysis. The Australian Bureau of Statistics (ABS) recently analysed the results of a global consultation on statistical-geospatial frameworks (with 52 replies from countries) at the request of the United Nations Statistical Commission (UNSC). Despite several success stories in the use of georeferencing at NSOs, they still have a limited capacity to increase the amount of data that has a georeference, and to ensure the quality. The results of the global consultation show that many NSOs have developed or are working on developing ways to provide statistical information for smaller geographic regions.

There is a great potential in the use of geographical information systems (GIS) for spatial analysis of the impacts of and vulnerability to climate change. For example, in Mexico and Brazil, geospatial and statistical activities are closely integrated and undertaken by a single organization, the NSO. In addition; for example, the NSOs of Canada, Colombia, Netherlands, New Zealand, Norway and
Singapore have a range of internal geospatial capabilities and a good level of collaboration with their national geospatial community. In Europe, the NSOs provide geospatial data support for the INSPIRE (Infrastructure for Spatial Information in the European Community) programme. As a conclusion of the global consultation, UNSD established an expert group87 composed of representatives of both statistical and geospatial communities to develop a global standard for the integration of statistical and geospatial information.

NSOs need to be careful with geo-referencing to ensure the quality of geo-referencing so that the data make sense. There may be problems in allocating variables geographically, for example, between enterprises’ headquarters and their local units. Another issue is where to allocate pollution originating from a certain factory: to the location of the factory or to the area where the pollution spreads.

ORGANISATIONAL STRUCTURES AND PRODUCTION RESOURCES

The developing role of NSOs in climate change related statistics may call for organizational changes in statistical offices. Most statistical offices have traditionally been organized according to either ‘subject matter’ (where economic statistics could be one of the units) or ‘function’ (where data collection could be one of the units), or a mix of the two. The development of cross-cutting areas, such as climate change, requires an organization that supports collaboration across different structural units and subject areas.

Production resources for new areas of statistics are naturally relatively small, for instance in environmental or climate change related statistics. For the moment, NSOs may not even mention measuring climate change related issues as a responsibility of one of the organizational units.

NSOs cannot and should not try to meet all users’ data requirements. Instead, they need to define their actions taking into account the limited resources, and consider what is both relevant and feasible by comparing data needs to the costs of responding to them. In the beginning, improvements could be achieved even with limited resources by:

1. Demonstrating possible uses of the existing official statistical data with regard to climate change
2. Providing access to the key data of various producers by creating national portals of climate related information
3. Avoiding duplication of data collection through better collaboration with data producers and researchers and
4. Reviewing existing data collections to identify where some changes could be done for the benefit of climate change analysis.

Modernising statistical production processes and services could enable some re-allocation of resources to new areas, and improve access to data across organisational units. Modernising statistical production is a CES initiative as NSOs need to improve their processes to free up resources for new developments. This improvement will be done by harmonising NSOs’ knowledge based on international standards such as the Generic Statistical Business Process Model (GSBPM) and the Generic Statistical Information Model (GSIM) and an alignment of the methods and technology of statistical production. According to the vision of the UNECE High-level Group for the Modernization of Statistical Processes and Services, “the challenge for statistical organizations is to be sufficiently flexible and agile to provide statistics according to user needs, at an acceptable cost.” They state that “in some specific statistical domains, only cross-border data make sense; for example, globalization, enterprise groups and climate change.”

Statistical products and services must become easier to produce, less resource-intensive, and less burdensome on data suppliers. New and existing products and services should make use of the vast amounts of data becoming available, to provide better measurements of new aspects of society, such as e-commerce and globalisation. Statistical organisations should create environments that facilitate the reuse and sharing of methods, components, processes and data repositories that not only enable the delivery of predetermined outputs and services but which also enable new products and services to be created more efficiently, as well as enabling end-users to specify and run their own analyses and produce outputs through remote access to underlying datasets. Organisational changes are required to implement this strategy. This will require strategic leadership from top managers. It is recognised, however, that willingness, readiness and ability to change will vary between organisations.

QUALITY ASSURANCE AND GUIDELINES

Different quality criteria guide the production of official statistics, scientific research and climate change related information. Nowadays, it is difficult for the user to assess the quality of climate information as it comes from various sources. If NSOs started to provide an easier access to these scattered data, they would not be able to provide any quality assurance for non-official statistics produced outside the national statistical system. NSOs could, nevertheless, facilitate access to the data relevant for climate change, but direct users’ questions to the producer of each dataset. Yet, NSOs could promote improvements in the coherence and reliability of climate change related statistics produced by others.

A challenge sometimes mentioned is that while research provides ad-hoc insights into the causes and impacts of climate change, it usually fails to provide regularly updated information and time series. Measuring change in time, on the other hand, is the core competence of statistical offices. In the future, a set of key climate change related statistics could be defined internationally and be provided regularly by national statistical systems for monitoring developments related to climate change.

Climate change is a highly sensitive issue for policy making. Therefore, neutrality of climate change data is very important. Involving NSOs in the compilation could help to prevent political interference to compilation of climate change related information. The strong professional independence of NSOs in most countries could help to increase trust in climate change related data and thus support the climate debate.

Opinions have been expressed that climate change related statistics should be included into the framework of official statistics so that their quality could be ensured. Some users call for quality stamped climate statistics and better metadata that explains where the data come from, how they have been produced and how they should be interpreted. Some countries have an established label of "official statistics" and a clear process and roles for the organizations that are part of producers of official statistics.

The NSOs normally have the coordination role of the national statistical system. In Mexico, for example, statistics that are of national interest belong to the sphere of official statistics and have to follow certain quality criteria. In the United Kingdom, agencies producing statistics have to apply for the national statistics badge, which may be granted based on an assessment of quality of production processes, not data quality directly. The production of environmental statistics in various national agencies could also benefit from closer coordination by NSOs. Currently, internationally recommended methodologies do not exist for many climate change related statistics.

KNOWLEDGE AND CAPACITY

Given that the statistical system includes economic, social and environmental data, the NSOs have acquired knowledge for measuring varying societal issues. However, climate change involves
complex interactions between systems, is multi-disciplinary and anchored largely in the natural sciences. Furthermore, methods for producing spatial statistics may not be so familiar to all NSOs.

The substantive knowledge in climate issues is now spread around many rather specialized agencies, ministries and research institutes that produce and use climate change related data. Climate change information is often collected outside NSOs or even the statistical system by meteorological and atmospheric monitoring networks. Scientific research has a predominant role in providing climate information. At the moment, most statistical offices do not mention climate change as one of the statistical topics they work with.

Measuring climate change requires specific knowledge, and many NSOs currently lack the qualifications necessary to do good work in this area. The knowledge gaps should be taken into account in recruiting staff with the appropriate professional training and experience. Most potential employees, however, might not have the combination of statistical work experience and the required subject knowledge. Therefore, also training on the job is needed. Instead of trying to acquire all the needed expertise themselves, NSOs should aim at getting it through partnering and collaboration with the relevant agencies and experts.

The low and middle income countries are often most severely struck by climate change. At the same time, their capacity to produce the relevant climate change related information is often low. Exchange of current practices and mutual support among countries would be helpful.

Building credibility as a player in the field of science-based climate analysis is a challenge, because statistical offices are relative newcomers to climate issues and do not have large teams of professionals dedicated to this area of work.

**COOPERATION NETWORKS**

Various types of information are needed for analysing the causes and impacts of climate change. One agency cannot produce all the required information. No statistical agency can function effectively without systematic cooperation with outside contacts. Thus, good cooperation is essential to finding ways to better respond to the growing information needs.

Many of the current challenges countries face in developing climate change related statistics are linked to an underdeveloped institutional setting or unclear division of work between organizations. This is the case both nationally, and to some extent also internationally.

With regard to cross-sectional data, such as climate change related statistics, close cooperation and networking with other organizations are a necessity. Coordination of joint work of different organisations is also important for ensuring efficient use of resources and division of work.

NSOs should appoint a contact point for climate change related statistics. As the organisation of national statistical systems and NSOs differs across countries, the relevant location of such a contact point in the organisation may vary. The contact point could be located in (1) the unit that compiles environmental-economic accounts, especially if the air emissions accounts are compiled there, or in (2) the unit of environmental statistics, or in (3) the energy statistics unit. Regardless of the location, the contact point or unit should have the recognised authority to coordinate with other units (e.g. energy, transport, agriculture, etc.) for the purposes of ensuring an adequate response to the cross-cutting nature of climate change statistics.

In the UNECE survey, NSOs underlined the need to improve international comparability of climate change related statistics in close cooperation and to enhance statistical capacities to produce these statistics. They also mentioned the necessity to enhance collaboration with the research community and between institutions involved in producing these statistics, better cooperation and coordination as a tool towards more efficient and consistent data collection, compilation and dissemination.

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The UNEP Environmental Observing and Assessment Strategy highlights several critical gaps that relate to statistical capacity and infrastructure:

- “The most serious problem in many developing countries is not the lack of information, but the failure to share existing information among agencies.”
- “At a more strategic level, these gaps relate to: lack of guidance and coordination of environmentally related observing (fragmented, incomplete and overlapping); too little emphasis on observing of causes and impacts; and too little attention to problem solving, i.e. existing and alternative policies and actions.”
- “Recent experience by UNEP, but also by many other organizations involved in regional or global data collection, particularly Eurostat, UNECE, EEA and OECD, shows that the problem of critical data gaps will not be solved for a long time to come with the current approach to data collection. The complexity and rapid evolution of environmental problems and knowledge mean that new data sets are required constantly.”

4.3 Conclusions on statistical infrastructure

1. For better collaboration, NSOs should have a contact person who would be in charge of coordinating GHG inventory source data issues, collaborating with the inventory compilers and keeping up with the outcomes of the UNFCCC conferences of the parties to better understand and prepare for the associated data requirements. Establishing a working group involving the inventory compiler and producers of official statistics that provide data for the inventories would be helpful.

2. Legislation has a crucial role in supporting production of emission inventories and cooperation among agencies. National legislation should facilitate effective cooperation between agencies belonging to the national emission inventory system and provide a legal basis for access to and exchange of data as required for the inventories.

3. The possibilities to improve the relationships between the concepts and classifications should be examined at the international level. For possibilities to build relationships with the UNFCCC, UNECE Protocol on PRTRs, WMO and IPCC, NSOs would have to be represented by an international entity, such as the Conference of European Statisticians.

4. The Task Force acknowledged the need for capacity building especially, but not only, in countries who have not yet produced annual GHG inventories. There are currently no recognized good practices for NSO role in GHG inventory compilation as their role varies across countries and there is no forum for sharing experience on the topic. It would be in the interest of both NSOs and inventory compilers to consider what these good practices would be.

5. Improvements in the current infrastructure of NSOs are required, such as balancing between detailed data needs and confidentiality; reviewing different statistical frameworks and standards; and in the longer term adjusting organizational structures to support production of cross-sectional statistics.

6. The High-level Group (HLG) for the Modernization of Statistical Processes and Services calls for flexibility of statistical organisations so that they would be agile to provide statistics according to user needs, at an acceptable cost. Cross-sectional statistics, such as climate change related statistics, may pose challenges to the structure and functioning of NSOs. Thus, producing climate change related statistics may be easier to undertake in an organization focused on serving the...
needs of different user categories and producing outputs by re-sorting and combining the collected data to match the user needs.

7. Statisticians will need to build **new kinds of expertise** for producing climate change related statistics. This includes building capacity to produce geo-referenced data; learning new methods of spatial statistics; improving the ability to match data from multiple sources; and building substantive knowledge in climate issues. More than anything else, closer networking with organizations involved in climate issues would be helpful.

8. The production of climate change related data **lacks coordination**. The users of climate data would benefit from better harmonization of concepts, classifications, methods and quality standards. NSOs role is to lead the way in the harmonization and standardization of statistical production and to ensure high-quality information produced, following common guidelines. Currently, such guidelines do not exist for most climate change related statistics other than GHG inventories. In some areas, the existing practices need to be promoted among the involved agencies.
5 RECOMMENDATIONS

This chapter introduces the Task Force’s recommendations for improving climate change related statistics and enhancing their support to greenhouse gas inventories. The recommendations are grouped as follows: 1) recommendations on the data needed for greenhouse gas inventories; 2) recommendations on other climate change related statistics; and 3) recommendations on statistical infrastructure required for this work. At the end of the chapter, the Task Force suggests an agenda for further work at international level.

The recommendations are based on the Task Force’s own discussions and on the following:

- A UNECE survey of national statistical offices (48 countries replied) on their involvement in climate change related statistics and greenhouse gas inventories
- Stakeholder interviews with users of official statistics in matters related to climate change
- Discussion of the interim recommendations by the Bureau of the Conference of European Statisticians (CES) in February 2013 and the CES plenary session in June 2013, and a written consultation of the interim recommendations in June-July 2013 among CES members
- Feedback from two expert meetings: on 19-20 November 2012 to discuss the initial findings and to identify directions for future and on 8-9 October 2013 to review the draft recommendations.

In February 2013, the Bureau of the Conference of European Statisticians stressed the need for urgent action by statistical offices to fill gaps related to climate change. It is hoped, therefore, that the recommendations below will be discussed and acted upon as a priority by NSOs.

5.1 Recommendations related to supporting greenhouse gas inventories

The following recommendations suggest, first, working at the national statistical system to improve data for GHG inventories; second, collaborating at the wider national level with the inventory compilers; third, creating a dialogue at the international level between the “statistical” and the “climate” communities. Concrete steps and priorities are provided as examples for each recommendation.

1. NSOs must improve data and statistics required for GHG inventories; including, energy, industry, transport, agriculture, waste, forestry and land-use statistics. To harmonize and streamline their work on GHG inventories, NSOs may wish to consider the following issues and actions:

   - NSOs should be more aware of how the data of national statistical systems are or could be used in GHG inventories to be able to take into account the related data needs. The national inventory reports submitted to the UNFCCC by GHG inventory compilers in each country and annual inventory review reports prepared by UNFCCC expert teams are important sources of information for NSOs to identify needs for data improvement.

   - Currently, existing NSO statistics are not used to their full potential for emission inventories and some duplication of data collection exists between NSOs and other organizations. Increasing awareness of existing statistics is necessary to avoid this duplication of work. As the coordinator of the national statistical system, NSOs should promote better awareness of existing data in the national statistical system and how they can be used for GHG inventories. Official statistics should be the backbone of the inventories and additional data collection should be carried out only where official statistics cannot be used. NSOs, together with other agencies, need to ensure that inventory calculations use existing statistics as much as
possible. This, in turn, would improve the quality of GHG estimates and consistency with other statistics.

- NSOs should take the initiative in improving quality of statistical data used for GHG inventories.
  
  o Improving coherence of GHG inventories and official statistics where possible by:
    
    - Clarifying the emission categories used in the UNFCCC Common Reporting Format (CRF) tables that are the basis for national inventory reports as compared to statistical classifications. Recompling GHG emissions data from national inventory reports according to the International Standard Industrial Classification (ISIC/NACE) to bring them into closer line with other statistics. Adjustments are currently being made to the CRF categories\(^9\) that may bring them towards using a logic that is closer to ISIC. Developing standardized tools for comparison of official statistics and inventory data, such as correspondence tables. Explaining the differences between GHG inventories and official statistics by using reconciliation.

  o Given the importance of good quality energy balances to underpin GHG inventories, particular emphasis should be put on improving the quality of energy statistics and the related inventory data. Energy statisticians (whether in NSOs or other organizations) should aim to improve the quality of energy statistics and balances and to ensure the consistency of activity data used in GHG inventories with the energy balances reported to international organizations (for example, to Eurostat and International Energy Agency (IEA)).

  o Several countries report the need to address data gaps or quality issues, especially on waste, agriculture, land use and forestry, the production of heat and electricity for own use and from renewable energy sources.

  o GHG inventory analysts would benefit from improved timeliness of activity data, including energy balances. Given the competence of NSOs in producing time series data, they could help develop longer time series for analysing the inventories; for example, data related to the drivers of emissions.

2. NSOs should be proactive in reaching out to national GHG inventory compilers and, ideally, they should be considered official institutions in the national systems of greenhouse gas inventories in all countries. The Kyoto Protocol provides the legal basis for the design of these national systems. Specifically, NSOs may wish to develop their role and involvement in GHG inventory compilation along the following lines.

- Considering that NSOs provide a considerable portion of the statistics required for GHG inventories, NSOs should have a clear role in providing statistics, assisting in calculations as needed and with quality assurance. This should be established through official agreements; for example, by including NSOs in the national systems responsible for GHG inventories. This could be done simply by explicitly noting the role of the NSO in the inventory documentation submitted to the UNFCCC or more formally via a Memorandum of Understanding between the NSO and the national entity responsible for the inventory. This would provide certainty about the roles and responsibilities of each institution and closer co-operation would help improve the quality of GHG inventories.

- Facilitating the collaboration of the national inventory compilers with the statistical system would be part of the NSOs’ role as the coordinator of the national statistical system.

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\(^9\)The draft new CRF-tables are at: unfcc.int/national_reports/annex_i_ghg_inventories/reporting_requirements/items/7691.php
Therefore, NSOs should be aware of the data needs of and be actively engaged in the national inventory system.

- Working with inventory compilers to identify and evaluate statistics needed for emission inventories would help see if the statistics are fit-for-purpose. This work could be started by drafting, together with the inventory compilers, a prioritized list of national data gaps and a road map on data development to improve official statistics for GHG inventories. Development of NSOs’ statistics should be prioritized based on where effective changes can be made in each country.

- It may be beneficial to create a national working group consisting of the NSO, inventory compilers and other relevant organisations belonging to the national statistical system. The objective would be to share information, review existing statistics, identify overlaps and areas for synergies and discuss challenges. The longer term goal would be to reduce costs, avoid duplicate data reporting, improve consistency and move towards multipurpose data systems serving various user needs.

- The experience of NSOs in quality assurance would be useful in supporting the efforts at strengthening the quality of GHG inventory. The European Statistics Code of Practice\(^91\) and the UN Fundamental Principles of Official Statistics\(^92\) form a clear institutional context for compiling objective and impartial statistical information that could be applied to GHG inventories. NSOs could use the approach of data confrontation to compare inventory results with other statistics to reveal unexpected results in the inventories. Such an approach is often useful in revealing errors.

3. **The international statistical community should take an active role** in contributing to the global GHG inventory system. The standards, classifications and methods of greenhouse gas inventories and official statistics are developed and agreed upon in international processes. Therefore, a better dialogue among international organisations, including international statistical organizations, working on climate issues would be beneficial. The international statistical community and the NSOs may wish to consider the following issues and actions:

- **Seeking closer collaboration** between international statistical organizations (for example, the UNECE Conference of European Statisticians and its Secretariat and the UN Statistics Division) and UNFCCC, IPCC, UNECE Protocol on PRTRs, WMO, International Renewable Energy Agency (IRENA), International Institute for Applied Systems Analysis (IIASA) and others. Better interaction at this level could help, for example, to ensure that inventory method development takes into account the availability of data and to avoid development of methods that require data that are not generally available in most countries.

- **Following up on the outcomes of the UNFCCC conferences of the parties to the convention.** This would help reduce the costs of the global system and improve the quality of inventories. The statistical community can add value by assessing data availability and feasibility of requirements related to the Kyoto Protocol, and by preparing themselves for possible new data requirements.

- **The 17th UNFCCC Conference of the Parties in Durban launched a new negotiation (the Durban Platform) that foresees a single new international agreement beyond 2020 that would bring all major emitters, developed and developing, under the same legal framework.** Involving NSOs from the beginning in countries that will enter this framework over the coming years could help to avoid creating overlapping data reporting systems.

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\(^92\) [unstats.un.org/unsd/dnss/gp/fundprinciples.aspx](unstats.un.org/unsd/dnss/gp/fundprinciples.aspx)
• Actively collaborating with UNFCCC review teams to engage more effectively with UNFCCC, UNECE Protocol on PRTRs and the IPCC work. This collaboration would offer insight into how official statistics could be better used in GHG inventories.

• The existing international network of NSOs could also help exchange experience on NSO’s contribution to the quality of GHG inventories; for example, through expert meetings, newsletters and other communications tools.

5.2 Recommendations on climate change related statistics (other than GHG inventories)

The following recommendations suggest, first, facilitating access to data that already exists; second improving the existing data for climate change analysis; and after that developing new statistics based on a review of key data needs in each country. Concrete steps and priorities are provided as examples for each recommendation.

4. NSOs must improve the contribution of official statistics to climate change analysis. One of the first steps should be facilitating access to existing statistics within the national statistical system. To do this, NSOs may wish to consider the following issues and actions:

• Creating national forums for discussions between producers and users of climate change related statistics; for example the meteorological agencies and the scientific community. These discussions would help NSOs identify their most relevant existing statistics and most urgent needs for new statistics.

• Promoting the use of the existing official statistics for the purposes of climate change analysis. If stakeholders have knowledge of existing data, duplication of data collection activities will be avoided.

• Using NSOs’ dissemination channels to provide access to climate change related statistics. This may include also data not produced by the NSO (for example, scientific data). At the moment, statistics needed for understanding the causes and consequences of climate change are scattered across various organizations. Creating a “portal” for climate change related statistics as part of NSOs’ dissemination channels would make them more accessible and easier to use. The portal would be an entry point to data and metadata on a wide range of existing data and statistics with relevance to climate change. This would require cooperation with scientific organizations. Meteorological services, for example, have long time series of data on climatic variables (temperature, precipitation, etc.) that could be provided with the data of national statistical systems.

• Considering new approaches to preserving confidentiality of respondents’ data to improve access to microdata for policy makers and scientists working on climate change.

5. The usefulness of existing environmental, social and economic statistics for climate change analysis should be improved; for example by better structuring them. To do this, NSOs may wish to consider the following issues and actions:

• Reviewing statistical programs and data collections from the view point of the data needs of climate change analysis; for example to see if they provide suitably detailed statistics on renewable energy, green jobs, food production, water use, health and diseases, tourism, population and population growth, among other things. In some cases, simple adjustments to data collections may improve the value of statistics for climate change analysis, leading to more efficient use of limited resources. Users could be invited to help guide these reviews to identify key needs for improvements.
• Addressing the difficulties in matching data from different statistical domains and the lack of coherence among data sets. NSOs should put emphasis in improving linking between socio-economic data sets and environmental data sets by means of increased methodological and operational harmonization.

• Geo-referencing all relevant data to support analysis of the spatial dimension of data linked to climate change. This would also improve linkage of existing data with climate change and other environmental data. A good example is the support provided by NSOs in Europe for the INSPIRE programme.

• Producing statistics for new geographical areas, such as coastal areas or areas prone to flooding or drought. More statistics related to urban areas and other small regions are needed especially in developing countries. Often survey samples do not provide sufficient coverage to compile small-area statistics. In some cases, it may be possible to obtain useful data from administrative sources that cover populations at a finer level of resolution than is possible with sample surveys.

6. NSOs should consider development of new statistics based on a review of the key data needs of climate change policy makers and analysts in their country. When considering the production of new statistics, it is important to recall the key competencies of NSOs and take into consideration the traditional boundaries of their work; for instance, NSOs do not usually compile forecasts or make judgements about cause-effect relationships. Based on the analysis presented in Chapter 3, the key data gaps to consider include among others:

• Analysing drivers of climate change by considering new efforts to connect economic information to climate change related issues by developing or expanding environmental accounts that allow, for example, GHG emissions and water use to be linked with economic activities. This would facilitate multi-sectoral analyses of the drivers of climate change. The SEEA-CF guidance should be followed in constructing such accounts. Implementing the SEEA-CF to support measurement of climate change related issues should be seen as an important strategic goal for NSOs. International statistical organisations should consider how to best support countries in the use of the SEEA-CF for the measurement of climate change related issues.

• Developing statistics on the use of economic instruments in climate change mitigation efforts for analysing the effectiveness of new instruments (for example carbon taxes, tradable emission permits, subsidies). The measurement of financial flows associated with the use of these instruments and the inclusion of these flows in a clear, consistent and observable fashion in government finance statistics and national accounts needs to be addressed.

• Developing statistics to address climate change adaptation and adaptive capacity; for example statistics measuring resilience, risks and vulnerability of population groups and societal preparedness to withstand the adverse impacts of climate change. Relevant measures include populations at the risk of natural disasters or at the risk of poverty due to climate change.

• Considering how to contribute to the on-going efforts to monitor biodiversity and ecosystems. Climate change is one among a range of human factors affecting ecosystems and the related goods and services. Establishing baseline estimates of ecosystems today will make the assessment of the impacts of climate change more robust. As this work falls quite far from NSOs’ normal area of work, this will require cooperation with environmental protection agencies and other organizations responsible for ensuring ecosystem quality.
5.3 Recommendations on statistical infrastructure

The following recommendations suggest, first, reviewing the current statistical infrastructure to see how the needs of climate change analysis are met; second, acquiring some new capacity, knowledge, skills and partnerships; and third considering how the current organisation of work in each country supports producing climate change related statistics. Concrete steps and priorities are provided as examples for each recommendation.

7. Existing classification systems, registers, definitions, statistical frameworks, products and services need to be reviewed to see that needs related to climate change analysis are appropriately addressed. Furthermore, the legislative environment for producing climate change related statistics and supporting the compilation of GHG inventories may need to be assessed. The following issues and actions may be considered by NSOs:

- Giving consideration in future revisions of international statistical standards and classifications to the data needs of climate change analysis, for instance, by introducing changes in the System of National Accounts to improve statistics on emission trading systems following the guidelines of the IPCC/UNFCCC. The relevant classifications to be reviewed include e.g. those relating to industries (ISIC), education (ISCED), employment (ICSE), trade (SITC) and products (CPC). If these classifications allowed for climate change related statistics to be more easily identified, NSOs could more readily extract and compile new statistics from existing statistical data. Improved classifications might, for example, enable extraction of data on climate-related education, research, jobs, “low-carbon” industries, “green” technologies, biotechnology products, and international trade flows.

- Identifying and addressing the obstacles to linking statistics across domains – in particular, environmental and energy statistics – both with each other and with the national accounts. Examples include reviewing differences in the concept of “energy” across statistical domains, ensuring data consistency across institutions and testing the use of supply-use and input-output data for linking industrial production to energy use and air emissions.

- Considering new approaches to preserving confidentiality of respondents’ data while providing access to microdata for policy makers and scientists working on climate change. Protection of confidential data is assured by statistical laws in most countries and is an important prerequisite for the production of reliable official statistics. Any solutions sought must, therefore, be in line with existing legal frameworks. An approach used in some countries is to assign those elements of the GHG inventory compilation process that require the use of confidential data to the NSO. New technological solutions may be needed for providing access to more detailed data without compromising data confidentiality. This could include the use of search engine type of tools which allow making queries to microdata through the website, such as the DECA tool presented in section 3.1.

- Considering the inclusion of explicit references to environmental statistics, including climate change related statistics, in statistical laws when there are opportunities to revise them. NSOs may not be provided with financial resources for developing climate change related statistics without an explicit legal mandate.

8. Statisticians will gradually require new partnerships, expertise and ability to adopt new methodologies for producing climate change related statistics. To strengthen the available knowledge, NSOs may wish to consider the following issues and actions:

- Building knowledge and understanding of the natural sciences among NSO staff who, traditionally, have been professional statisticians specialized in economic and social topics. This can be achieved, largely, by partnering and collaboration with other agencies and experts, and in part, by looking beyond traditional disciplines when recruiting staff. Staff with such knowledge will be better able to communicate with experts involved in the
IPCC/UNFCCC regarding, for example, the kinds of activity data that NSOs realistically can and cannot provide. It should be recognized, however, that some of the areas of GHG inventories (for example, land use) and climate change related statistics require specialized expertise that would not be sensible for NSOs to acquire. In those instances, the focus should be on acquiring the required expertise through partnering.

- **Familiarizing staff with GHG inventory methodologies** and their evolution to increase synergies between inventory compilers and official statisticians. NSO staff should, for example, understand the logic of the CRF tables and the IPCC methodologies and guidelines, as well as review the issues raised in the *Inventory Review Reports* regarding source data for the inventories.

- **Developing knowledge, methodologies and tools for producing and using geo-referenced data** across the statistical system.

- **Ensuring the effective transfer of knowledge and skills among NSOs** internationally. Tackling the challenges of climate change will require good quality, comparable data across a wide range of countries. A basic level of knowledge and skills in this domain will, therefore, be required in all countries.

9. In the longer run, **organizational changes may be needed** in NSOs, the national statistical system and the national system for greenhouse gas inventories to support the production of climate change related statistics. In this regard, NSOs may wish to consider the following issues and actions:

- **Assigning, as a first step, a person or group with the primary responsibility for ensuring the quality and availability of climate change related statistics**, including statistical data for GHG inventories, and establishing contacts with key users and producers of climate information.

- **Modifying, in the longer term, the organizational structure of NSOs** or the national statistical systems to support production of climate change related statistics that cut across the statistical system. According to the *High-level Group for the Modernization of Statistical Processes and Services*,

93 "the challenge for statistical organizations is to be sufficiently flexible and agile to provide statistics according to user needs, at an acceptable cost." They note that crosscutting data are necessary but may pose challenges to the existing structures and functioning of NSOs.

- **As suggested above, especially in the context of GHG inventories, changes and clarifications may be needed in the division of work and responsibilities** between the different producers of climate change related data and GHG inventories.

- **Earmarking sufficient resources** for the development of environmental statistics and climate change related statistics. The modernization of statistical processes that many NSOs are targeting currently may liberate financial and human resources that could be used to meet new needs related to climate change.

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93 [www1.unece.org/stat/platform/display/hlgbas/High-Level+Group+for+the+Modernisation+of+Statistical+Production+and+Services;jsessionid=A1510C0DA74657AC6CB50E183E689069](http://www1.unece.org/stat/platform/display/hlgbas/High-Level+Group+for+the+Modernisation+of+Statistical+Production+and+Services;jsessionid=A1510C0DA74657AC6CB50E183E689069)
Next steps and unresolved issues

The recommendations above are the first that have been developed to help NSOs improve climate change related statistics and enhance their support to the compilation of GHG inventories. They cannot, therefore, be taken to be the final word on this topic and NSOs can be expected to require further guidance to help them take account of the needs of climate change analysis and GHG inventories.

The Task Force suggests that guidance be provided to countries that wish to move forward in the implementation of these initial recommendations. Therefore, it is suggested that a small steering group, comprising 6-8 countries and international organizations, be established to provide on-going direction to countries wishing to move forward.

A longer term goal should be to define a set of key climate change related statistics. Several countries are currently developing climate change indicator sets for policy purposes. This work should be internationally coordinated to enable availability of comparable statistics across countries.

One of the key conclusions of the Task Force work has been the need for better dialogue between NSOs and those involved in climate change policy and analysis. During the course of its work, the Task Force established good contacts and working relationships with the IPCC, UNFCCC, UNECE Protocol on PRTRs and WMO. The members of the statistical system need to continue engaging with these organisations to further define and establish the role of NSOs and other members of the system in support of climate change policy and analysis. For this to happen, NSOs, GHG inventory compilers and relevant international organizations must continue to share ideas, good practices and areas for collaboration.

Therefore, the Task Force suggests establishing an international forum for discussions among the producers and users of climate change related statistics with the participation of IPCC, UNFCCC UNECE Protocol on PRTRs and WMO as a logical next step. These partners have expressed support for forming such a forum. The forum could identify specific areas of climate change related statistics that require further methodological work. These, in turn, could be addressed by setting up focused task forces to help countries tackle the related methodological work. The Forum should be country driven and designed to facilitate:

- Sharing development ideas and experience, as well as good practices in climate change related statistics.
- Discussing collaboration, roles and division of responsibilities among the statistical community, greenhouse gas inventory compilers and the relevant international organisations.
- Exploring the priority data needs in climate change related statistics to enable selection of a key set of climate change related statistics.
- Discussing concepts and measurement frameworks to be developed for the key climate change related statistics.
- Identifying areas where practical methodological guidance would need to be developed for NSOs.

There are many unresolved issues that should be considered in order to develop climate change related statistics further. Below is a sample of some of the unresolved issues to be discussed as part of future international work on climate change related statistics:

- What statistics should be disseminated in climate change portals and in what level of detail?
- How to ensure coherence of GHG inventory data with official statistics (energy, environmental accounts, and national accounts)?
- How best to use SEEA-CF for the measurement of climate change related statistics?
- How to update existing statistical standards or classifications to better serve climate change data needs?
An important challenge will be to find the balance between country-specific development work and setting standards to improve quality and comparability of climate change related statistics internationally. Both will be needed – methodologies cannot be developed without country experience and research – but standards must be developed before diversified statistical practices are in place.
ANNEX 1
Terms of reference

ECONOMIC COMMISSION FOR EUROPE
CONFERENCE OF EUROPEAN STATISTICIANS

Second Meeting of the 2011/2012 Bureau
Geneva, Switzerland, 2-3 November 2011

Item 4(c) of the Provisional
Agenda

TERMS OF REFERENCE FOR A TASK FORCE ON CLIMATE CHANGE RELATED STATISTICS
Prepared by the UNECE secretariat

I. BACKGROUND

1. In recent years, several initiatives have highlighted the need to develop climate change related statistics for the purpose of climate change mitigation, impact and vulnerability analysis, and adaptation. The Stiglitz-Sen-Fitoussi Commission’s report called for a set of well-chosen indicators to describe the environmental aspect of sustainability, including climate change. The need to complement Gross Domestic Product (GDP) with other statistics (for example, to address climate change, had also been noted by the EU Commission’s initiative “GDP and beyond”. More recently, an EU sponsorship group on measuring progress, well-being and sustainable development has selected further development of climate change indicators to be among its priorities for future work.

2. The UN Statistical Commission (UNSC) has also supported the work on developing climate change related statistics. Led by the UN Statistics Division in New York, two Conferences on Climate Change and Official Statistics were organized in 2008. Soon thereafter, the Australian Bureau of Statistics prepared a programme review for the UNSC on how official statistics can better contribute to the climate change debate. The programme review recommended developing a framework for climate change related statistics, improving the quality of greenhouse gas (GHG) inventories and advocating the use of official statistics for climate change policies. The UNSC recognised the role of official statistics in closing these data gaps, and emphasised the need for better understanding of the data requirements of stakeholders.

3. Climate change related statistics is a new area for the national statistical offices (NSOs), and therefore, the UNECE considers important that the NSOs define their role among the institutions involved in producing climate change related statistics. During its two latest Commission sessions, the UNECE stressed the need to work towards robust, timely and comparable statistics on climate change in the context of environmental indicators.

4. In view of the latest developments, the Bureau of the Conference of European Statisticians (CES) decided to take stock of the current state of work on climate change related statistics in the NSOs, and asked the UNECE to conduct a survey. The aim of the survey was to find out the extent to which the NSOs are involved in producing climate change related statistics and to identify issues of common concern for further work at international level.

5. The survey was also undertaken at the request of the UN Committee of Experts on Environmental-Economic Accounting, and the UN Statistics Division supported the work. The
questionnaire was consulted with experts from Statistics Norway, Statistics Finland, Eurostat and the European Environment Agency (EEA).

6. The survey covered 69 countries reaching beyond UNECE region, and 47 countries replied. A report on the findings is provided in document ECE/CES/BUR/2011/NOV/9 Add.1. According to the survey, 75 per cent of NSOs that replied participate in producing GHG inventories, whilst almost 40 per cent of them produce climate change indicators. Many countries have concrete plans on how to improve work in this area.

7. The respondents identified the following priorities for international work:
   - establishing a framework for climate change indicators
   - defining areas for NSOs to improve the accuracy and quality of GHG inventories
   - harmonising and mapping the GHG and statistical classifications
   - considering the role of NSOs among other agencies dealing with climate change related statistics.

8. The draft Terms of Reference are prepared to address the needs identified by countries in the survey. The draft was consulted with Statistics Finland, Statistics Norway, Eurostat and EEA, and incorporates their comments.

II. MANDATE

9. The work of the Task Force is conducted within the framework of the Conference of European Statisticians (CES) and its Bureau. The Task Force will be created for a period of two years, after which it will submit a final report.

III. OBJECTIVE

10. The main objective of the Task Force is to identify practical steps to support future development of climate change related statistics to meet user needs, and to enhance the role of official statistics in GHG inventories.

11. In pursuing this objective, the Task Force will discuss and collaborate with other bodies involved in international work on climate change related statistics, including the work of the United Nations Framework Convention on Climate Change (UNFCCC), the Intergovernmental Panel on Climate Change (IPCC), Eurostat, EEA and UNSD. Regular progress reports will be submitted for consultation with the UN Committee of Experts on Environmental-Economic Accounting (UNCEEA) established by the UN Statistical Commission.

12. The work will address issues of climate change related statistics, in particular those related to GHG inventories, statistics on the consequences of climate change and measures taken to reduce climate change and its adverse effects.

IV. PLANNED ACTIVITIES AND OUTPUTS

13. The Task Force will undertake the following activities:
   (a) Define the scope of work for the Task Force and what is meant by climate change related statistics
   (b) Assess the gap between the user needs and the available climate change related statistics, including international reporting activities
   (c) Explore ways for harmonising the GHG and statistical practices by mapping the classifications and identifying what data NSOs have for GHG inventories
   (d) Identify possibilities to simplify the calculation and improve the quality of GHG data, and consider issues for further revisions
(e) Review links between climate change related statistics, the System of Environmental-
Economic Accounts (SEEA) and the UN Framework for the development of environmental statistics
(FDES), both currently under revision.

(f) Consider organisational issues and the role of NSOs in climate change related statistics.

14. The output will be a review of the current state of climate change related statistics and
possibilities to develop and streamline the work, with a proposal for:

(a) Developing climate change related statistics for evidence-based climate change policies:
concrete steps and priorities for further work

(b) Harmonising and streamlining the work of NSOs on the GHG inventories.

V. TIMETABLE

15. The Task Force will work for the period from January 2012 to end of 2013.

VI. METHODS OF WORK

16. The Task Force should develop a more detailed work plan at its first meeting, which will be
presented to the CES Bureau. The Task Force will meet face-to-face at least once per year as agreed
by the Chair and members. Much of the work is expected to be carried out electronically.

17. The Task Force should be chaired by a statistician with experience and knowledge of the
issues. The Chair will have the responsibility for ensuring that the Task Force fulfils its mandate and
that its composition is balanced between statisticians and other experts. A leadership sub-group
from among the Task Force members will be created to assist the Chair in managing the work.

18. The UNECE will provide secretariat support to the work of the Task Force.

VII. MEMBERSHIP

19. The Task Force will be open to all CES members. International organisations, including UN
bodies and other agencies are welcome to participate.

20. The work will be initiated with a small group, including the NSOs of Canada, Finland, Italy,
Norway and United Kingdom, as well as EEA, Eurostat and UNSD. At the first stage, this group will
focus on defining the scope of work and assessing the gap between the user needs and the available
statistics.
ANNEX 2
Examples of variables in selected frameworks and approaches

A. DRIVING FORCES – PRESSURE – STATE – IMPACTS – RESPONSE (DPSIR)

State:

- **Atmosphere and climate**: earth’s surface and the stratosphere; air temperature; hot and cold extremes; precipitation extremes; ozone concentrations
- **Cryosphere**: glaciers; Arctic sea ice; mountain permafrost; snow cover
- **Marine biodiversity and its ecosystems**: sea level rise; sea surface temperature; storm surges; retreat of shorelines due to erosion; distribution of marine species

Driving forces:

- **Population structure and movement**: Population movements; urbanization and structure of households (lower number of members).
- **Wealth and consumption**: demand for energy and transport; demand for housing (more and bigger houses occupied by smaller households; more heated houses; more household appliances); intensive agricultural practices higher levels of waste and changing diets (demand for meat; industrial scale food production; processed foods; imported foods; etc.).
- **Economic activity**: Increasing mining; manufacturing and construction; increasing GDP and higher economic growth.
- **Globalisation**: Internationalization of the economy (more global trade; outsourcing to third countries; especially "carbon leakage" in the case of more polluting industries; and tourism that increases international transportation.

Pressures:

- Combustion of fossil fuels in different industry sectors
- Production of fossil fuels
- Livestock in agriculture
- Emission factors
- Production of ozone depleting substances
- Waste treatment methods; etc.

Impact:

Impacts in terms of natural phenomena:

- **Water quantity**: water availability; extreme events/floods/droughts and water discharge
- **Freshwater quality and biodiversity**: lake/river temperatures; lake/river ice cover; water quality; aquatic ecosystems; movements of freshwater species
- **Terrestrial ecosystems and biodiversity**: shifts in plant species northward and uphill; seasonal cycles in plants; behaviour of birds and insects; composition of ecosystems
- **Soil**: carbon sequestration in vegetation and soils; water retention capacity

Socio-economic impacts on the well-being of society:

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94 These are the categories four to seven of the state and impact indicators of climate change as defined by the European Environment Agency (EEA):
acm.eionet.europa.eu/reports/CC\%20State\%20Impact\%20Indicators\%20in\%20Europe

95 These are the first three categories of the state and impact indicators of climate change as defined by EEA.
• **Agriculture and forestry**: growing season and yields of key crops; agricultural crops cycle; irrigation; pests and diseases; forest growth; forest fires
• **Human health**: mortality due to heat-waves; hospital admissions (allergies, hay fever); distribution of vector-borne diseases (for example, malaria and Lyme-disease); and food-water-borne diseases; vulnerable groups
• **Economic impacts**: insurance costs; electricity, gas and water consumption; shifts of major flows of tourism; vulnerable regions; losses resulting from weather and climate-related events in industry and transport sectors; changes in income levels and income distribution

**Responses:**
Responses cover measures taken and are often expressed as official targets, such as, for example, the quantified emission limitations or reduction objectives under the Kyoto Protocol to the UNFCCC:
- % reduction of greenhouse gas emissions compared with 1990 levels
- % share of energy from renewable sources in gross final energy consumption
- % increase in energy efficiency

Information on:
- Economic opportunities generated, like eco-industries, “green” jobs and “green” growth
- Community actions to mitigate the effects and adapt to climate change
- Development of eco-friendly technology and technology exchange

**B. THE SYSTEM OF ENVIRONMENTAL-ECONOMIC ACCOUNTING (SEEA-CF)**

**Accounts for physical flow of materials and energy:**
Natural inputs are flows from the environment to the economy, such as:
- **Natural resource inputs**: flows from the environment (e.g. of minerals, timber, fish, water inputs) and extraction of natural inputs
- **Other natural inputs**: energy use and supply, renewable and non-renewable energy sources, energy from solar and wind sources and the air used in combustion processes

Products flows (supply and use by source) that take place within the economy
- Output, intermediate consumption, value added, household and government final consumption expenditure, gross capital formation, imports, exports

Residuals refer to the flows from the economy to the environment, such as:
- Residuals generated by industry, households or scrapping and demolition of produced assets (e.g. data on sources of waste, air emissions by origin and destination)
- Collection and treatment of waste and other residuals (e.g. incineration), accumulation of waste in controlled landfill sites (e.g. landfill emissions of methane), residual flows direct to environment

**Accounts for stocks of environmental assets:**
Size and changes of environmental assets, such as:
- **Ecosystem assets**: some countries have tested the compilation of experimental ecosystem accounts in which ecosystem stocks are evaluated from a number of perspectives, including that of climate change

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96 These are the last three categories of the state and impact indicators of climate change as defined by EEA.
• **Land assets**: opening stock; additions (e.g. natural growth); reductions (e.g. removals, natural losses and catastrophic losses); closing stock; land use by type of use; land cover types; managed or natural expansion, natural regression and reappraisal of land cover types;

• **Other natural assets**: opening stocks, additions to and reductions of stocks and closing stocks for example for energy (and energy from renewable sources), soil (e.g. soil erosion, catastrophic losses), forest (e.g. afforestation; deforestation), timber (e.g. carbon accounts for timber resources), aquatic resources, other biological resources (e.g. cultivated animals and plants including livestock, annual crops) and water resources (e.g. surface, ground, soil water, precipitation, use)

**Accounts for economic activities and transactions related to the environment:**

**Environmental protection**: for example protection of ambient air and climate, wastewater management, waste management, protection of biodiversity and landscapes, related research and development

• **Environmental Protection Expenditure Accounts (EPEA)**: output, intermediate consumption, gross value added, net operating surplus, labour input, gross fixed capital formation of environmental protection specific services, supply and use of these services, expenditure for environmental protection purposes and financing these expenditures.

• **Environmental goods and services (EGSS)**: for analysing degradation and depletion; producers of EGSS, output, value added, employment, exports, and gross fixed capital formation related to the production of environmental goods and services reflecting only amounts related to an establishment’s production of EGSS (except for output). At this stage, a full functional account for the EGSS has not been defined.

**Resource management**: for example managing biodiversity and landscapes, ecological functions; the quality of the natural environment and restoring natural resource stocks

• **Resource management expenditure** (following the EPEA structure, not yet widely developed): production of resource management specific services, supply and use of the services, national expenditure and financing

**Other transactions** related to the environment are often linked to the economic aspects of the environment and influencing the behaviour of producers and consumers with respect to the environment providing data such as:

• **Payments to government**: environmental taxes on products, production, income etc. of something that has a proven, specific, negative impact on the environment (e.g. energy, transport, pollution or resource taxes); rent for the use of environmental assets; fines and penalties; permits to extract and harvest natural resources (e.g. mineral, energy, timber, aquatic, water resources) and permits for the use of the environment as a sink (e.g. accounting for tradable emission permits)

• **Payments by government**: environmental subsidies intended to support activities which protect the environment or reduce the use and extraction of natural resources; social benefits to households are current transfers received by households intended to provide for the needs that arise from certain events or circumstance; investment grants; and other transfers

• **Environmental consequences of disposing fixed assets**: costs incurred to prevent environmental problems when production or operation ceases and use of fixed assets ends
C. FRAMEWORK FOR THE DEVELOPMENT OF ENVIRONMENT STATISTICS (FDES)

Environmental conditions and quality:

- **Physical conditions**: data on atmosphere, climate and weather, hydrological systems, terrestrial, marine coastal area and island characterizations, geographic information
- **Soil and Land cover**: soil characteristics (including degradation) and land cover
- **Biodiversity and ecosystems**: state of and changes in ecosystems, flora, fauna and terrestrial and marine biodiversity, forests, existence of protected areas and species, extent, localization, health, characteristics, main patterns, trends and vulnerabilities of ecosystems
- **Environmental quality**: concentrations of climate process drivers (emissions of these pollutants will be covered under component 3); biological, hydro morphological and physico-chemical parameters of fresh and marine water; and finally soil quality.

Environmental resources and their use:

- **Non-energy mineral resources**: stocks and changes (due to new discoveries, extraction, catastrophic losses, reappraisals, etc.)
- **Energy resources**: stocks and changes (due to new discoveries, extraction, catastrophic losses, reappraisals, etc.) renewable and non-renewable energy production, energy consumption
- **Land**: land use and land use change by land use category (for example, agriculture, forestry, built up land and land used for maintenance and restoration of environmental functions with an impact to climate)
- **Biological resources**: stocks and changes in timber resources; changes in aquatic resources (different species) and other biological resources (flora and fauna organisms), crops and livestock
- **Water resources**: water stocks, use and returns, including in snow, ice and glaciers.

Residuals:

- **Emissions to air**: GHG released to the atmosphere and consumption of ozone depleting substances (ODS).

Extreme Events and Disasters:

- **Natural extreme events and disasters**: frequency, location, intensity and impact (people affected, economic loss and ecosystem integrity) of disasters and extreme events deriving from climate change (storms, tornados, droughts, floods, extreme temperatures, mass movement, wildfires, earthquakes, volcano eruptions, tsunamis).

Human Settlements and Environmental Health:

- **Human habitat**: data on housing conditions allowing to identify houses in zones vulnerable to climate related natural disasters and extreme events, population exposed to air pollution
- **Environmental health**: data on epidemic changes (vector borne diseases) and incidences, morbidity and mortality related to climate change phenomena.

Environment protection, Management and Engagement:

- **Protection and resource management expenditure**: costs of mitigation and adaptation measures
- **Environmental governance and regulation**: climate change related protection measures and climate conventions; regulation (norms, environmental licensing, recycling and energy efficiency programmes, number of quotas and other restrictive production norms, per sector or economic activity), economic instruments (climate change related taxes, subsidies, eco labelling, certification and other market instruments)
• **Extreme Event Preparedness and Disaster Management**: management systems address to cope with climate change related extreme events

• **Environmental Information and Awareness**: climate change related information education and perception

**D. NATURAL CAPITAL APPROACH**

**Natural assets:**

**Ecosystems:**

• Terrestrial ecosystem
• Aquatic ecosystem
• Atmospheric ecosystem

**Land:**

• **Provision of space**: dwellings, transportation infrastructure, agriculture and recreation
• **Types of land area**: land areas of specific types can be augmented or diminished as a result of climate change and changes in the way in which land is used. For example, increasing use of land for urban purposes.

**Sub-soil resources:**

• **Stocks of ecological goods**: for example, minerals, fossil fuels and water

**Ecological good and service flows:**

• The **provision of space** for human activities may be impacted by changing patterns of rainfall and temperature and by flooding of coastal areas. Currently viable agricultural land may become less productive if rainfall decreases and/or temperatures increase. Coastal areas that provide living space for millions of people and much of the world’s economic activity may become less habitable.

• The **flood protection** service offered by forests and wetlands may be disrupted by changing rainfall patterns and, especially, the greater frequency of severe storms.

• Protection from the spread of **vector-borne diseases** may be hindered as changes to ecosystems allow the spread of insects and other disease-carrying organisms to areas where they did not previously exist.

• The **transportation service** offered by rivers, lakes and oceans may be disrupted in places where water levels fall below historical averages as a result of decreased rainfall or where increased storms add additional risk to the use of the services. Increased rainfall leading to increased runoff and, ultimately, to increased siltation of river beds and harbours, with consequences for navigability.

• The **recreational opportunities** offered by the environment are likely to be reduced in a variety of ways. Forests, for example, may become less attractive as destinations if trees are unable to adapt quickly enough to changing conditions and die as a result. Similarly, the quality of seaside recreational experiences will decline if ocean levels rise sufficiently to flood beaches and if coral reefs die in large numbers.

• Those who appreciate the environment for its **aesthetic, cultural or existence value** may find fewer reasons to appreciate the environment for what it offers in these regards as a result of climate change.

• **Food production** may be reduced if rainfall and temperature patterns change such that agricultural land becomes less productive (the opposite may occur if unproductive land becomes productive because of warmer temperatures or increased rainfall).
• **Flows of marine resources** (seafood, etc.) may be reduced if ocean temperatures and currents change.
• Timber and other **forest product flows** may be reduced if forest ecosystems are disrupted.
• **Surface and groundwater flows** may be reduced in areas where rainfall decreases. Increased temperatures may lead to warmer surface water and increased growth of organic matter, reducing water quality even where water quantity is not affected.

The range of statistical variables:
• Capacity of natural assets to deliver ecological goods and services
• Flows of ecological goods and service from natural assets to the human sphere
• Flows of waste materials and energy from the human sphere to natural assets
• Flows related to environmental protection activities
• Flows related to substitution of other asset services for natural asset services.

E. IMPACTS, MITIGATION AND ADAPTATION

Impacts:

Consequences of climate change:
• **Natural impacts** of the changing climate: for example, heat waves, rising oceans, glaciers retreats, droughts, the state of environment, biodiversity and natural resources etc.
• **Socio-economic impacts**: for example, reduced crop yields, changes in crop pattern, health impacts from extreme weather, reduced air quality and climate-sensitive diseases, changes in housing, social conditions and equity, poverty, changes in access to services and resources due to weather events, economic losses to industry and society

Adaptation:

Actions and measures taken to adapt to the inevitable consequences of climate change as far as they are statistically quantifiable:
• People exposed to high risk of natural disasters, by type (for example, hurricanes, floods) or to the risk of poverty due to climate change
• Statistics on large infrastructure facilities (ports, airports, bridges, electricity/water supply networks, etc.) at the risk of damage by natural disasters
• Costs and benefits of adaptation, per country or region
• Environmental protection expenditures dedicated to addressing issues of climate change in planning and policies
• Water availability and scarcity; changes in stream flow, flooding and drought risks
• Agriculture statistics (farmland area, crop productivity, water use, agricultural inputs, soil management, land-use management, crop diversification, resilience of crops and livestock)
• National Adaptation Strategies typically list measures but all of them may not be expressed in quantifiable terms. For example, educational work is important for effective adaptation.

Mitigation:

Efforts to control the causes of climate change: the greenhouse gas emissions and all the underlying activities behind them
• Subsidies; for example, for “green” technologies or fossil fuels
• Turnover and employment in the "green" sectors; for example, the renewable energy technology industries, electric vehicles, recycling, etc.
• Research and development: financing of research and development related to "green" sectors or climate mitigation
• Energy efficiency: energy use per unit of human activity
• Energy mix: renewable energy sources (solar, wind, hydro, geothermal and biomass energy)
• Ratio of emissions to turnover/gross value added for economic sectors to assess the greatest growth potential in relation to the emission abatement potential
• Environmental taxes, including energy, transport, pollution and resource taxes
• Environmental protection expenditure for climate-related activities; for example, the costs of fighting coastal erosion, costs of mitigation activities in general
• Land use management: reducing and avoiding deforestation, forest management and restoration, afforestation and reforestation
• Mitigation of the broader causes of climate change such as population growth, urbanisation, activities of industries that have an impact on increased emissions
• Data on the carbon market and trade etc.
## ANNEX 3
Coverage of statistical topics by the frameworks and approaches

### Summary table

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<th>Relevance</th>
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<td>2.4 Sectoral statistics</td>
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<td><strong>Demographic and social statistics</strong></td>
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<td><strong>1.1 Population and migration</strong></td>
<td>Drivers: population and migration movements</td>
<td>Human settlements: total population</td>
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<td><strong>1.2 Labour</strong></td>
<td>Responses: “green” jobs</td>
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<td>Environment protection: climate related information education and awareness</td>
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<td>Human settlements: Water related, airborne and vector-borne diseases, UV and pollution exposure, morbidity and mortality</td>
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<tr>
<td>1.5 Income and consumption</td>
<td>Drivers: level of wealth, consumption,</td>
<td>Extreme events: economic losses due to disasters</td>
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<td></td>
<td>Impact: electricity, gas and water consumption, changes in income distribution, economic losses</td>
<td>Environmental resources: as a source of income and consumption habits</td>
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<td>Responds: protection of vulnerable groups/regions, finance</td>
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<td>1.6 Social protection</td>
<td>Responses: protection of vulnerable groups/regions, finance</td>
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<tr>
<td>1.7 Human settlements and housing</td>
<td>Drivers: urbanisation, structure of households, demand for housing; Impact: heating days, economic losses, disasters</td>
<td>Residuals: greenhouse gas emissions, generation of waste; Extreme events: economic losses due to disasters; Human settlements: pressure from built environment, living conditions</td>
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<td>1.8 Justice and crime</td>
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<td>1.9 Culture</td>
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<tr>
<td>1.10 Political and other community activities</td>
<td>Responses: political measures, adaptation and mitigation, financing</td>
<td>Environmental protection: environmental governance and protection activities</td>
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<td>1.11 Time use</td>
<td>Drivers: changing habits and diets</td>
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<tr>
<td>Economic statistics</td>
<td>Drivers: level of economic activity, GDP</td>
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<tr>
<td>2.1 Macroeconomic statistics</td>
<td>Drivers: level of economic activity by sectors Impact: changes in economic activity by sector/industry</td>
<td>-</td>
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</tbody>
</table>
### 2.3 Business statistics

<table>
<thead>
<tr>
<th>Impact</th>
<th>Environmental resources and use</th>
<th>Socio-economic development</th>
<th>Accounts for activities and transactions</th>
<th>Natural assets</th>
<th>Impact</th>
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</thead>
<tbody>
<tr>
<td>economic performance, economic opportunities and limitations, eco-industries</td>
<td>land use, timber resources, crops, livestock</td>
<td>production patterns</td>
<td>investing in technologies to reduce pollution; financing environmental protection; costs of pollution prevention; environmental goods and services; exports from the sector; use of renewable energy.</td>
<td>availability of inputs and raw material</td>
<td>economic losses to industry</td>
</tr>
</tbody>
</table>

**Mitigation:** eco-industries, environment friendly technologies

**Adaptation:** finding new economic opportunities, adaptation to economic limitations

### 2.4 Sectoral statistics

#### 2.4.1 Agriculture, forestry, fisheries

<table>
<thead>
<tr>
<th>Drivers</th>
<th>Environmental resources and use</th>
<th>Climate process drivers</th>
<th>Accounts for physical flows</th>
<th>Natural assets</th>
<th>Impact</th>
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</thead>
<tbody>
<tr>
<td>agricultural practices, demand for meat, livestock in agriculture, production of fossil fuels, forestry and land use, greenhouse gas emissions</td>
<td>land use, timber resources, crops, livestock</td>
<td>greenhouse gas emissions</td>
<td>water use and availability, energy use, use of natural inputs, waste, emissions</td>
<td>degradation leading to changes in ecosystems and in the distribution of and quality of different types of land and forests</td>
<td>as reduced crop yields or changes in crop pattern</td>
</tr>
</tbody>
</table>

**Mitigation:** reduction of greenhouse gas emissions, renewable energy resources; measures to mitigate these

**Adaptation:** to reduced crop yields, changed crop patterns and seasons, crop varieties, forest fires
| 2.4.2 Energy | **Drivers:** demand for energy and heating; **Pressures:** production of fossil fuels, greenhouse gas emissions  | **Environmental resources and use:** production of energy (renewable and non-renewable), energy consumption  |
| | **Responses:** energy, material and emissions efficiency | **Climate process drivers:** greenhouse gas emissions  |
| | **Residuals:** greenhouse gas emissions, generation of waste; **Extreme events:** economic losses due to disasters | **Accounts for physical flows:** supply and use of energy, (non-)renewable sources, energy intensity, efficiency and productivity  |
| | | **Accounts for environmental assets:** size and changes in energy resources  |
| | | **Natural assets:** changes in the energy resources and sub-soil resources  |
| | | **Ecological good and service flows:** changes in flows of waste and energy, and inputs to industrial processes and home heating  |
| | | **Mitigation:** reduction of greenhouse gas emissions, use of the carbon market and trade, renewable energy resources  |
| | | **Adaptation:** changes in energy demand and use  |

<p>| 2.4.3 Mining, manufacturing, construction | <strong>Drivers:</strong> mining, manufacturing and construction levels, changes in food production; <strong>Pressures:</strong> production of fossil fuels, greenhouse gas emissions, production of ozone depleting substances; <strong>Impact:</strong> economic losses from climate-related events | <strong>Environmental resources and use:</strong> minerals  |
| | | <strong>Residuals:</strong> greenhouse gas emissions, generation of waste  |
| | | <strong>Climate process drivers:</strong> greenhouse gas and aerosol emissions  |
| | | <strong>Extrem events:</strong> economic losses due to disasters  |
| | | <strong>Socio-economic development:</strong> production patterns; <strong>Climate process drivers:</strong> greenhouse gas and aerosol emissions  |
| | | <strong>Accounts for physical flows:</strong> supply of natural inputs (water); product and waste flows; air emissions  |
| | | <strong>Accounts for environmental assets:</strong> size and changes of environmental assets  |
| | | <strong>Natural assets:</strong> changes in the sub-soil resources, mineral, liquids and gases and sub-soil resources  |
| | | <strong>Ecological good and service flows:</strong> changes in inputs to industrial processes and construction  |
| | | <strong>Mitigation:</strong> reduction of greenhouse gas emissions, use of the carbon market and trade, renewable energy resources  |
| | | <strong>Adaptation:</strong> in energy demand and use  |
| 2.4.4 Transport | <strong>Drivers:</strong> demand for transport; <strong>Pressures:</strong> production of fossil fuels, greenhouse gas emissions; <strong>Impact:</strong> economic losses from climate-related events | <strong>Environmental resources and use:</strong> pressures on the climate | <strong>Climate process drivers:</strong> greenhouse gas emissions | <strong>Accounts for physical flows:</strong> emissions from transport, use of energy | <strong>Natural assets:</strong> changes in the provision of space; <strong>Ecological good and service flows:</strong> changed transportation services of waters and atmosphere | <strong>Mitigation:</strong> reduction of greenhouse gas emissions, renewable energy resources |
| 2.4.5 Tourism | <strong>Drivers:</strong> levels of tourism, demand for transport <strong>Pressures:</strong> production of fossil fuels, greenhouse gas emissions; <strong>Impact:</strong> shifts of tourism flows, economic losses from climate-related events | <strong>Residuals:</strong> greenhouse gas emissions, generation of waste <strong>Extreme events:</strong> economic losses due to disasters | - | <strong>Accounts for physical flows:</strong> consumption activity of a tourist; waste generated by tourists; emissions from transport used | <strong>Ecological good and service flows:</strong> changes in the attractiveness of destinations for tourism, and in the aesthetic, cultural and existence value | <strong>Mitigation:</strong> reduction of greenhouse gas emissions; <strong>Adaptation:</strong> changes in tourism flows |
| 2.4.6 Banking, insurance, financial statistics | <strong>Impact:</strong> insurance costs; <strong>Responses:</strong> financial costs of responses and protection | <strong>Environment protection:</strong> climate protection expenditure | - | <strong>Accounts for activities and transactions:</strong> how expenditure on environmental protection (incl. elimination of emissions) is financed | - | <strong>Mitigation:</strong> financial tools; <strong>Adaptation:</strong> costs of adaptation |</p>
<table>
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<tr>
<th>Section</th>
<th>Responses</th>
<th>Environment Protection</th>
<th>Socio-economic Development</th>
<th>Accounts for Activities and Transactions</th>
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<td>financing and government measures in adaptation and mitigation</td>
<td>climate protection and management expenditure, regulation related to climate, participation in climate conventions</td>
<td>governance, mitigation, adaptation</td>
<td>financing of government environmental protection action, environmental taxes and subsidies</td>
<td>using financial and legislative tools, governance;</td>
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<td>mitigation of legislation and institutional mechanisms, adaptation measures</td>
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<td>2.6 International trade and balance of payments</td>
<td>Internationalisation of the economy, carbon leakage</td>
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<td>ecological good and service flows: changed transportation services</td>
<td>responsible trade</td>
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<td>2.7 Prices</td>
<td>energy prices, oil prices and others</td>
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<td>through changes in pricing</td>
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<td>2.9 Science, technology and innovation</td>
<td>eco-friendly technology development and technology exchange</td>
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<td>investing in technologies to prevent or reduce pollution</td>
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<td>through technology transfer and capacity building</td>
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</tbody>
</table>
### Environment and multi-domain statistics

| 3.1 Environment | State: atmosphere and climate, cryosphere, marine biodiversity and its ecosystems; **Drivers:** waste from production and consumption | **Drivers:** waste from production and consumption | **Pressures:** combustion of fossil fuels, waste treatment methods, greenhouse gas emissions; **Impact:** water quantity, freshwater quality and biodiversity, terrestrial ecosystems and biodiversity, soil, access to water; **Responses:** reduction of emissions, renewable energy, energy efficiency, environmental protection expenditure, recycling and waste, environment taxes and subsidies, permits and certificates | **Environmental conditions:** atmosphere, climate, hydrographic issues, weather, geological and geographic conditions, soil, land cover, biodiversity, ecosystems, forests; **Drivers:** greenhous e gas and aerosol emissions and concentrations | **Climate change:** temperature change, precipitation change, sea level rise and extreme events | **Impacts and vulnerability:** Impacts on ecosystems and water resources | **Climate process drivers:** greenhouse gas and aerosol emissions and concentrations | **Accounts for physical flows:** natural inputs, products and residuals | **Accounts for environmental assets:** the size and changes of environmental assets | **Accounts for activities and transactions:** activity to preserve or protect the environment | **Natural assets:** changes in ecosystems, land and sub-soil resources; **Ecological good and service flows:** provision of space, flood protection service of forests and wetlands, transportation services by waters, recreational opportunities and aesthetic, cultural and existence value, marine resources | **Impact:** heat waves, rising oceans, glaciers retreats, droughts, the state of environment, biodiversity and natural resources; **Adaptation:** to heat waves, rising oceans, glaciers retreats, droughts, seasonal changes, different variety of species, water supply changes, new crop varieties, changes in ecosystems including biodiversity and ecosystem goods and services; **Mitigation:** of the adverse impacts of the above changes |
### 3.2 Regional and small area statistics

**Impact**: extreme events, regional impacts on environment, agriculture, economy and humans  
**Responses**: regional measures

**Extreme events**: occurrence of disasters, people affected by disasters  
**Human settlements**: location of habitats, specific concerns of urban habitat, vulnerable groups

**Impacts and vulnerability**: regional impacts on ecosystems and water resources, settlements, society, food security and human health

**Accounts for physical flows**: basic data on natural inputs, products and residuals useful for regional statistics  
**Accounts for environmental assets**: size and use of environmental assets useful for regional statistics

**Natural assets**: changes in ecosystems, land and sub-soil resources  
**Ecological good and service flows**: food production, space at coastal areas, floods

**Impact**: of extreme events  
**Mitigation**: of the impacts of extreme events  
**Adaptation**: to changed local conditions

### 3.3 Multi-domain statistics and indicators

#### 3.3.1 Living conditions, poverty and cross-cutting social statistics

**Drivers**: level of wealth, consumption habits  
**Impact**: electricity, gas and water consumption, changes in income distribution, economic losses

**Human settlements**: access to water, sanitation and energy; specific concerns of urban habitat, green areas

**Impacts and vulnerability**: impacts on human settlements and society  
**Socio-economic development**: socio-cultural preferences, equity

**Accounts for environmental assets**: valuations of environmental assets could be combined with produced and financial assets to provide broader estimates of national wealth

**Ecological good and service flows**: food production, marine resources, forest products, space, floods, transportation services, recreation, aesthetic, cultural or existence value of environment

**Impact**: in social conditions and poverty  
**Mitigation**: against hunger and poverty  
**Adaptation**: to changed environmental conditions and changes in income distribution
| 3.3.2 Gender and special population groups | **Impact:** vulnerable groups, redistribution of wealth  
**Responses:** social protection and financing | **Human settlements:** vulnerability to disasters | **Impacts and vulnerability:**  
impacts on vulnerable settlements, society, food security and human health  
**Socio-economic development:** equity | - | **Ecological good and service flows:**  
food production, space at coastal areas, floods | **Impact:** in equity  
**Mitigation:** against adverse effects of climate change towards vulnerable population groups  
**Adaptation:** to changed conditions |
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</tr>
</thead>
<tbody>
<tr>
<td>3.3.3 Information society</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>3.3.4 Globalisation</td>
<td><strong>Drivers:</strong> Internationalisation of the economy, carbon leakage</td>
<td>-</td>
<td><strong>Socio-economic development:</strong> changes in trade patterns</td>
<td>-</td>
<td><strong>Ecological good and service flows:</strong> changes in transportation services</td>
<td><strong>Mitigation:</strong> responsible trade</td>
</tr>
</tbody>
</table>
| 3.3.5 Indicators related to Millennium Development Goals | **Impact & responses:**  
links to MDG1 on poverty, MDG6 on diseases, MDG7 on environmental sustainability | **Human settlements:** links to MDG6 on diseases, MDG7 on environmental sustainability | **Socio-economic development:** links to MDG1 on poverty, MDG6 on diseases, MDG7 on environmental sustainability | **Accounts for environmental assets:** MDG7 on environmental sustainability | **Natural assets & Ecological good and service flows:**  
link to MDG1 on poverty, MDG6 on diseases, MDG7 on environmental sustainability | **Mitigation & adaptation:** link to MDG1 on poverty, MDG6 on diseases, MDG7 on environmental sustainability |
<table>
<thead>
<tr>
<th>3.3.6 Sustainable development</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Responses:</strong> links to sustainable development, e.g. through reduction of emissions, renewable energy, energy efficiency, environmental protection, recycling, environment taxes and subsidies, permits and certificates, “green” growth and “green” jobs</td>
</tr>
<tr>
<td><strong>Environmental resources and use:</strong> sustainable use of natural resources</td>
</tr>
<tr>
<td><strong>Environmental protection:</strong> sustainable use of natural resources related to climate</td>
</tr>
<tr>
<td><strong>Impacts and vulnerability:</strong> impacts on ecosystems; <strong>Socio-economic development:</strong> governance, mitigation</td>
</tr>
<tr>
<td><strong>Accounts for environmental assets:</strong> sustainable use of resources and the capacity of environmental assets to continue to provide inputs</td>
</tr>
<tr>
<td><strong>Natural assets:</strong> level of sustainable use of natural assets</td>
</tr>
<tr>
<td><strong>Mitigation:</strong> measures in support of sustainable development, environmental protection, taxes and subsidies, permits and certificates, “green” jobs</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>3.3.7 Entrepreneurship</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Drivers:</strong> level of economic growth</td>
</tr>
<tr>
<td><strong>Impact:</strong> economic performance, economic opportunities and limitations, eco-industries</td>
</tr>
<tr>
<td><strong>Extreme events:</strong> losses of revenue due to disasters</td>
</tr>
<tr>
<td><strong>Socio-economic development:</strong> opportunities of technology exchange</td>
</tr>
<tr>
<td><strong>Accounts for activities and transactions:</strong> technologies to prevent or reduce pollution; financing of environmental protection; industries that produce environmental goods and services</td>
</tr>
<tr>
<td><strong>Natural assets:</strong> availability of inputs and raw material</td>
</tr>
<tr>
<td><strong>Impact:</strong> costs to entrepreneurs</td>
</tr>
<tr>
<td><strong>Mitigation:</strong> eco-industries, environment friendly technologies</td>
</tr>
<tr>
<td><strong>Adaptation:</strong> economic opportunities, adaptation to limitations</td>
</tr>
</tbody>
</table>
**ANNEX 4**

Tool for reviewing sectoral details, methodologies and data sources of the greenhouse gas inventory (example by the United Kingdom)

<table>
<thead>
<tr>
<th>National Communication</th>
<th>Methodology</th>
<th>Summary of activity/emissions data sources</th>
<th>Status of underlying data</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Category</td>
<td>IPCC category</td>
<td>Emission factor * activity</td>
</tr>
<tr>
<td>Energy Supply</td>
<td>Name</td>
<td></td>
<td>Energy Statistics, plant operator and EU Emissions Trading System (EUETS) data</td>
</tr>
<tr>
<td></td>
<td>Power Stations</td>
<td>1A1a</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Refineries</td>
<td>1A1b</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Manufacture of solid fuels and other energy industries</td>
<td>1A1c</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Coal mining and handling</td>
<td>1B1a</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1B1c</td>
<td>Modelled</td>
</tr>
<tr>
<td></td>
<td>Exploration, production and transport of oils</td>
<td>1B2a</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Offshore oil and gas - Flaring</td>
<td>1B2cii</td>
<td>Operator reported emissions</td>
</tr>
<tr>
<td></td>
<td>Offshore oil and gas - Venting</td>
<td>1B2ci</td>
<td>Operator reported emissions</td>
</tr>
<tr>
<td></td>
<td>Power stations - FGD</td>
<td>2A3</td>
<td>Emission factor * activity</td>
</tr>
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</table>

Data sources:
- Energy Statistics
- Oil and Gas Industry data
- UK Minerals Yearbook and Pollution Inventory data
<table>
<thead>
<tr>
<th>Business</th>
<th>Code</th>
<th>Description</th>
<th>Sources</th>
<th>Verification</th>
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</thead>
<tbody>
<tr>
<td>Exploration, production and transport of gas</td>
<td>1B2b</td>
<td>Modelled (natural gas leakage); operator reported emissions (offshore activities)</td>
<td>Gas operators, Oil and Gas Industry data</td>
<td>Yes</td>
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<tr>
<td>Iron and steel - combustion and electricity</td>
<td>1A2a</td>
<td>Emission factor * activity</td>
<td>Energy Statistics</td>
<td>Yes</td>
</tr>
<tr>
<td>Other industrial combustion and electricity</td>
<td>1A2b</td>
<td>Emission factor * activity</td>
<td>Energy Statistics</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>1A2c</td>
<td>Emission factor * activity</td>
<td>Energy Statistics</td>
<td>Yes</td>
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<td></td>
<td>1A2d</td>
<td>Emission factor * activity</td>
<td>Energy Statistics</td>
<td>Yes</td>
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<tr>
<td></td>
<td>1A2e</td>
<td>Emission factor * activity</td>
<td>Energy Statistics</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>1A2f</td>
<td>Emission factor * activity (stationary sources); modelled (mobile sources)</td>
<td>Energy Statistics, Plant operators and industry data, UK off-road model</td>
<td>Partly</td>
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<tr>
<td>Miscellaneous industrial and commercial combustion and electricity</td>
<td>1A4a</td>
<td>Emission factor * activity</td>
<td>Energy Statistics</td>
<td>Yes</td>
</tr>
<tr>
<td>Energy recovery from waste fuels</td>
<td>2B5</td>
<td>Emission factor * activity</td>
<td>Pollution Inventory; Mineral Products Association (MPA)</td>
<td>Partly</td>
</tr>
<tr>
<td>Refrigeration and air conditioning</td>
<td>2F1</td>
<td>Modelled</td>
<td>UK model verified against sales data from the British Refrigeration Association</td>
<td>Partly</td>
</tr>
<tr>
<td>Foams</td>
<td>2F2</td>
<td>Modelled</td>
<td>Estimates supplied by Caleb Management Services - UK consultancy</td>
<td>Yes</td>
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<tr>
<td>Firefighting</td>
<td>2F3</td>
<td>Modelled</td>
<td>March (1999), Fire Industry Council, updated based on consultation with ASSURE Property Inventory Services</td>
<td>Yes</td>
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<tr>
<td>Solvents</td>
<td>2F5</td>
<td>Modelled</td>
<td>Harnisch and Schwarz, 2003</td>
<td>Yes</td>
</tr>
<tr>
<td>One Component Foams</td>
<td>2F9</td>
<td>Modelled</td>
<td>Harnisch and Schwarz, 2003</td>
<td>Yes</td>
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<tr>
<td>Category</td>
<td>Identification</td>
<td>Methodology</td>
<td>Emission Data Source</td>
<td>Activity Coverage</td>
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<td>------------------------------------</td>
<td>--------------------------------------------------------------------------------------</td>
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<tr>
<td>Electronics, electrical insulation and sporting goods</td>
<td>2F9</td>
<td>Modelled</td>
<td>Microelectronics Environmental Advisory Committee (UKMEAC) (semiconductors); BEAMA (representing equipment manufacturers) and the Electricity Association (electrical equipment); Sales data reported by the manufacturer (sporting goods);</td>
<td>Yes</td>
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<tr>
<td>Civil aviation (Domestic, Cruise)</td>
<td>1A3a</td>
<td>Model based on Civil Aviation Authority (CAA) data and Energy Statistics</td>
<td>Civil Aviation Authority, Energy Statistics</td>
<td>Yes</td>
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<tr>
<td>Civil aviation (Domestic, Landing and take off)</td>
<td>1A3a</td>
<td>Model based on Civil Aviation Authority (CAA) data and Energy Statistics</td>
<td>Civil Aviation Authority, Energy Statistics</td>
<td>Yes</td>
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<tr>
<td>Passenger cars</td>
<td>1A3b</td>
<td>Modelled</td>
<td>Energy Statistics, Transport Statistics</td>
<td>Yes</td>
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<tr>
<td>Light duty vehicles</td>
<td>1A3b</td>
<td>Modelled</td>
<td>Energy Statistics, Transport Statistics</td>
<td>Yes</td>
</tr>
<tr>
<td>Buses</td>
<td>1A3b</td>
<td>Modelled</td>
<td>Energy Statistics, Transport Statistics</td>
<td>Yes</td>
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<tr>
<td>HGVs</td>
<td>1A3b</td>
<td>Modelled</td>
<td>Energy Statistics, Transport Statistics</td>
<td>Yes</td>
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<tr>
<td>Mopeds &amp; motorcycles</td>
<td>1A3b</td>
<td>Modelled</td>
<td>Energy Statistics, Transport Statistics</td>
<td>Yes</td>
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<td>LPG emissions (all vehicles)</td>
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<td>Modelled</td>
<td>Energy Statistics, Transport Statistics</td>
<td>Yes</td>
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<tr>
<td>Other (road vehicle engines)</td>
<td>1A3b</td>
<td>Modelled</td>
<td>Energy Statistics, Transport Statistics</td>
<td>Yes</td>
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<tr>
<td>Railways</td>
<td>1A3c</td>
<td>Emission factor * activity</td>
<td>Office of Rail Regulation National Rail Trends Yearbook, Translink - Northern Ireland public transport service</td>
<td>Partly</td>
</tr>
<tr>
<td>Railways - stationary combustion</td>
<td>1A4a</td>
<td>Emission factor * activity</td>
<td>Energy Statistics</td>
<td>Yes</td>
</tr>
<tr>
<td>Fishing vessels</td>
<td>1A4c</td>
<td>Emission factor * activity</td>
<td>Entec shipping study, Carbon factors review, European Monitoring and Evaluation Programme (EMEP)/Corinair Guidebook</td>
<td>Yes</td>
</tr>
<tr>
<td>Military Aircraft and ship Pollution Inventorying</td>
<td>1A5b</td>
<td>Emission factor * activity</td>
<td>Civil Aviation Authority (CAA), Ministry Of Defence (MOD)</td>
<td>Yes</td>
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<td></td>
<td></td>
<td>Modelled</td>
<td>Energy Statistics; UK off-road model</td>
<td></td>
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<tr>
<td>Aircraft Support Vehicles</td>
<td>1A3e</td>
<td>Emission factor * activity</td>
<td>Energy Statistics</td>
<td>Yes</td>
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<tr>
<td>Public</td>
<td>1A4a</td>
<td>Emission factor * activity</td>
<td>Energy Statistics</td>
<td>Yes</td>
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<tr>
<td>Residential combustion</td>
<td>1A4b</td>
<td>Emission factor * activity</td>
<td>Energy Statistics</td>
<td>Yes</td>
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<tr>
<td>Use of non aerosol consumer</td>
<td>2B5</td>
<td>Emission factor * activity</td>
<td>Energy Statistics; Sales data from Cosmetic,</td>
<td>Yes</td>
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<tr>
<td>products</td>
<td></td>
<td></td>
<td>Toiletry &amp; Perfumery Association (CTPA)</td>
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<td>Accidental vehicle fires</td>
<td>6C</td>
<td>Emission factor * activity</td>
<td>Based on Department of Communities and Local</td>
<td>Yes</td>
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<td></td>
<td></td>
<td></td>
<td>Government statistics</td>
<td></td>
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<tr>
<td>Aerosols and metered dose</td>
<td>2F4</td>
<td>Modelled</td>
<td>British Aerosols Manufacturers Association;</td>
<td>Yes</td>
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<td>inhalers</td>
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<td></td>
<td>Metered Dose Inhalers Import/Export data from</td>
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<td></td>
<td></td>
<td></td>
<td>manufacturers</td>
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<tr>
<td>Stationary and mobile</td>
<td>1A4c</td>
<td>Emission factor * activity</td>
<td>Energy Statistics</td>
<td>Partly</td>
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<td>combustion</td>
<td></td>
<td>(stationary sources); modelled</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(mobile sources)</td>
<td></td>
<td></td>
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<tr>
<td>Breakdown of pesticides</td>
<td>2B5</td>
<td>Emission factor * activity</td>
<td>British Agrochemicals Association,</td>
<td>Yes</td>
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<tr>
<td></td>
<td></td>
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<td>Crop Protection Association</td>
<td></td>
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<tr>
<td>Enteric Fermentation - Cattle</td>
<td>4A1</td>
<td>Tier 2 Emission factor * activity</td>
<td>Department of Environment, Food and Rural</td>
<td>Yes</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Affairs (Defra) Economics and Statistics Group</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- June Census and Devolved Administrations</td>
<td></td>
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<tr>
<td>Enteric Fermentation - Sheep</td>
<td>4A3</td>
<td>Tier 2 Emission factor * activity</td>
<td>- same as above</td>
<td>Yes</td>
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<tr>
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<tr>
<td>Enteric Fermentation - Goats</td>
<td>4A4</td>
<td>Emission factor * activity</td>
<td>- same as above</td>
<td>Yes</td>
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<tr>
<td>Enteric Fermentation - Horses</td>
<td>4A6</td>
<td>Emission factor * activity</td>
<td>- same as above</td>
<td>Yes</td>
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<tr>
<td>Enteric Fermentation - Swine</td>
<td>4A8</td>
<td>Emission factor * activity</td>
<td>- same as above</td>
<td>Yes</td>
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<tr>
<td>Enteric Fermentation - Deer</td>
<td>4A10</td>
<td>Tier 2 Emission factor * activity</td>
<td>- same as above</td>
<td>Yes</td>
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<tr>
<td>Wastes - Cattle</td>
<td>4B1</td>
<td>Tier 2 Emission factor * activity</td>
<td>- same as above</td>
<td>Yes</td>
</tr>
<tr>
<td>Wastes - Sheep</td>
<td>4B3</td>
<td>Tier 2 Emission factor * activity</td>
<td>- same as above -</td>
<td>Yes</td>
</tr>
<tr>
<td>Wastes - Goats</td>
<td>4B4</td>
<td>Emission factor * activity</td>
<td>- same as above -</td>
<td>Yes</td>
</tr>
<tr>
<td>Wastes - Horses</td>
<td>4B6</td>
<td>Emission factor * activity</td>
<td>- same as above -</td>
<td>Yes</td>
</tr>
<tr>
<td>Wastes - Swine</td>
<td>4B8</td>
<td>Emission factor * activity</td>
<td>- same as above -</td>
<td>Yes</td>
</tr>
<tr>
<td>Wastes - Poultry</td>
<td>4B9</td>
<td>Emission factor * activity</td>
<td>- same as above -</td>
<td>Yes</td>
</tr>
<tr>
<td>Wastes - Deer</td>
<td>4B10</td>
<td>Emission factor * activity</td>
<td>- same as above -</td>
<td>Yes</td>
</tr>
<tr>
<td>Wastes - Manure Liquid Systems</td>
<td>4B12</td>
<td>Emission factor * activity</td>
<td>- same as above -</td>
<td>Yes</td>
</tr>
<tr>
<td>Wastes - Solid Storage and Dry Lot</td>
<td>4B13</td>
<td>Emission factor * activity</td>
<td>- same as above -</td>
<td>Yes</td>
</tr>
<tr>
<td>Wastes - Other manure management (N₂O)</td>
<td>4B14</td>
<td>Emission factor * activity</td>
<td>- same as above -</td>
<td>Yes</td>
</tr>
<tr>
<td>Direct Soil Emission</td>
<td>4D</td>
<td>Emission factor * activity</td>
<td>- same as above -</td>
<td>Yes</td>
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<tr>
<td>Field burning of agricultural wastes</td>
<td>4F1</td>
<td>Emission factor * activity</td>
<td>Estimates compiled by Rothamsted Research</td>
<td>Yes</td>
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<tr>
<td></td>
<td>4F5</td>
<td>Emission factor * activity</td>
<td>Estimates compiled by Rothamsted Research</td>
<td>Yes</td>
</tr>
</tbody>
</table>

<p>| Sinter production | 1A2a | Carbon balance approach | Energy Statistics | Yes |
| Lime production | 2A2 | Emission factor * activity | UK Minerals Yearbook, EU ETS | Partly | Partly |
| Limestone and dolomite use | 2A3 | Emission factor * activity | International Steel Statistics Bureau (ISSB) Annual Statistics and Industry data | Yes |
| | 2A7 | Emission factor * activity | Industry data | Yes |
| Soda ash production and use | 2A7 | Emission factor * activity | Industry data | Yes |
| Fletton bricks | 2A7 | Calculated, based on operator reported emissions data and brick production statistics | Based on Office of National Statistics data; Pollution Inventory | Partly | Partly |
| Ammonia production | 2B1 | Calculated, based on operator reported data on CO₂ produced, emitted and sold. | Plant Operators data | Yes |</p>
<table>
<thead>
<tr>
<th>Activity</th>
<th>Methodological Approach</th>
<th>Data Sources</th>
<th>Processing</th>
<th>Modelled Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminium production</td>
<td>Emission factor * activity; operator reported data</td>
<td>UK Minerals yearbook, Pollution Inventory</td>
<td>Yes</td>
<td></td>
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<tr>
<td>Nitric acid production</td>
<td>Operator reported data</td>
<td>Plant Operators data, Pollution Inventory</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>AdiPollution Inventoryc acid production</td>
<td>Operator reported data</td>
<td>Industry data</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Other - Chemical industry</td>
<td>Calculated, based on operator reported emissions and plant capacity data.</td>
<td>Based on plant capacity and data reported to the Pollution Inventory</td>
<td>Yes</td>
<td></td>
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<tr>
<td>Halocarbon production</td>
<td>Operator reported data</td>
<td>Pollution Inventory</td>
<td>Partly</td>
<td>Partly</td>
</tr>
<tr>
<td>Magnesium cover gas</td>
<td>Modelled; Operator reported data</td>
<td>Pollution Inventory</td>
<td>Partly</td>
<td>Partly</td>
</tr>
<tr>
<td>Forest Land remaining Forest Land</td>
<td>Modelled</td>
<td></td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Biomass burning (Forest Land)</td>
<td>Modelled</td>
<td></td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Land converted to forest land</td>
<td>Modelled</td>
<td></td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Direct N₂O emission from N fertilisation of forest land</td>
<td>Modelled</td>
<td></td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Drainage of Organic Soils (Forest Land)</td>
<td>Modelled</td>
<td></td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Biomass burning (Cropland)</td>
<td>Modelled</td>
<td></td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Liming (Cropland)</td>
<td>Modelled</td>
<td></td>
<td>Yes</td>
<td></td>
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<tr>
<td>Cropland remaining cropland</td>
<td>Modelled</td>
<td></td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Land converted to cropland</td>
<td>Modelled</td>
<td></td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>N₂O emissions from disturbance associated with land-use conversion to cropland</td>
<td>Modelled</td>
<td></td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Biomass burning (Grassland)</td>
<td>Modelled</td>
<td></td>
<td>Yes</td>
<td></td>
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<tr>
<td>Liming (Grassland)</td>
<td>Modelled</td>
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<td>Yes</td>
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<td>Number</td>
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<tr>
<td>---------------------------------------</td>
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<td>----------</td>
<td>----------------------------------------------------------------------------</td>
<td>------------</td>
</tr>
<tr>
<td>Grassland remaining grassland</td>
<td>SC1</td>
<td>Modelled</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Land converted to grassland</td>
<td>SC2</td>
<td>Modelled</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wetlands remaining Wetland</td>
<td>SD1</td>
<td>Modelled</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-CO$_2$ emissions from</td>
<td>SD2</td>
<td>Modelled</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Land converted to Wetland</td>
<td>SD2</td>
<td>Modelled</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Settlements remaining settlements</td>
<td>SE1</td>
<td>Modelled</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biomass burning (Settlements)</td>
<td>SE2</td>
<td>Modelled</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Land converted to settlements</td>
<td>SE2</td>
<td>Modelled</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Harvested wood</td>
<td>SG</td>
<td>Modelled</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Landfill</td>
<td>6A1</td>
<td>Modelled</td>
<td>UK landfill waste methane model (MELMod)</td>
<td>Yes</td>
</tr>
<tr>
<td>Waste-water handling</td>
<td>6B1</td>
<td>Emission factor * activity</td>
<td>Department of Environment, Food and Rural Affairs (Defra), IPCC Defaults</td>
<td>Yes</td>
</tr>
<tr>
<td>Waste Incineration</td>
<td>6C</td>
<td>Emission factor * activity</td>
<td>Her Majesty's Inspectorate of Pollution (HMIP), Department of Energy and Climate Change (DECC), Pollution Inventory</td>
<td>Yes</td>
</tr>
<tr>
<td>Waste Incineration</td>
<td>6B2</td>
<td>Modelled</td>
<td>Office of National Statistics (ONS); Department of Environment, Food and Rural Affairs (Defra); water companies, Water Services Regulation Authority (Ofwat)</td>
<td>Partly, Partly, Partly</td>
</tr>
</tbody>
</table>
### ANNEX 5
**European Statistical System (ESS) quality criteria for statistical output compared to the criteria for greenhouse gas inventories**

<table>
<thead>
<tr>
<th>ESS criteria[97]</th>
<th>IPCC guidelines</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Relevance</strong> is the degree to which statistics meet current and potential users’ needs. It refers to whether all statistics that are needed are produced and the extent to which concepts used (definitions, classifications etc.) reflects user needs.</td>
<td>-</td>
</tr>
<tr>
<td><strong>Accuracy and reliability:</strong> In a statistical sense, refers to the closeness of the statistical data to the (in general) unknown true or exact value of the measured phenomena. Usually this closeness can be measured by using statistical indicators such as bias and variability of the statistical data.</td>
<td><strong>Accuracy</strong> is a relative measure of the exactness of an emission or removal estimate. Estimates should be accurate in the sense that they are systematically neither over nor under true emissions or removals, as far as can be judged, and that uncertainties are reduced as far as practicable. Appropriate methodologies should be used, in accordance with the IPCC good practice guidance, to promote accuracy in inventories</td>
</tr>
<tr>
<td><strong>Completeness</strong> means that an inventory covers all sources and sinks, as well as all gases, included in the IPCC Guidelines as well as other existing relevant source/sink categories which are specific to individual Annex I Parties and, therefore, may not be included in the IPCC Guidelines. Completeness also means full geographic coverage of sources and sinks of an Annex I Party.</td>
<td>-</td>
</tr>
<tr>
<td><strong>Timeliness and punctuality</strong>&lt;br&gt;Punctuality refers to the time lag between the release date of data and the target date when it should have been delivered, for instance, with reference to dates announced in some official release calendar, laid down by Regulations or previously agreed among partners.&lt;br&gt;Timeliness of information reflects the length of time between its availability and the event or phenomenon it describes</td>
<td>-</td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>ESS criteria”</th>
<th>IPCC guidelines</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Coherence and comparability</strong></td>
<td><strong>Consistency</strong> means that an inventory should be internally consistent in all its elements with inventories of other years. An inventory is consistent if the same methodologies are used for the base and all subsequent years and if consistent data sets are used to estimate emissions or removals from sources or sinks. Under certain circumstances, an inventory using different methodologies for different years can be considered to be consistent if it has been recalculated in a transparent manner, in accordance with the IPCC Good Practice. <strong>Comparability</strong> means that estimates of emissions and removals reported by Annex I Parties in inventories should be comparable among Annex I Parties. For this purpose, this Annex should use the methodologies and formats agreed by the COP for estimating and reporting inventories. The allocation of different source/sink categories should follow the split of the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories, and the IPCC Good Practice Guidance for Land Use, Land-Use Change and Forestry, at the level of its summary and sectoral tables.</td>
</tr>
<tr>
<td>Coherence of statistics is their adequacy to be reliably combined in different ways and for various uses. It is, however, generally easier to show cases of incoherence than to prove coherence. Comparability aims at measuring the impact of differences in applied statistical concepts and measurement tools/procedures when statistics are compared between geographical areas, non-geographical domains, or over time. We can say it is the extent to which differences between statistics are attributed to differences between the true values of the statistical characteristic. There are three main approaches under which comparability of statistics is normally addressed: comparability over time, between geographical areas, and between domains.</td>
<td></td>
</tr>
<tr>
<td><strong>Accessibility and clarity</strong></td>
<td><strong>Transparency</strong> means that the assumptions and methodologies used for an inventory should be clearly explained to facilitate replication and assessment of the inventory by users of the reported information. The transparency of inventories is fundamental to the success of the process for the communication and consideration of information.</td>
</tr>
<tr>
<td>Accessibility refers to the physical conditions in which users can obtain data: where to go, how to order, delivery time, clear pricing policy, convenient marketing conditions (copyright, etc.), availability of micro or macro data, various formats (paper, files, CD-ROM, Internet…), etc. Clarity refers to the data’s information environment whether data are accompanied with appropriate metadata, illustrations such as graphs and maps, whether information on their quality also available (including limitation in use…) and the extent to which additional assistance is provided by the NSO.</td>
<td></td>
</tr>
</tbody>
</table>

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This Glossary intends to support the reader in understanding the statistical terminology used in these recommendations. The definitions are mainly drawn from existing international recommendations, most often they are quoted word for word and reference is provided. In some cases, they have been modified to suit the context of these recommendations. These definitions mostly include a practical explanation of the term rather than an exact scientific definition.

| **Accessibility** | Accessibility refers to the physical conditions in which users can obtain data: where to go, how to order, delivery time, clear pricing policy, convenient marketing conditions (copyright, etc.), availability of micro or macro data, various formats (paper, files, CD-ROM, Internet...), etc. (ESS Quality Criteria) |
| **Accuracy** | The accuracy of statistical outputs in the general statistical sense is the degree of closeness of estimates to the true values. (ESS Quality Criteria) |
| **Activity data** | Activity data, according to the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories, are defined as data on the magnitude of human activity resulting in emissions or removals taking place during a given period of time. (UNFCCC) |
| **Annex I Parties** | Under the UNFCCC, Annex I Parties are the industrialized countries listed in Annex I to the Convention, which committed to returning their greenhouse-gas emissions to 1990 levels by the year 2000 as per Article 4.2 (a) and (b). They have also accepted emissions targets for the period 2008-12 as per Article 3 and Annex B of the Kyoto Protocol. They include the 24 original OECD members, the European Union, and 14 countries with economies in transition. (Croatia, Liechtenstein, Monaco, and Slovenia joined Annex I at COP-3, and the Czech Republic and Slovakia replaced Czechoslovakia.) (UNFCCC) The full list of Annex I parties is provided at: unfccc.int/parties_and_observers/parties/annex_i/items/2774.php |
| **Asset** | Asset is a store of value representing a benefit or series of benefits accruing to the economic owner by holding or using the entity over a period of time. It is a means of carrying forward value from one accounting period to another. (SEEA Central Framework) |
| **Biodiversity** | Biodiversity refers to the range of genetic differences, species differences and ecosystem differences in a given area. (OECD) |
| **Capital approach** | A method to measure sustainable development by calculating the stocks of capital. The capital approach is in line with the future-oriented view on sustainable development measuring the stock of economic, natural, human and social capital passed on to future generations. (UNECCE, 2013) |

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<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clarity</td>
<td>Clarity refers to the data’s information environment whether data are accompanied with appropriate metadata, illustrations such as graphs and maps, whether information on their quality also available (including limitation in use...) and the extent to which additional assistance is provided by the NSO. (ESS Quality Criteria)</td>
</tr>
<tr>
<td>Coherence</td>
<td>Coherence of statistics is their adequacy to be reliably combined in different ways and for various uses. It is, however, generally easier to show cases of incoherence than to prove coherence. (ESS Quality Criteria)</td>
</tr>
<tr>
<td>Comparability</td>
<td>Comparability aims at measuring the impact of differences in applied statistical concepts and measurement tools/procedures when statistics are compared between geographical areas, non-geographical domains, or over time. We can say it is the extent to which differences between statistics are attributed to differences between the true values of the statistical characteristic. There are three main approaches under which comparability of statistics is normally addressed: comparability over time, between geographical areas, and between domains. (ESS Quality Criteria)</td>
</tr>
<tr>
<td>Confidentiality</td>
<td>Data confidentiality is a property of data, usually resulting from legislative measures, which prevents it from unauthorized disclosure. (OECD)</td>
</tr>
<tr>
<td>Consumption</td>
<td>Consumption is the use of goods and services for the satisfaction of individual or collective human needs or wants. (SEEA Central Framework)</td>
</tr>
<tr>
<td>Data</td>
<td>Characteristics or information, usually numerical, that are collected through observation. (OECD)</td>
</tr>
<tr>
<td>Ecosystems</td>
<td>An ecosystem is a system in which the interaction between different organisms and their environment generates a cyclic interchange of materials and energy. (OECD) Ecosystems are areas containing a dynamic complex of biotic communities (for example, plants, animals and micro-organisms) and their non-living environment interacting as a functional unit to provide environmental structures, processes and functions. (SEEA Central Framework)</td>
</tr>
<tr>
<td>Ecosystem services</td>
<td>Ecosystem services are the benefits supplied by the functions of ecosystems and received by humanity. (SEEA Central Framework)</td>
</tr>
<tr>
<td>Emission categories</td>
<td>Emission estimates are presented in accordance with the categories of the Intergovernmental Panel on Climate Change Guidelines for National Greenhouse Gas Inventories (1996). (UNFCCC)</td>
</tr>
<tr>
<td>Emission factors</td>
<td>An emission factor is defined as the average emission rate of a given GHG for a given source, relative to units of activity. (UNFCCC)</td>
</tr>
<tr>
<td>Emissions</td>
<td>Emissions are substances released to the environment by establishments and households as a result of production, consumption and accumulation processes. (SEEA Central Framework)</td>
</tr>
<tr>
<td><strong>Emission inventory</strong></td>
<td>An emission inventory is a listing, by source, of the amounts of pollutants actually or potentially discharged. Such an inventory is used to establish and put forth emission standards. (OECD) In the context of UNFCCC/Kyoto Protocol Reporting, the inventories refer to the annual national GHG inventories covering emissions and removals of direct greenhouse gases (CO$_2$, CH$_4$, N$_2$O, HFCs, PFCs and SF$_6$) from six sectors (Energy, Industrial processes, Solvents, Agriculture, LULUCF, Waste), and for all years from the base year or period to the most recent year. (UNFCCC/KP)</td>
</tr>
<tr>
<td><strong>Energy balances</strong></td>
<td>Materials and energy balances are accounting tables that provide information on the material input into an economy delivered by the natural environment, the transformation and use of that input in economic processes (extraction, conversion, manufacturing, consumption) and its return to the natural environment as residuals (wastes). The accounting concepts involved are founded on the first law of thermodynamics, which states that matter (mass/energy) is neither created nor destroyed by any physical process. (OECD)</td>
</tr>
</tbody>
</table>
| **Environmental accounting** | Environmental accounting refers to:
- national accounting: physical and monetary accounts of environmental assets and the costs of their depletion and degradation;
- corporate accounting: the term usually refers to environmental auditing, but may also include the costing of environmental impacts caused by the corporation. (OECD) |
<p>| <strong>Environmental assets</strong> | Environmental assets are the naturally occurring living and non-living components of the Earth, together comprising the bio-physical environment, that may provide benefits to humanity. (SEEA Central Framework) |
| <strong>Greenhouse gases</strong> | Greenhouse gases refer to carbon dioxide, nitrous oxide, methane, ozone and chloro—fluorocarbons occurring naturally and resulting from human (production and consumption) activities, and contributing to the greenhouse effect (global warming). (OECD) The Kyoto Protocol lists six gases, excluding ozone (see Annex A of the Kyoto Protocol). |
| <strong>Household</strong> | The concept of household is based on the arrangements made by persons, individually or in groups, for providing themselves with food or other essentials for living. A household may be either (a) a one-person household, that is to say, a person who makes provision for his or her own food or other essentials for living without combining with any other person to form part of a multi-person household or (b) a multi-person household, that is to say, a group of two or more persons living together who make common provision for food or other essentials for living. The persons in the group may pool their incomes and may, to a greater or lesser extent, have a common budget; they may be related or unrelated persons or constitute a combination of persons both related and unrelated. A household may be located in a housing unit or in a set of collective living quarters such as a boarding house, a hotel or a camp, or may comprise the administrative personnel in an institution. The household may also be homeless. (OECD) |</p>
<table>
<thead>
<tr>
<th><strong>Index</strong></th>
<th>The name “index” comes originally from Latin and means a pointer (UNSD, 2010). An index is a ratio that indicates the increase or decrease of a magnitude (Allen, 1975). The index form is used not only for intertemporal comparisons but for comparisons between countries (Balk, 2008).</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>International trade</strong></td>
<td>The two main data items used in the concept of international trade are imports and exports. Imports of goods measures the value of goods that enter the domestic territory of a country irrespective of their final destination. Exports of goods similarly measures the value of goods which leave the domestic territory of a country, irrespective of whether they have been processed in the domestic territory or not. Imports (and exports) of services reflect the value of services provided to residents of other countries (or received by residents of the domestic territory). (OECD)</td>
</tr>
<tr>
<td><strong>Kyoto Protocol</strong></td>
<td>The Kyoto Protocol is an international agreement linked to the United Nations Framework Convention on Climate Change, which commits its Parties by setting internationally binding emission reduction targets. (UNFCCC)</td>
</tr>
<tr>
<td><strong>Land cover</strong></td>
<td>Land cover reflects the (bio) physical dimension of the earth’s surface and corresponds in some regard to the notion of ecosystems. Typical examples for land cover categories are built-up areas, grassland, forests or rivers and lakes. (OECD)</td>
</tr>
<tr>
<td><strong>Land degradation</strong></td>
<td>Land degradation is the reduction or loss of the biological or economic productivity and complexity of rain—fed cropland, irrigated cropland, or range, pasture, forest or woodlands resulting from natural processes, land uses or other human activities and habitation patterns such as land contamination, soil erosion and the destruction of the vegetation cover. (OECD)</td>
</tr>
<tr>
<td><strong>Land use</strong></td>
<td>Land use is based on the functional dimension of land for different human purposes or economic activities. Typical categories for land use are dwellings, industrial use, transport, recreational use or nature protection areas. (OECD)</td>
</tr>
<tr>
<td><strong>Material flow accounts</strong></td>
<td>An account that provides an aggregate overview of annual material inputs and outputs of an economy in tonnes. (OECD)</td>
</tr>
<tr>
<td><strong>Metadata</strong></td>
<td>Metadata provide information on data and about processes of producing and using data. Metadata describe statistical data and to some extent - processes and tools involved in the production and usage of statistical data. (UNECE, 1995.)</td>
</tr>
<tr>
<td><strong>Methodology</strong></td>
<td>A methodology is a structured approach to solve a problem. (OECD)</td>
</tr>
<tr>
<td><strong>Monitoring(environmental)</strong></td>
<td>Monitoring refers to the continuous or frequent standardized measurement and observation of the environment (air, water, land/soil, biota), often used for warning and control. (OECD)</td>
</tr>
<tr>
<td><strong>National Statistical System</strong></td>
<td>National statistical systems comprise the ensemble of statistical organisations and units within a country that jointly collect, process and disseminate official statistics on behalf of national government. They also include the mechanisms of interaction between suppliers, producers, users and other stakeholders. One agency has the coordination role of the national statistical system, usually the national statistical office. In addition, there are international statistical systems that focus on the production of official statistics at the regional or global level. The term “statistical system” used in this report refers generically to the ensemble of all national and international statistical systems.</td>
</tr>
<tr>
<td><strong>Natural capital</strong></td>
<td>Natural capital refers to the earth’s natural resources, land and the ecological systems that provide goods and services necessary for the economy, society and all living things. This publication uses the capital boundary of the SEEA Central Framework, but expands this to include ecosystems and climate. (UNECE, 2013)¹</td>
</tr>
<tr>
<td><strong>Natural resources</strong></td>
<td>Natural resources are natural assets (raw materials) occurring in nature that can be used for economic production or consumption. (OECD)</td>
</tr>
<tr>
<td><strong>Official statistics</strong></td>
<td>Official statistics are statistics disseminated by the national statistical system, excepting those that are explicitly stated not to be official. (OECD) Official statistics are the result of statistical activities carried out within a national statistical system, or under the statistical programme of an intergovernmental organization. They are by definition compiled in accordance with the Fundamental Principles for Official Statistics, the European Statistics Code of Practice or a similar authoritative international framework ensuring professional standards.</td>
</tr>
<tr>
<td><strong>Ozone depleting substances</strong></td>
<td>Ozone depleting substances (ODSs) are those substances which deplete the ozone layer and are widely used in refrigerators, airconditioners, fire extinguishers, in dry cleaning, as solvents for cleaning, electronic equipment and as agricultural fumigants. (Australian Government Department of the Environment)</td>
</tr>
<tr>
<td><strong>Portal</strong></td>
<td>A portal is the term given to that part of a Website which acts as a gateway, or launch point, through which users navigate the World Wide Web. (OECD)</td>
</tr>
<tr>
<td><strong>Punctuality</strong></td>
<td>Punctuality refers to the time lag between the release date of data and the target date when it should have been delivered, for instance, with reference to dates announced in some official release calendar, laid down by Regulations or previously agreed among partners. (ESS Quality Criteria)</td>
</tr>
<tr>
<td><strong>Relevance</strong></td>
<td>Relevance is the degree to which statistics meet current and potential users’ needs. It refers to whether all statistics that are needed are produced and the extent to which concepts used (definitions, classifications etc.) reflects user needs. (ESS Quality Criteria)</td>
</tr>
<tr>
<td><strong>Reliability</strong></td>
<td>Reliability and accuracy, in a statistical sense, refer to the closeness of the statistical data to the (in general) unknown true or exact value of the measured phenomena. Usually this closeness can be measured by using statistical indicators such as bias and variability of the statistical data. (ESS Quality Criteria)</td>
</tr>
<tr>
<td><strong>Renewable energy</strong></td>
<td>Energy from renewable non-fossil sources, namely wind, solar, aerothermal, geothermal, hydrothermal and ocean energy, hydropower, biomass, landfill gas, sewage treatment plant gas and biogases. (EU Directive 2009/28/EC on the promotion of the use of energy from renewable sources)</td>
</tr>
<tr>
<td>----------------------</td>
<td>------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>Revisions</strong></td>
<td>Data revisions are defined broadly as any change in a value of a statistic released to the public by an official national statistical agency. (OECD)</td>
</tr>
<tr>
<td><strong>Scope</strong></td>
<td>The scope is the coverage or sphere of what is to be observed. It is the total membership or population of a defined set of people, object or events. (OECD)</td>
</tr>
<tr>
<td><strong>Seasonal adjustment</strong></td>
<td>Seasonal adjustment is the process of estimating and then removing from a time series influences that are systematic and calendar related. Observed data need to be seasonally adjusted, as seasonal effects can conceal both the true underlying movement in the series as well as certain non-seasonal characteristics which may be of interest to analysts. (Australian Bureau of Statistics)</td>
</tr>
<tr>
<td><strong>Soil</strong></td>
<td>Soil is the loose and unconsolidated outer layer of the earth's crust, made up of small particles of different sizes. (OECD)</td>
</tr>
<tr>
<td><strong>Source data</strong></td>
<td>Data collected on a regular basis (by survey from respondents, or from administrative sources) by survey statisticians in the national statistical system to be edited, imputed, aggregated and/or used in the compilation and production of official statistics. (OECD)</td>
</tr>
<tr>
<td><strong>Standard classifications</strong></td>
<td>Standard classifications are those that follow prescribed rules and are generally recommended and accepted. They aim to ensure that information is classified consistently regardless of the collection, source, point of time, etc. (OECD)</td>
</tr>
<tr>
<td><strong>Statistical micro-data</strong></td>
<td>An observation data collected on an individual object - statistical unit. (OECD)</td>
</tr>
<tr>
<td><strong>Statistical data</strong></td>
<td>Statistical data refers to data from a survey or administrative source used to produce statistics. (OECD)</td>
</tr>
<tr>
<td><strong>Statistical infrastructure</strong></td>
<td>Statistical infrastructure is defined as tools that refers to tools, which support the operation of a statistical system. These tools can help to organise the statistical system, improve efficiency, add value, create new outputs or simply perform tasks within the system. Examples of statistical infrastructure include computer systems, metadata repositories, legislation, standards and classifications, frameworks and information development plans. (Australian Bureau of Statistics)</td>
</tr>
<tr>
<td><strong>Statistics</strong></td>
<td>Numerical data relating to an aggregate of individuals; the science of collecting, analysing and interpreting such data. (OECD)</td>
</tr>
<tr>
<td><strong>Survey</strong></td>
<td>A survey is an investigation about the characteristics of a given population by means of collecting data from a sample of that population and estimating their characteristics through the systematic use of statistical methodology. (OECD)</td>
</tr>
</tbody>
</table>
### Sustainable development

The report follows the Brundtland definition, which states that sustainable development is “a development that meets the needs of the present without compromising the ability of future generations to meet their own needs.” Furthermore, the publication takes into account the well-being of people in other countries, which was also advocated in the Brundtland Report. (UNECE, 2013)

### Time series

Time series is a set of regular time-ordered observations of a quantitative characteristic of an individual or collective phenomenon taken at successive, in most cases equidistant, periods or points of time. (OECD)

### Timeliness

The timeliness of statistical outputs is the length of time between the event or phenomenon they describe and their availability. (ESS Quality Criteria)

### Transparency

Transparency means that the assumptions and methodologies should be clearly explained to facilitate replication and assessment of the methodology by users of the reported information. The transparency of statistics is fundamental to the success of the process for the communication and consideration of information. (modified based on the definition of the IPCC guidelines)

### Urbanization

Urbanization refers to increase in the proportion of a population living in urban areas and the process by which a large number of people becomes permanently concentrated in relatively small areas, forming cities. (OECD)

### Waste

Waste refers to materials that are not prime products (that is, products produced for the market) for which the generator has no further use in terms of his/her own purposes of production, transformation or consumption, and of which he/she wants to dispose. (OECD)