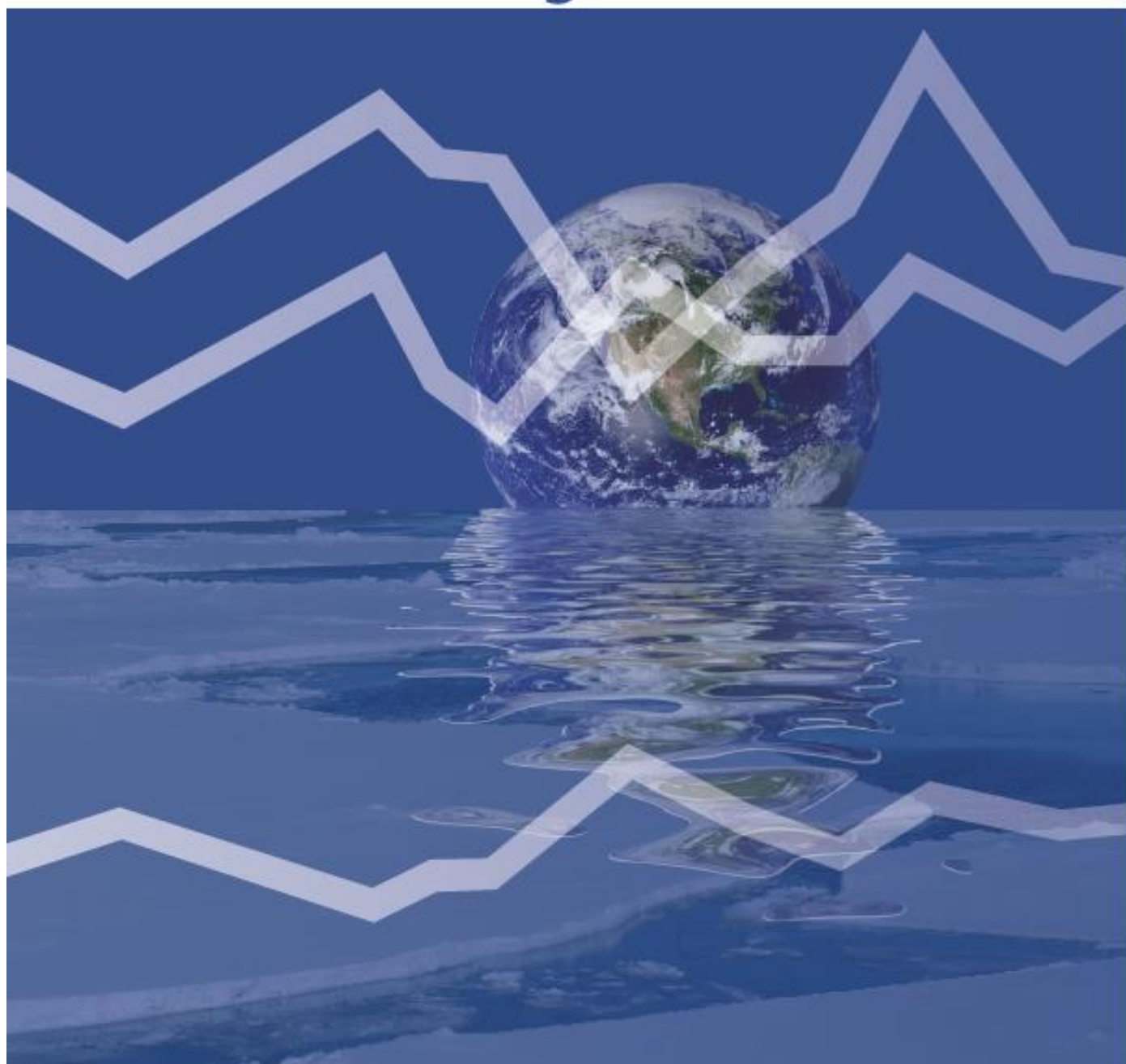


UNITED NATIONS ECONOMIC COMMISSION FOR EUROPE

Conference of European Statisticians Recommendations on **Climate Change-Related Statistics**



Geneva, 2014

Note

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EXECUTIVE SUMMARY

This publication 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. More than 60 countries and international organisations endorsed the recommendations in the plenary session of the Conference of European Statisticians in April 2014. The recommendations were developed by the *Task Force on Climate Change-Related Statistics* at the request of the heads of 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.

These recommendations primarily address data that are already collected as part of official statistics and that can support analysis or research related to climate change. They also serve as a tool for discussion with producers of climate information outside the national statistical systems. The recommendations do not focus on scientific or meteorological data describing changes in weather and climate.

In 1992, most countries of the world joined a treaty, the United Nations *Framework Convention on Climate Change*, to jointly consider what they could do to limit average global temperature increases and climate change. In 2010, governments agreed that greenhouse gas emissions must be reduced to levels that will ensure limiting global temperature increases to less than 2 degrees Celsius compared to pre-industrial levels. In June 2012, the Rio+20 Conference on Sustainable Development further emphasized climate change as an immediate global priority. The Sustainable Development Goals call for “taking urgent action to combat climate change and its impacts”, and “promoting mechanisms for raising capacities for effective climate change-related planning and management”. All of this has increased the pressure to provide new information to support analysis of climate change and improve existing statistics.

To address these demands, the Task Force organised two expert meetings. The meetings explored user needs and existing practices within national statistical systems to identify recommendations for improving climate change-related statistics. The Task Force also 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 experts from 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 the consequences.

The publication 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 data compilation and reporting process guided by the United Nations Framework Convention on Climate Change. While the agencies responsible for compiling and reporting such greenhouse gas inventories usually lie outside of the national statistical system, statistical offices are often a source of primary data for the inventories (for example, energy balances). Other official climate change-related statistics are less well developed, though several statistical offices have started to work in this direction. Still, the Task Force found that the wide

range of official environmental, social and economic statistics that exist today could be much better utilized for climate change policy and analysis.

The publication recommends that national statistical offices work more closely with the agencies responsible for greenhouse gas inventories to ensure that official statistics better meet their needs. Given the considerable contribution of official statistics to the inventories, it is recommended that national statistical offices be recognised as formal entities in the greenhouse gas inventory systems. These “national inventory systems”¹ are designed and operated to ensure the transparency, consistency, comparability, completeness and accuracy of the inventory through planning, preparation and management of inventory activities. Their implementation differs according to national circumstances. Recognition of national statistical offices as formal entities in these systems could be done simply by explicitly noting the role of the 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. Furthermore, it may still be beneficial to create national working groups around greenhouse gas inventory data and other climate change-related statistics in order to sustain continuous quality improvements.

It is recommended that national statistical offices start improving climate change-related statistics gradually and based on their key competencies. First, access to existing environmental, social and economic statistics should be improved for the purposes of climate change analysis; for example, official statistical dissemination channels could be better used to provide researchers and decision makers with better access to climate change information. As a second step, the usefulness of existing statistics for climate change analysis should be improved by reviewing and improving existing data collection systems. In this context, the Task Force underlines the importance of improving the coherence between existing datasets to maximize their potential for climate change analysis; for example, it would be useful if existing data were more commonly geo-coded to allow their dissemination according to ecological as well as political/administrative regions. Third, development of additional statistics may be considered where particular aspects of climate policy cannot be addressed with existing statistics; for example, the social and economic impacts of climate change, population vulnerability to extreme weather conditions and adaptation efforts.

National statistical offices should act as facilitators for the agencies responsible for greenhouse gas inventories by together with them:

- assessing the usefulness of existing official statistics for inventory compilation;
- improving the quality of the statistical data used in greenhouse gas inventories, for instance using the recommendations of annual inventory review reports;
- reviewing the statistical requirements related to the Kyoto protocol² and other global or regional climate change agreements;
- 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 may 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

¹ “National systems” comprise all the institutional arrangements within a country put in place to ensure the compilation of greenhouse gas emission inventories.

² 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. It sets more stringent reporting and review requirements and its targets and rules apply to Annex I Parties.

analysis. So too will new ways to ensure confidentiality of official statistics while providing climate change researchers 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. While the recommendations represent useful first steps, further international work will be required to support their implementation. To this end, the Task Force recommends that an international forum be established to share good practices, improve collaboration and discuss priority data needs, a key set of climate change-related statistics and 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. A better dialogue among the statistical community and international organisations working on climate issues would be beneficial. At European level, the Conference of European Statisticians and its Secretariat would be well placed to ensure cooperation with the International Panel on Climate Change, United Nations Economic Commission for Europe's Protocol on Pollutant Release and Transfer Registers, United Nations Food and Agriculture Organisation, United Nations Framework Convention on Climate Change, World Meteorological Organization and others.

LIST OF ABBREVIATIONS

ABS	Australian Bureau of Statistics
AFOLU	Agriculture, forestry and other land use
CES	Conference of European Statisticians
CIS	Commonwealth of Independent States
CO ₂	Carbon dioxide
COP	Conference of the Parties
CPC	Central Product Classification
CRF	Common Reporting Format
CSA	Classification of Statistical Activities
DECC	Department of Energy and Climate Change of the United Kingdom
DG-CLIMA	Directorate-General on Climate Action of the European Commission
DPSIR	Driving force – Pressure – State – Impact – Response
ECLAC	Economic Commission for Latin America and the Caribbean
EU	European Union
EEA	European Environment Agency
ETS	European Union Emissions Trading System
FAO	Food and Agriculture Organisation of the United Nations
FDES	Framework for the Development of Environment Statistics
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GNI	Gross National Income
GVA	Gross Value Added
IEA	International Energy Agency
IMA	Impact, Mitigation and Adaptation
IPCC	Intergovernmental Panel on Climate Change
ISIC	International Standard Industrial Classification of all economic activities
LULUCF	Land use, land-use change and forestry
NACE	Nomenclature statistique des activités économiques dans la Communauté européenne / Statistical classification of economic activities in the European Community
NASA	National Aeronautics and Space Administration of the United States

NSO	National Statistical Office
NSS	National Statistical System
OECD	Organisation for Economic Co-operation and Development
PRTRs	Pollutant Release and Transfer Registers
QA/QC	Quality Assurance/Quality Control
SEEA-CF	System of Environmental-Economic Accounting Central Framework
SIEC	Standard International Energy Product Classification
SNA	System of National Accounts
SNAP97	Selected Nomenclature for Air Pollution
UNCEEA	United Nations Committee of Experts on Environmental-Economic Accounting
UNECE	United Nations Economic Commission for Europe
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNSC	United Nations Statistical Commission
UNSD	United Nations Statistics Division (in New York, secretariat to UNSC)
WHO	World Health Organization
WMO	World Meteorological Organization

INTRODUCTION

This publication 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). More than 60 countries and international organisations endorsed the recommendations in the plenary session of the Conference of European Statisticians in April 2014. While the recommendations are aimed primarily at official statisticians, they are also intended as a tool to promote discussions with stakeholders, including agencies responsible for greenhouse gas inventories and other producers and users of climate change-related statistics.

The recommendations were developed by the Task Force on Climate Change-Related 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 Conference of European Statisticians (CES).³ 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 in the Task Force: Robert Smith (Canada, Chair), Leo Kolttola (Finland, Vice Chair), Enrique de Alba (Mexico), Julio Cabeça (Eurostat), Helen Champion (United Kingdom), Ricardo Fernandez (EEA), Angela Ferruzza (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 (ABS)⁴ and the outcome of two conferences held on this topic in 2008.⁵ As an outcome of the review, UNSC recognized the important role of 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 CES member countries. 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

³ CES includes UNECE and OECD members and other countries, such as Brazil, China, Colombia, Mexico and South Africa.

⁴ The report by ABS: unstats.un.org/unsd/statcom/doc09/2009-2-ProReview-E.pdf

⁵ 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/.

beyond the UNECE region. Of the 48 countries that replied,⁶ 37 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 agencies responsible for 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 in some way 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 European Commission’s Directorate General for Climate Action (DG-CLIMA), European Environment Agency, Eurostat, Intergovernmental Panel on Climate Change (IPCC), United Nations Framework Convention on Climate Change (UNFCCC) and United Nations Statistics Division (UNSD). The Task Force submitted regular progress reports to the United Nations Committee of Experts on Environmental-Economic Accounting (UNCEEA).

The objective of the Task Force was 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 the six topics below.

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 interviews⁷ and by carrying out desk studies on the data needs for emission inventories and climate policies.
3. Reviewing existing statistics that have relevance to climate change and comparing those against the needs. Analysing the results of the survey of statistical offices 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.

⁶ 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, Republic of Moldova, Montenegro, Netherlands, New Zealand, Norway, Poland, Portugal, Romania, Russian Federation, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, the former Yugoslav Republic of Macedonia, Turkey, Ukraine, United Kingdom and United States.

⁷ 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), Finnish Environment Institute, Carbon Brief and World Wildlife Fund.

5. Reviewing the statistical infrastructure, such as standards, classifications and methods, used to report on climate change-related statistics. Examining the existing 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.⁸ 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 2013⁹, again in Geneva, to discuss a draft version of these recommendations. The meeting brought various producers and users of climate change information together to discuss 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 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 publication 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 the inventories 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 in particular the needs related to climate policies and climate change analysis and looks at existing statistics and gaps in those statistics.

Chapter 4 addresses the challenges faced by the statistical infrastructure of NSOs in meeting the need for improved 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 publication 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 national and international levels are also considered.

⁸ 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.

⁹ 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 periods.

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.”¹⁰

Climate change is defined in the United Nations Framework Convention on Climate Change (UNFCCC)¹¹ 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, resilience¹² 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 that 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.”¹³

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

¹⁰ Source: www.nasa.gov/mission_pages/noaa-n/climate/climate_weather.html

¹¹ Article 1 of the Full text of the Convention:

unfccc.int/essential_background/convention/background/items/1349.php

¹² 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.”

¹³ Source: www.nasa.gov/mission_pages/noaa-n/climate/climate_weather.html

components (atmosphere, hydrosphere, etc.) and their interactions, and the consideration that 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 system¹⁴ has a lot of features that are important in relation to climate change. Official statistics¹⁵ adhere to international principles that bring a number of important attributes to the discourse on climate change. Given the sometimes controversial nature of this discourse, **professional independence** is one such attribute. Official statistics are an important source of reliable information because of the strict conditions and **quality criteria** under which they are produced. Other attributes include a commitment to the use of **sound, transparent and commonly agreed methodologies** and a commitment to data **accessibility**.

The statistical systems’ main **focus is on human systems**. Official statistics typically measure the activities of enterprises, individuals and households. Monitoring the state of environment and climate is usually done outside the statistical system. However, when environmental and climate data are linked with industries and households that influence the environment or are affected by it, these data may fall under the sphere of official statistics.

Official statistics often also include a link to the geographic region and, in some countries, exact co-ordinates are attributed to statistics through **geo-referencing**. This valuable practice could be further developed as the spatial dimension is important in the context of climate change.

¹⁴ National statistical offices in most countries are part of a broader *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 regional or global levels. The term “statistical system” used in this report refers generically to all national and international statistical systems.

¹⁵ *Official statistics* comprise any statistical activity carried out within a national statistical system or under the statistical programme of an intergovernmental organization (www.sdmx.org/). They are, by definition, compiled in accordance with the United Nations *Fundamental Principles for Official Statistics* (www.unece.org/stats/archive/docs.fp.e.html), the *European Statistics Code of Practice* (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.

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 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 **long, consistent time series** is a core competency of the statistical system.

Official statistics include well-developed methods to adjust data so **changes 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**. This is done through 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. Official statisticians have developed their methods and data collection to improve timeliness, so statistical offices can help respond 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 development¹⁶. In this area, the statistical system could provide **existing data to link with climate information** in order to provide a broader and more informed description of the socio-economic aspects of climate change.

Recently, official statistics' **focus on environmental and climate issues has broadened** with many offices compiling environmental accounts measuring natural resource assets, energy, waste, water and air emissions as well as environmental protection expenditures. The UN Statistical Commission (UNSC) recently adopted the System of Environmental-Economic Accounting Central Framework¹⁷ (SEEA-CF) at global level. This new standard will provide important support to the development of climate change-related statistics by enhancing work on environmental accounts. SEEA-CF 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. In general, **existing official statistics were not 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 way official statistics are disseminated, possibly also to data collections, and it 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 crosscutting data and measuring interactions** between the subject areas. Identifying and modelling interactions is often the work of economists, academics, government ministries and others working outside of the statistical system.

¹⁶ Source: Climate change 1995, Economic and Social Dimensions of Climate Change: www.ipcc.ch/ipccreports/sar/wg_III/ipcc_sar_wg_III_full_report.pdf

¹⁷ unstats.un.org/unsd/envaccounting/seea.asp

In many countries, **national statistical offices (NSOs) may not be 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. However, in most countries NSOs are entrusted with the overall coordination of the national statistical system. One of the challenges of developing climate change-related statistics is, therefore, **to establish also in this area an efficient coordination** and division of work between various national bodies.

Moreover, incorporating and **developing new statistics to support climate change analysis** in the statistical system, such as monitoring the move towards greener consumption and production patterns, will be a challenge for the system.

Chapter 4 discusses further the competences and challenges of the statistical system.

1.3 Frameworks that can help define the scope of climate change-related statistics

Since the climate change-related statistics cover a wide range of topics, the Task Force examined different frameworks to help in its delineation of 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 identify the statistical subject areas that are related to climate change and ensure that all relevant topics were covered in the Task Force's work. Examples of variables that could be covered by the frameworks are provided in Annex 2. The following frameworks were analysed:

- Driving force-Pressure-State-Impact-Response (DPSIR);
- UN System of Environmental-Economic Accounting Central Framework (SEEA-CF);
- UN Framework for the Development of Environment Statistics (FDES);
- Natural capital approach;
- Impact, mitigation and adaptation.

The aim of the exercise was not to identify which is the “best” framework for structuring climate change-related statistics. Rather, it is acknowledged that each framework has its own purpose and advantages.¹⁸ It is also acknowledged that the frameworks are not entirely independent of one another. The natural capital approach, in particular, is closely related to SEEA-CF, the latter being a statistical implementation of much but not all of the former.¹⁹ FDES also includes natural capital concepts. The impact, mitigation and adaptation framework is very similar to the DPSIR framework, the main difference being the explicit use of the climate change policy terminology in the former and more neutral, broadly applicable language in the latter.

An important feature of SEEA-CF is its endorsement by the UN Statistical Commission which places SEEA-CF in the same category as the influential System of National Accounts (SNA). SNA is the international statistical standard and framework used by NSOs for the calculation of gross domestic product (GDP) and other macroeconomic variables, and SEEA-CF puts environmental statistics into relation with these economic statistics. This status makes SEEA-CF an attractive framework for use in the measurement of climate change statistics, since NSOs have already internationally agreed to its use in the elaboration of environmental accounts.

¹⁸ Scope of Climate change-related statistics, note prepared by the Task Force.

www.unece.org/fileadmin/DAM/stats/documents/ece/ces/ge.33/2012/mtg3/Scope_of_Climate_Change_Related_Statistics.pdf

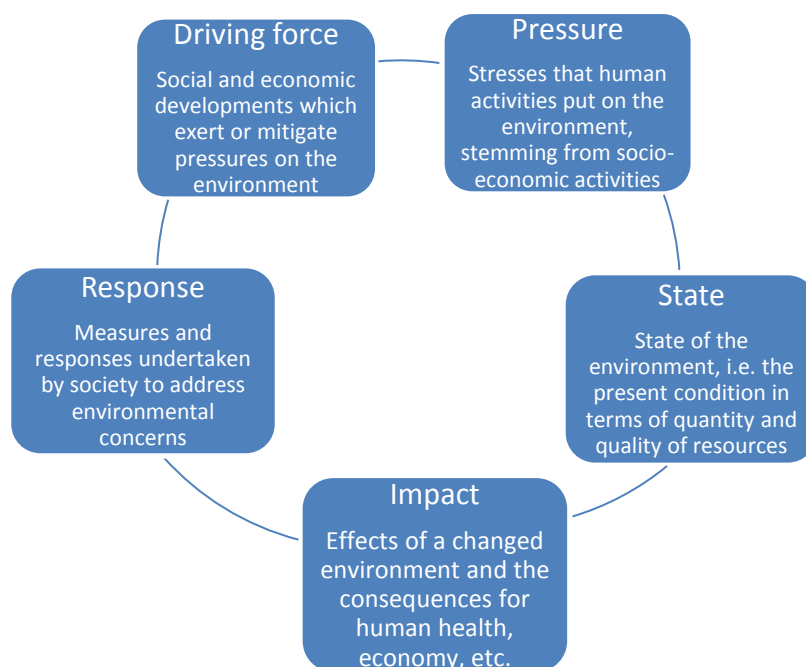
¹⁹ Main difference between SEEA-CF and natural capital approach is inclusion of ecosystems in the latter, not in the former.

DRIVING FORCE-PRESSURE-STATE-IMPACT-RESPONSE (DPSIR) FRAMEWORK

Climate change-related statistics could be examined and structured according to the so-called Driving force-Pressure-State-Impact-Response (DPSIR) model (see figure 1). The DPSIR model is used by the European Environment Agency (EEA), for example, to structure thinking about the interplay between the environment and socio-economic activities.²⁰ 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 structure statistics from different domains that can inform the various aspects of climate change, including broad socio-economic developments, sources of greenhouse gas emissions, measures related to adaptation and mitigation, among others.

Figure 1. The Driving force-Pressure-State-Impact-Response (DPSIR) model



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 FORCE

Driving forces encompass information on socio-economic developments, changes in lifestyles, 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. The data

²⁰ The DPSIR framework used by the EEA: ia2dec.ew.eea.europa.eu/knowledge_base/Frameworks/doc101182/

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 includes data and projections (using sophisticated models) on the state of the atmosphere, oceans, cryosphere (glaciers, Arctic and Antarctic sea ice, ice sheet, snow cover) and marine biodiversity and its ecosystems. A good example of state variables is the so-called set of Essential Climate Variables (ECVs) of the Global Climate Observing System (GCOS)²¹.

The main authorities responsible for meteorological and climatological data at national level are typically meteorological and hydrological services. Currently, in most countries NSOs do not collect data on the state of the climate. They may, however, be involved in dissemination of these data alongside the data that are produced within the statistical system. At international level, the World Meteorological Organization (WMO) has been producing since 1993 an annual statement on the status of global climate²² describing the variations and changes, with historical and geographical contexts, which affect the state of the climate as well as statistical data on extreme weather and climate events occurring in the world. Furthermore, its Global Atmosphere Watch²³ monitors greenhouse gas concentration in the atmosphere.

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, the socio-economic impacts of these physical changes can be regarded; for example, impacts 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.

RESPONSE

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 for eco-industries, technology exchange, “green” jobs and “green” growth. The statistical system already measures a number of variables relevant to responses; for example, statistics on environmental protection, investment, energy, prices, waste, employment, government finance and education.

²¹ The ECVs are variables for which a set of measurements is considered to be both feasible for global implementation and important for meeting requirements of UNFCCC and for future climate services. Many observing systems contribute to the GCOS network of global climate observing systems and, hence, to the generation of ECVs. GCOS Essential Climate Variables: www.wmo.int/pages/prog/gcos/index.php?name=EssentialClimateVariables

²² www.wmo.int/pages/prog/wcp/wcdmp/CA_2.php

²³ www.wmo.int/pages/prog/arep/gaw/ghg/ghgbull06_en.html

THE SYSTEM OF ENVIRONMENTAL-ECONOMIC ACCOUNTING

The United Nations *System of Environmental-Economic Accounting Central Framework* (SEEA-CF)²⁴ 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 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 SEEA-CF are given in Annex 2.

ACCOUNTS FOR PHYSICAL FLOW OF MATERIALS AND ENERGY

The physical flow accounts of 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 SNA.

From the perspective of climate change, the SEEA-CF air emissions 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 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 that would be useful for policy purposes.

By implementing SEEA-CF, NSOs would create the basis for climate change-related indicators such as energy use and greenhouse gas (GHG) emissions per unit of GDP by industry; measures of “consumption based” GHG emissions²⁵; and measures of “decoupling” between the economy and the environment.²⁶

GHG inventories are important data sources for air emissions 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)

²⁴ *System of Environmental-Economic Accounting Central Framework*: unstats.un.org/unsd/envaccounting/White_cover.pdf

²⁵ *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 of units legally registered in the country.

²⁶ 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 in such a way that it makes less use of the environment, both in absolute and in relative terms.

responsible for them in the air emissions accounts. When compiling air emissions accounts, it is essential that their differences from GHG inventories be clearly explained to users, including clear descriptions of the conceptual and methodological reasons for the distinctions (see the Canadian case study 12, Section 2.3).²⁷

ACCOUNTS FOR STOCKS OF ENVIRONMENTAL ASSETS

The SEEA-CF stock accounts measure the size of environmental assets (ecosystems²⁸, 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 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.²⁹ Australia has developed an experimental framework for a carbon asset account following the SEEA-CF approach.³⁰ 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 activities 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:

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

²⁷ A recent EEA report provides a detailed explanation of the differences in accounting approaches for air emissions: www.eea.europa.eu/publications/european-union-co2-emissions-accounting/.

²⁸ 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*.

²⁹ Statistics Canada, 2013, *Human Activity and the Environment: Measuring ecosystem goods and services in Canada* www.statcan.gc.ca/pub/16-201-x/16-201-x2013000-eng.htm

³⁰ unstats.un.org/unsd/envaccounting/ceea/archive/Framework/eap_Aus.pdf

A related set of information in 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.

SEEA-CF also provides guidance on the measurement of environmental taxes, subsidies, permits and licenses 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.

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 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.

Finally, SEEA-CF should not be confused with “accounting” as the term is used in the context of 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 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. The accounting concerns the rules and procedures for settling all these elements at the end of the commitment period.³¹

FRAMEWORK FOR THE DEVELOPMENT OF ENVIRONMENT STATISTICS (FDES) AND IPCC SCHEMATIC FRAMEWORK

The Framework for the Development of Environment Statistics (FDES) is a multi-purpose framework that is comprehensive and integrative in nature and marks out the scope of environment statistics. It provides an organizing structure to guide the collection and compilation of environment statistics at national level. It is broad and holistic in nature, covering the issues and aspects of the environment that are relevant for policy analysis and decision making by applying it to crosscutting issues such as climate change. FDES is compatible with and supports other frameworks, such as SEEA-CF and the Driving force-Pressure-State-Impact-Response framework. The UN Statistical Commission endorsed the updated FDES in 2013 as a framework for strengthening environment statistics in countries.

FDES 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 include 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

³¹ For more on accounting under the Kyoto Protocol: unfccc.int/resource/docs/publications/08_unfccc_kp_ref_manual.pdf

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. Related 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 SEEA-CF³² and to both state and pressure elements of DPSIR. It comprises data on energy resources, land, biological and water resources linked with climate change. Part of these data is available from the statistical systems; for example, statistics on population, energy, agriculture, forestry, mining and land use.

RESIDUALS

This component contains information on emissions of greenhouse gases and consumption of ozone depleting substances. This component 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 emissions accounts that allow distinguishing emissions originating from production (by economic activity) and consumption.

EXTREME EVENTS AND DISASTERS

The occurrence of climate change-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 DPSIR, and they relate to the SEEA-CF asset accounts.

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 data on population 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.

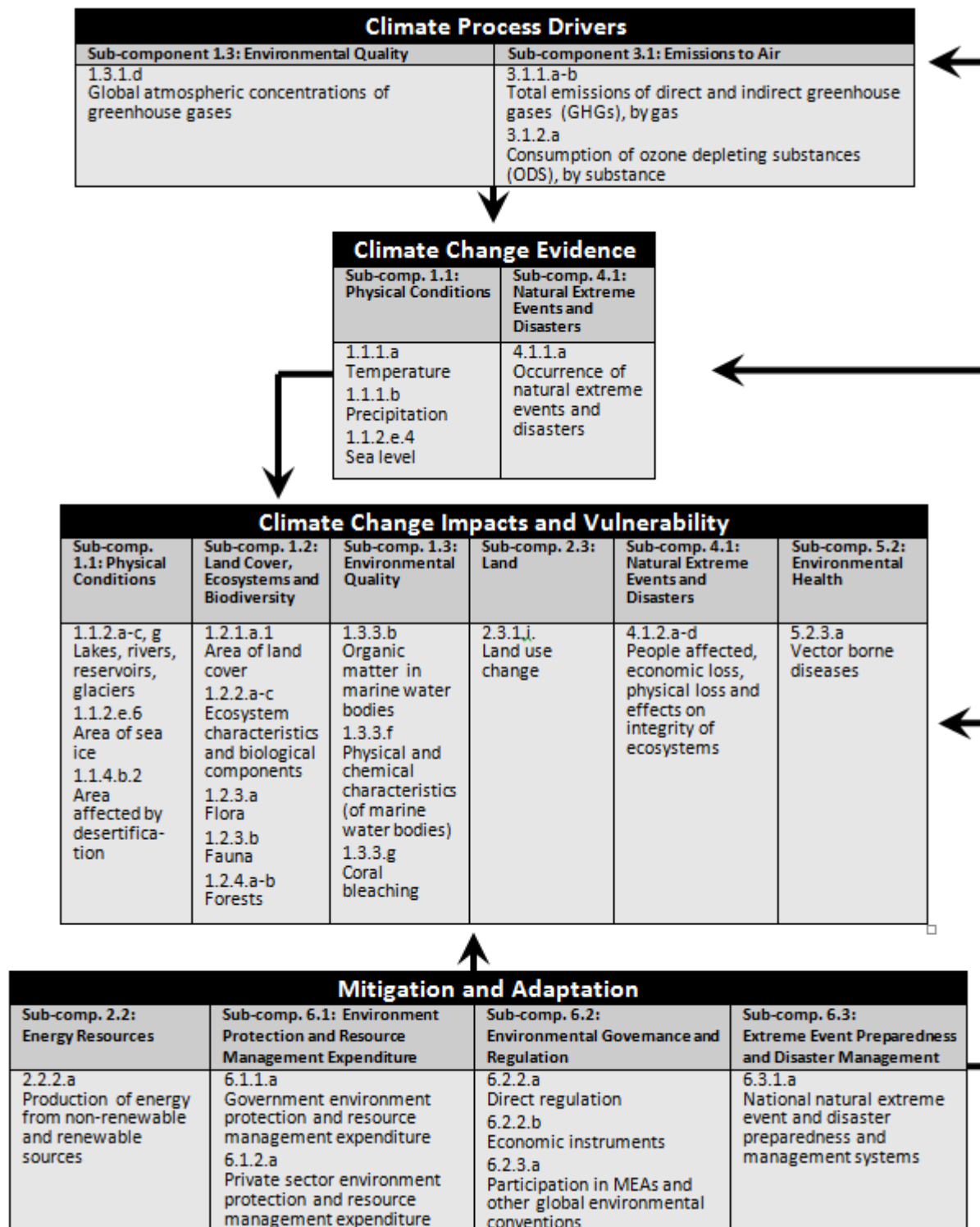
ENVIRONMENT PROTECTION, MANAGEMENT AND ENGAGEMENT

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.

³² The System of Environmental-Economic Accounting (SEEA): unstats.un.org/unsd/envaccounting/seea.asp

Part of this information consists of qualitative data on projects and norms related to protection of the climate system and management of extreme events. Some quantitative data, however, on costs of mitigation and adaptation, finance, taxes and subsidies could be available from statistical systems. The role of statistical systems in measuring the effectiveness of economic instruments is evolving.

Figure 2: Topics in the FDES that relate to climate change – organized by the IPCC framework



Source: FDES, version submitted to the UN Statistical Commission, Figure 5.8, page 182.

The FDES report includes a section on topics in the FDES that relate to climate change. Figure 2 presents topics in 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 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. FDES also provides a list of concrete climate change statistics available in environmental statistics (see FDES, pages 183-185).

NATURAL CAPITAL APPROACH

Another framework that facilitates defining the scope of climate change statistics is found in the body of thought around natural capital. This approach links environmental quality and human well-being through the flows of ecological goods and services from natural assets to humans. It should be noted that both SEEA-CF and FDES are based to a significant extent on the concept of natural capital.

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.

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 be seen as changed flows of ecological goods in, for example, 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).

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 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”.³³ 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.”³⁴ 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.

FINDINGS FROM THE ANALYSIS OF DIFFERENT FRAMEWORKS

Each framework presented above provides a different viewpoint on climate change-related statistics. The Task Force used the *Classification of Statistical Activities (CSA)*³⁵ as a tool to summarise the coverage of statistical issues in the 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.

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. The DPSIR and IMA are highly flexible and comprehensive and any variable that might be related to climate change can be 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 or climate science).

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” 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, DPSIR and IMA should be treated as tools for organizing the climate change-related information, not as models for analysing causality between its parts.

³³ IPCC definition: www.ipcc.ch/publications_and_data/ar4/wg2/en/ch18s18-1-2.html

³⁴ IPCC definition in Climate Change 2007, Impacts, adaptation and vulnerability: www.ipcc.ch/pdf/assessment-report/ar4/wg2/ar4_wg2_full_report.pdf

³⁵ unstats.un.org/unsd/iiss/Classification-of-International-Statistical-Activities.ashx

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 and its status as an international statistical standard. 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. Linkages of social and demographic statistics to permit their analysis in the context of, for example, vulnerable population groups, could increase the value of SEEA-CF data for climate change analysis.

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 natural capital approach is not, however, a statistical framework in itself and so is not suitable on its own to define the scope of climate change-related statistics. As noted above, however, it serves as a primary conceptual foundation for both SEEA-CF and FDES.

1.4 Definition of the scope of climate change-related statistics

The Task Force analysed the above frameworks – along with its own assessment of user needs – as the basis for a discussion of the scope of climate change-related statistics. The Task Force did not advocate any particular framework, though it did acknowledge the particular value of SEEA-CF as an internationally accepted statistical standard and its strength in integrating economic and environmental data.

One conclusion of these discussions on the scope of climate change-related statistics is that since climate change impacts the environment, the economy and society in complex, multi-faceted ways, a conceptually based definition of climate change-related statistics would be too broad to be of practical use. Climate change touches upon a broad range of human activities – from energy use to transportation, waste generation, agriculture, manufacturing and tourism and more. Indeed, few human activities are not related somehow to climate change, either as a contributing factor or *via* an impact. Climate change also influences a wide range of natural phenomena – rainfall, temperatures, ocean and air currents and ecosystems – that have an impact on human activities. The Task Force therefore sought a more pragmatic approach to defining the scope of climate change-related statistics.

In its search for a pragmatic definition, the Task Force noted a common feature of all frameworks and approaches examined: the measurement of 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 Task Force chose then to define **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 the consequences.

Whereas climate change is multi-disciplinary and anchored largely in the natural sciences, the statistical system is focused on anthropomorphic or human systems and provides data for administrative regions within national boundaries. The broad definition above is, therefore, still not fully suitable for statistical offices wishing to improve climate change-related statistics. An approach is needed to narrow the scope to those areas where the statistical system's involvement will be most valuable. These are the 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 chose finally to focus on environmental, social and economic statistics that measure climate change-related:

1. **emissions:** GHG emissions and their *human cause*;
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 the consequences*.

It should be noted that the Task Force chose not to focus on climate change statistics in general. Beyond the five areas listed above (what the Task Force called "climate change-related statistics"), climate change statistics more generally would also include data that measure climate and weather directly; for example, temperature and precipitation. These statistics are frequently, but not always, collected and analysed by agencies outside of the statistical system; for example, by meteorological organizations. Since such statistics are normally not the responsibility of the statistical system and because their inclusion would have broadened the scope of the Task Force's work too greatly, the focus of the Task Force was exclusively on what it defined as climate change-related statistics.

The recommendations presented in the following chapters divide climate change-related statistics into two groups: 1) statistics needed directly for the compilation of greenhouse gas inventories and 2) other climate change-related statistics. This approach reflected the mandate given to the Task Force by CES (see Annex 1).

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 (NSOs) – in support of compiling national greenhouse gas inventories and national communications. The chapter considers the current and potential role of NSOs in the *national inventory systems*³⁶ that produce greenhouse gas 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 for inventories
- identify major gaps and areas where NSOs could make an improved contribution.

All Annex I Parties³⁷ to the United Nations Framework Convention on Climate Change (UNFCCC) are required, among other things, to compile and submit to UNFCCC annually³⁸ a national greenhouse gas inventory providing data in a *common reporting format* (CRF) with explanatory notes on data sources and methodologies in *national inventory reports* (NIR). Non-Annex I Parties submit a less detailed greenhouse gas inventory every four years, depending on funding. Recently, new reporting has also been agreed for non-Annex I Parties to UNFCCC requiring *biennial update reports* of emissions.

Inventory compilation comprises various activities. These include collecting “activity data” on a variety of economic activities; selecting appropriate methods and emission factors; estimating GHG emission sources and sinks;³⁹ implementing quality assurance/quality control (QA/QC) procedures; verifying national data; submitting data to UNFCCC; and reviews carried out by expert review teams. Currently, a process of “consideration” is also being launched for non-Annex I Parties as a kind of a lighter expert review. Furthermore, all Parties are required to submit policy-related information on mitigation, adaptation and funding every four years in *national communications* with an interim update every two years. This work is carried out under UNFCCC and IPCC guidance.

The following documents provide the methodological basis for GHG inventory compilation:

- *2006 IPCC Guidelines for National Greenhouse Gas Inventories*⁴⁰, based on the *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories*⁴¹, are effective as of 2015;
- *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories*⁴² provides support for the development of high quality inventories;
- *2013 Revised Supplementary Methods and Good Practice Guidance Arising from the Kyoto Protocol*⁴³ for reporting emissions and removals from land use, land-use change and forestry.

³⁶ Article 5.1 of the Kyoto Protocol (*Guidelines for national systems under Article 5, paragraph 1, of the Kyoto Protocol*: www.ciesin.columbia.edu/repository/entri/docs/cop/Kyoto_COP001_019.pdf) requires that Annex I Parties to the Convention have a “national system 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.

³⁷ List of Annex I Parties: unfccc.int/parties_and_observers/parties/annex_i/items/2774.php In addition to Annex I Parties, a number of other countries compile greenhouse gas inventories for their own purposes. The 17th UNFCCC Conference of the Parties in Durban (in November 2011) agreed to adopt by 2015 a global protocol to be implemented from 2020 that will require all countries (not only those in Annex I) to submit annual inventories.

³⁸ Examples of GHG inventory submissions from Annex I Parties:

unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/8108.php

³⁹ The IPCC source/sink sectors are: 1) energy; 2) industrial processes and product use; 3) agriculture, forestry and other land use; 4) waste (www.ipcc-nggip.iges.or.jp/public/2006gl). 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.

⁴⁰ www.ipcc-nggip.iges.or.jp/public/2006gl

⁴¹ www.ipcc-nggip.iges.or.jp/public/gl/invs6.html

⁴² www.ipcc-nggip.iges.or.jp/public/gp/english/

⁴³ www.ipcc-nggip.iges.or.jp/home/2013KPSupplementaryGuidance_inv.html

This chapter focuses on the role of NSOs as 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 a few countries, the NSO not only provides activity data but also 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 the agencies formally responsible for compilation of the national GHG inventory.

2.1 User needs

Each national GHG inventory provides information on emissions and their historical trends that are relevant to policy makers in designing climate mitigation policies and assessing the impact of those policies. Moreover, all national inventories in Annex I parties 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.

The users of statistics with respect to GHG inventories can be classified as: 1) the agencies responsible for greenhouse gas inventories; 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, climate change analysts, 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.

AGENCIES RESPONSIBLE FOR GREENHOUSE GAS INVENTORIES

From the perspective of agencies responsible for greenhouse gas inventories, 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 the quality of the GHG emissions inventory.

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.

INVENTORY REVIEWERS

From the inventory reviewer perspective, it can be 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.

CLIMATE CHANGE AND INVENTORY ANALYSTS

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 from coal to gas. This information can be derived from the activity data reported in GHG inventories and in the NIRs that countries are required to submit along with their inventories.

Similarly, **linking emissions to socio-economic data**, explanatory variables and other data produced by national statistical systems will help provide a more complete picture of the underlying reasons for increasing or decreasing trends in emissions. Analysts may wish to know which industries are emitting, which of them are among the most energy- or carbon-intensive, and what is their contribution to GDP, exports and imports? This type of information is needed for instance for preparing the national communications in Annex I Parties.

Analysts also seek **timelier information** to meet the growing demands of policy makers and the public and to raise the profile of climate change information in comparison to 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 management data on agriculture, forestry and other land use;
- 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. It is worth noting that the *IPCC Guidelines* for inventory compilation are flexible, allowing three “tiers” of methods of increasing complexity. Tier 1 methods are relatively undemanding in terms of data needs as they mostly make use of reference values. Tier 2 methods require more country-specific data and tier 3 require the use of detailed country-specific data and models. All tiers are intended to provide unbiased estimates. Accuracy and precision should, in general, improve from tier 1 to tier 3. Similarly, data requirements increase when moving to higher tier methods.

A Eurostat publication on the use of official statistics to calculate greenhouse gas emissions⁴⁴ 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 inventory 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. The *IPCC Good Practice Guidance*⁴⁵ requires that greenhouse gas inventories be based in several areas on official national data when these are available and consistent with the recommended methodology.

The 2011 UNECE survey⁴⁶ 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 out of 48) 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

⁴⁴ *Using official statistics to calculate greenhouse gas emissions. A statistical guide*
epp.eurostat.ec.europa.eu/cache/ITY_OFFPUB/KS-31-09-272/EN/KS-31-09-272-EN.PDF

⁴⁵ www.ipcc-nggip.iges.or.jp/public/gp/english/

⁴⁶ www.unece.org/stats/climate.html

reported their countries' inventories. Most NSOs who participated in the process did so by collaborating with other institutions, such as ministries or research bodies, 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:

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

Based on the feedback received from countries and international organisations during the expert meetings organized by the Task Force, the greater the involvement of NSOs in national inventory systems, 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 produce a coherent and harmonised system of **energy statistics** that is reported to Eurostat and to the International Energy Agency (IEA). This is a source of information on energy consumption, energy dependency, energy intensity of the economy, electricity generation and statistics on renewable energy sources. It serves as an important source of data for GHG inventories and for calculations of other air emissions. **Energy balances** have long been an important component of energy statistics. Increasingly, **energy accounts** (as described in SEEA-CF) also form part of energy statistics and their preparation will likely become more widespread in coming years. For instance, they are planned to be included as part of the second version of the Eurostat directive on environmental accounts.

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.

Table 1: Number of NSOs, in the UNECE survey, that collect or calculate data by IPCC source/sink categories⁴⁷

	DATA COLLECTION	EMISSIONS CALCULATION
Energy	21	8
Agriculture	19	7
Industrial processes	18	9
Land-use change and forestry	13	1
Waste	12	4
Solvent and other product use	7	2

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

The UNECE survey also explored the involvement of NSOs in the calculation of specific greenhouse gases. Of the NSOs that responded, 13 were involved in the calculation of at least one of the six

⁴⁷ The survey was collected applying the previous IPCC source/sink categories as presented in the table. The new categories, used as of 2015, are presented in the *2006 IPCC Guidelines*: www.ipcc-nggip.iges.or.jp/public/2006gl

major greenhouse gases, most commonly carbon dioxide (CO₂), methane (CH₄) or nitrous oxide (N₂O). The same number of NSOs was involved in calculating some of the emissions of indirect greenhouse gases; most often those of nitrogen oxides (NO_x) and sulphur dioxide (SO₂).

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

It should be noted that a relatively small number of NSOs was involved in some way in all three phases of the inventory process; namely, collection, compilation and reporting of the data. There were, in fact, five countries where the NSO was actually responsible for most of the inventory compilation: Finland, Israel, Norway, Turkey and (partially) Sweden.⁴⁸

In 11 countries, the NSO had no involvement in the inventory process.

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

- 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 emission 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 were 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 were involved in the inventory process, a number were 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 case study 1 for details).

⁴⁸ In Sweden, the NSO produces a large share of the results as a service commissioned by other government bodies.

Case study 1: National Bureau of Statistics of China's Plan for Improving Statistics for GHG Inventories

Domain	Responsible Entity	Statistics improvement
Energy	National Bureau of Statistics, the National Energy Board	Increase energy types measured in energy statistics Refine and improve the national energy balance
	National Bureau of Statistics	Refine the industrial energy statistical reporting
		Improve energy consumption statistics in construction
		Improve energy consumption statistics in service sector
	Government Offices Administration of the State Council	Establish an energy consumption survey of selected road and river transport enterprises
Ministry of Transportation	Improve energy consumption statistics for public buildings Strengthen energy consumption statistics in selected transportation enterprises	
Industry	National Bureau of Statistics	Improve data on selected industrial products related to GHG emissions
	Ministry of Environmental Protection	Establish statistical reporting system on fluorine gas production, import, export and consumption
	National Energy Board, the State Administration of Production Safety Supervision	Improve statistics on methane emissions and utilization from coal production enterprises
	China Petroleum and Chemical Industry Association	Improve statistics on fugitive emissions from oil and natural gas production
	China Electricity Council	Improve statistics related to thermal power generation
	China Steel Industry Association	Improve statistics related to steel production
Agriculture	National Bureau of Statistics	Refine the survey on seeded cropland area Refine the survey on livestock and poultry
	Ministry of Agriculture	Conduct specific investigations on crop characteristics
		Conduct specific investigations on livestock characteristics
		Conduct specific survey on poultry feeding and manure treatment
Forestry	State Forestry Administration	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
Waste	Ministry of Housing and Urban-Rural Development	Improve statistics on municipal solid waste
	Ministry of Environmental Protection, Ministry of Housing and Urban-Rural Development	Improve statistics on sewage disposal and treatment

A few countries are also producing timelier estimates of greenhouse gas inventories. In fact, a new EU Regulation (EU No. 525/2013) foresees the compilation of approximated greenhouse gas inventories submitted at 7 months delay from 2015 onwards. Some statistical offices have, therefore, started to consider producing early estimates of air emissions accounts.

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 case study 2). 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. An English version of Statistics Netherlands's quarterly press release is available at: www.unece.org/fileadmin/DAM/stats/pr/Netherlands_press_release.pdf

Case study 2: 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.

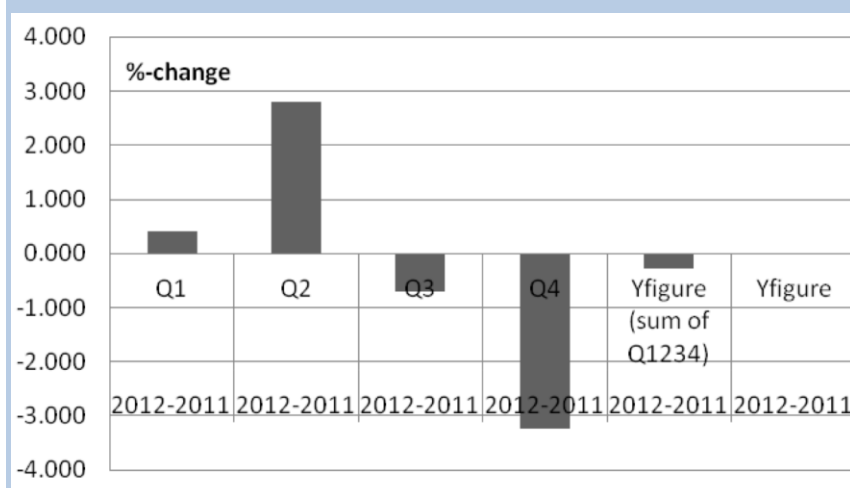
Though much less detailed than the Dutch GHG inventory, these statistics are much timelier – the GHG inventories become available only after a long delay. The quarterly release focuses on the changes in emissions of five key sectors of the economy: agriculture, mining, manufacturing and construction; energy, water and environmental service companies; transportation; 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 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 (using data from the Dutch emission inventory); 2) determine for every quarter the emissions for the different energy inputs in a particular industry; 3) select an indicator that is suitable for estimating emissions for the same quarter the next year for a particular energy input in a particular industry; 4) aggregate emissions to the reporting level and calculate the year-to-year changes; and 5) after carrying out the estimation for the four quarters, rebase the sum of the four quarters to match the 'real' emissions for the year. This last step is important for two reasons. Firstly, the rebased figures are needed in order to produce figures for t+1 (the new base year). Secondly, it is important to monitor the quality of the estimations done.

CO₂ emissions on quarterly basis (2012-2011), comparison sum of four quarters with yearly figures (environmental accounts)



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 emissions 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

www.unece.org/fileadmin/DAM/stats/pr/Netherlands_press_release.pdf

Source: Statistics Netherlands, environmental accounts

Case studies 3-10 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.

Case studies 3-10: Ways of organising the national systems for greenhouse gas inventories and the NSO role

ALBANIA – NSO to be involved in the future

In the past, the Albanian Ministry of Environment, Forests and Water Administration found that data availability and quality presented a barrier to improving the accuracy of the national 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 2012, the current legislation did not oblige data providers to submit their data for emission inventories but amendments were underway. In addition, the Albanian 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.

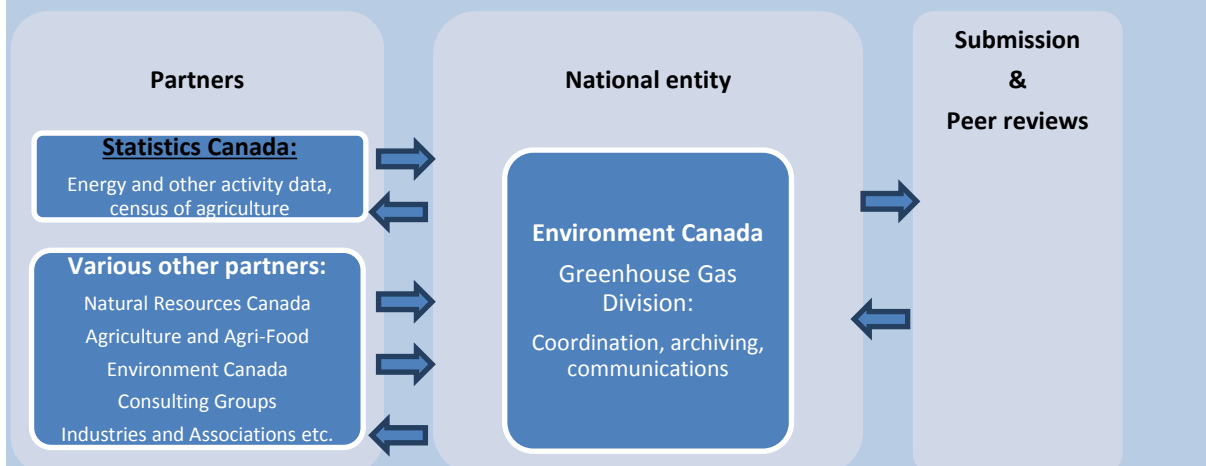
AUSTRALIA – NSO making quality checks to GHG as part of national statistics

In Australia, the Department of Climate Change within the Australian Government is responsible for all aspects of GHG inventories and their submission to 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.



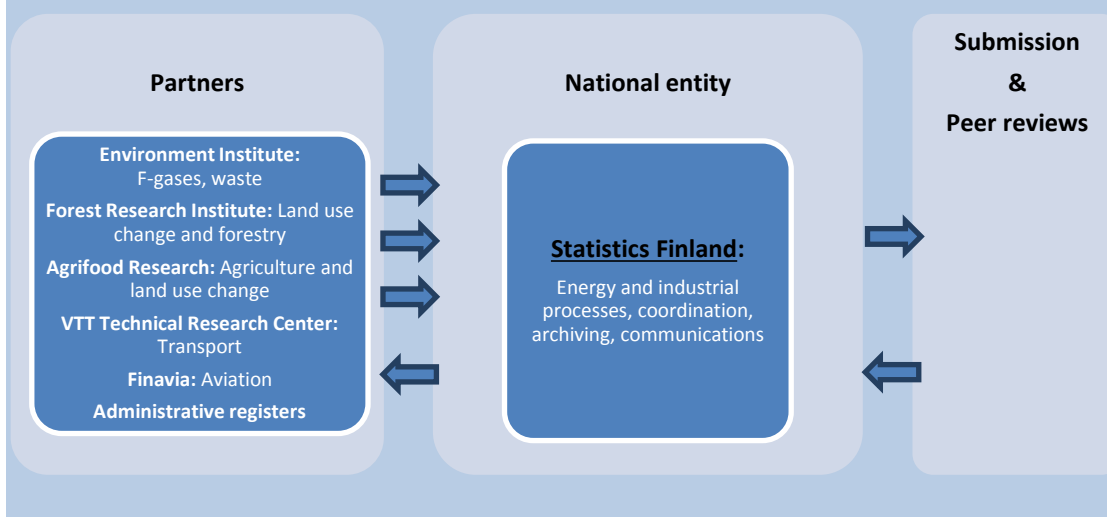
FINLAND – NSO as the national entity

The Government in Finland noted problems associated with emissions data being spread between several sources and, therefore, 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 general administration, quality management and communication of the inventory to 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 Environment and Statistics Finland.

According to the Finnish experience, 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. Another major advantage is that no additional data collection is needed for the emission inventory. A disadvantage is that the NSO cannot publicly release company-specific information unlike other government agencies are sometimes able to.

A number of areas have been identified for improvement in Finland, including the need for more frequent energy statistics for the purposes of emission inventories.



THE NETHERLANDS – NSO involved in emission register established in 1974

In 1974, the first steps were taken by a number of organisations, including Statistics Netherlands, to establish an integrated Pollutant Release and Transfer Register (PRTR) in the Netherlands (www.prtr.nl). More recently, this register has been expanded to include the GHG inventory system.

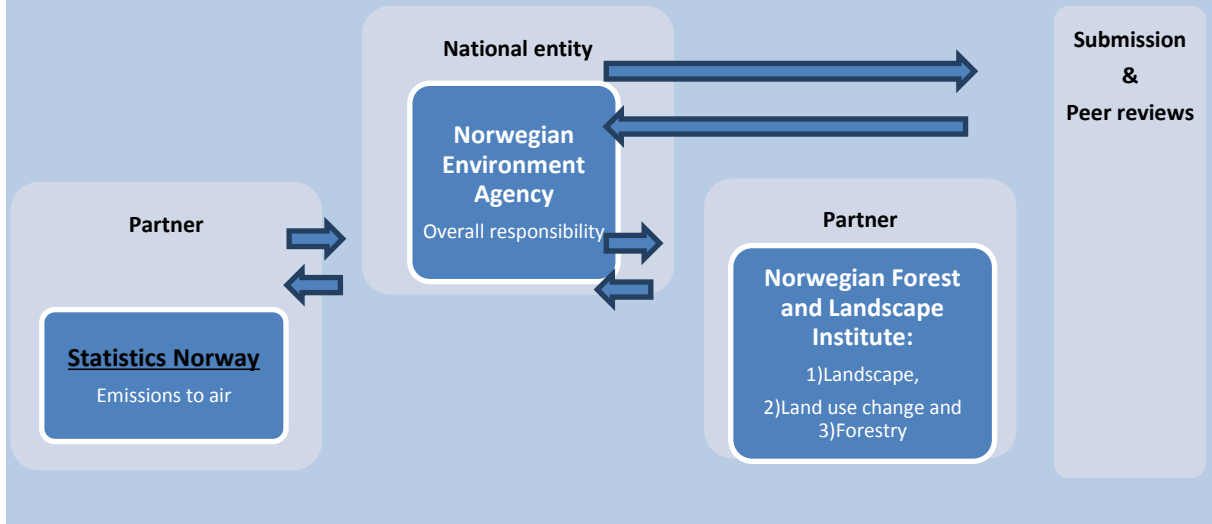
The register covers five dimensions: 1) **components** (350 pollutants, based on reporting obligations like the Kyoto Protocol, NEC Directive, Water Framework Directive and E-PRTR); 2) **sinks** (emissions to air, soil and water); 3) **emission sources** (from agriculture; industry, energy and refineries; construction; transport; trade, services and government; consumers; and waste disposal); 4) **location** (diffuse sources for agriculture, consumers and road traffic and point sources for individual enterprises); and 5) **time**, with a focus on trends.

The National Institute for Public Health and Environment (RIVM) co-ordinates the annual compilation of the emission register on behalf of the Ministry of Infrastructure and Environment. The Netherlands Enterprise Agency, part of Ministry of Economic Affairs, acts as the official national entity. Data are provided by Statistics Netherlands as part of its legislated statistical activities in co-operation with several other organisations. A formal agreement is drawn up by all participating organisations.

In total, about 70 emission experts from 10 institutes are involved in the process of collecting, processing and reporting of the emission data in the Netherlands. The formally approved data are stored in a central database from which all (inter)national reporting is done. National emissions are spatially allocated using a geographic information system.

NORWAY – NSO in close triangular cooperation

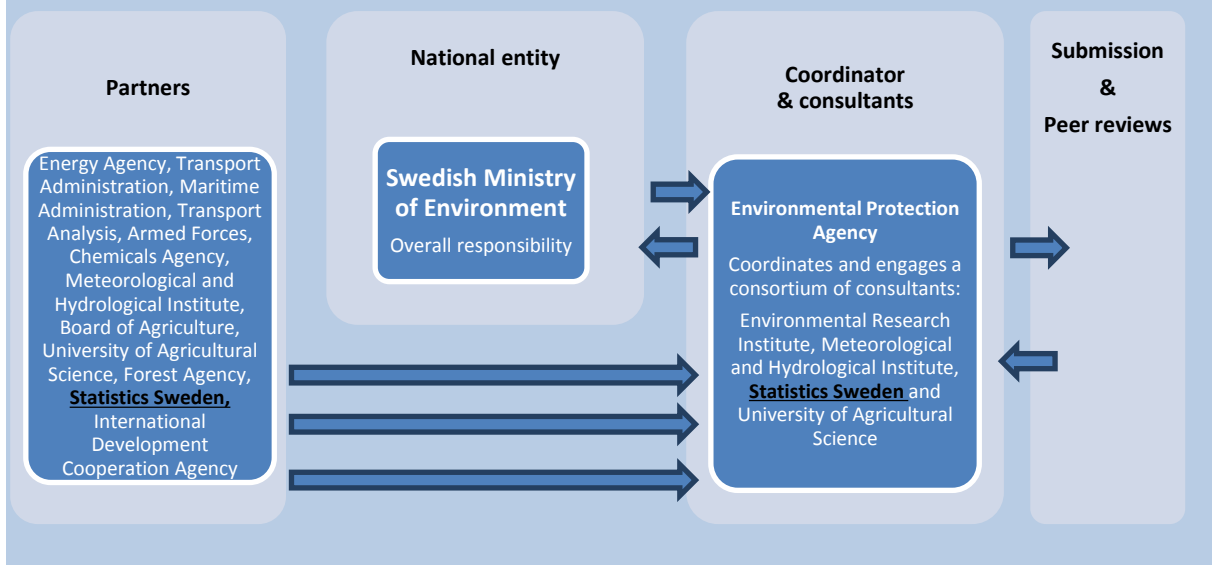
The Norwegian national GHG inventory system is based on a triangular cooperation between the Norwegian Environment Agency, Statistics Norway and the Norwegian Forest and Landscape Institute. The Norwegian Environment Agency has been appointed by the Ministry of the Environment as the national entity 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 national entity with overall responsibility for Sweden’s GHG inventory but the Swedish Environmental Protection Agency has specific responsibilities for coordinating the production of the inventory, maintaining the reporting system and assuring the quality of the inventory. Statistics Sweden is part of a consortium of consultants that contribute to the inventory. It 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, and 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 estimating emissions from energy, agriculture and parts of the waste sector. It is also involved in estimating emissions from industrial processes. The University of Agricultural Sciences is responsible for estimating emissions from land-use change and forestry, and the Environmental Research Institute for estimating emissions from industrial process, solvent and other product use and parts of the waste and energy sectors.



UNITED KINGDOM – NSO coordinates the work of the national entity for inventories

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 are classified as official statistics in the United Kingdom, reflecting the fact that they comply with the Code of Practice for Official Statistics and are authorised by the Chief Statistician for DECC, who has a direct reporting line to the National Statistician. This system is common for many official statistics in the United Kingdom, which has a decentralized statistical system.⁴⁹ 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 official 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, that 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, the agencies responsible for greenhouse gas inventories, inventory reviewers and analysts. It is meant as a general discussion of gaps and challenges and, as such, does not consider the effect of selecting between IPCC's three tiers of inventory methods. As the higher tier methods require more detailed data, data gaps also differ depending on the chosen methodology.

AGENCIES RESPONSIBLE FOR GREENHOUSE GAS INVENTORIES

From the viewpoint of the agencies responsible for greenhouse gas inventories, NSOs have a lot of data needed for GHG inventories. The challenge is that these data were collected for different purposes and may be organised in a way that makes them difficult to apply to inventory compilation.

Awareness of existing statistics is important for efficient work. As the coordinators of national statistical systems, NSOs should promote better awareness of how their data could be used for greenhouse gas inventories. Wherever possible, official statistics should be the backbone of emission inventories and additional primary data collection should be carried out only where existing statistics cannot be used.

Some activity data are readily available from current official statistics, while others are not available but could be **easily added to existing data collections**. For example, agricultural data usually include numbers 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 the latter information. Similar situation exists 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. Agriculture, forestry and other land use data are also often regarded as an area for improvement where NSOs' support would be valuable. The following case study presents a tool developed by FAO that can be used for identifying and filling data gaps in agriculture, forestry and land use.

⁴⁹ Most, but not all, countries have centralized statistical systems in which the national statistical office is responsible for the majority of official statistics. For example the United Kingdom and United States have a decentralized system.

Case study 11: Addressing data gaps with the FAOSTAT Emissions Database

Agriculture directly accounts for 10-12% of global greenhouse gas emissions, the equivalent of some five billion tonnes of carbon dioxide each year. Furthermore, changes in the way land is used, especially deforestation, account for a further 10-12% percent of total greenhouse gas emissions.⁵⁰

Estimating and reporting emissions from agriculture, forestry and other land use at national level is challenging for a number of countries due to the need to collect, compile and update a wide range of underlying rural statistics that are often unavailable, especially in some developing countries. To support its member States to address some of these data and methodological gaps, and thus enhance national processes linked to the compilation of national GHG inventories, FAO has launched the FAOSTAT Emissions Database⁵¹. The Database uses official country tier 1 data and follows the IPCC 2006 Guidelines. The Database covers agriculture emissions by country from 1961 to present and includes projections up to 2030 and 2050.

The FAOSTAT Emissions Database provides countries with the opportunity to identify the official agricultural and forestry statistics needed for building a reference database of GHG emission estimations. The Database is also useful for filling data gaps and performing quality control and assurance analyses. An accompanying manual, *Estimating Greenhouse Gas Emissions in Agriculture, A Manual to Address Data Requirements for Developing Countries*⁵² allows users to better understand the international climate policy context, the basic data and methodological requirements and provides step-by-step guidance on how to access and use the FAOSTAT Emissions Database.

The Task Force's stakeholder interviews confirmed that **access to detailed source data** and microdata continues to be a challenge. Questions have been asked whether the level of detail required for inventories is excessive and whether it would be possible to achieve a better balance between costs of data collection and accuracy of results. It should be noted that data gaps depend on the choice made between the tier 1 to 3 methodologies of the *IPCC Guidelines*. The higher tier methods and more complex models often require the use of more detailed data.

Another challenge is that NSOs are often **not aware of the data needs** of emission inventories and thus not prepared to respond to the data requirements. NSOs should inform themselves about inventory data needs through closer collaboration with compilers and by reviewing *national inventory reports* and the related *inventory review reports* prepared by UNFCCC expert teams. To assist with this task, the Task Force developed a table – based on the situation in the United Kingdom – that sets out the key datasets against each of the inventory sectors (see Annex 4). This table can be used as a tool to help identify the data NSOs should provide for emission inventories.

A good starting point for improving NSOs' contribution to inventory compilation would be to draft, together with the agencies responsible for greenhouse gas inventories, 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 energy statistics, including energy balances and accounts, 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, in turn, on the quality of the energy balance. The Task Force noted a particular interest in cooperation among NSOs, energy agencies and the agencies responsible for GHG inventories to **improve energy statistics** and to clarify how energy statistics feed into inventory calculations. The Oslo Group on Energy Statistics, which provides a forum for discussion among energy statisticians, offers a useful starting point for building this cooperation.⁵³

⁵⁰ www.fao.org/docrep/019/i3671e/i3671e.pdf

⁵¹ [FAOSTAT Emissions Database: faostat3.fao.org/faostat-gateway/go/to/browse/G1/*/*E](http://faostat3.fao.org/faostat-gateway/go/to/browse/G1/*/*E)

⁵² www.fao.org/climatechange/41521-05e3c91baed6f1a1f6799294ff2b02876.pdf

⁵³ The Oslo Group (OG) on energy statistics: oslogroup.org/index.asp?page=oslogroup.html

INVENTORY REVIEWERS

The perspective of inventory reviewers and the challenges of GHG inventories are reflected in the *Inventory Review Reports*⁵⁴. 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 generally 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) IPCC estimation methods; use of country-specific emission factors; and more accurate activity data. At the same time, reviews note deficiencies in **waste data** in some countries regarding, for example, the types of waste disposed and wastewater; problems with the quality and availability of time series data on **land use and forestry**; and concerns about the **timeliness of activity data**.

General areas of improvement noted in inventory reviews can be summarized as follows:

- **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;
- **organization and capacity**: descriptions of institutional arrangements and capacity.

There are also gaps in the capacity for the compilation of GHG inventories in a number of countries. The recently introduced biennial update reporting adds incentives to all countries to develop inventories. The non-Annex I Parties to the UNFCCC should provide their first biennial update report by end-2014 consistent with their capabilities and level of support. The report includes for instance a summary of emissions by sources and removals by sinks, information on programmes containing measures to mitigate climate change etc. It would be beneficial for NSOs to be involved in the process, especially when new data requirements are first implemented in countries.

CLIMATE CHANGE AND INVENTORY ANALYSTS

Inventory analysts constantly request **timelier estimates of emissions** and several NSOs have experience in “now-casting”; that is, compiling timelier statistics using estimation. The Eurostat *Sponsorship Group on Measuring Progress, Well-being and Sustainable Development*⁵⁵ identified the need to produce more timely estimates of CO₂ emissions based on monthly energy statistics. In some cases, the **length of time series** is inadequate for analysing important dimensions of climate change; for instance, the drivers of emissions.

Examples of practical data gaps highlighted by the Task Force’s 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, agriculture and management;
- soil carbon data;
- emissions of GHGs other than CO₂ and information about “off-shored” emissions.⁵⁶

⁵⁴ Examples of inventory review reports:

unfccc.int/national_reports/annex_i_ghg_inventories/inventory_review_reports/items/8452.php

⁵⁵ Final report of the Sponsorship Group on Measuring Progress, Well-being and Sustainable Development:

epp.eurostat.ec.europa.eu/portal/page/portal/pgp_ess/0_DOCS/estat/SpG_Final_report_Progress_wellbeing_and_sustainable_deve.pdf

⁵⁶ 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 International Standard Industrial Classification (ISIC) or by developing GHG emissions accounts following the guidelines in 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. In future releases, they will be careful to explain the differences between the SEEA-CF concepts and the inventory concepts so there is no confusion among users (see case study 12).

Case study 12: Statistics Canada's approach to the different emission estimates

The differences between the estimates of greenhouse gas emissions according to Environment Canada's National Inventory Report and Statistics Canada's Greenhouse Gas Account (part of its Physical Flow Accounts), produced following the guidelines of SEEA-CF, are explained by two main factors: a) conceptual differences between the UNFCCC reporting guidelines and SEEA-CF; 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 SEEA-CF is in the treatment of emissions stemming from solid waste. Emissions from landfill gas could be allocated to the waste management industry in the Greenhouse Gas Account but these emissions are not a result of current production. Rather, they represent releases associated with the decay of waste discarded in previous accounting periods. As such, they are excluded from the greenhouse gas portion of the PFA since they do not vary with current period economic output. The Greenhouse Gas Account is used in conjunction with Statistics Canada's input-output tables for modelling purposes and, since the input-output accounts measure only current economic activity, inclusion of landfill gas emissions would lead to improper conclusions.

The Greenhouse Gas Account is based on the residence principle, which is the basis for the economic definition of a country, whereas international agreements on air emissions, such as the Kyoto Protocol, use a national territory principle. Thus, international aviation fuel purchases are the second largest conceptual difference between UNFCCC and SEEA-CF. UNFCCC requires airline emissions to be calculated based on the national territory. SEEA-CF requires that those emissions be based on the residence principle, meaning that the Statistics Canada Greenhouse Gas Account must include emissions of aviation fuel purchased abroad by domestic airlines and exclude emissions from fuel purchased by foreign airlines in Canada. UNFCCC guidelines, on the other hand, require that the total emissions reported in Canada's national inventory report include emissions that occur over Canadian territory regardless of the ownership of the aircraft 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 in different countries depends on the structure of a country's economy.

Three gases are covered in the UNFCCC NIR which are not covered in Statistics Canada's Greenhouse Gas Account; namely, hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF₆). These are excluded from the Greenhouse Gas Account 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 Greenhouse Gas Account 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 sector 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. All transportation activity is treated as a sector unto itself in the NIR regardless whether the activity is undertaken by industries, governments or households. Environment Canada models the fuel use from transportation so that it can be attributed to different vehicle types for the calculation of emissions. The modelling process introduces a discrepancy between the modelled fuel use and the fuel-use totals from Statistics Canada's energy balance. The Greenhouse Gas Account retains the fuel consumption statistics from the energy balances leading to the difference between the two accounting approaches.

The remaining statistical difference results from other factors, including changes to source data required to reconcile with other data sources. To explain the differences between the NIR and the Greenhouse Gas Account, an approach called "bridging" between the two systems developed by Eurostat is used. Bridging helps understand the causes and magnitude of gaps between official statistics on GHG and other air emissions data.

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

2.4 Conclusions

1. Existing official statistics that could be used as the basis of GHG inventories need to be examined to determine if they adequately cover the **data needs of the main users**; namely, the agencies responsible for greenhouse gas inventories, reviewers and analysts. Improving NSOs' contribution to inventory compilation could start by drafting, with the agencies responsible for greenhouse gas inventories, **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 disaggregated 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 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 country 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 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 will be changed in the short term. Yet, they increase workloads as the agencies responsible for greenhouse gas inventories need to reclassify and recompile existing data and in some cases similar data must 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 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, air emissions, energy balances and energy accounts.
5. NSOs could work with the agencies responsible for greenhouse gas inventories to make activity data available at an earlier stage to help develop **timelier emission estimates** as opposed to the current 17-18 months' lag. They could also develop early, less detailed 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 are also needed for analysing drivers of emissions.⁵⁷
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 accounts, and heating/cooling degree-days. Furthermore, NSOs are well placed to help analyse emissions by economic sectors, using energy statistics or developing accounts similar to air emissions accounts 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 include greater use of NSOs' knowledge of the underlying datasets and the high public trust afforded to NSOs as professionally independent producers of statistics. Great NSO involvement would also help reduce parallel and sometimes duplicate reporting systems that lead to unnecessarily high costs of data collection and respondent burden.
8. Data requirements under UNFCCC and the Kyoto Protocol are well established already and significant changes are unlikely in the short term. NSOs should, therefore, **adjust their statistics 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 balances and energy accounts. Experts from NSOs could help 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 the agencies responsible for greenhouse gas inventories, statistical systems or respondents.

⁵⁷ In this context, it is worth noting the creation of a new EU Regulation (No. 525/2013) for the compilation of "approximated greenhouse gas inventories". Article 8 of this regulation requires member states to submit approximated greenhouse gas inventories at T + 7 months from 2015 onwards.

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:** greenhouse gas 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 the 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 in the above list). It explores users' needs for climate change-related statistics in both the scientific and policy communities. It also reviews existing statistics and involvement of NSOs with the aim to identify those needs that are currently unmet and 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, its 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, also 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 crosscutting 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 Oslo⁵⁸ and Seoul⁵⁹ 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.

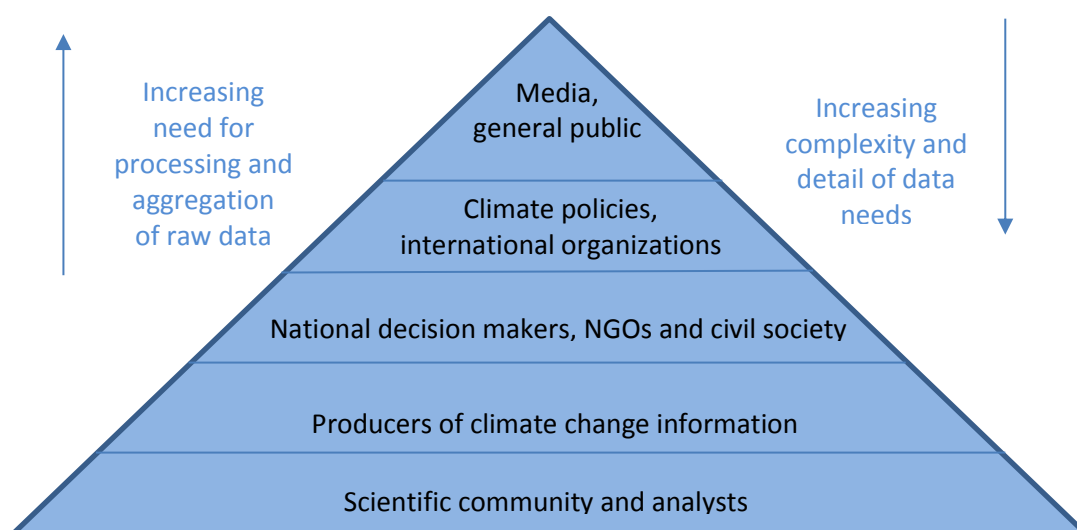
⁵⁸ Conference on Climate Change and Official Statistics, Oslo: unstats.un.org/unsd/climate_change/default.htm

⁵⁹ Conference on Climate Change, Seoul: unstats.un.org/unsd/climate_change/korea/

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.

- 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 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. Similarly, **civil society and non-governmental organisations (NGOs)** require data to monitor and assess developments in their specific interest area;
- **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 datasets. They will, however, usually welcome statisticians' support 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



The following text looks at data needs by grouping the above user categories more roughly into three groups: general public (group 1), climate policies and decision makers (2 and 3), and researchers and producers (4 and 5). Moreover, these users could be further grouped into: 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 first discusses key data need relating to impacts of climate change, then mitigation and finally adaptation. This follows the scope of other 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 should 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

GENERAL PUBLIC

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.

CLIMATE POLICIES AND DECISION MAKERS

Climate policies are becoming more focused on the socio-economic impacts of climate change. The national communications and reports to 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 IPCC. These assessments make use of environmental data and statistics.

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.

RESEARCHERS AND PRODUCERS

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 data linkage opportunities. A meeting of the *Climate Observation Community*, organised by the World Meteorological Organization in December 2011, underlined the “need to establish mechanisms for connecting climate data and socio-economic data, including accessibility to the latter data. It noted that socio-economic data exist but are generally not known within climate communities.”⁶⁰ The opposite is also true for climate/meteorological data and awareness about it in statistical communities.

Case study 13 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.

⁶⁰ Report of the meeting of the Climate Observation Community:
www.wmo.int/pages/prog/wcp/wcdmp/documents/obs_mon_outcomes.pdf

Case study 13: Indicators of Climate Change Impacts in California

Indicators of Climate Change in California include 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 help portray the interrelationships between 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 research institutions, and include a lot of biophysical data not collected by NSOs but sometimes available from the statistical system.

Physical systems	Humans	Vegetation	Animals
Annual Sierra Nevada snowmelt runoff and snow-water content	Mosquito-borne diseases	Tree mortality	Migratory bird arrivals
Glacier change	Heat-related mortality and morbidity	Large wildfires	Small mammal range shifts
Sea level rise	Exposure to urban heat islands	Forest vegetation patterns	Spring flight of Central Valley butterflies
Lake water, delta water and coastal ocean temperature		Subalpine forest density	Effects of ocean acidification on marine organisms
Oxygen concentrations in the California Current		Vegetation distribution shifts	Copepod populations
		Alpine and subalpine plant changes	Sacramento fall run Chinook salmon abundance
		Wine grape bloom	Cassin’s auklet populations, Shearwater and auklet populations off Southern California
			Sea lion pup mortality and coastal stranding

Source: Office of Environmental Health Hazard Assessment, California Environmental Protection Agency, 2013, *Indicators of Climate Change in California* (www.oehha.ca.gov/multimedia/epic/2013EnvIndicatorReport.html).

MITIGATION

GENERAL PUBLIC

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 and activities of industries that have an impact on increased emissions.

CLIMATE POLICIES AND DECISION MAKERS

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 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 emissions accounts and better data on environmental protection expenditure.⁶¹ The EU’s framework for energy and climate policies up to 2020 focuses on three headline targets: 20% reduction in GHG emissions, 20% of energy coming from renewable energy sources and 20% increase in energy efficiency. These need to be measured by reliable statistics⁶². The targets are part of the broader ten-year policy framework of the European Union, the *Europe 2020 Strategy on smart, sustainable and inclusive growth*⁶³. 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 calls for 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.

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

⁶¹ *Climate change and European Official Statistics*, by Cesare Constantino and Angelica Tudini in *Statistika* Vol. 93 (2) 2013

⁶² Eurostat publishes information on all Europe 2020 indicators:
epp.eurostat.ec.europa.eu/portal/page/portal/europe_2020_indicators/headline_indicators

⁶³ ec.europa.eu/europe2020/index_en.htm

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.

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 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.

RESEARCHERS AND PRODUCERS

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.

ADAPTATION

GENERAL PUBLIC

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 adaptation⁶⁴, 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, livestock, etc.);
- 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.

CLIMATE POLICIES AND DECISION MAKERS

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.

⁶⁴ OECD studied the issues in *Economic Aspects of Adaptation to Climate Change: Costs, Benefits and Policy Instruments*: www.oecd.org/env/cc/economicaspectsofadaptationtoclimatechangecostsbenefitsandpolicyinstruments.htm

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. 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.”

Besides knowing what biophysical impacts have taken place (for example, floods, droughts, heat-waves, reduced rainfall, rising sea levels and 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.

RESEARCHERS AND PRODUCERS

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 case study 14.

Case Study 14: 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*.⁶⁵ The objective of the tool is to support the incorporation of population dynamics into climate change adaptation and national development strategies.

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 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.

⁶⁵ The Demography of Adaptation to Climate Change: www.unfpa.org/public/home/publications/pid/13218

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 UN Statistical Commission recognised the role of official statistics in closing data gaps related to climate change.

Since 2005, Eurostat has produced a monitoring report of the EU sustainable development strategy that provides statistics related to climate change and energy. The report includes indicators on GHG emission reductions and the gap between current performance and 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 are 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 Database⁶⁶) are most often collected by research organisations or commercial enterprises (for example, the natural catastrophe database⁶⁷ operated by the re-insurance firm Munich RE). Only recently have public institutions engaged in similar exercises; for example, EEA 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 responding NSOs (18) produced some climate change-related statistics or indicators. The survey was structured according to the state and impact indicators of climate change defined by EEA. NSOs most often produced statistics on: *water quantity, river floods and droughts* (ten countries among those who responded) 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*.

⁶⁶ www.emdat.be/

⁶⁷ www.munichre.com/en/reinsurance/business/non-life/georisks/natcatservice/default.aspx

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

TYPE OF CLIMATE CHANGE INDICATORS	NUMBER OF NSOs	INDICATORS PRODUCED BY NSOs
Water quantity, river floods and droughts	10	Indicators on wastewater treatment, water yield, water levels, allocation, outflow and use, water discharge, river floods and drought.
Agriculture and forestry	9	Indicators on crop yields, irrigated area, forest area, area under organic farming, distribution of pests and weeds.
Terrestrial ecosystems and biodiversity	7	Indicators on the extent of natural reserves, diversity of species, leaf and bloom dates, plant hardiness zones, growing season, bird wintering ranges, impact of human settlements, etc.
Atmosphere and climate	7	Average monthly temperatures, precipitation, ozone concentration, number of successive dry days and cyclone intensity.
Human health	7	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.)
Freshwater quality and biodiversity	6	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.
Marine biodiversity and ecosystems	4	Indicators describing sea levels, fish stocks, sea surface temperature, ocean heat content and acidity.
Economic impacts	3	Transport statistics, waste statistics, use of cleaner fuels and indicators for the EU monitoring mechanism for GHG emissions.
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.

Case study 15 highlights the wide range of driving force and response indicators that can be produced based on existing statistics.

Case study 15: Climate change indicators for Nordic countries using existing statistical data

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 report⁶⁸ also analysed the results of the selected indicators for the Nordic countries. The table below presents their summary 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. The report did not consider monitoring of adaptive capacities and vulnerabilities. Since 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.

⁶⁸ Inventory of Climate Change Indicators for the Nordic Countries: www.ssb.no/a/histstat/doc/doc_199916.pdf

Driving force indicators	Pressure indicators	State indicators	Response indicators
Climate and natural conditions: land use, annual forest growth	Actual emissions: emission of all GHGs (Index, per capita), of carbon dioxide (total, per source), of methane per source, of nitrous oxide per source and of other GHGs	Global temperature	Goals and agreements: GHG emissions compared to requirements of Kyoto Protocol
Population: size, density, development and share of population in major cities		Atmospheric concentration of carbon dioxide	Response indicators for CO₂: environmental taxes and prices of selected fuels (gasoline prices and taxes, 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
Natural resources: reserves of non-renewable energy sources, renewable energy sources, annual production capacity for hydropower	Adjusted emissions: energy consumption ad. for temperature, emissions of CO ₂ equivalents per GDP unit	Atmospheric concentration of other GHG (Methane, CFC-11 etc.)	
Transport, roads and infrastructure: road length, road transport of goods, domestic passengers by air, personal journeys by mode of transport, transport of oil and gas by pipelines, by tankers	Sinks of CO₂: forest sinks	Radiative forcing	
Economic conditions and production: GDP per capita, expenditures (housing, heating, transport), consumer prices: total, housing, heating, transport, private consumption, "industry profiles", value added per unit emission, industrial structure and exports of goods		Other state indicators	
Housing and building structure: population in big blocks of flats, district heating of total residential heating, energy sources for heating by building types, residential area			Response indicators for CH₄: taxes on waste deposition, collection of methane from landfills, methane from animals
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 fuel wood, 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			

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 **plans to define a set of climate change indicators** and to identify the needed data from the statistical system. Others had no such plans because they required further consultations within the country as different institutions are involved in the work or because they were awaiting an international framework for climate change-related indicators to be defined.

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

A conclusion from the survey is that the experience of NSOs in climate change-related statistics is at very different levels. It seems that NSOs have started to collect data and study the phenomena even without many common guidelines or opportunities to exchange experience. There are many sets of indicators produced with a lack of standardization of definitions and methodologies. These are often developed for the monitoring of national climate change adaptation strategies. This is the case, for example, in Finland, France, Germany, the Netherlands, the United Kingdom, Spain and others.

NSOs could consider providing basic statistical data that 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 case study 16). The set includes, for example, an indicator of the share of urban population that the analysts can link with climate change themselves.

Many NSOs have started developing SEEA-CF. SEEA-CF is a tool for integrating economic and environmental data in a way that benefits 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. Stepwise development of integrated environmental-economic accounts linked to climate change is an important strategic direction of work for NSOs.

Case study 16: World Bank’s climate change data

The World Bank has developed many services for distributing climate change relevant data mainly using official statistics as the starting point. They use 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.⁶⁹

The World Bank’s *Little Data Book on Climate Change* includes data on climate-relevant topics, current and projected climate conditions, exposure to climate impacts, resilience, greenhouse gas emissions, climate finance, and current national and international efforts to take action.⁷⁰

The *Climate Change Knowledge Portal*⁷¹ 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.

⁶⁹ The World Bank climate change and development indicators: data.worldbank.org/topic/climate-change

⁷⁰ The World Bank’s Little Data Book: data.worldbank.org/products/data-books/little-data-book-on-climate-change

⁷¹ The World Bank’s Climate Change Knowledge Portal: worldbank.org/climateportal

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, they have collaborated with the National Development and Reform Commission (the national entity for GHG inventories) to develop a system of 36 indicators to measure 1) climate change and its impacts; 2) adaptation; 3) greenhouse gas emissions; 4) funding and 5) standard setting and management (see case study 17).

Case study 17: China's National Climate Change Indicator Set

Domain	Category	Indicator
1. Climate change and its impacts	1. GHG concentrations	1. Atmospheric concentration of carbon dioxide
	2. Climate change	2. Annual average temperature by region
		3. Annual average precipitation by region
		4. Sea level changes over the last year in coastal provinces
		5. Crop area affected by flood and drought
	3. Impacts of climate change	6. Direct economic losses caused by meteorological disasters
2. Adaptation to climate change	1. Agriculture	1. Area cultivated with conservation tillage
	2. Forestry	2. Increase in improved pasture area
		3. Increase in desertified land area
	3. Water	4. Effective coefficient of utilization of irrigation water
		5. Area irrigated using water efficient methods
	4. Coastal zone	6. Area of near-shore and coastal wetlands
3. Monitoring of GHG emissions	1. Consolidated	1. Rate of reduction in carbon dioxide emissions per unit of GDP
	2. GHG emissions	2. National GHG emissions
		3. GHG emissions by sector and gas
	3. Industrial structure	4. Proportion of tertiary industry value added in GDP
	4. Energy conservation and energy efficiency	5. Proportion of the new strategic industry value added in GDP
		6. Rate of reduction of energy consumption per unit GDP
		7. Rate of reduction of energy consumption per unit of industrial added value for enterprises above a designated size
5 Non-fossil energy	8. Rate of reduction of energy consumption per square metre area of public buildings	
	9. Proportion of non-fossil energy consumption to total energy consumption	
6. Increase forest carbon sinks	10. Forest coverage	
	11. Volume of forest	
7. Control of GHG emissions in industry, agriculture and other sectors	12. Change in forest area	
	13. Proportion of waste substituted for raw materials in cement production	
	14. Mass of steel scrap cost per unit raw steel in steel-clean	
	15. Fertilized cropland area reference to soil test	
	16. Annual biogas generation by household and enterprises in rural area	
4. Funding to combat climate change	1. Technology	1. Funds for scientific research related to climate change
	2. Adaptation	2. Financing of flood control on major rivers
		3. Investment in energy conservation
	3. Mitigation	4. Investment in non-fossil energy development
		5. Investment in expanding forest carbon sinks
	4. Other	6. Funds for the associated program on GHG emissions statistics, accounting and investment appraisal and capacity building
5. Climate change-related standards and management	1. Measurement, standards and certification	1. The number of carbon emission standards issued for industrial products
		2. The number of low-carbon product certifications

3.3 Data gaps and challenges of climate change-related statistics

GENERAL PUBLIC

The improvement needs 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.

CLIMATE POLICIES AND DECISION MAKERS

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 substantive gaps, the EU *Sponsorship Group on Measuring Progress, Well-being and Sustainable Development*⁷² has identified the following priorities in relation to climate change:

- indicators derived on the basis of air emissions 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 Task Force's expert meetings included:

- economic data linked to climate change that allows quantification of 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).

The UN Environment Programme (UNEP), in particular, provided a general list of environmental data gaps that underlines the breadth of the gaps, many of which are relevant to climate change policies (see case study 18). A UNEP *Environmental Observing and Assessment Strategy*⁷³ 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." UNEP also strongly recommended that "all of these important data be geo-referenced so that spatial analysis could be performed". The strategy also pointed 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."

⁷² Final report of the Sponsorship Group on Measuring Progress, Well-being and Sustainable Development: unstats.un.org/unsd/broaderprogress/pdf/Measuring%20Progress,%20Well-being%20and%20Sustainable%20Development.pdf

⁷³ A UNEP *Environmental Observing and Assessment Strategy*: www.un.org/earthwatch/about/docs/unepstrx.htm

Case study 18: 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)

Several global **portals** for climate change data exist, but these portals have been developed for specific analytical and policy purposes and often do not include the official social or economic statistics or all relevant environmental data. For example, the *Global Climate Observing System*⁷⁴ focuses on so-called *Essential Climate Variables*, providing regularly updated physical, chemical and biological climate data. The International Renewable Energy Agency and the International Energy Agency are developing a joint *Global Renewable Energy Policies and Measures Database*.⁷⁵ The *Pacific Risk Information System*⁷⁶ 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*⁷⁷ 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, EEA also hosts *Climate-ADAPT*⁷⁸ that helps users access and share information on impacts, vulnerability and adaptation.

The World Meteorological Organization (WMO) coordinates the development of the *Global Framework for Climate Services*⁷⁹, 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.

⁷⁴ Global Climate Observing System: www.wmo.int/pages/prog/gcos/index.php?name=News

⁷⁵ Global Renewable Energy Policies and Measures Database: www.iea.org/policiesandmeasures/renewableenergy/

⁷⁶ Pacific Catastrophe Risk Assessment and Financing Initiative (PCRAFI): pcrafi.sopac.org/

⁷⁷ www.eea.europa.eu/themes/climate/dc

⁷⁸ climate-adapt.eea.europa.eu/

⁷⁹ Global Framework for Climate Services: www.gfcs-climate.org/

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 issues related to the border 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 statistics⁸⁰ and another containing other key data with sufficient background information for policy makers and researchers⁸¹. The latter portal is owned jointly by Statistics Netherlands, Wageningen University and the Netherlands Environmental Assessment Agency (PBL).

RESEARCHERS AND PRODUCERS

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, duplication of data collection activities may result.

For example, national communications to 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, basic data used for emission projections, 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 NSOs to review the expert reports found in the *in-depth reviews of the national communications*⁸². The availability of data varies a great deal across countries. However, the general issues for improvement highlighted by these reviews include:

- **impact** of climate change on key economic sectors (for example, tourism) and social issues;
- **mitigation**: cost and effect of policies and measures across sectors, financial resources for mitigation and 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 detail 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.

⁸⁰ The website of Statistics Netherlands: www.cbs.nl

⁸¹ The website for other than official statistics: www.compendiumvoordeleefomgeving.nl

⁸² Examples of in-depth review reports: unfccc.int/national_reports/annex_i_natcom/idr_reports/items/2711.php

Researchers and climate analysts could help improve NSOs' contribution by analysing climate related issues using NSOs' data. This would require removing obstacles to **linking official statistical data** to other climate data. This may not be NSOs' task, 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 also be made more compatible and inter-linkable with each other. As coordinators of statistical systems, NSOs are in a position to promote better coherence among the data produced by others. NSOs should 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, households, 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 on pressures imposed on climate by changing population dynamics, migration, urbanization, transport and consumption patterns. Linking 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. Linking to transport statistics may be useful in identifying 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 through education statistics. **Employment statistics** could help document 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 poverty.

Economic statistics, especially GDP and gross national income (GNI), linked with emissions 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 through, for example, 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 and 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 and accounts 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. Accounts on environmental revenues and expenditure are often compiled 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 such as search-engine type of access to statistical microdata would be useful.

Adding **geographic locators** to place-based statistics (for example, latitude/longitude of a manufacturing facility) 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 that, although not fully geo-referenced, allows identification of specific facilities at regional level. Furthermore, the UNECE *Protocol on Pollutant Release and Transfer Registers* (PRTR) provides publicly available geo-referenced data on industrial pollutants, including greenhouse gas emissions. Most of the parties to the Kyoto Protocol, including EU and its member states already provide data through PRTR. Further, the US, Canada and Mexico, as well as Chile, Japan and many other countries around the globe have comparable systems in place.

Both biophysical and socio-economic data should be geo-referenced to enable linkages with climate information. The 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, 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:

- **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 resources (water consumption, energy use, sources), waste generation, agriculture (crop production), extreme weather events (type, intensity, magnitude) and environmental protection.

There are also wide gaps in the capacity for the compilation of climate change-related statistics among countries and this hampers data availability. IPCC notes, for example, that there is a notable lack of data on the consequences of climate change in developing countries.⁸³ Due to shortcomings in data, there are difficulties in assessing adaptation costs, funding and investment⁸⁴. In addition, developing countries are required to report on the Nationally Appropriate Mitigation Actions (NAMAs) referring to policies and actions aimed at a reduction in emissions. More information will be needed to describe these activities, timeframe and estimated cost, to identify support needs and estimate potential greenhouse gas emission reductions.

3.4 Conclusions

1. Climate change-related statistics comprise a very broad range of data that stretch across the entire statistical system. Most official statistics are not collected specifically for climate analysis and therefore **NSOs must better understand user needs** to effectively direct their efforts. 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 researchers require access to detailed data (often microdata) that has been geo-referenced.

⁸³ www.ipcc.ch/pdf/assessment-report/ar4/wg2/ar4_wg2_full_report.pdf

⁸⁴ ipcc-wg2.gov/AR5/images/uploads/IPCC_WG2AR5_SPM_Approved.pdf

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 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 jobs⁸⁵, new or recurrent diseases linked to climate change. 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 more effective use of limited resources. NSOs' capacity in linking datasets produced by various organizations should also be strengthened. Data matching requires not only better technical capacity but also 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; for example, 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 indicator sets to inform public environmental policies. **Development of a set of key climate change-related statistics** would help improve comparability across countries. In the longer term, high relevance areas for climate change-related issues should be defined. The key set should be provided as official statistics regularly.

⁸⁵ See the Report of the 19th International Conference of Labour Statisticians, regarding statistics on green jobs: www.ilo.org/global/statistics-and-databases/meetings-and-events/international-conference-of-labour-statisticians/19/WCMS_234124/lang--en/index.htm

4 CHALLENGES WITH STATISTICAL INFRASTRUCTURE

This chapter discusses the challenges with statistical infrastructure when filling the statistical gaps in climate change-related statistics. Unlike the previous two chapters, which treated greenhouse gas inventories and other climate change-related statistics separately, in this chapter the issue of infrastructure is dealt with generally for all climate change-related statistics. This is because the needs with respect to infrastructure do not differ greatly between the two.

The **advantages** offered by the statistical system infrastructure to the compilation of climate change-related statistics include access by producers of official statistics to confidential source data; high levels of transparency through metadata and archiving; use of internationally comparable methods; NSOs' position as a coordinator of the statistical system and well-developed quality assurance methods. For example, using their comprehensive datasets on energy and other activity data, as well as their knowledge on compilation methodology, NSOs could contribute to data quality and consistency analysis.

There are also several **shortcomings** of statistical infrastructure with regard to the production of climate change-related statistics. According to the UNECE survey, such challenges include data confidentiality rules, limited database management resources in some countries, data coherence issues and challenges in cooperation between involved agencies.

Providing better statistical data for climate change analysis may require reviewing and partly changing the way NSOs work. Though this may require additional effort, changes would allow existing official statistics to better serve the needs of compilation of emission inventories and analysis of the impacts of climate change as well as the efforts to mitigate or adapt to these impacts.

Though there is no common definition of statistical infrastructure, the Australian Bureau of Statistics provides one that is simple and useful and covers the tools that support the operation of a statistical system. This chapter focuses, in particular, on legislation; frameworks and integration; standards and classifications; statistical methods; organizational structures and production resources; quality assurance and guidelines, knowledge and capacity; and cooperation networks.

4.1 Legislation

Legislation has a crucial role in supporting the production of climate change-related statistics. Without unambiguous legislation and clear division of work between organizations, the compilation of GHG inventories, in particular, could 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 the agencies responsible for greenhouse gas inventories.

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 the agencies responsible for greenhouse gas inventories that are outside the statistical system from having full access to detailed activity data. A concern in the opposite direction is that data submitted under the EU *Emissions Trading System* are also not always accessible to the producers of official statistics. Another example is that the need to use emissions 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.

When there is an opportunity to revise statistical legislation, it should be reviewed from the viewpoint of mandating official statisticians' work on climate change. Statistical legislation should **facilitate effective cooperation** between agencies and **permit access to the data required by the inventories**. 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 the agencies responsible for greenhouse gas inventories as part of the official statistical system (see the United Kingdom case study 10, 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.

Ideally, national legislation should **provide agencies responsible for inventory compilation with the right to access data** needed for emission inventory compilation. Such legislation would have to be aligned with the national statistical laws and principles. In 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 Emission Trading System;
- 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 (see case study 19).

Case study 19: Access to information through the UNECE Protocol on Pollutant Release and Transfer Registers

The UNECE Protocol on Pollutant Release and Transfer Registers (PRTR)⁸⁶ 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 report information on pollution emissions — such as greenhouse gases and heavy metals — from industrial sites and other sources to national 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 help the public, decision makers, scientists and journalists make informed choices. The protocol is a legally binding instrument aimed at ensuring minimum standards for equal rights and transparency in the use of environmental data.

Harmonized regional PRTR databases exist in Europe (for EU countries, Norway, Iceland, Liechtenstein, Switzerland and Serbia) and in North America (for Canada, United States, Mexico). In Central America, a regional 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 the matter in order to compare results from bottom-up calculations to top-down estimation of GHG emissions.

⁸⁶ For information on PRTRs : www.unece.org/prtr_grt2013.html, www.unece.org/env/pp/welcome.html and prtr.net/

Of course, it is not just statistical laws that are relevant to climate change-related statistics. As case study 20 from Mexico below demonstrates, other laws pertaining to climate change can also be used to provide a legislative framework for climate change-related statistics.

Case study 20: 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 2012. 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) for the measurement of climate change; namely, defining indicators for climate policies; monitoring the progress and results of the climate policies; and coordinating the development and maintenance of a new Climate Change Information System.

The new Climate Change Information System will integrate a set of key indicators to monitor the impacts of climate change and the efficiency of climate change policies. The system will include at least the following topics:

1. GHG emissions as measured by the national inventory
2. GHG emission reduction projects
3. Atmospheric conditions, including short-term climate predictions, long-term projections and characterization of 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 will be integrated into a geographic information system providing public access through a website. The website will include descriptive material, such as inventory reports and assessments of the national climate change policy. INEGI is currently developing the system following guiding principles of accessibility, transparency, objectivity and independence of data production. Analysis of climate change-related issues requires linking data from a number of sources, surveys, registers, administrative sources, research data, etc. The ability of statistical offices to get access to administrative data is not self-evident in all countries.

Climate change researchers and analysts clearly need better access to official statistics. Detailed analysis of climate change drivers can sometimes require **access to microdata**. 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.

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 access where the user only receives the aggregated results of his/her queries to the data. It is worth noting that several NSOs are developing tools for improved access to microdata within the context of existing statistical laws and respecting the need to safeguard confidentiality.

- Australia⁸⁷ is developing Remote Analysis Servers;
- The US Census Bureau⁸⁸ has developed a Microdata Analysis System for researchers to perform certain statistical analysis without direct access to microdata;
- Finland⁸⁹ 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 Canadian Centre for Data Development and Economic Research;⁹⁰
- 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;⁹¹
- Eurostat has put in place rules and procedures for access to confidential data for scientific purposes, governed by Commission Regulation (EU) 557/2013.⁹²

4.2 Frameworks and integration

Statistical frameworks help 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. It would also be useful to review statistical frameworks by 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. As an example, statistical business registers could be more useful for producing climate change-related statistics if they included a geo-reference for the relevant data.

Examples of statistical frameworks that are linked to climate change-related statistics include SEEA-CF and UN FDES. SEEA-CF contains the internationally agreed standards for producing environmental accounts and linking them with economic statistics. 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 considers the links between data needed for monitoring climate change and existing environmental statistics. These frameworks provide a tool for NSOs to derive data relevant for climate change that have been brought under a consistent and integrated system.

Similar accounting or statistical frameworks would be useful for improving the linkage of climate change information with social and economic data, such as with data of the **System of National Accounts** (SNA). Air emissions accounts are an example of how national accounts data can be linked

⁸⁷ www.unecce.org/fileadmin/DAM/stats/documents/ece/ces/2013/29.pdf

⁸⁸ www.amstat.org/sections/srms/proceedings/y2011/Files/302160_67955.pdf

⁸⁹ www.unecce.org/fileadmin/DAM/stats/documents/ece/ces/2013/33.pdf

⁹⁰ www.statcan.gc.ca/cder-cdre/index-eng.htm

⁹¹ www.cbs.nl/en-GB/menu/informatie/beleid/zelf-onderzoeken/default.htm?Languageswitch=on.

⁹² epp.eurostat.ec.europa.eu/portal/page/portal/microdata/introduction

with climate change-related statistics. These accounts are produced by all NSOs in 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, allowing emissions to be assigned 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. However, the direct usability of GHG inventory data in environmental accounts is limited because of the differences between them (see next section). As a result, in some countries these are two separate systems with limited synergies that are compiled by different agencies. In countries where GHG inventories are compiled using national energy balances it is more feasible to link between inventories, environmental accounts and energy statistics.

In 2011, the Inter-Secretariat Working Group on National Accounts (ISWGNA) drafted instructions for recording tradable emission permits in national accounts, but noted that the issue must be reviewed again in the future⁹³. Ways to strengthen the links between national accounts and emission trading data from carbon markets should be considered.

Cross-checking 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, the IPCC *Reference Approach* (an independent method for estimating CO₂ emissions) uses data from national energy balances.⁹⁴ Ideally, there should not be significant differences between CO₂ emission estimates reported in GHG inventories and estimates based on national energy balances. If the difference between the two approaches in a given country is more than 2 per cent, the country is required to provide a clear explanation in its national 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. Similar quality assurance approach can be applied to agriculture statistics and surveys may need to be slightly adjusted to accommodate information needs for GHG inventories.

4.3 Standards and classifications

Statistical offices typically approach new measurement requirements by first agreeing on **standard definitions** and then designing **standard methods**, including classifications, for data collection and reporting. Given that climate change-related statistics is largely a new area for NSOs, the statistical community should address the need to develop standardized definitions and methods in the domain. As the amount of climate change-related information – both official statistics and others – is growing quickly, the need to do so should be considered urgent.

The statistical system has the responsibility for definitions, classifications, nomenclatures, methodologies, certification, accounting standards and data quality of official statistics. These standard tools assist in maximising the quality of statistics and the efficiency of their production process in terms of comparability (over time, space, industry, etc.) and coherence of the statistics.

While comparability and coherence are important for any dataset, they are particularly important for climate change-related statistics since analysis of climate change requires statistical data from many different sources and domains. The **ability to combine data from multiple sources** is a precondition for carrying out such analysis. For example, many climate change indicators require

⁹³ SNA News: The Recording of Emission Permits Issued under Cap and Trade Schemes in the National Accounts, clarification by the Inter-Secretariat Working Group on National Accounts: unstats.un.org/unsd/nationalaccount/sna/nn30-31-en.pdf

⁹⁴ 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.

data that are representative of small geographic areas. This can be difficult to achieve without combining official statistics with data from administrative registers or with scientific data sets that provide greater local detail.

Current **statistical standards and classifications do not fully support** the production climate change-related statistics. If statistical classifications allowed climate change-related statistics to be more easily identified, NSOs could extract and compile relevant statistics from existing databases. For example, statistics on environmental education, climate change research, “green” jobs and technologies and international trade in climate change-related products and services could all be more easily produced if classifications were to identify these things explicitly. It should be noted, however, that the structure of current classifications may not work for a crosscutting issue like climate change and that additional dimensions or layers will be required in the existing classifications.

Bearing these points in mind, statistical **classifications should be adapted** to include new elements with relevance to climate change analysis. The statistical system has a process for periodic reviews of its classifications that could 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 services in the economy. Similar reviews could be undertaken for this and other classification systems with respect to climate change during future revisions. Other standard classifications that could be reviewed include those on education (ISCED), employment (ICSE), trade (SITC) and products (CPC). Specific working groups could be dedicated to assessing each classification from the point of view of climate change-related statistics.

One of the most common problems encountered by countries is the **mismatch between the reporting classifications** for GHG inventories, as defined by IPCC and statistical classifications. This represents a major obstacle in analysing and linking inventory data with official statistics. The mismatch complicates both the use official statistics for GHG compilation and, *vice versa*, NSOs’ use of GHG inventory results in combination with other official statistics. In some countries, this leads to duplicate data collections.

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 statistical reconciliation entries or so called “difference components”. A known cause of 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 emissions 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 (see the case study on Canada on p. 33 for further details).

The data of the GHG inventories are reported to UNFCCC according to the *common reporting format* (CRF) framework, which uses a classification developed by IPCC. The CRF framework encompasses the different sources and sinks of greenhouse gas emissions arising from human activity, grouping them in sectors.

The source/sink sectors⁹⁵ in the IPCC *common reporting format* (CRF) are the following:

1	Energy
2	Industrial processes and product use
3	Agriculture
4	Land use, land-use change and forestry (LULUCF)
5	Waste
6	Other

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 or outside) falls under the sector **energy**, which includes combustion in industry, transport, energy transformation, refineries, etc. From the viewpoint of official statistics, the IPCC sectors are 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). Thus, the meaning of the energy sector in GHG inventories 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”.

The category for **industrial processes and product use** refers to emissions from an industrial process involving chemical or physical reactions other than combustion and where the primary purpose of the industrial process is not energy production, for example emissions from mineral, metal and chemical production. Industrial product use means the use of a product for an industrial process that does not react in the process, such as SF₆ and HFCs used in the magnesium industry as a cover gas.

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

The CRF sector on **land use, land use change and forestry** (LULUCF) includes the emissions caused by changes in land cover and CO₂ emissions from soil, including agricultural soil. Other greenhouse gases from agricultural soil are included in agriculture sector.

The category on **waste** refers to emissions that result from waste disposal, wastewater and wastewater treatment at a facility. This includes landfilling of solid waste, flaring of landfill gas and waste incineration. Greenhouse gas emissions from using waste material directly as fuel or converted into fuel is included in the energy sector.

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

⁹⁵ This table presents source/sink sectors of the *common reporting format* as agreed by the Conference of Parties (COP): unfccc.int/national_reports/annex_i_ghg_inventories/reporting_requirements/items/7956.php. The overall breakdown is available in the cross-sectoral tables. Previously the sectors were: 1) energy; 2) industrial processes; 3) solvent and other product use; 4) agriculture; 5) land use, land-use change and forestry; 6) waste; and 7) other sector.

Though the Eurostat *Manual for Air Emissions Accounts*⁹⁶ and SEEA-CF handbook on energy accounts⁹⁷ present general procedures for linking emission inventory data to economic (ISIC/NACE) and household activities, there is no universal approach to bridging between inventory data and official statistics that can be easily applied in all cases. This is complex and country-specific work that requires detailed understanding of the frameworks and their evolution over time.

4.4 Statistical methods and systems

Improving climate change-related statistics will require both **development of new statistical methods** not currently used in the statistical system as well as application of existing methods to new data. For example, statisticians are already **experienced in applying adjustments** to make statistics comparable over time, such as adjusting them for seasonal variation. These kinds of adjustments may also be useful for measuring climate change-related phenomena.

Improving climate change-related statistics will also require enhancements in **the capacity and inter-functionality of the IT systems** used by NSOs; for example, to permit the linking of different types of data from different sources.

A significant challenge is that **sample surveys do not typically provide enough local detail** for analysis of, for example, the regional economic and social impacts of extreme weather events. Furthermore, geo-referencing is a precondition for compiling small area statistics. 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 UN Statistical Commission (UNSC). Despite several success stories in the use of geo-referencing, most NSOs still have **limited capacity for provision of geospatial data**. However, the results of the consultation show that many NSOs have developed or are working on developing ways to provide statistical information for smaller geographic regions. As an outcome of consultation, UNSD established an expert group⁹⁸ composed of representatives of both the statistical and geospatial communities to develop a global standard for the integration of statistical and geospatial information.

There is 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. Likewise, the NSOs of Canada, Colombia, Netherlands, New Zealand, Norway and Singapore have a range of internal geospatial capabilities and good collaboration with their national geospatial communities. In Europe, NSOs provide geospatial data support for the INSPIRE programme (Infrastructure for Spatial Information in the European Community).

To ensure their full potential is realized, NSOs must exercise caution to **ensure the quality of geo-referencing**. There can be problems in allocating variables geographically; for example, between an enterprise's headquarters and its local units. Another issue is where to allocate pollution originating from a given factory: To the location of the factory? Or to the area where the pollution spreads?

With respect to GHG inventories, the quality of official statistics used for inventory compilation could be improved if official statisticians had a better **understanding of the concepts and methods used in inventory compilation**. This would help ensure that official statistics are established in such a way that they can be easily used, compared and linked with inventory data. Statisticians could develop

⁹⁶ The manual for Air Emissions Accounts:

epp.eurostat.ec.europa.eu/cache/ITY_OFFPUB/KS-RA-09-004/EN/KS-RA-09-004-EN.PDF

⁹⁷ unstats.un.org/unsd/envaccounting/seeae/

⁹⁸ United Nations Expert Group on the Integration of Statistical and Geospatial Information:

ggim.un.org/UN_Statistical_Geospatial_EGM.html

such understanding by reviewing the *common reporting format* tables, the IPCC inventory methodologies and guidelines⁹⁹ and the issues raised in the *Inventory Review Reports*.

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 may be 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 NSOs 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. It would also be beneficial if NSOs were involved in the processes of adapting to updated methodological guidelines. NSOs could help, for example, assess availability of new data and prepare for the new or changed requirements.

4.5 Organisational structures and production resources

The increased role for official statistics in climate change-related statistics **may call for organizational changes** in NSOs. Most statistical offices are organized along either “subject matter” lines (for example, economic statistics) or “functional” lines (for example, data collection) or, often, a mix of the two. Working in crosscutting areas, such as climate change, requires an organization that supports collaboration across different structural units and subject areas. At the moment, many NSOs do not even consider measuring climate change-related issues as their responsibility.

The relatively few NSOs that are directly involved in the compilation of emission inventories have a specific organisational unit that has been assigned the related tasks. Such a unit is, however, **missing within most NSOs**. Identifying a contact point or a unit could help the agencies responsible for greenhouse gas inventories obtain the statistics required from the NSO and communicate their statistical development needs.

NSOs must target their efforts in meeting users’ data requirements taking into account available resources (which are likely to be limited) and consider what is both relevant and feasible by comparing data needs to the costs of responding to them. At first, improvements could be achieved with even limited resources by:

- demonstrating possible uses of existing official statistical data with regard to climate change;
- facilitating access to data of other producers by creating national portals for climate change-related information;
- avoiding duplication of data collection through better collaboration with data producers and researchers;
- reviewing existing data collections to identify where some changes could be done for the benefit of climate change analysis.

As noted, it is likely that resources of climate change-related statistics will be limited (as is often the case for new domains). One possible source of funding is the savings associated with **modernising statistical production processes and services** in other domains. This could allow some re-allocation of human and financial resources to new areas like climate change, and development of new

⁹⁹ These methodological guidelines can be found at: www.ipcc-nggip.iges.or.jp/public/2006gl, www.ipcc-nggip.iges.or.jp/public/gl/invs6.html and www.ipcc-nggip.iges.or.jp/home/2013KPSupplementaryGuidance_inv.html

methods for using multiple data sources. At the moment, modernising statistical production is a priority for many NSOs and for the Conference of European Statisticians (CES). Improvements are being sought by harmonising and streamlining NSOs' processes based on international standards such as the *Generic Statistical Business Process Model* (GSBPM) and the *Generic Statistical Information Model* (GSIM) and by aligning the methods and technology of statistical production across countries. According to the vision of the UNECE High-level Group for the Modernization of Statistical Production 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."

4.6 Quality assurance and guidelines

Different quality criteria guide the production of official statistics, scientific research and other climate change-related data. For statisticians, quality refers to adherence to quality standards in the framework of the UN *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 global assessments of national systems are carried out in Eastern Europe, Caucasus and Central Asia by UNECE, Eurostat and EFTA.

The agencies responsible for greenhouse gas inventories, in contrast, 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 at international level (for example, from International Energy Agency, the UN Food and Agriculture Organization or other established data providers).

Given the different approaches to quality, it can be **difficult for users to assess the quality** of climate change-related information. The differences also mean that NSOs that provide access to broad climate change-related information through their communications portals are unable to provide quality assurance for non-official statistics produced outside the national statistical system. Users' questions about quality would have to be directed to the producer of each dataset. For this and other reasons, NSOs could facilitate improvements in the quality of climate change-related statistics regardless of the producer.

Another challenge related to research data is that, while it can provide important insights into the causes and impacts of climate change, research often is not intended to provide **regularly updated data in the form of consistent time series**. Measuring changes over time, on the other hand, is a core competence of NSOs and an important part of their quality framework. One means to exploit this feature of the statistical system would be to define a set of key climate change-related indicators internationally and assign NSOs the responsibility to report on them regularly.

Climate change is a highly sensitive issue for policy making. Therefore, neutrality of climate change-related information is very important. Involving NSOs, who normally operate at arm's length from the political side of government, in its compilation could help prevent political interference in compilation of climate change-related information. This **strong professional independence** of NSOs could help increase trust in climate change-related information and, therefore, its usefulness in the climate debate.

Some users express a **desire for "quality-stamped" climate change-related statistics**, with better metadata to explain where the statistics come from, how they have been produced and how they should be interpreted. Such official designations exist in some, but not all, countries.

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 meet

certain quality criteria. In the United Kingdom, agencies producing statistics have to apply for the national statistics “stamp”, which may be granted based on an assessment of quality of production processes rather than data quality directly.

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.

Perhaps the most important difference in the quality frameworks of official statistics and GHG inventories concerns the **institutional framework for data production**. For official statistics, the *European Statistical System Code of Practice* and the *UN Fundamental Principles of Official Statistics* include standards for professional independence, mandate for data collection, adequacy of resources, quality commitment, statistical confidentiality, impartiality and objectivity. Of the above, 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, however, require member states to ensure that the agencies responsible for greenhouse gas inventories have access to the data. UNFCCC rules also require the establishment and maintenance of a well-functioning national system for inventory compilation, including the institutional, legal and organisational arrangements that are needed to produce GHG inventories. Under the Kyoto Protocol, this obligation is also subject to annual review, and shortcomings in the national system can be considered as non-compliance with Kyoto obligations.

In the area of statistical processes, the codes governing official statistics include recommendations on sound methodology, appropriate statistical procedures, management of respondent burden 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** for GHG inventories and the *European Statistical System Code of Practice* and *Fundamental Principles of Official Statistics* that guide official statistics. The latter require relevance, accuracy, reliability, timeliness, coherence, comparability, accessibility and clarity. The UNFCCC reporting guidelines suggest similar criteria for the annual GHG inventories including transparency, consistency, comparability, completeness and accuracy¹⁰⁰. The practice, however, differs considerably between the two. 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 in Annex I Parties before publishing the results of GHG inventories. The reviews are guided by *the UNFCCC Guidelines for the Technical Review of GHG Inventories*¹⁰¹ and the *Code of Practice for the Treatment of Confidential Data*.¹⁰² 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

¹⁰⁰ Updated UNFCCC reporting guidelines on annual inventories: unfccc.int/resource/docs/2006/sbsta/eng/09.pdf

¹⁰¹ Review process: unfccc.int/national_reports/annex_i_ghg_inventories/review_process/items/2762.php

¹⁰² UNFCCC Code of practice for the treatment of confidential information: unfccc.int/files/national_reports/annex_i_ghg_inventories/application/pdf/ext_cp0306a1.pdf

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 Statistical System Code of Practice* with an emphasis on the institutional environment and dissemination of statistics. The peer review reports are made publicly available.¹⁰³

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. A similar point is covered under the accessibility and clarity criterion of the *European Statistical System Code of Practice*. The code underlines clearly the need to present statistics in a clear and understandable form. The UNFCCC reporting guidelines go further to require a specific format for data reporting.

Beginning in 2007, an approach was launched in the UNFCCC process called "measurement, reporting and verification" (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 for parts of inventories, 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. On the other hand, when 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.

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 the agencies responsible for greenhouse gas inventories, would be problematic or impossible for organisations working as part of the statistical system. The agencies responsible for greenhouse gas inventories may consider emission inventories 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.

4.7 Knowledge and capacity

Given that the statistical system includes economic, social and environmental data, NSOs have acquired broad knowledge and capacity for measuring societal issues. However, climate change involves complex interactions between systems, is multi-disciplinary and is anchored largely in the natural sciences. Methods for producing spatial statistics, an important component of climate change-related statistics, may not be familiar to all NSOs.

Knowledge and capacity related to climate change is spread around many agencies, ministries and research institutes, many of which produce and use climate change-related statistics outside the statistical system; for example, through meteorological and atmospheric monitoring networks. At

¹⁰³ The Eurostat Code of Practice [peer review reports:](http://epp.eurostat.ec.europa.eu/portal/page/portal/quality/code_of_practice/peer_reviews)
epp.eurostat.ec.europa.eu/portal/page/portal/quality/code_of_practice/peer_reviews

the moment, **most statistical offices do not mention climate change as one of the statistical topics they work on.**

Building credibility as players in the field of climate change is a challenge for NSOs because they are relative newcomers and do not have large teams of professionals dedicated to this area of work. Measuring climate change **requires specific knowledge**, and many NSOs currently lack the qualifications necessary to do good work in this area. These knowledge gaps should be taken into account in **recruiting staff**. Many potential employees, however, will not have the necessary combination of statistical and subject matter knowledge. 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. Training on the job for statisticians regarding climate change is also needed.

Low- and middle-income countries are often the most severely struck by climate change. At the same time, their **capacity to produce relevant climate change-related statistics** is generally low. Since NSOs form **an international network for statistical development** and sharing of experience, they could **share experience** across countries on how they take part in the emission inventory process, for example. This could save resources and the mutual support among countries would be helpful for capacity development. 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 require all countries, developed and developing, to report GHG emissions at least every second year. It is to be expected that this new framework would also lead to common quality assurance rules, allowing for the tracking of progress on emissions across all countries, including those that currently do not provide inventories. The recently introduced biennial update reporting and the requirement to provide information on the Nationally Appropriate Mitigation Actions (NAMAs) add incentives to non-Annex I Parties to develop their 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.

Given that the statistical system holds a lot of data with relevance to emission inventory compilation, official statisticians' **knowledge of the data needs of the agencies responsible for greenhouse gas inventories** should be improved. This would enable reviewing and potentially reorganizing the existing data of NSOs to match the source data needs of emission inventories. If the agencies responsible for greenhouse gas inventories 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, there was a case when an NSO decided to discontinue iron and steel statistics without realizing that the cancellation 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 inventory estimates; the quarterly emission estimate produced by Statistics Netherlands (see the case study on p. 26) is a good example of the possible contribution NSOs could offer.

The international statistical community should increase its **awareness of new priorities** stemming from the climate negotiations, as these negotiations not only have implications for inventories but also for the statistical system.

4.8 Cooperation networks

Various types of information are needed to analyse the causes and impacts of climate change. No single agency can produce all the required information. Thus, **good cooperation is essential** to finding ways to better respond to the growing information needs. For example, some NSOs underline the need for cooperation to **improve international comparability** of climate change-related statistics and to **enhance statistical capacities** to produce these statistics. They also point out the need to **enhance collaboration** with the research community.

Many of the current challenges countries face in developing climate change-related statistics are linked to **underdeveloped institutional settings or unclear division of labour between organizations**. This is the case both nationally and to some extent also internationally, as highlighted by case study 21. To deal with this, NSOs should appoint a **contact point for climate change-related statistics**. Such a contact point could be located in the unit that compiles environmental-economic accounts, especially if the air emissions accounts are compiled there; in the unit responsible for environmental statistics (if this is different than the former); or in the energy statistics unit. Regardless of the location, the contact point should have the recognised authority to coordinate with other units of the NSO (e.g. energy, transport, agriculture, etc.) and outside organisations for the purposes of ensuring an adequate response to the crosscutting nature of climate change statistics.

Case study 21: Capacity gaps identified in the UNEP Environmental Observing and Assessment Strategy

The UNEP *Environmental Observing and Assessment Strategy*¹⁰⁴ 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.”

Countries and international organisations commented during the expert meetings organized by the Task Force that the greater the involvement of NSOs in national GHG inventory systems, the better the results in terms of making use of official statistics. Furthermore, a clear distribution of responsibilities is important. Both NSOs and the agency responsible for greenhouse gas inventories should be effectively supporting in each other’s work.

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 agencies responsible for greenhouse gas

¹⁰⁴ A UNEP *Environmental Observing and Assessment Strategy*: www.un.org/earthwatch/about/docs/unepstrx.htm

inventories. In some countries the shortcomings of the inventory system relate to institutional arrangements of the national inventory system. NSOs are not always involved, which is why their competencies cannot be used to support the process. This means as well that the **data of national statistical systems are not used to the full extent** for GHG inventories. Limited involvement of NSOs also partly explains why the **links between inventories and other statistics** are sometimes weak.

Closer cooperation between NSOs and the agencies responsible for greenhouse gas inventories has the potential to be mutually beneficial not only because GHG inventories rely on the data from the 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 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 the agencies responsible for greenhouse gas inventories 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. At European level, good results have been achieved by organising a joint session of existing expert networks; for example, 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 initiative, the agencies responsible for greenhouse gas inventories discovered the existing practices of the NSOs (for example, the existence of energy statistics manuals) and statisticians started to understand better the needs of inventories.

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. As discussed in Chapter 2, relations with the agencies responsible for greenhouse gas inventories can be formalised whereby the NSO is officially recognised as part of the national inventory system. **Greater interaction** between statistical offices, agencies responsible for greenhouse gas inventories and environmental and energy agencies needs to be established in order to find synergies. Furthermore, 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.

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, 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 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 the agencies responsible for greenhouse gas inventories.

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. If NSOs were better represented at international level, they could be more effectively informed of the implications of climate negotiations and other climate change work at international level.

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.

4.9 Conclusions

1. To improve cooperation, NSOs should create a **contact point** to take charge of coordinating GHG inventory source data issues, collaborating with the agencies responsible for greenhouse gas inventories 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 agency responsible for greenhouse gas inventories and NSOs that provide data for the inventories would be helpful.
2. **Legislation** plays a crucial role in supporting production of GHG 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 for improving the relationships between the concepts and classifications used in official statistics and other climate change-related statistics should be examined at **international level**. In building 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. **Capacity building** is needed especially, but not only, in countries that have not yet produced GHG inventories. There are currently no **recognised good practices** for NSOs in GHG inventory compilation, as their roles vary across countries and there is no forum for sharing experience on the topic. It would be in the interest of both NSOs and the agencies responsible for greenhouse gas inventories to consider what these good practices are.
5. **Improvements in the 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 Production and Services calls for **flexibility of statistical organisations** so that they may provide statistics that respond to user needs at an acceptable cost. Crosscutting statistics, such as climate change-related statistics, pose challenges to the current structures and functioning of NSOs. Thus, producing climate change-related statistics may be more easily undertaken in an organization focused on serving the needs of different users and producing outputs by re-sorting and combining collected data to match the user needs.
7. Statisticians will need to build **new kinds of expertise** to produce climate change-related statistics. This includes building capacity to produce geo-referenced data; learning new methods for dealing with spatial statistics; improving capacity to link data from multiple sources; and building substantive knowledge in climate issues. More than anything else, closer networking with other organizations involved in climate issues would be helpful.
8. The production of climate change-related statistics **lacks coordination**. Users would benefit from better harmonization of concepts, classifications, methods and quality standards. NSOs' can play a leading role in the harmonization and standardization of statistical production and to ensure that high-quality information is produced following common guidelines. Currently, such guidelines do not exist for most climate change-related statistics other than GHG inventories. In some areas, existing good practices should be shared among 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. Though targeted primarily at NSOs, the recommendations are also relevant to other users and producers of climate change-related statistics, both inside and outside the statistical system.

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 of the Task Force 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 1) working within the national statistical system to improve data for GHG inventories; 2) enhancing collaboration at the wider national level between NSOs and the agencies responsible for greenhouse gas inventories; and 3) creating a dialogue at 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 in collaboration** with agencies responsible for greenhouse gas inventories including energy, industry, transport, agriculture, waste, forestry and land use statistics. This is particularly the case for NSOs in Annex I Parties to UNFCCC with annual inventory reporting obligations, but NSO’s involvement would be helpful in all countries reporting on greenhouse gas inventories. To harmonize and streamline their work on GHG inventories, NSOs may wish to consider the following issues and actions:

- **Enhancing awareness in the national statistical systems of how their data are or could be used for GHG inventories.** This would enable NSOs to take into account the related data needs. For a variety of reasons, existing NSO statistics are not always used to their full potential for emission inventories and some duplication of data collection exists between NSOs and other organizations. As the coordinator of the national statistical system, NSOs should also promote better awareness of existing data in the national statistical system and how they can be used for GHG inventories;

- **Ensuring**, in collaboration among NSOs, the agencies responsible for greenhouse gas inventories and the national inventory focal point, **that inventory calculations use existing statistics as much as possible**. This should be done recognising that IPCC gives the guidance on what data to use to estimate GHG emissions. Official statistics should, where possible, be the primary data source for inventory compilation. Additional data collection should be carried out only where official statistics cannot be used. This would improve the consistency of GHG estimates with other statistics;
- **Improving quality of official statistical data used for GHG inventories**, in collaboration with the agencies belonging to the national inventory system. The *national inventory reports* submitted to the UNFCCC by 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. NSOs may wish to consider some of the following actions:
 - **Coherence of GHG inventories and official statistics should be improved where possible** by developing standardized tools for comparison of official statistics and inventory data, such as correspondence tables, and recompiling GHG emissions data from national inventory reports according to the International Standard Industrial Classification (ISIC/NACE) to bring them closer in line with other statistics to aid analysts wishing to study, for example, the links between GHG emissions and economic growth. This requires taking note of the differences between the emission categories used in the IPCC *common reporting format* tables that are the basis for national inventory reports and standard statistical classifications. The differences between GHG inventories and official statistics need to be clearly explained to users;
 - Given the importance of good quality energy balances to underpin GHG inventories, **particular emphasis should be put on improving the quality of energy statistics**, including SEEA-based energy accounts. Energy statisticians and accountants (whether in NSOs or other organizations) should aim to improve the quality of energy balances and accounts 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;
 - Important data **gaps related to, among others, the agriculture, forestry and other land use sector should be filled**. Though the contribution of this sector to total GHG emissions in most countries is relatively small, the uncertainty associated with the emission estimates from it is currently very large;
 - Even though data gaps should mainly be assessed nationally, it can be noted that many countries have gaps in **data on waste and the production of heat and electricity for own use and from renewable energy sources**;
 - GHG inventory analysts would benefit from **improved timeliness of activity data**, including energy balances. Some NSOs also produce early estimates of emissions.
 - Given the competence of NSOs in producing time series data, they could also help develop **longer and more consistent time series** for analysing the inventories; for example, data related to the drivers of emissions.
- **Drafting**, together with the agencies responsible for greenhouse gas inventories, **a prioritized list of national data gaps and a road map on data development** to improve official statistics for GHG inventories. This would entail identifying and evaluating statistics needed for emission inventories to determine if they are fit-for-purpose. Development of NSOs' statistics should be prioritized based on where effective changes can be made in each country, while taking into account the recommendations from the UNFCCC review process, the national improvement plan in GHG inventories and the IPCC inventory methodologies and guidelines.

2. NSOs especially in UNFCCC Annex I Parties to UNFCCC should **be proactive in reaching out to national agencies responsible for greenhouse gas inventories** 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 GHG inventory processes, including the establishment of national systems incorporating all “institutional, legal and procedural arrangements necessary to” prepare inventories. Though NSOs are not considered part of the national system in many countries, the Kyoto Protocol clearly provides the flexibility for this. Therefore, NSOs may wish to develop their role and involvement in GHG inventory compilation along the following lines:
- **Facilitating collaboration between the statistical system**, the national agency responsible for greenhouse gas inventories and the national inventory focal point would be part of the NSOs’ role as the coordinator of the national statistical system. Therefore, NSOs should be aware of the data needs of and be actively engaged in the national inventory system;
 - **Creating a national working group may be beneficial** comprising the NSO, the agencies responsible for greenhouse gas inventories 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. This could contribute to reducing costs, avoiding data collection duplication, improving consistency and creating multipurpose data systems to serve various user needs;
 - **Clarifying NSO’s role in providing statistics and assisting, as needed, in greenhouse gas inventory calculations.** Considering that NSOs provide a considerable portion of the statistics required for GHG inventories, their role 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 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;
 - **Supporting the efforts at strengthening the quality of GHG inventories in line with the IPCC’s guidelines on quality control and quality assurance.** NSO’s experience in quality assurance might be useful in support of inventories. The *European Statistics Code of Practice*¹⁰⁵ and the *UN Fundamental Principles of Official Statistics*¹⁰⁶ form a clear institutional context for compiling objective and impartial statistical information that could be applied to GHG inventories. They also stress the importance of minimizing burden on respondents and overall cost-effectiveness in all statistical activities, two objectives that are not as clearly stressed in the guidelines for compiling GHG inventories. NSOs could use the approach of data confrontation, as recommended also by the *IPCC Guidelines*, to compare inventory results with other statistics to reveal unexpected results in the inventories. Such an approach is often useful in revealing errors.

¹⁰⁵ epp.eurostat.ec.europa.eu/portal/page/portal/quality/code_of_practice

¹⁰⁶ unstats.un.org/unsd/dnss/gp/fundprinciples.aspx

3. **The international statistical community**, including national statistical systems and international statistical organisations, **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 the statistical community and organisations working on climate issues would be beneficial. The international statistical community and NSOs may wish to consider the following issues and actions:

- **Seeking closer collaboration between the statistical community and international organisations working on climate issues.** At European level, the Conference of European Statisticians and its Secretariat would be well placed to collaborate with UNFCCC, IPCC, UNECE Protocol on PRTRs, WMO and others. Better interaction at this level could help to ensure that inventory method development takes into account the availability of data and avoids development of methods that require data that are not generally available in most countries. It could also help reduce the possibility of overlapping international demands for data collection and reporting;
- **Actively engaging, at national level, with the national representatives delegated to the relevant UNFCCC forums** to assist in data-related issues, comment on the inventory methodologies and assist in inventory review processes;
- **Following up on the outcomes of the UNFCCC conferences of the Parties to the Convention.** This would help ensure that any requirements for new or modified data resulting from the Conference of Parties (COP) outcomes are made in a timely and efficient manner, reducing the costs associated with inventory preparations and improving the quality of inventories. The statistical community can add value by assessing the feasibility of meeting new requirements with existing data and by preparing themselves for possible new data requirements;
- **Involving NSOs from the beginning in countries that will enter the Convention** over the coming years could help evaluate the feasibility of meeting new data needs and avoid creating overlapping data systems by assessing availability of existing data. 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 will require all countries, developed and developing, to report GHG emissions at least every second year;
- **Existing international networks of NSOs could also help exchange experience** on NSO's contribution to improving the quality of GHG inventories; for example, at expert meetings and other communications channels.

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

The following recommendations suggest 1) facilitating access to climate change-related statistics that already exist; 2) improving the utility of these statistics for climate change analysis and; 3) 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. The recommendations focus on statistics that are relevant to climate change analysis, which should be understood as a sub-set of all official statistics. Even then, it is recognised that the scope of the recommendations could be very broad in many countries. Therefore, their implementation should be undertaken with full consideration given to the implications for human and financial resource demands and national data needs.

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 or events** for discussions between producers and users of climate change-related statistics; for example with 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 climate change analysis. If stakeholders have knowledge of existing data, duplication of data collection activities is easier to avoid;
- **Providing access to climate change-related statistics using NSOs' dissemination channels.** This may include also data not produced by the NSO, for example scientific data. At the moment, data needed for understanding climate change, its causes and consequences, are scattered across various organisations. Providing a possibility to combine official statistics with other data through studies, is one way NSOs might improve access to them. Beyond this, "portals" for climate change-related statistics could be created as part of NSO dissemination channels. Such portals could serve as entry points to statistics and metadata on a wide range of existing statistics. Their creation would require cooperation with scientific organizations. For example, meteorological services have long time series of data on climatic variables (temperature, precipitation, etc.) that could be disseminated *via* national statistical system channels;
- **Improving access to microdata for researchers working on climate change.** This also calls for considering new approaches and techniques for data access and preserving confidentiality of respondents' data. The latter is discussed further in Section 5.3.

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

- **Reviewing statistical programs and data collections from the viewpoint 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. This should be undertaken in a way that will ensure efficiency and that reflects national priorities; for example, it could be incorporated into periodic reviews that are part of every statistical system or implemented as part of new development projects. 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 reviews to identify key improvements;
- **Addressing the difficulties in matching data from different statistical domains** and the lack of coherence among data sets. NSOs should improve linking between socio-economic and environmental data 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:
- **Improving data for analysing drivers of climate change** by connecting economic and climate change-related information. This could be done by developing or expanding environmental accounts that allow, for example, GHG emissions and water use to be linked with economic activities. Implementing 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 SEEA-CF for the measurement of climate change-related issues;
 - **Developing statistics on the use of economic instruments** in climate change mitigation efforts to help analyse 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 1) reviewing the current statistical infrastructure to see how the needs of climate change analysis are met; 2) acquiring some new capacity, knowledge, skills and partnerships; and 3) 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** by introducing changes in, as one example, the System of National Accounts to improve statistics on emission trading systems following the IPCC/UNFCCC guidelines. Relevant classifications to be reviewed include 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 researchers 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 case study 14, 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 **mainly by partnering and collaborating** with other agencies and experts but also, 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 recognised, however, that some of the areas of GHG inventories (for example, land use) and climate change-related statistics require specialized expertise that may not be easy 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 the agencies responsible for greenhouse gas inventories and official statisticians. NSO staff should, for example, understand 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. This calls for closer collaboration with geospatial experts;
- **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 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, including users and producers within the NSO itself;
 - **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 Production and Services,¹⁰⁷ "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;
 - **Defining and clarifying, if needed, 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.

5.4 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.

Another goal should be to **define a set of key climate change-related statistics**, starting from areas of traditional NSO strength such as the economic and social costs of climate change mitigation and adaptation. 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 and to ensure the use of official statistics to the possible extent.

One of the key conclusions of the Task Force's work has been the **need for better dialogue among NSOs and with other data producers 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 IPCC, UNFCCC, UNECE Protocol on PRTRs and WMO. The members of the statistical system need to continue engaging with these and other 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, the agencies responsible for greenhouse gas inventories and relevant international organizations must continue to share ideas, good practices and areas for collaboration.

¹⁰⁷ www1.unece.org/stat/platform/display/hlgbas

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 FAO, IPCC, UNFCCC, UNECE Protocol on PRTRs, UNSD 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 the following activities.

- Sharing ideas, experience and good practices in climate change-related statistics among NSOs;
- Discussion of improved concepts, methods and data sources as they relate to NSOs for greenhouse gas emissions inventories and other climate change-related statistics, recognising that the experts involved in each will differ;
- Discussing collaboration, roles and division of responsibilities among the statistical community, the agencies responsible for greenhouse gas inventories and the relevant international organisations;
- Exploring the priority data needs in climate change-related statistics to enable selection of a key set of internationally agreed-upon climate change-related statistics;
- Discussing concepts and measurement frameworks to be developed for the key climate change-related statistics.

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.

- How best to use SEEA-CF for the measurement of climate change-related statistics?
- How to ensure coherence of GHG inventory data with official statistics (energy, environmental accounts and national accounts)?
- What statistics should be disseminated *via* NSO channels and in what level of detail?
- 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**

ECE/CES/BUR/2011/NOV/9/Rev.1
13 October 2011

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

Approved

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 48 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 environment 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 FORCE – PRESSURE – STATE – IMPACT – RESPONSE (DPSIR)

Driving force:

- **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.

Pressure:

- 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.

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.¹⁰⁸

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.¹⁰⁹

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

- **Agriculture and forestry:** growing season and yields of key crops; agricultural crops cycle; irrigation; pests and diseases; forest growth; forest fires;

¹⁰⁸ These are the categories four to seven of the state and impact indicators of climate change as defined by EEA: acm.eionet.europa.eu/reports/CC%20State%20Impact%20Indicators%20in%20Europe

¹⁰⁹ These are the first three categories of the state and impact indicators of climate change as defined by EEA.

- **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.¹¹⁰

Response:

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;
- **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,

¹¹⁰ These are the last three categories of the state and impact indicators of climate change as defined by EEA.

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 of FDES); 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 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 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 services 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 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

Statistical area	Frameworks						Relevance
	DPSIR	FDES	IPCC	SEEA-CF	Capital	IMA	
Demographic and social statistics							
1.1 Population and migration	x	x	x			x	closely
1.2 Labour	partly			partly			indirectly
1.3 Education	partly	partly	partly	partly		partly	indirectly
1.4 Health	x	x	x		partly	x	closely
1.5 Income and consumption	x	partly	partly	partly		x	related
1.6 Social protection	partly			partly		x	indirectly
1.7 Human settlements and housing	x	x	x	partly	x	x	closely
1.8 Justice and crime							indirectly
1.9 Culture			x	partly	partly		indirectly
1.10 Political and other community activities	x	partly	x	x		x	closely
1.11 Time use	partly		partly	partly	partly	partly	related

Economic statistics							
2.1 Macroeconomic statistics	x			partly		x	indirectly
2.2 Economic accounts	x			partly	partly	x	indirectly
2.3 Business statistics	partly	partly	partly	partly	x	partly	related
2.4 Sectoral statistics							
2.4.1 Agriculture, forestry, fisheries	x	partly	partly	x	x	x	closely
2.4.2 Energy	x	partly	partly	x	x	x	closely
2.4.3 Mining, manufacturing, construction	x	partly	partly	x	x	x	closely
2.4.4 Transport	x	partly	partly	partly	x	x	closely
2.4.5 Tourism	x	x		x	x	x	closely
2.4.6 Banking, insurance, financial statistics	partly	partly		partly		partly	indirectly
2.5 Government finance, fiscal, public sector	partly	partly	partly	partly		partly	related
2.6 International trade, balance of payments	x		x	partly	partly	partly	related
2.7 Prices	x					x	indirectly
2.8 Labour cost							indirectly
2.9 Science, technology and innovation	x		x	partly		x	closely

Environment and multi-domain statistics							
3.1 Environment	x	x	x	x	x	x	closely
3.2 Regional and small area statistics	x	x	x	x	x	x	closely
3.3 Multi-domain statistics and indicators							
3.3.1 Living conditions, poverty, social issues	x	x	x	partly	partly	partly	closely
3.3.2 Gender and special population groups	partly	partly	x		partly	x	related
3.3.3 Information society							indirectly
3.3.4 Globalisation	x		x		partly	partly	related
3.3.5 Millennium Development Goals	partly	partly	partly	partly	partly	partly	related
3.3.6 Sustainable development	x	x	x	x	x	x	closely
3.3.7 Entrepreneurship	partly	partly	partly	partly	partly	partly	related

Issues relevant to climate change that are covered by the different frameworks and approaches

	DPSIR	FDES	IPCC	SEEA-CF	Capital	IMA
Demographic and social statistics						
1.1 Population and migration	Drivers: population and migration movements	Human settlements: total population	Socio-economic development: population	-	-	Mitigation: of population growth, urbanization Adaptation: migration movement
1.2 Labour	Responses: “green” jobs	-	-	Accounts for activities and transactions: the extent of employment in the production of environmental goods and services	-	-
1.3 Education	Responses: climate related education	Environment protection: climate related information education and awareness	Socio-economic development: literacy	Accounts for activities and transactions: education related to environmental protection or resource management	-	Adaptation: education to cope with changing climate
1.4 Health	Impact: climate related mortality, allergies, hay fever, vector-borne diseases, food-/waterborne diseases	Human settlements: Water related, airborne and vector-borne diseases, UV and pollution exposure, morbidity and mortality	Impacts and vulnerability: impacts on human health Socio-economic development: Health	-	Ecological good and service flows: disrupted protection from vector-borne diseases	Impact: health impacts from extreme weather, reduced air quality and climate-sensitive diseases Adaptation: changes in health environment due to climate change

	DPSIR	FDES	IPCC	SEEA-CF	Capital	IMA
1.5 Income and consumption	Drivers: level of wealth, consumption Impact: electricity, gas and water consumption, changes in income distribution, economic losses	Extreme events: economic losses due to disasters Environmental resources: as a source of income and consumption habits	Socio-economic development: consumption patterns	Accounts for physical flows: consumption based GHG emissions Accounts for environmental assets: depletion as a cost against income	-	Impact & adaptation: changes in income and consumption due to climate change and adaptation to them
1.6 Social protection	Responses: protection of vulnerable groups/regions, finance	-	-	Accounts for activities and transactions: Social benefits to households to provide for the needs that arise from certain events or circumstances	-	Impact: changes in access to services and resources due to weather events Adaptation: actions taken for social protection
1.7 Human settlements and housing	Drivers: urbanisation, structure of households, demand for housing Impact: heating days, economic losses, disasters	Residuals: greenhouse gas emissions, generation of waste, Extreme events: economic losses due to disasters, Human settlements: pressure from built environment, living conditions	Impacts and vulnerability: settlements and society	Accounts for environmental assets: Land used for residential buildings, urbanisation Accounts for activities and transactions: Social benefits due to housing conditions	Ecological good and service flows: changes in the provision of space, in flood protection, in the recreational opportunities and cultural value of environment	Impact: changes in housing Mitigation: urbanization
1.8 Justice and crime	-	-	-	-	-	-

	DPSIR	FDES	IPCC	SEEA-CF	Capital	IMA
1.9 Culture	-	-	Socio-economic development: socio-cultural preferences	Accounts for environmental assets: Land, nature reserves and other protected areas such as those of specific cultural interest, cultural sites: archaeological and historic sites, classified monuments, ruins and stately homes etc.	Ecological good and service flows: changes in the aesthetic, cultural and existence value of environment	-
1.10 Political and other community activities	Responses: voluntary work and political activities relating to adaptation and mitigation	Environmental protection: voluntary work and political activities on environmental protection	Socio-economic development: voluntary work and political activities on mitigation and adaptation	Accounts for activities and transactions: voluntary work and political activities environmental protection	-	Mitigation: voluntary work and political activities on mitigation
1.11 Time use	Drivers: changing habits and diets	-	Socio-economic development: socio-cultural preferences	Accounts for physical flows: recreational use of natural inputs Accounts for environmental assets: recreational facilities Accounts for activities and transactions: licenses to use natural inputs for recreation	Ecological good and service flows: changes in recreational use and attractiveness of environment	Adaptation: changes in time use to adapt to climate change

	DPSIR	FDES	IPCC	SEEA-CF	Capital	IMA
Economic statistics						
2.1 Macroeconomic statistics	Drivers: level of economic activity, GDP	-	-	Accounts for physical flows: decoupling indicators, emissions per unit of GDP Accounts for activities and transactions: economic activity for environmental purposes, contribution of environmental protection activities to the economy	-	Impact: economic losses to society Mitigation: level of economic activity
2.2 Economic accounts	Drivers: level of economic activity by sectors Impact: changes in economic activity by sector/industry	-	-	Accounts for physical flows: emissions resulting from economic activity Accounts for environmental assets: GDP, value added and GNI can be constructed from balancing items	Natural assets: availability of inputs and raw material for economic activity	Mitigation: level of economic activity Adaptation: changes in activity of industries

	DPSIR	FDES	IPCC	SEEA-CF	Capital	IMA
<p>2.3 Business statistics</p>	<p>Impact: economic performance, economic opportunities and limitations, eco-industries</p>	<p>Environmental resources and use: land use, timber resources, crops, livestock</p> <p>Residuals: greenhouse gas emissions, generation of waste</p> <p>Extreme events: losses of revenue due to disasters</p>	<p>Socio-economic development: production patterns</p>	<p>Accounts for activities and transactions: 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</p>	<p>Natural assets: availability of inputs and raw material</p>	<p>Impact: economic losses to industry</p> <p>Mitigation: eco-industries, environment friendly technologies</p> <p>Adaptation: finding new economic opportunities, adaptation to economic limitations</p>
<p>2.4 Sectoral statistics</p> <p>2.4.1 Agriculture, forestry, fisheries</p>	<p>Drivers: agricultural practices, demand for meat</p> <p>Pressures: livestock in agriculture, production of fossil fuels, forestry and land use, greenhouse gas emissions</p> <p>Impact: growing season and crop yields, irrigation, pests and diseases, forest growth, fires, losses from climate-related events</p>	<p>Environmental resources and use: land use, timber resources, crops, livestock</p> <p>Residuals: greenhouse gas emissions, generation of waste</p> <p>Extreme events: economic losses, crop losses and damage due to disasters</p>	<p>Climate process drivers: greenhouse gas emissions</p>	<p>Accounts for physical flows: water use and availability, energy use, use of natural inputs, waste, emissions</p> <p>Accounts for environmental assets: size and changes of land, soil, water assets</p> <p>Accounts for activities and transactions: organic agriculture</p>	<p>Natural assets: degradation leading to changes in ecosystems and in the distribution of and quality of different types of land and forests</p> <p>Ecological good and service flows: changes in timber and other forest product flows</p>	<p>Impact: as reduced crop yields or changes in crop pattern</p> <p>Mitigation: reduction of greenhouse gas emissions, renewable energy resources, measures to mitigate these</p> <p>Adaptation: to reduced crop yields, changed crop patterns and seasons, crop varieties, forest fires</p>

	DPSIR	FDES	IPCC	SEEA-CF	Capital	IMA
2.4.2 Energy	<p>Drivers: demand for energy and heating, Pressures: production of fossil fuels, greenhouse gas emissions Responses: energy, material and emissions efficiency</p>	<p>Environmental resources and use: production of energy (renewable and non-renewable), energy consumption Residuals: greenhouse gas emissions, generation of waste, Extreme events: economic losses due to disasters</p>	<p>Climate process drivers: greenhouse gas emissions</p>	<p>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</p>	<p>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</p>	<p>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	<p>Drivers: mining, manufacturing and construction levels, changes in food production, Pressures: production of fossil fuels, greenhouse gas emissions, production of ozone depleting substances, Impact: economic losses from climate-related events</p>	<p>Environmental resources and use: minerals Residuals: greenhouse gas emissions, generation of waste Extreme events: economic losses due to disasters</p>	<p>Socio-economic development: production patterns, Climate process drivers: greenhouse gas and aerosol emissions</p>	<p>Accounts for physical flows: supply of natural inputs (water), product and waste flows, air emissions Accounts for environmental assets: size and changes of environmental assets</p>	<p>Natural assets: changes in the sub-soil resources, mineral, liquids and gases and sub-soil resources Ecological good and service flows: changes in inputs to industrial processes and construction</p>	<p>Mitigation: reduction of greenhouse gas emissions, use of the carbon market and trade, renewable energy resources Adaptation: in energy demand and use</p>

	DPSIR	FDES	IPCC	SEEA-CF	Capital	IMA
2.4.4 Transport	<p>Drivers: demand for transport</p> <p>Pressures: production of fossil fuels, greenhouse gas emissions</p> <p>Impact: economic losses from climate-related events</p>	<p>Environmental resources and use: pressures on the climate</p>	<p>Climate process drivers: greenhouse gas emissions</p>	<p>Accounts for physical flows: emissions from transport, use of energy</p>	<p>Natural assets: changes in the provision of space,</p> <p>Ecological good and service flows: changed transportation services of waters and atmosphere</p>	<p>Mitigation: reduction of greenhouse gas emissions, renewable energy resources</p>
2.4.5 Tourism	<p>Drivers: levels of tourism, demand for transport</p> <p>Pressures: production of fossil fuels, greenhouse gas emissions</p> <p>Impact: shifts of tourism flows, economic losses from climate-related events</p>	<p>Residuals: greenhouse gas emissions, generation of waste</p> <p>Extreme events: economic losses due to disasters</p>	-	<p>Accounts for physical flows: consumption activity of a tourist, waste generated by tourists, emissions from transport used</p>	<p>Ecological good and service flows: changes in the attractiveness of destinations for tourism, and in the aesthetic, cultural and existence value</p>	<p>Mitigation: reduction of greenhouse gas emissions</p> <p>Adaptation: changes in tourism flows</p>
2.4.6 Banking, insurance, financial statistics	<p>Impact: insurance costs</p> <p>Responses: financial costs of responses and protection</p>	<p>Environment protection: climate protection expenditure</p>	-	<p>Accounts for activities and transactions: how expenditure on environmental protection (incl. elimination of emissions) is financed</p>	-	<p>Mitigation: financial tools</p> <p>Adaptation: costs of adaptation</p>

	DPSIR	FDES	IPCC	SEEA-CF	Capital	IMA
2.5 Government finance, fiscal and public sector	Responses: financing and government measures in adaptation and mitigation	Environment protection: climate protection and management expenditure, regulation related to climate, participation in climate conventions	Socio-economic development: governance, mitigation, adaptation	Accounts for activities and transactions: financing of government environmental protection action, environmental taxes and subsidies	-	Mitigation: using financial and legislative tools, governance Adaptation: of legislation and institutional mechanisms, adaptation measures
2.6 International trade and balance of payments	Drivers: Internationalisation of the economy, carbon leakage	-	Socio-economic development: trade	Accounts for physical flows: Exports and imports of environmental goods and services	Ecological good and service flows: changed transportation services	Mitigation: responsible trade
2.7 Prices	Responses: energy prices, oil prices and others	-	-	-	-	Adaptation: through changes in pricing
2.8 Labour cost	-	-	-	-	-	-
2.9 Science, technology and innovation	Responses: eco-friendly technology development and technology exchange	-	Socio-economic development: technology	Accounts for activities and transactions: investing in technologies to prevent or reduce pollution	-	Mitigation and adaptation: through technology transfer and capacity building

	DPSIR	FDES	IPCC	SEEA-CF	Capital	IMA
Environment and multi-domain statistics						
3.1 Environment	<p>State: atmosphere and climate, cryosphere, marine biodiversity and its ecosystems</p> <p>Drivers: waste from production and consumption</p> <p>Pressures: combustion of fossil fuels, waste treatment methods, greenhouse gas emissions</p> <p>Impact: water quantity, freshwater quality and biodiversity, terrestrial ecosystems and biodiversity, soil, access to water</p> <p>Responses: reduction of emissions, renewable energy, energy efficiency, environmental protection expenditure, recycling and waste, environment taxes and subsidies, permits and certificates</p>	<p>Environmental conditions: atmosphere, climate, hydrography, weather, geological and geographic conditions, soil, land cover, biodiversity, ecosystems, forests, air, freshwater and marine water quality</p> <p>Environmental resources and use: aquatic and water resources, use, returns</p> <p>Residuals: GHG emissions, waste generation and management wastewater</p> <p>Extreme events: disasters</p> <p>Human settlements : urban environment,</p> <p>Environment protection: protection costs, regulation, measures and education</p>	<p>Climate change: temperature change, precipitation change, sea level rise and extreme events</p> <p>Impacts and vulnerability: Impacts on ecosystems and water resources</p> <p>Climate process drivers: greenhouse gas and aerosol emissions and concentrations</p>	<p>Accounts for physical flows: natural inputs, products and residuals</p> <p>Accounts for environmental assets: the size and changes of environmental assets</p> <p>Accounts for activities and transactions: activity to preserve or protect the environment</p>	<p>Natural assets: changes in ecosystems, land and sub-soil resources</p> <p>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</p>	<p>Impact: heat waves, rising oceans, glaciers' retreats, droughts, the state of environment, biodiversity and natural resources</p> <p>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</p> <p>Mitigation: of the adverse impacts of the above changes</p>

	DPSIR	FDES	IPCC	SEEA-CF	Capital	IMA
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 crosscutting 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

	DPSIR	FDES	IPCC	SEEA-CF	Capital	IMA
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
3.3.3 Information society	-	-	-	-	-	-
3.3.4 Globalisation	Drivers: Internationalisation of the economy, carbon leakage	-	Socio-economic development: changes in trade patterns	-	Ecological good and service flows: changes in transportation services	Mitigation: responsible trade
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

	DPSIR	FDES	IPCC	SEEA-CF	Capital	IMA
3.3.6 Sustainable development	<p>Responses: Sustainable Development Goals (SDGs), 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</p>	<p>Environmental resources and use: SDGs, sustainable use of natural resources Environmental protection: SDGs, sustainable use of natural resources related to climate</p>	<p>Impacts and vulnerability: SDGs , impacts on ecosystems, Socio-economic development: SDGs, governance, mitigation</p>	<p>Accounts for environmental assets: data for SDGs, sustainable use of resources and the capacity of environmental assets to continue to provide inputs</p>	<p>Natural assets: SDGs, level of sustainable use of natural assets</p>	<p>Mitigation: SDGs, measures in support of sustainable development, environmental protection, taxes and subsidies, permits and certificates, “green” jobs</p>
3.3.7 Entrepreneurship	<p>Drivers: level of economic growth Impact: economic performance, economic opportunities and limitations, eco-industries</p>	<p>Extreme events: losses of revenue due to disasters</p>	<p>Socio-economic development: opportunities of technology exchange</p>	<p>Accounts for activities and transactions: technologies to prevent or reduce pollution, financing of environmental protection, industries that produce environmental goods and services</p>	<p>Natural assets: availability of inputs and raw material</p>	<p>Impact: costs to entrepreneurs Mitigation: eco-industries, environment friendly technologies Adaptation: economic opportunities, adaptation to limitations</p>

ANNEX 4

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

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Category	National Communication	IPCC category	Methodology	Summary of activity/emissions data sources	Status of underlying data					
					Published as Official Statistics	Official Statistics, but with further disaggregation	Publicly available, but not as official statistics	Based on non-public data, specifically requested	Commercially confidential	Based on other published research
Energy Supply	Power Stations	1A1a	Emission factor * activity	Energy statistics, plant operator and EU Emissions Trading System(EUETS)	Partly	Partly		Partly	Partly	
	Refineries	1A1b	Emission factor * activity	Energy statistics, plant operator and EUETS data	Partly	Partly			Partly	
	Manufacture of solid fuels and other energy industries	1A1c	Emission factor * activity	Energy statistics	Yes					
	Coal mining and handling	1B1a	Emission factor * activity	Energy statistics	Yes					
		1B1c	Modelled	from WSP-consultancy						Yes
	Solid fuel transformation	1B1b	Carbon balance approach	Energy statistics	Yes					
	Exploration, production and transport of oils	1B2a	Emission factor * activity, operator reported emissions	Energy statistics, oil and gas industry data	Partly	Partly			Partly	
	Offshore oil and gas - flaring	1B2cii	Operator reported emissions	Oil and gas industry data					Yes	
Offshore oil and gas - venting	1B2ci	Operator reported emissions	Oil and gas industry data					Yes		

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	
	Power stations - FGD	2A3	Emission factor * activity	UK Minerals Yearbook and pollution inventory data			Yes				
	Exploration, production and transport of gas	1B2b	Modelled (natural gas leakage), operator reported emissions (offshore activities)	Gas operators, oil and gas industry data				Yes			
Business	Iron and steel - combustion and electricity	1A2a	Emission factor * activity	Energy statistics	Yes						
	Other industrial combustion and electricity	1A2b	Emission factor * activity	Energy statistics	Yes						
		1A2c	Emission factor * activity	Energy statistics	Yes						
		1A2d	Emission factor * activity	Energy statistics	Yes						
		1A2e	Emission factor * activity	Energy statistics	Yes						
		1A2f	Emission factor * activity (stationary), modelled (mobile)	Energy statistics, plant operators and industry data, UK off-road model	Partly						Partly
	Miscellaneous industrial and commercial combustion and electricity	1A4a	Emission factor * activity	Energy statistics	Yes						
	Energy recovery from waste fuels	2B5	Emission factor * activity	Pollution inventory, Mineral Products Association			Partly		Partly		
	Refrigeration and air conditioning	2F1	Modelled	UK model verified against sales data from the British Refrigeration Association						Partly	Partly
	Foams	2F2	Modelled	Estimates supplied by Caleb Management Services - consultancy							Yes
Fire fighting	2F3	Modelled	Fire Industry Council, updated based on consultation with ASSURE Property Inventory Services							Yes	
Solvents	2F5	Modelled	Harnisch and Schwarz, 2003 ¹¹¹							Yes	

¹¹¹ Harnisch, J. and W. Schwarz, 2003: Costs and the Impact on Emissions of Potential Regulatory Framework for Reducing Emissions of Hydrofluorocarbons, Perfluorocarbons and Sulphur Hexafluoride. Report prepared for the European Commission, Ecofys/Öko-Recherche, Nürnberg, Germany, 57 pp (ec.europa.eu/clima/policies/eccp/docs/ecofys_oekorecherchestudy_en.pdf).

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
	One component foams	2F9	Modelled	Harnisch and Schwarz, 2003						Yes
	Electronics, electrical insulation and sporting goods	2F9	Modelled	Microelectronics Environmental Advisory Committee (semiconductors), BEAMA (equipment manufacturers) and the Electricity Association (electrical equipment), sales data by the manufacturer (sporting goods)					Partly	Partly
Transport	Civil aviation (domestic, cruise)	1A3a	Model based on Civil Aviation Authority (CAA) data and Energy Statistics	Civil Aviation Authority, energy statistics		Yes				
	Civil aviation (domestic, landing and take off)	1A3a	Model based on Civil Aviation Authority (CAA) data and energy statistics	Civil Aviation Authority, energy statistics		Yes				
	Passenger cars	1A3b	Modelled	Energy statistics, transport statistics		Yes				
	Light duty vehicles	1A3b	Modelled	Energy statistics, transport statistics		Yes				
	Buses	1A3b	Modelled	Energy statistics, transport statistics		Yes				
	HGVs	1A3b	Modelled	Energy statistics, transport statistics		Yes				
	Mopeds & motorcycles	1A3b	Modelled	Energy statistics, transport statistics		Yes				
	LPG emissions (all vehicles)	1A3b	Modelled	Energy statistics, transport statistics		Yes				
	Other (road vehicle engines)	1A3b	Modelled	Energy statistics, transport statistics		Yes				
	Railways	1A3c	Emission factor * activity	Office of Rail Regulation National Rail Trends Yearbook, Translink - Northern Ireland public transport service			Partly	Partly		
	Railways - stationary combustion	1A4a	Emission factor * activity	Energy statistics	Yes					
	National navigation	1A3d	Emission factor * activity	Energy statistics, Entec (2010)	Partly					Yes
	Fishing vessels	1A4c	Emission factor * activity	Entec shipping study, carbon factors review, European Monitoring and Evaluation Programme / Corinair Guidebook						Yes

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
	Military aircraft and ship pollution inventorying	1A5b	Emission factor * activity	Civil Aviation Authority, Ministry Of Defence				Yes		
	Aircraft support vehicles	1A3e	Modelled	Energy statistics, UK off-road model						Yes
Public	Public	1A4a	Emission factor * activity	Energy statistics	Yes					
Residential	Residential combustion	1A4b	Emission factor * activity	Energy statistics	Yes					
	Use of non aerosol consumer products	2B5	Emission factor * activity	Energy statistics, sales data from Cosmetic, Toiletry & Perfumery Association			Yes			
	Accidental vehicle fires	6C	Emission factor * activity	Statistics of the Department of Communities and Local Government	Yes					
	Aerosols and metered dose inhalers	2F4	Modelled	British Aerosols Manufacturers Association, Metered Dose Inhalers Import/Export data from manufacturers				Yes		
Agriculture	Stationary and mobile combustion	1A4c	Emission factor * activity (stationary sources), modelled (mobile sources)	Energy statistics	Partly					Partly
	Breakdown of pesticides	2B5	Emission factor * activity	British Agrochemicals Association, Crop Protection Association			Yes			
	Enteric fermentation - cattle	4A1	Tier 2 Emission factor * activity	Department of Environment, Food and Rural Affairs (Defray) Economics and Statistics Group - June Census and Devolved Administrations	Yes					
	Enteric fermentation - sheep	4A3	Tier 2 Emission factor * activity	- same as above -	Yes					
	Enteric fermentation - goats	4A4	Emission factor * activity	- same as above -	Yes					
	Enteric fermentation - horses	4A6	Emission factor * activity	- same as above -	Yes					
	Enteric fermentation - swine	4A8	Emission factor * activity	- same as above -	Yes					
	Enteric fermentation - deer	4A10	Tier 2 Emission factor * activity	- same as above -	Yes					

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
	Wastes - cattle	4B1	Tier 2 Emission factor * activity	- same as above -	Yes					
	Wastes - sheep	4B3	Tier 2 Emission factor * activity	- same as above -	Yes					
	Wastes - goats	4B4	Emission factor * activity	- same as above -	Yes					
	Wastes - horses	4B6	Emission factor * activity	- same as above -	Yes					
	Wastes - swine	4B8	Emission factor * activity	- same as above -	Yes					
	Wastes - poultry	4B9	Emission factor * activity	- same as above -	Yes					
	Wastes - deer	4B10	Emission factor * activity	- same as above -	Yes					
	Wastes - manure liquid systems	4B12	Emission factor * activity	- same as above -	Yes					
	Wastes - solid storage and dry lot	4B13	Emission factor * activity	- same as above -	Yes					
	Wastes - other manure management (N ₂ O)	4B14	Emission factor * activity	- same as above -	Yes					
	Direct soil emission	4D	Emission factor * activity	- same as above -	Yes					
	Field burning of agricultural wastes	4F1	Emission factor * activity	Estimates compiled by Rothamsted Research	Yes					
	4F5	Emission factor * activity	Estimates compiled by Rothamsted Research	Yes						
Industrial Process	Sinter production	1A2a	Carbon balance approach	Energy statistics	Yes					
	Cement production	2A1	Emission factor * activity	UK Minerals Yearbook, British Cement Association, EUETS			Partly		Partly	
	Lime production	2A2	Emission factor * activity	UK Minerals Yearbook, EUETS			Partly		Partly	
	Limestone and dolomite use	2A3	Emission factor * activity	International Steel Statistics Bureau's 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	Office of National Statistics' data, pollution inventory	Partly		Partly			

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
	Ammonia production	2B1	Calculated, based on operator reported data on CO ₂ produced, emitted and sold	Plant operators data				Yes		
	Iron and steel production	2C1	Carbon balance approach	Energy statistics, International Steel Statistics Bureau's annual statistics	Partly		Partly			
	Aluminium production	2C3	Emission factor * activity, operator reported data	UK Minerals yearbook, pollution inventory			Yes			
	Nitric acid production	2B2	Operator reported data	Plant operators data, pollution inventory				Yes		
	Air pollution inventory - acid production	2B3	Operator reported data	Industry data					Yes	
	Other - chemical industry	2B5	Calculated, based on operator reported emissions and plant capacity data.	Based on plant capacity and data reported to the pollution inventory			Yes			
	Halocarbon production	2E1	Operator reported data	Pollution inventory			Partly		Partly	
		2E2	Operator reported data	Pollution inventory			Partly		Partly	
	Magnesium cover gas	2C5	Modelled, operator reported	Pollution inventory			Partly	Partly		
Land Use Change	Forest land remaining forest	5A1	Modelled							Yes
	Biomass burning (forest land)	5A	Modelled							Yes
	Land converted to forest land	5A2	Modelled							Yes
	Direct N ₂ O emission from N fertilisation of forest land	5A2	Modelled							Yes
	Drainage of organic soils (forest land)	5A	Modelled							Yes
	Biomass burning (cropland)	5B	Modelled							Yes
	Liming (cropland)	5B1	Modelled							Yes
	Cropland remaining cropland	5B1	Modelled							Yes
	Land converted to cropland	5B2	Modelled							Yes
	N ₂ O emissions from disturbance associated with land use conversion to cropland	5B2	Modelled							Yes
	Biomass burning (grassland)	5C	Modelled							Yes
	Liming (grassland)	5C1	Modelled							Yes

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
	Grassland remaining grassland	5C1	Modelled							Yes
	Land converted to grassland	5C2	Modelled							Yes
	Wetlands remaining wetland	5D1	Modelled							Yes
	Non-CO ₂ emissions from drainage of soils and wetlands	5D2	Modelled							Yes
	Land converted to wetland	5D2	Modelled							Yes
	Settlements remaining settlements	5E1	Modelled							Yes
	Biomass burning (settlements)	5E	Modelled							Yes
	Land converted to settlements	5E2	Modelled							Yes
	Harvested wood	5G	Modelled							Yes
Waste Management	Landfill	6A1	Modelled	UK landfill waste methane model						Yes
	Waste-water handling	6B1	Emission factor * activity	Department of Environment, Food and Rural Affairs (Defra), IPCC default	Yes					
		6B2	Modelled	Office of National Statistics, Food and Rural Affairs (Defra), Department of Environment, water companies, Water Services Regulation Authority	Partly		Partly	Partly		
	Waste incineration	6C	Emission factor * activity	Her Majesty's Inspectorate of Pollution (HMIP), Department of Energy and Climate Change (DECC), pollution inventory			Yes			

ANNEX 5

European Statistical System (ESS) quality criteria for statistical output compared to the criteria for greenhouse gas inventories

ESS criteria ¹¹²	IPCC guidelines
<p><i>Relevance</i> 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.) reflect user needs.</p>	-
<p><i>Accuracy and reliability:</i> 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.</p>	<p><i>Accuracy</i> 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</p>
-	<p><i>Completeness</i> means that an inventory covers all sources and sinks, as well as all gases, included in the <i>IPCC Guidelines</i> 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 <i>IPCC Guidelines</i>. Completeness also means full geographic coverage of sources and sinks of an Annex I Party</p>
<p><i>Timeliness and punctuality</i></p> <p>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.</p> <p>Timeliness of information reflects the length of time between its availability and the event or phenomenon it describes</p>	-

¹¹² Quality Assurance Framework of the European Statistical System:
epp.eurostat.ec.europa.eu/cache/ITY_PUBLIC/QAF_2012/EN/QAF_2012-EN.PDF

ESS criteria ¹²	IPCC guidelines
<p><i>Coherence and comparability</i></p> <p>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.</p> <p>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.</p>	<p><i>Consistency</i> 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</p> <p><i>Comparability</i> 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 <i>the IPCC Guidelines</i>, and the IPCC Good Practice Guidance for Land Use, Land-Use Change and Forestry, at the level of its summary and sectoral tables</p>
<p><i>Accessibility and clarity</i></p> <p>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.</p> <p>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 are also available (including limitation in use...) and the extent to which additional assistance is provided by the NSO.</p>	<p><i>Transparency</i> 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 communication process and consideration of information</p>

ANNEX 6

Glossary of terms

<p>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.</p>	
<i>Accessibility</i>	<p>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)</p>
<i>Accuracy</i>	<p>The accuracy of statistical outputs in the general statistical sense is the degree of closeness of estimates to the true values. (ESS Quality Criteria)</p>
<i>Activity data</i>	<p>Activity data, according to the <i>Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories</i>, are defined as data on the magnitude of human activity resulting in emissions or removals taking place during a given period of time. (UNFCCC)</p>
<i>Annex I Parties</i>	<p>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)</p> <p>The full list of Annex I Parties to UNFCCC is provided at: unfccc.int/parties_and_observers/parties/annex_i/items/2774.php</p>
<i>Asset</i>	<p>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)</p>
<i>Biodiversity</i>	<p>Biodiversity refers to the range of genetic differences, species differences and ecosystem differences in a given area. (OECD)</p>
<i>Capital approach</i>	<p>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. (UNECE, 2013)¹¹³</p>

¹¹³ UNECE 2013: As defined in the CES recommendations on measuring sustainable development

<i>Clarity</i>	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 are also available (including limitation in use...) and the extent to which additional assistance is provided by the NSO. (ESS Quality Criteria)
<i>Coherence</i>	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)
<i>Comparability</i>	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)
<i>Confidentiality</i>	Data confidentiality is a property of data, usually resulting from legislative measures, which prevents it from unauthorized disclosure. (OECD)
<i>Consumption</i>	Consumption is the use of goods and services for the satisfaction of individual or collective human needs or wants. (SEEA Central Framework)
<i>Data</i>	Characteristics or information, usually numerical, that are collected through observation. (OECD)
<i>Ecosystems</i>	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)
<i>Ecosystem services</i>	Ecosystem services are the benefits supplied by the functions of ecosystems and received by humanity. (SEEA Central Framework)
<i>Emission categories</i>	Emission estimates are presented in accordance with the categories of the Intergovernmental Panel on Climate Change Guidelines for National Greenhouse Gas Inventories (1996). (UNFCCC)
<i>Emission factors</i>	An emission factor is defined as the average emission rate of a given GHG for a given source, relative to units of activity. (UNFCCC)
<i>Emissions</i>	Emissions are substances released to the environment by establishments and households as a result of production, consumption and accumulation processes. (SEEA Central Framework)

<i>Emission inventory</i>	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 four sectors (energy; industrial processes and product use; agriculture, forestry and land use; and waste), and for all years from the base year or period to the most recent year. (UNFCCC/Kyoto Protocol)
<i>Energy balances</i>	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)
<i>Environmental accounting</i>	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)
<i>Environmental assets</i>	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)
<i>Greenhouse gases</i>	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).
<i>Household</i>	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)

<i>Index</i>	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).
<i>International trade</i>	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. Exports (and imports) of services reflect the value of services provided to residents of other countries (or received by residents of the domestic territory). (OECD)
<i>Kyoto Protocol</i>	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. It sets more stringent reporting and review requirements, and its targets and rules apply to Annex I Parties. (UNFCCC)
<i>Land cover</i>	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)
<i>Land degradation</i>	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)
<i>Land use</i>	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) Land use is "the total of arrangements, activities, and inputs that people undertake in a certain land cover type" (FAO).
<i>Material flow accounts</i>	An account that provides an aggregate overview of annual material inputs and outputs of an economy in tonnes. (OECD)
<i>Metadata</i>	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.)
<i>Methodology</i>	A methodology is a structured approach to solve a problem. (OECD)
<i>Monitoring(environmental)</i>	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)

<i>National statistical system</i>	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 regional or global level. The term “statistical system” used in this report refers generically to the ensemble of all national and international statistical systems.
<i>Natural capital</i>	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. (UNECE, 2013) ¹
<i>Natural resources</i>	Natural resources are natural assets (raw materials) occurring in nature that can be used for economic production or consumption. (OECD)
<i>Official statistics</i>	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.
<i>Ozone depleting substances</i>	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)
<i>Portal</i>	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)
<i>Punctuality</i>	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)
<i>Relevance</i>	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.) reflect user needs. (ESS Quality Criteria)
<i>Reliability</i>	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)

<i>Renewable energy</i>	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)
<i>Revisions</i>	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)
<i>Scope</i>	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)
<i>Seasonal adjustment</i>	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)
<i>Soil</i>	Soil is the loose and unconsolidated outer layer of the earth's crust, made up of small particles of different sizes. (OECD)
<i>Source data</i>	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)
<i>Standard classifications</i>	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)
<i>Statistical micro-data</i>	An observation data collected on an individual object - statistical unit. (OECD)
<i>Statistical data</i>	Statistical data refers to data from a survey or administrative source used to produce statistics. (OECD)
<i>Statistical infrastructure</i>	Statistical infrastructure refers to tools that support the operation of a statistical system. These tools can help 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)
<i>Statistics</i>	Numerical data relating to an aggregate of individuals, the science of collecting, analysing and interpreting such data. (OECD)
<i>Survey</i>	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)
<i>Sustainable development</i>	The Brundtland definition 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." (UNECE, 2013) ¹

<i>Time series</i>	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)
<i>Timeliness</i>	The timeliness of statistical outputs is the length of time between the event or phenomenon they describe and their availability. (ESS Quality Criteria)
<i>Transparency</i>	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)
<i>Urbanization</i>	Urbanization referst to increase in the proportion of population living in urban areas and the process by which a large number of people become permanently concentrated in relatively small areas, forming cities. (OECD)
<i>Waste</i>	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)

Conference of European Statisticians Recommendations on
Climate Change-Related Statistics

The first ever recommendations on climate change-related statistics are aimed at improving existing official statistics to support climate change analysis and reporting on greenhouse gas emissions under the Kyoto Protocol. The focus of the recommendations is not on scientific or meteorological data describing changes in weather and climate, but rather on statistics that are relevant for analysing climate change, its causes and impacts. The recommendations are primarily targeted at official statisticians building on the key competences of official statisticians. The publication can also be useful when establishing partnerships with other producers and users of climate change-related statistics.

More than 60 countries and international organisations endorsed the recommendations in April 2014. The recommendations were developed in collaboration with Canada (Chair), Finland, Italy, Mexico, Norway, Qatar and the United Kingdom and a number of international organisations, including European Environment Agency, Eurostat, Directorate-General on Climate Action of the European Commission, Intergovernmental Panel on Climate Change, UNECE Protocol on Pollutant Release and Transfer Registers, United Nations Food and Agriculture Organisation, United Nations Framework Convention on Climate Change and World Meteorological Organisation.

According to the recommendations, the usefulness of existing statistics should be improved by reviewing and developing data collection and compilation systems. While national statistical offices produce a considerable portion of the statistics required for greenhouse gas inventories, existing official statistics are not yet used to their full potential. Access to detailed, geo-referenced data is important for research and analysis of climate change. Additional statistics may also need to be developed to describe the social and economic impacts of climate change, population vulnerability as well as mitigation and adaptation efforts.

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