

Monitoring Brief

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The accessibility and coherence of statistics about climate change

Issue

1. In recent years there has been increasing acceptance that economic and social pressures have contributed to climate change and that it poses significant risks to the environment. The availability of relevant statistical data is vital to the development of policy. This short review concludes that, as far as we can tell and in broad terms, government has access to sufficient statistical evidence on the topic. But, especially in the light of public uncertainty about the part human activities play in driving climate change, it is important that the statistical evidence and advice is presented in a form that is widely accessible and understandable.
2. This Brief reviews the extent to which official statistics relating to climate change are coherent and accessible.
3. Official statistics about climate change are unusual in some respects, and in ways that affect their coherence and accessibility:
 - The topic of climate change crosses a number of established statistical domains and this both increases the volume of relevant data and presents challenges in bringing them together.
 - The statistics are based on more varied sources than most official statistics – financial information, scientific data, and the results of opinion surveys, for example. There are also differences in kind in relation to timescales, and geographical levels.
 - The boundary between statistical data and scientific observations is not clear cut and this can create problems of co-ordination and quality assurance.
 - Policy responsibility for different aspects of climate change is split between the Department for Environment, Food and Rural Affairs (Defra) – which has policy responsibility for climate change *adaptation*, and the Department of Energy and Climate Change (DECC) – which deals with climate change *mitigation*.
 - There is no readily identified set of official statistics that clearly relates to ‘climate change’.

Findings

4. There are a number of organisations and individuals working to improve the evidence on climate change, and the Authority does not want to increase the burden on those who are dealing with the many developments already in train. We have however identified some weaknesses in the current arrangements that the government departments with primary responsibility in this area – particularly Defra and DECC - may need to consider further:
 - We note that whilst all official statistics are expected to be produced and released according to the requirements of the *Code of Practice for Official Statistics* – and are liable to formal assessment against the standards of that Code – there are many scientific (or

broader research) data sets used in this field about which there is little in the way of **standardised information on quality** readily available. Given that the official statistics and other data are often presented and used together, it would be helpful if more information could be compiled centrally on the quality of the data that fall outside official statistics.

- There is currently no main ‘climate change information’ **internet site**. We think users of the statistics would benefit from a portal that brought together statistics about climate change, with links to available data sources and to the information documented and collected in response to the government’s current climate change risk assessment.
 - We see potential for the use of **interactive maps** to illustrate aspects of climate change for the general public and non-specialist user.
 - There is a need for an intuitive **framework for statistics** about climate change that could be used as the basis for reviewing the statistical evidence base, and for the presentation of these and related official statistics. The Framework for Developing Environmental Statistics¹ produced by Statistics Canada and work carried out by the United Nations Statistical Commission² are relevant.
 - Despite the importance of the subject to government and society, there is no regular, free-standing **statistical report** about climate change, covering both adaptation and mitigation, aimed at the non-specialist audience.
5. We note also that, at present, there is no environmental statistics user group – let alone a ‘climate change statistics’ user group. A suggestion to establish an environmental statistics group was made by the (National Statistics) Natural and Built Environment theme working group in July 2002³ but was not taken forward. We see expert user groups of this kind as playing a valuable role in sharing ideas and knowledge, and in working with producers to guide the development of official statistics. We understand however that the recently re-formed Agricultural and Environmental Statistics Topic Group (led by Defra), will have links with relevant users. The Authority welcomes this development. We would encourage the Topic Group to consider the merits of establishing a sub-group with a remit to focus specifically on climate change. Such a sub-group might benefit from establishing contact with relevant experts via the Statistics User Forum of the Royal Statistical Society⁴.
6. It is self-evident that the public perception of statistical information about climate change is heavily dependent on the way that the news media report it. Controversy in recent years about the validity of various statements made by different groups is likely to have adversely affected public confidence in the statistics and steps to enhance trust should be actively sought. Whilst various reports⁵ concluded that the scientific rigor and honesty of the Climatic Research Unit was not in doubt, they did encourage the routine publication of base data for analysis. The Statistics Authority endorses this emphasis on enabling others to analyse and re-use statistics and statistical data where feasible. We have been told that in the United States the culture is for science agencies to allow open access to climate observation records and relevant computer code⁶. That seems to us to be the sort of step that will help avoid unnecessary controversy in the future.

¹ http://unstats.un.org/unsd/environment/fdes.htm/FDES_Canada_Paper.pdf

² <http://unstats.un.org/unsd/environment/fdes.htm>

³ <http://www.ons.gov.uk/about-statistics/ns-standard/themes/environment/minutes-150702.doc>

⁴ The Royal Statistical Society has an Environmental Statistics section, formed as a study group in 1996; this section maintains a mailing list of statisticians and environmental scientists and organises meetings on topics of interests to these users.

⁵ <http://www.cce-review.org/>

⁶ For example, National Oceanic and Atmospheric Administration (NOAA) freely provides many climate observation records, University Corporation for Atmospheric Research (UCAR) allows the download the raw computer code of its

7. DECC's statisticians stressed to us that in the area of climate change in general, there is currently no single set of correct figures, and that statisticians work closely with scientific experts. We endorse this view, and recognise that substantial statistical and scientific expertise is required in order to add value to the existing wealth of raw data about climate change.

External views

8. In 2008, the United Nations Statistical Commission invited the Australian Bureau of Statistics (ABS) to advise how official statistics could better contribute to the climate change debate. The key issues identified by ABS were discussed at the Conference on Climate Change and Official Statistics held in Oslo in April 2008. The Conference agreed that there should be an agenda for action to increase the use of official statistics in the climate change arena, although it recognised that the growth of these statistics should be organic, and that it should take account of differing national capacities within the global statistical community. The ABS report explores the areas in which official statistics can provide input and add value to analysis related to climate change. The specific recommendations from the report are listed at Annex A.

9. The ABS report mentions that the international official statistics community engages with users of climate change information 'unsystematically' and that levels of engagement vary greatly. The report also mentions that the measurement of the extent and impact of climate change is largely based on sources outside the official statistics system: hence its recommendation to ensure that official statistics on specific sectors are reviewed to take into account the requirements of climate change-related reporting and analysis.

10. The main *users* of official statistics about climate change (and the messages contained in the statistics) in the UK include:

- Parliament
 - the House of Commons Environmental Audit Committee monitors the environmental impact of public policies and programmes for all government departments and non-departmental bodies;
 - the House of Commons Climate Change Committee is an independent body established under the Climate Change Act (2008)⁷ which advises the government on emissions targets and reports to Parliament on progress made in reducing greenhouse gas emissions.
- central government departments with policy responsibility for different aspects of climate change (adaptation and mitigation);
- local government, in monitoring and developing local climate change initiatives;
- the business community, in activities relating to the mitigation of climate change, such as investment in energy efficient technologies;
- the scientific community, in the development of an evidence base about climate change;
- the media, in communicating information relating to climate change; and
- the general public, in informing individuals' choices about, for example, the use of energy.

11. This diversity of users makes it difficult to summarise a user perspective. In the course of producing this Brief we talked to a number of experts, and – mindful that we are considering the perspective of non-specialist users – we have also looked at the issues from a more 'general public' perspective.

12. In the UK there are numerous producers of scientific and research data relating to climate change, many of which are outside government and outside the official statistics system. This

Community Climate System Model, and the NASA Goddard Institute for Space Studies (GISS) does the same for the code it uses to compute global surface temperatures.

⁷ <http://www.theccc.org.uk/about-the-ccc/climate-change-act>

has resulted in a complex set of interrelationships between scientific bodies and other users of climate change data. Our discussions with a range of these bodies indicate that there may be scope for improving communication between policy departments and those expert bodies that produce statistics and research about aspects of climate change.

13. For example, **the Natural Environment Research Council (NERC)** (which is funded by central government) is responsible for funding and managing research in environmental sciences. Our discussions with NERC highlighted the fact that although more is being done to improve policy-relevant research, there are still concerns about how central government communicates its needs to NERC and vice versa. Within NERC, all research proposals have to include a 'pathways to impact' statement which details who may make use of the research, how they may use it and methods for disseminating data in the most effective manner. NERC also maintains a database of research - the Science Impacts Database - which is used partly to report ongoing work on specific topics back to central government.
14. The **Climatic Research Unit (CRU)** at the University of East Anglia is one of the leading centres for research relating to climate change. A representative of the Centre highlighted the very diverse needs of users who contact the Centre for advice and information in this field. The CRU maintains a range of complex datasets covering temperature, precipitation and other climatic indicators which feed into the UK Climatic Impacts Programme and associated scenarios and projections. Although there seems to be a very broad range of users, from specialists needing detailed technical advice to relatively novice users wanting general information about trends, the common demand was still for advice and guidance about which sources, datasets and variables to use. The discussion with the CRU concluded that there was a need for more support for users rather than a demand for better science. Engaging new users and providing them with statistical information relevant to their decisions and actions was central.
15. The **Met Office** produces weather and climate change data for the UK. Monthly, seasonal and annual weather summaries (text, graphs, maps and data) are available from the Met Office website for a ten year time series. Historic data from UK climate and weather statistics are also available with time series for some stations starting in the 1800s. The website also provides a climate guide which includes topics such as how climate has changed and the science behind climate change. Much of the focus of the climate data is on climate monitoring and climate modelling, both of which are carried out by the Hadley Centre.
16. The Met Office emphasised a number of issues to us, including that:
 - the science of climate change is still developing, and that because of the uncertainty about the processes and interactions it is difficult to define the subset of official statistics that could be said to be most relevant;
 - datasets of scientific observations are of limited value to those without access to scientific expertise, and the technical resource to make use of the mass of data – instead, non-specialists require assurance of the veracity and robustness of the data (as well as the science);
 - the complexity of the subject, and the nature of the data involved, merit collaborative and co-ordinated responses, both within the UK and internationally. One element of this is to peer-review the science; another is to develop⁸ a web-based portal to provide access to standards-compliant data, models and value-added services;
 - the Met Office is creating a Climate Service, analogous to its weather service.

⁸ On which the Met Office is leading a 4-way consortium which includes IBM, Imperial College Business School, and the Grantham Institute for Climate Change.

Producer views

17. Within central government, responsibility for different aspects of climate change falls to Defra, DECC and, to a lesser extent, the Department for Business, Innovation and Skills (BIS) which is responsible for engaging with businesses on adaptation and supporting sustainable economic growth. Discussions with DECC indicated that for users outside government, the distinction between non-official and official statistics is unclear, particularly as many environmental publications present data from a variety of different sources, including sources collected by voluntary bodies, non-government organisations and research councils. In many cases DECC and Defra have links with these organisations but, due to the complex nature of the topic, these links tend to be in relation to the provision of specific datasets or a particular area of scientific development.
18. DECC statisticians told us that they manage a shared mailbox for queries about climate change statistics, and that over the two years that this mailbox has been in place not a single enquiry has been received about wider climate change statistics. In addition, we were told that a recent user consultation exercise run by DECC statisticians did not highlight any issues concerning user needs for more general “climate change” data. DECC has concluded that it “does not appear to be the case that users see DECC as the organisation responsible for pointing them in the right direction if needed”.
19. DECC statisticians also told us that their role is currently focused on the publication of UK greenhouse gas statistics⁹; that they do not have the technical expertise to quality assure or assess the robustness of climate change datasets produced by others; and that they take the view that the quality assurance process is best provided by the individual peer review of published papers or data.
20. Whilst the division of organisational responsibilities for official statistics on the topic is beyond the scope of this Brief, we do think there would be merit in a review of the arrangements for statistical co-ordination. Concerns about climate change are likely to be with us for many years to come and a well-co-ordinated statistical base will benefit generations of users of these statistics in the future.
21. DECC and Defra tend to publish aggregated data, such as summary rainfall data, but many scientists and other users want more detailed outputs – in the case of rainfall data, spatially referenced datasets – which are produced by other organisations, such as the Met Office. It is a particular challenge for producers of official statistics about climate change to keep abreast of the diversity in the range of stakeholders, what they offer and what they need. Indeed, DECC told us that since much of the relevant data is collected by different organisations under separate research programmes, it has historically been difficult to achieve the objective of robust, publicly available and easily accessible data. This echoes the point¹⁰ made to us by the Met Office; it may be addressed in part by the government’s transparency¹¹ agenda which aims to make public data openly available.

⁹ Greenhouse gases are water vapour, carbon dioxide, methane, nitrous oxide, ozone and halocarbons. Of these, carbon dioxide, methane, nitrous oxide and halocarbons are classified as pollutants.

¹⁰ See para 16, second bullet.

¹¹ <http://www.communities.gov.uk/localgovernment/transparency/>

Background

UK and other official statistics about climate change

22. Climate change data and statistics for the UK fall into the following main categories: greenhouse gas emissions; atmospheric, sea or surface observations; and modelled scenarios or projections. Further detail about the types of data available under each of these categories can be found in Annex A.
23. Different government departments are responsible for sets of official statistics about climate change (and other environmental topics). Defra produces a range of compendium publications, including *Measuring Progress: Sustainable Development Indicators* and *UK Biodiversity Indicators* - both of which contain a range of statistics on various aspects of the environment. The sustainable development indicators set is a well established and fairly comprehensive set of summary statistics in relation to the environment (as a whole). It comprises 68 indicators, three of which relate directly to climate change, which form part of the government's sustainable development strategy for the UK, published in March 2005. The indicators are used to monitor progress with this strategy; they are updated annually and published on Defra's website at the national and regional levels, and on the Audit Commission's website for sub-national areas. Although the statistics are not accompanied by a great deal of metadata, the wide ranging nature of the indicator set provides a useful source of statistics on the environment as a whole. *Environment in Your Pocket* provided users with summary information about aspects of climate change, but included no information for users looking for more detailed data (it has now been discontinued). DECC also produces a range of compendium publications including the *Digest of UK Energy Statistics (DUKES)*, *UK energy sector indicators* and *UK Energy in Brief*.
24. The Scottish Government publishes *Key Scottish Environmental Statistics* on its website. This includes headline statistics (generally tables and charts) on a range of topics related to the environment, alongside source information. There are also further links to Excel tables containing additional detail. This follows a similar format to the Defra e-digest, and is a useful resource for accessing a range of summary statistics on particular topics but provides limited information about the source data and how the data are used in the measurement of aspects of climate change.
25. At the European level, Eurostat publishes a range of summary statistics in its *Energy, transport and environment indicators pocketbook*. The European Environment Agency also publishes data on a range of environmental topics including climate change. The UN Environmental Programme Global Environment Outlook data portal provides access to more than 450 indicators covering a wide range of topic areas, whilst the OECD also has an environmental data compendium which brings together data on economic and policy analysis on climate change through a statistics portal.
26. Users looking for more detailed information about a particular aspect of climate change are faced with the challenge of understanding which of a wide range of producers of non-official statistics, research and analysis to engage with – each of which publishes its information in different ways. The nature of the links between organisations collecting and collating large volumes of data and those producing official statistics on the same topic are often unclear. The volume and complexity of the data relating to climate change means that in many cases only a sub-set of data is passed to government departments with the producer body maintaining the full datasets. The National Atmospheric Emissions Inventory (NAEI), for example, is maintained by AEA, an energy and climate change consultancy organisation. The Inventory contains very detailed information on estimated pollution by type and source; statistics can be downloaded for all types of pollutants including those linked to climate change. AEA is responsible for the UK's annual submission to the United Nations Framework Convention on Climate Change.

DECC publishes the headline figures from the submission as National Statistics¹² along with commentary about progress towards targets.

27. The UK Environmental Observation framework (UK-EOF) programme is an initiative being developed under the Living With Environmental Change programme (LWEC)¹³. LWEC is a partnership of government departments, agencies, Devolved Administrations, local government and research councils. It aims to provide relevant information about climate change to support decision making within government. The UK-EOF is aimed specifically at improving environmental monitoring in the UK through better co-ordination of monitoring activities. As part of this, the LWEC board has agreed to support the development of an Environmental Information Framework for the UK. The aim of the Framework is to build on the data.gov.uk initiative by coordinating all environmental data and information with the necessary governance, standards, vocabularies and infrastructure. The development of the Framework could usefully stimulate improved access to the wealth of data in the UK related to climate change, as might also the work of the Met Office-led consortium¹⁴ and indeed the Met Office's new Climate Service.

UK government climate change risk assessment

28. The Climate Change Act¹⁵ (2008) requires the UK government to carry out an assessment every five years of the risks to the UK from climate change¹⁶. The first cycle is due to report to Parliament in January 2012. In July 2010, Defra's Chief Scientific Advisor wrote to government departments seeking assistance in identifying the datasets required as part of this risk assessment. The aim is for the first assessment to draw heavily on existing evidence and to provide a framework for the development of future assessments.
29. The current data collection exercise lists the broad sector to which the data refers (e.g marine), the data topic (e.g coastal erosion), and the climate variables (sea level, storm surge, waves). It asks departments to list the metrics required under each sector and any relevant data needs. Technical consultants have been employed to take this work forward.
30. It is very likely that the information collected as part of this exercise, documenting the range of datasets produced by departments and agencies relating to climate change, would be of value beyond government. We think that all the information documented and collected in response to the government's climate change risk assessment should be made readily available, together with appropriate supporting information to enhance its accessibility and usefulness.

Presenting climate change statistics

31. The nature of climate change statistics offers opportunities to exploit new technological and methodological developments. Two such (related) areas of development are satellite remote sensing - to collect data - and the use of Geographical Information Systems (GIS) - to cut across information silos and to map and analyse the impacts of climate change both globally and locally. This sort of analysis is highly specialised, and most appropriate for government research and scientific analysis, although the non-specialist user may well find interactive maps valuable in understanding the dynamics of climate change. We therefore see potential for the use of such maps to illustrate aspects of climate change for the general public and the non-specialist user.

¹² Emissions statistics were the subject of an Assessment Report 31 published in March 2010¹². The full range of statistical outputs on the environment produced by Defra will be assessed by the Authority over the summer 2011.

¹³ <http://www.lwec.org.uk/>

¹⁴ Ibid 8.

¹⁵ <http://www.theccc.org.uk/about-the-ccc/climate-change-act>

¹⁶ <http://www.defra.gov.uk/environment/climate/adaptation/ccra/index.htm>

32. The non-specialist user's understanding of statistical information about climate change would also seem to benefit from its presentation as part of an agreed, accessible and intuitive framework. Improved understanding of the statistics, and the messages contained in them, are important in building trust in any aspect of official statistics; we think that this is particularly important in relation to climate change given the complexity and controversy that attend the topic.
33. The development of a framework for climate change-related statistics was recommended in the ABS report to the UNSC, mentioned earlier. The recommendation outlined the need for a framework for 'identifying and assessing existing statistics and gaps relevant to climate change and for the organisation of climate change-related statistics', and said that it should be developed 'based on the scientific and policy framework established by the IPCC and UNFCCC. This framework should also make it possible for countries to identify a set of data items and statistics tables or indicators for compilation according to their national priorities and circumstances.'
34. There are a number of frameworks in existence which relate specifically to the actions required in relation to climate change - the Climate Change Strategic Framework produced by Defra, for example. And frameworks exist for several areas of official statistics, such as national accounts¹⁷ and the labour market¹⁸, which enable producers to simplify topics that are inherently complicated or inter-related, to identify gaps and duplication; and to present individual sets of statistics in the context of a wider system. Conversely, the presentation of statistics about topics as complicated as climate change in the absence of such a framework makes understanding them very difficult for non-specialists.

Statistical reports about climate change

35. Official statistics related to climate change, and indeed about the environment more generally, differ in a number of respects from 'traditional' official statistics on topics such as the economy, health or crime. Some of these characteristics are covered in further detail in Annex A. These particular characteristics mean that statistics on climate change are less easily presented, explained and compared than statistics about most other statistical domains. But these same characteristics, together with the significance of climate change, make it all the more important that statistical experts take steps to improve the coherence of reporting about climate change.
36. There are now many collectors of environmental data operating on the ground, in the air and from space as a result of the technical advances, such as the use of satellite-based observations. Many of the datasets are not intended specifically for statistical monitoring and reporting; inevitably this results in a great deal of variation in terms of the types of data collected, the methods used, the quality of the data, and their uses. To understand this and produce sound statistical summaries of trends requires much understanding of physical science and of measurement technology. The responsibility for producing accessible statistical summaries rests with government statisticians, whilst the technical expertise (or ready access to it) is available within government departments. We would therefore see value in a free-standing statistical report about climate change, covering both adaptation and mitigation, within the context of the framework proposed above, aimed at the non-specialist audience.

¹⁷ <http://www.statistics.gov.uk/CCI/nugget.asp?ID=55>

¹⁸ <http://www.ons.gov.uk/about-statistics/user-guidance/lm-guide/lm-framework/index.html>

Annex A: Research undertaken

Recommendations in the Australian Bureau of Statistics report on Climate Change Statistics

1. The ABS report made a number of specific recommendations. These are grouped under the broad headings of:
 - Mainstreaming the climate change dimension in official statistics;
 - Strengthening the role of official statistics in the compilation of national greenhouse gas emission inventories;
 - Developing statistics on measures of mitigation, adaptation and their supporting mechanisms;
 - Good practices in official statistics for the assessment of impacts of, and vulnerability and adaptation to, climate change;
 - Cross-cutting recommendations, including the development of a framework for climate change-related statistics and promoting the use of indicators at the national level.

Categories of climate change data and statistics

Greenhouse Gas Emissions

2. Over the first five year commitment period of the Kyoto Protocol (2008 – 2012) the UK agreed to reduce its Greenhouse Gas Emissions by 12.5% against a 1990 base year (1995 for fluorinated compounds). The Climate Change Act includes a commitment to reduce domestic emissions by 34% by 2020 and 80% by 2050. The Act also uses 1990 as its baseline year.
3. DECC contracts AEA to produce the UK Greenhouse Gas Inventory for annual submission to the UNFCCC for monitoring the UK's commitments under the Kyoto Protocol. AEA¹⁹ maintains a website from which users can download the most recent data for individual pollutants, and different sectoral and geographic breakdowns.
4. DECC publishes annually the main figures from the inventory along with commentary reporting on trends and progress towards national and international targets. DECC also publishes Local Authority level CO₂ emissions as a National Statistics release. As the release of the final data are not particularly timely (the national figures are published 13 months after the reference year and LA figures 21 months after the reference year) DECC publishes earlier provisional figures, based on energy usage, 3 months after the reference period. These provisional estimates are for the whole UK only. The Statistics Authority published its assessment report (on the extent to which these sets of statistics complied with the Code of Practice) in March 2010²⁰ and concluded that the statistics could be published as *National Statistics* providing a number of improvements were made (and which subsequently *have* been made).

Atmospheric, sea and surface observations

5. DECC publishes some summary statistics on atmospheric sea and surface observations which include information about thermal growing seasons, surface temperature, sea level rise and precipitation.
6. These publications consist of commentary on the main trends over the period for which records are available – either the late 1700's or early 1800's depending on the series – and

¹⁹ <http://www.naei.org.uk/index.php>

²⁰ <http://www.statisticsauthority.gov.uk/assessment/assessment-reports/assessment-report-31---emissions-statistics.pdf>

an Excel file containing the annual summary data. These statistics are not currently badged as *National Statistics*. The underlying data are held by the Met Office (Hadley Centre)²¹.

7. The Hadley Centre observation data are available free of charge for personal and academic (not commercial) use. Data can be downloaded from the Hadley Centre website. Monthly, seasonal and annual weather summaries (text, graphs, maps and data) are available from the Met Office website for a ten year time series. Historic data from 37 UK climate and weather stations are also available with time series for some stations starting in the 1800s though others start much later.

Modelled scenarios or projections

8. The UK Climate Impacts Programme (UKCIP), largely funded by Defra, produces UK Climate Projections (UKCP09) for the UK up to the end of this century. Projections are based on simulations from the Met Office Hadley Centre climate models. These projections are based on a new methodology designed by the Met Office which allows a measure of uncertainty in future climate projections to be included in the information. The Programme was launched in June 2009; it brings together different strands of work relating to projecting climate change. The marine component of UKCP09 is significantly more advanced than UKCIP02 which has enabled a report looking specifically at marine and coastal projections²².
9. Monthly climate change projections are also available from the Met Office, also from the Hadley Centre models, and are free to download. English Heritage include projections on its website which use the UKCP09 source data.
10. Data from environmental observations data have been recorded for many years. Near-surface air temperature measurements are available in England as far back as the 1770s and other sources of data relevant to climate change, such as sea level measurements and precipitation, have similar historic timescales. Our ability to analyse climate change has been hugely facilitated over the last 40 years by the evolution of satellite-based observations of many phenomena imaged in many parts of the electromagnetic spectrum, along with rapid developments in telecommunications, computer processing power and database mining techniques. There are now many collectors of environmental data operating on the ground, in the air and from space. Many of the datasets are not intended specifically for statistical monitoring and reporting; inevitably this results in a great deal of variation in terms of the types of data collected, the methods used, the quality of the data, and their uses. To understand this and produce sound statistical summaries of trends requires much understanding of physical science and of measurement technology.

Scientific research and analysis.

11. The focus of much of the work in this area is on developing an understanding of the causes and impact of climate change on the environment. The raw or calibrated measurements are widely used for scientific and academic research (such as the impacts of increasing sea temperatures on some harmful algae bloom species and modelling the impact of weather damage in the UK).

²¹ <http://hadobs.metoffice.com/>

²² <http://www.mccip.org.uk/uk-marine-projections.aspx>

Measuring progress against targets

12. There is an abundance of targets in the field of climate change, many of which relate to international and national commitments to reducing the extent of greenhouse gas pollution. The United Nations Framework Convention on Climate Change (UNFCCC) was developed from the findings of the Intergovernmental Panel on Climate Change and came into force in 1994; 192 countries have ratified it. The UNFCCC is an international environmental treaty aimed at stabilising greenhouse gas concentrations in the atmosphere. The treaty itself contains no mandatory limits on greenhouse gas emissions for individual nations, but includes provisions for updates called 'protocols' which would set mandatory emission limits. The Kyoto Protocol establishes legally binding commitments for the reduction a range of greenhouse gases.
13. In the UK, the Climate Change Act received Royal Assent in November 2008. It set out a legally binding framework to target climate change, including a commitment to reduce emission from all greenhouse gases by 80% by 2050. Scotland, Wales and Northern Ireland have their own climate change strategies and set their own targets.

Characteristics of environmental, including climate change, data

Timescales

14. Climate change statistics are unusual in that they are often based on data covering long time periods. Temperature observations, for example, are modelled back to the early part of the 20th century in order to provide the best possible inputs to forecasting models. Some data, such as about air quality²³, are very frequent and collected on an hourly basis, but in terms of how the data are used from a climate change analysis perspective, as opposed to their use for some monitoring purposes, short term fluctuations are less important than the trends over the last decade. Aside from meteorological data, other published data sources are also available for long time series, such as Scottish Government's Commercial Fish Stock statistics²⁴ which has nearly 50 years of data. Conversely, some data available online has only been collected once, such as Scottish Government's Causes of Loch Pollution²⁵ (in 1995), and has not been updated since.

Geographical levels

15. The organisation of statistics on the environment can be regarded as operating on two geographical levels: global and local. At the international level, indicators of climate change for the UK as a whole are required to comply with EU legislation, to contribute to the OECD set of key environmental indicators and as part of the responsibilities arising from the UNFCCC. On a local level, statistics for small geographic areas are required for the measurement of local water quality, pollution and landfill sites and to identify areas liable to flooding. Levels of disaggregation vary according to the topic being studied although in many cases environmental factors require the collection and dissemination of statistics for the smallest geographical areas possible.
16. Often local information is aggregated in various ways, for example in the measurement of air quality. The air quality indicator is one of the 68 indicators of the government's sustainable development strategy and levels of pollution are reported for urban and rural areas separately.
17. In general, statistics are available for the UK as a whole, although in some cases Defra publishes statistics for England and Wales, and the Scottish Government (SG) those for Scotland. For example, average rainfall figures are produced for the UK by the Met Office but available separately on the Defra and SG website. This may not be a concern as the

²³ <http://www.airquality.co.uk/bulletin.php?type=Current>

²⁴ http://www.scotland.gov.uk/stats/envonline/_data/WILDLIFEfishstocks.xls

²⁵ http://www.scotland.gov.uk/stats/envonline/_data/WATERcauseslochpollution.xls

nature of the topic means that local area information is generally of more use than national figures.

Quality

18. Given the large number of data producers involved with the collection of huge amounts of complex data in the field of climate change, it is perhaps inevitable that summary quality information is not always available in a simple and accessible way. A number of areas have clearly defined methods and classifications as a result of European or international agreement on best practice. One such area is that of environmental accounts which in the UK are compiled as a satellite of the main National Accounts and measure the environmental impact of UK economic activity. Environmental satellite accounts add new information to the core accounts, such as measures of emissions, material use and costs of remediation. Information on emissions by sector feeds into these accounts. Data are provided in units of physical measurement (volume or mass) although some are in monetary units. Environmental satellite accounts are compiled by the Office for National Statistics and published on an annual basis²⁶. Quality information also tends to be available where there is a requirement to report on international indicators. Greenhouse gas emissions reported to UNFCCC, for example, are required to follow IPCC guidelines and the quality of the data is checked regularly.

Volume of data

19. Reflecting the breadth of topics covered under the environmental statistics domain, the range of data collected and disseminated is larger than other areas of statistics. This is compounded by the fact that a great deal of the information collected on the environment relates to scientific measurement collected on a frequent basis. The Met Office Hadley Centre, for example, receives terabytes of meteorological information requiring sophisticated computer environments to manage the processing of data on this scale and analyse the results.

20. The volume of data also presents challenges in terms of analysing data which often necessitates the use of maps and other visual means of presentation to condense some of this information. This becomes an issue when the relevant tools to interpret the data are not widely available, particularly to the non-expert user. A wide range of indicators are also used to measure change and also for summary purposes, such as to measure progress against targets. Defra, for example, uses indicators to present data on climate change and energy statistics on its website²⁷. Indicators tend to be the focus of international data collection and reporting exercises relating to climate change as a result of their use in providing comparable information, at least at an aggregate level, in order to assess change.

Types of data

21. Again, reflecting the broad scope of environmental statistics, the types of data available are varied. The physical environment is measured through scientific measurement whereas more general surveys establish public opinion on climate change. Biotic environment statistics are produced through aggregated counts and censuses, whilst Environmental Accounts²⁸ compendium provides indices and financial trends. Some climate change statistics are based on historically modelled data, which support modelled projections

²⁶ <http://www.statistics.gov.uk/pdfdir/ea0610.pdf>

²⁷ <http://www.defra.gov.uk/sustainable/government/progress/national/climate-change.htm>

²⁸ http://www.statistics.gov.uk/downloads/theme_environment/EnvironmentalAccounts2010.pdf