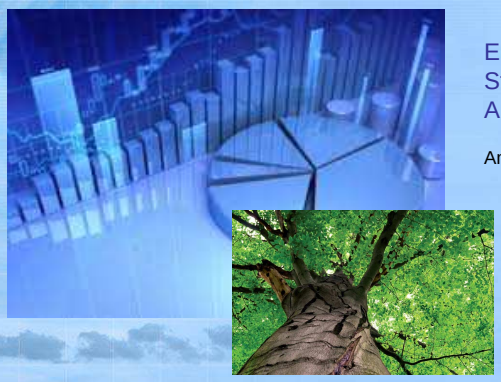
Fundamentals of Environment Statistics



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Environment and Energy Statistics Branch, United Nations Statistics Division

- This presentation has been elaborated by the Environment Statistics Section of the United Nations Statistics Division.
- It is based on Chapter 1 of the Framework for the Development of Environment Statistics (FDES) 2013 that can be downloaded here: http://unstats.un.org/unsd/statcom/doc13/BG-FDES-Environment.pdf
- All presentations, handouts and background materials for the workshop can be downloaded here: http://unstats.un.org/unsd/ENVIRONMENT/otherworkshops.htm

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1. Objective of environment statistics

To provide information about the environment and the main factors that influence the environment, including the most important changes over time and across locations.

Ultimately, ES aims at providing high quality statistical information to:

- Improve knowledge of the environment
- Support evidence-based policy and decisions
- Provide high quality statistical information
- Support evidence-based policy and decision making,
- Provide information for the general public & specific user groups

2. Scope of environment statistics

- Covers biophysical aspects of the environment and those aspects of the socio-economic system that directly influence and interact with the environment
- The scope of environment, social and economic statistics overlap and it is not easy to draw a fine dividing line between these statistical areas
  - Social and economic statistics describing processes or activities that have a direct impact on, or interact directly with, the environment are widely used in environment statistics and they are within the scope of the FDES
- Relevant social and economic statistics required to put environmental issues in context and to facilitate the integrated analysis of environmental, social and economic processes.
  - The use of consistent definitions and classifications among these fields helps their integration

3. Users and main types of environment statistics

The type, the level of thematic, spatial and temporal aggregation, and the format of environment statistics depend on the type of user and the intended purpose of use.

User Groups	Main Types of Environment Statistics
Policy and Decision Makers	**Environmental indicators and more aggregated statistics**
General Public (including media and civil society)	**Environmental indicators and more aggregated statistics**
Analysts, Researchers, and Academia	**Extensive and detailed environment statistics**
International Agencies	**Well-described environmental data and statistics**

Products of Environment Statistics

The main products of environment statistics are:

- Detailed tabulated environment statistics series
- Environmental indicators

Both can be:

- Stored in multi-purpose databases
- Disseminated in the form of
  - On-line databases
  - Publications (i.e. compendia, yearbooks and state of the environment reports)

4. Environmental information, data, statistics and indicators

Examples of quantitative environmental information
Environmental data
Environment statistic
Environmental indicators
Environmental indices
Environmental-economic accounts

4. Environmental information, data, statistics and indicators

Environmental information

- Environmental information describes quantitative, qualitative or geographically referenced facts representing the state of the environment and its changes.
- **Quantitative environmental information**
  - **Consists of data, statistics and indicators and is generally disseminated through databases, spreadsheets, compendia and yearbook type products.**
- Qualitative environmental information
  - Consists of descriptions (e.g. textual, pictorial) of the environment or its constituent parts that cannot be adequately represented by accurate quantitative or geographically referenced descriptors.
- Geographically referenced environmental information
  - Provides facts on the environment and its components using digital maps, satellite imagery and other sources linked to a location or map feature.

4. Environmental information, data, statistics and indicators

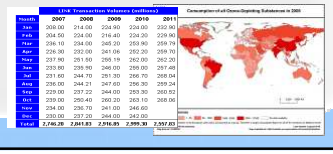
Environmental data

- Environmental data are large amounts of unprocessed observations and measurements about the environment (or its components) and related processes.
- They can be collected or compiled by:
  - NSOs, environmental ministries, sectoral authorities (water, forest, mining, etc)
  - Using different types of sources:
    - Statistical surveys (censuses or sample surveys)
    - Administrative records, registers, and inventories
    - Monitoring networks, remote sensing, scientific research, and field studies.

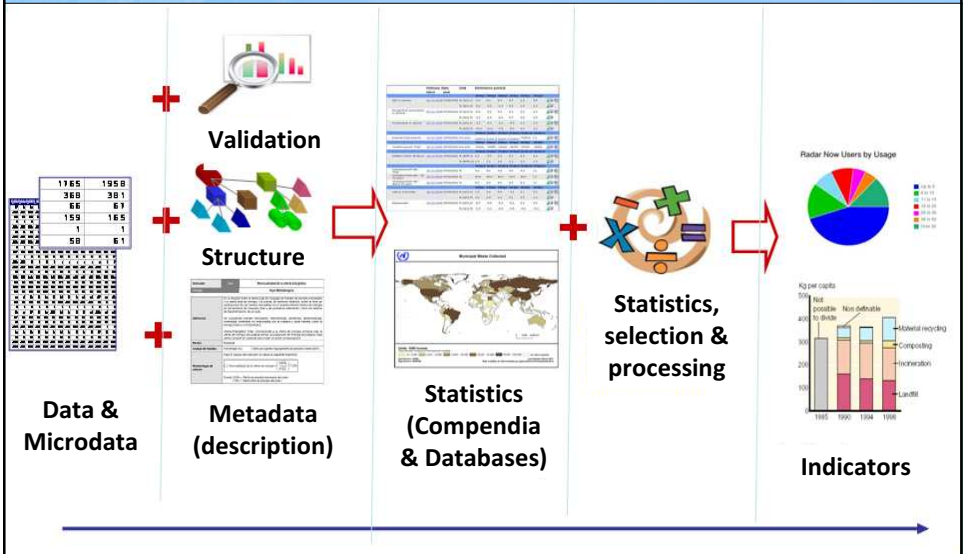
4. Environmental information, data, statistics and indicators

Environment statistics

- Environment statistics describe, aggregate, synthesize and structure environmental and other data according to statistical methods, standards and procedures.
- Environment statistics process environmental data into meaningful statistics describing the state and trends of the environment and the main processes affecting it.
- Not all environmental data are used in the production of environment statistics.
  - The FDES provides a framework that identifies environmental data that fall within its scope
  - The FDES contributes to structuring, synthesizing and aggregating the data into statistical series and indicators



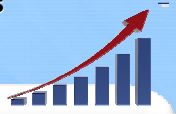
Environment statistics units compile, collect, validate, describe and structure environmental data to produce environment statistics series.



Statistical process: from raw data to statistics and indicators

4. Environmental information, data, statistics and indicators

Environmental indicators



- Environmental indicators:
  - Are environment statistics that are in need of further processing and interpretation. ES are usually too numerous and detailed to satisfy the needs of policy makers and the general public
- Environmental indicators:
  - Synthesize and present complex statistics
  - Are measures that summarize, simplify and communicate information
  - Define objectives, assess present and future direction with respect to goals and values
  - Evaluate specific programmes, demonstrate progress, measure changes in a specific condition or situation over time.
  - Determine impact of programmes and conveying messages.

Frameworks such as the **DPSIR**, or policy frameworks such as the **MDGs, sustainable development indicator frameworks** are used for the identification and structuring of indicators

There are various regional environmental/SD indicator frameworks in place

4. Environmental information, data, statistics and indicators

Environmental indices

- Environmental indices:
  - Defined as composite or more complex measures that combine and synthesize more than one indicator or statistic that are weighted according to different methods.
- Benefit:
  - An index can provide a valuable summary measure for communicating important messages in a popular way and thus raising awareness.
- Possible limitation
  - May raise questions related to its methodological soundness, the subjectivity of weighting, the quality of the underlying statistics and their proper interpretation.

5. Sources of environment statistics

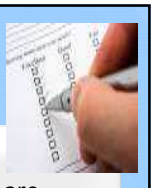
- Environment statistics synthesize data originating from a wide range of source types.
- Data used for the production of environment statistics are compiled by many different collection techniques and institutions.
- Understanding and knowing pros and cons of different type of source is key in environment statistics production

Types of sources

1. Statistical surveys (i.e., censuses or sample surveys of population, housing, agriculture, enterprises, households, employment, and different aspects of environment management)
2. Administrative records of government and non-government agencies in charge of natural resources as well as other ministries or authorities
3. Remote sensing (i.e., satellite imaging of land use, water bodies or forest cover)
4. Monitoring systems (i.e., field-monitoring stations for water quality, air pollution or climate)
5. Scientific research and research projects undertaken to fulfill national or international demand

Please see Handout 1: Sources of ES

5. Sources of environment statistics



Statistical Surveys

(a) **Censuses**: collection of data from the entire population of interest

(b) **Sample Surveys**: carried out using a sampling method, in which data are collected from a representative portion of the population of interest

Environment statistics can be collected from surveys by:

(i) adding environment-related questions (modules) to surveys primarily intended to collect data on other topics

(ii) using surveys primarily intended to collect environment statistics

When environmental data are collected through environment statistics surveys, the survey is designed according to its objective of producing environment statistics.

- Environment statistics surveys are not always feasible or economical with restricted budgets
- Data can be obtained from other existing (e.g., demographic, social, economic, sectoral) statistical surveys which have a primary objective different from the production of environment statistics

5. Sources of environment statistics

Administrative records

Administrative data kept by **government agencies** may be used for environment statistics production

Government data produced in response to legislation/internal admin. purposes i.e:

- Env. education, env.management, env. health, households and establishments activities related to environment

Advantage:

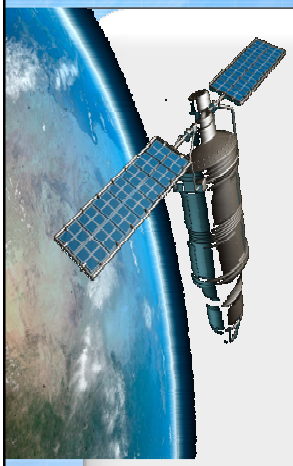
- Cost of collecting such data is significantly less than establishing and conducting your own survey
- Level of response burden is minimized
- Complete coverage is assured of units under administration

Possible Limitations:

- Differences between administrative and statistical terms and definitions
- Risk of deliberate misreporting
- Data may not be checked or validated for statistical purposes; there may be restrictions of access to the data
- Coverage of data, though complete for administrative purposes, might not match statistical requirements

5. Sources of environment statistics

Remote Sensing



Remote sensing makes it possible to:

- Collect data on dangerous or inaccessible areas
- Replace costly and slow data collection on the ground, ensuring in the process that areas or objects are not disturbed

- Include: satellite, aircraft, spacecraft, buoy, ship, balloon and helicopter images
- Result can be: mapped, imaged, tracked and observed

Example:

Remote sensing data can be captured and analyzed to measure forest cover, compare the impact of natural disasters, changes in the area of soil erosion, the extension of pollution, changes in land cover **or** population estimates of different animal species.

Remote sensing, combined with sufficient validation using actual measurements in the field, usually provides high quality data for environment statistics.

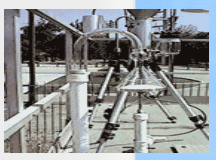
5. Sources of environment statistics

Monitoring systems

Typically comprised of **field-monitoring stations** which are used to describe the qualitative and quantitative aspects of the environmental media, i.e. air, water or soil quality; hydrological or meteorological parameters and characteristics.

Main advantages of these data are that they are:

(i) Usually collected using verifiable scientific methods
(ii) Usually validated
(iii) Often available as time series
(iv) Frequently use models to improve data quality



Possible limitations of data from monitoring systems are:

- Field-monitoring stations are usually located in "hot-spot" areas where there are
  (i) high levels of pollution
  (ii) highly sensitive areas
  (iii) large numbers of the population are affected

Consequently, the measurements will be location-specific and harder to aggregate over space, in order to arrive at measures of quality over larger territories.

Illustration of Water Monitoring System Device

Measures:

- Dissolved Oxygen
- Turbidity
- Water temperature
- Specific conductance
- Ph levels

5. Sources of environment statistics

Scientific Research

Main advantages of using data from scientific research and special projects are:

(i) These data are usually available for free or for low cost

(ii) they minimize response burden

(iii) they can be used to fill in data gaps

(iv) they are useful for developing coefficients for models

Possible limitations of using these sources include:

(i) they often use terms and definitions that differ from those used in statistics

(ii) access to microdata may be limited

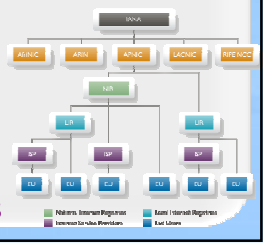
(iii) metadata may be missing

(iv) often data are available only for case examples (i.e. limited areas or industries)

(v) often data are available on a one-time basis

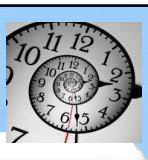
6. Classifications relevant to environment statistics

- There is no overall environment statistics classification. There are co-existing and emerging classifications, categorization and groupings for specific subject areas relevant to ES.
- ES use specific classifications, i.e.: FAO Land Cover Classification System, UN Classification for Energy and Mineral Resources, Classification of Environmental Activities (CEA)
- Additionally, ES uses categories and groupings, i.e.: Natural and technological disaster (CRED-EMDAT), Classification for Protected Areas and for Threatened Species (UNEP-WCMC and IUCN), source categories for GHGs from IPCC, etc.
- ES also uses economic and social-demographic statistical, i.e.:
  - International Standard Industrial Classification of All Economic Activities (ISIC)
  - Central Product Classification (CPC)
  - International Classification of Diseases (ICD)
- The use of these classifications facilitates the integration of environment statistics with economic and social and demographic statistics.



See handout 2: Classifications used in ES

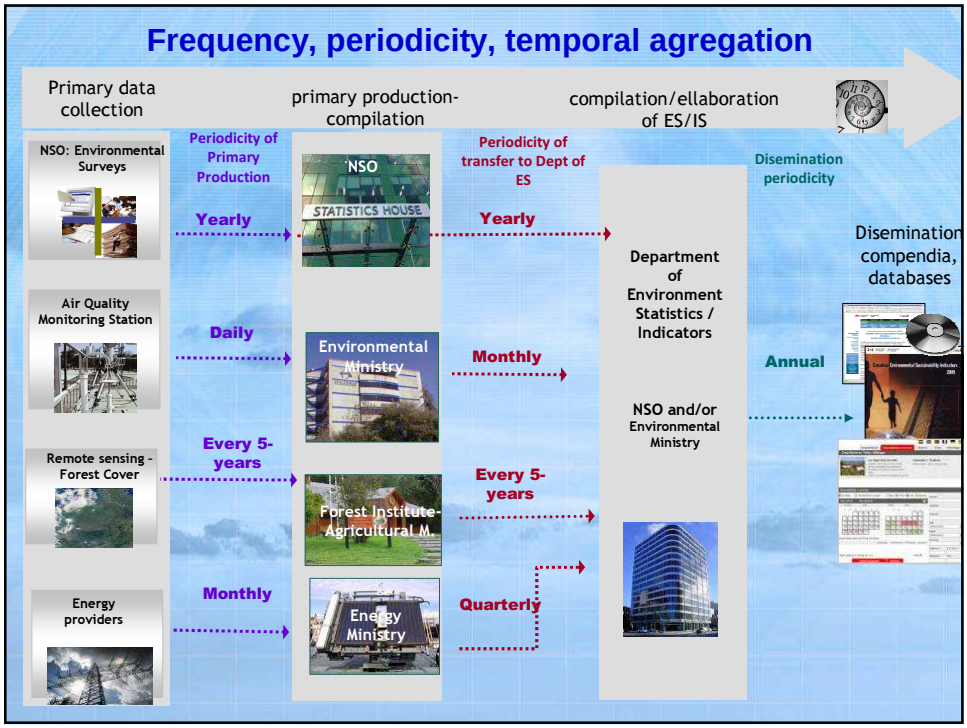
7. Temporal and spatial considerations



Temporal Considerations

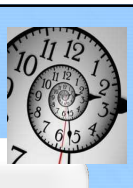
- The use of different time scales, longer or shorter time periods is necessary for the aggregation of environmental data over time.
- For example air pollution daily… forest cover every 5-years
- Determining the appropriate temporal aggregation and periodicity of production of environment statistics involves different considerations depending on the nature of the measured phenomena
- Statistics often point out the maximum, the minimum, state levels below or above certain benchmarks
- Not restricted to a sum or an average over a longer period.

Although environmental data are produced primarily at different intervals, if there are enough data points in each period, environment statistics based on these data can still be produced at regular intervals.



7. Temporal and spatial considerations

Temporal Considerations (2)



Example:

- **Fluid environmental phenomena**, careful consideration of the temporal dimension is needed since there can be ebbs and flows, **droughts** and **floods**, **snow** and **runoffs** which all influence measurements.
- Sometimes there may be daily variations and at other times variations may be seasonal depending on what is being measured.
  - Seasonal variations can be seen in the fluctuations in rainfall, temperature, certain types of fish biomass, surface water levels, ice cap surface or the incidence of fires.
  - *In cases of seasonal variations monitoring needs to be focused more during some months than others.*

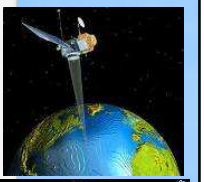
7. Temporal and spatial considerations

Spatial Considerations

- The occurrence and impacts of environmental phenomena are distributed through space without regard for political-administrative boundaries.
- **Meaningful spatial units for environment statistics are natural units**:
  - 1. Watersheds, ecosystems, eco-zones, landscape or land cover units
  - 2. Management and planning units based on the natural units,
    - i.e.: Protected areas, coastal areas or river basin districts.
- Economic and social statistics are traditionally aggregated according to administrative units.
  - This difference can complicate the collection and analysis of environment statistics especially when there is a need to combine them with data originating from social and economic statistics.
  - But geo-referenced data, would overcome some of the spatial complications of analysis.

8. Geospatial information & environment statistics

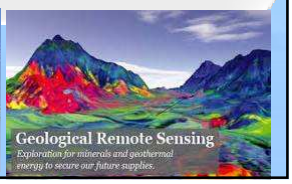
- Geospatial information:
  - Presents the location and characteristics of different attributes of the atmosphere, surface and sub-surface.
  - Is used to describe, display and analyze data that have discernible spatial aspects, such as land use, water resources and natural disasters.
  - Allows for the visual display of different statistics in a map-based layout
- Benefits:
  - Can make it easier for users to work with and understand the data.
  - Allows for a deeper analysis of the relationship among the phenomena such as population, environmental quality, and environmental health



8. Geospatial information and environment statistics

Remote Sensing satellites

- Remote sensing data from satellites are acquired digitally and communicated for processing and analysis in GIS.
- Digital satellite images can be analyzed in GIS to produce maps of land cover and land use. When different types of geospatial data are combined in GIS the data must be transformed so they fit the same coordinates. (e.g., through combining satellite remote sensing land use information with aerial photographic data on housing development growth)
- GIS uses the processing power of a computer, together with geographic mapping techniques (cartography), to transform data from different sources onto one projection and one scale so that the data can be analyzed together.

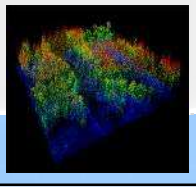


8. Geospatial information and environment statistics

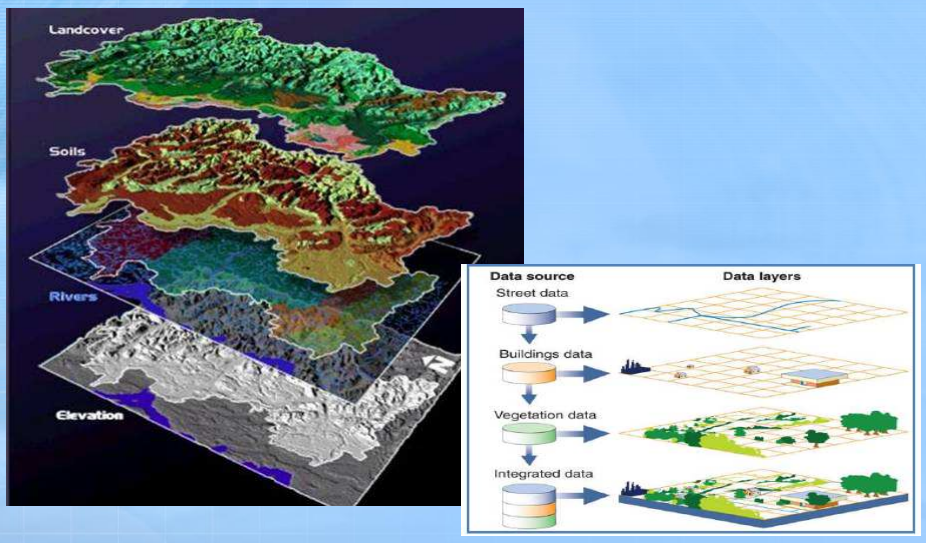
Geographic information system (GIS)

A GIS is a computer system capable of capturing, storing, analyzing, and displaying geographically referenced information.

- Geospatial data can be acquired using a variety of technologies i.e.:
  - Global Positioning System (GPS) and Remote Sensing satellites.
- The attributes of the collected data can be entered:
  - Manually (Land-use information, demographics, landscape features)
  - Digitized from a map to a digital format by electronic scanning (land survey mapping, surface waters)
- The final representation of the data is constructed by superimposing different layers of information as required by the analytical and/or policy requirements.



Example of GIS data layers or themes



Source: GAO (2004)

9. Institutional dimension of ES

- As important as technical capacity when developing environment statistics at the national level.
- Given the multi-disciplinary and cross-cutting nature of environment statistics, the production of environmental data and statistics involves numerous stakeholders, actors and producers.
- Insufficient institutional development, overlapping mandates and functions, inadequate interagency coordination and other institutional issues are very common in many countries.

These limitations also exist at international level: multiple partner agencies operate with different mandates, work programmes, and production timetables.

9. Institutional dimension of environment statistics

Resolving institutional concerns

- Identifying the primary institutional obstacles that impede the production of environment statistics and developing a strategy to overcome these is vital for countries keen on developing or strengthening their environment statistics programmes.
- Four key elements pertaining to the institutional dimension that need to be considered and dealt with simultaneously while developing environment statistics:
  - The legal framework
  - Institutional development
  - Inter-institutional collaboration
  - Institutional cooperation of national, regional and global bodies

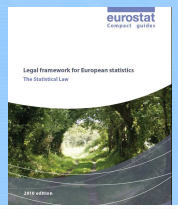
9. Institutional dimension of environment statistics

Legal Framework

Relevant for environment statistics production includes statistical, environmental and sectoral legislation such as for water, energy and agriculture.

Usually:

- National statistical legislation: NSO is the responsible authority for creating and coordinating the national statistical system.
- Laws/regulation do not explicitly refer to environment statistics (relatively new statistical domain). Insufficient guidelines for statistical coordination among the relevant statistical parties in the country.
- Responsibility for national environmental information systems lies with the Environmental Ministries.



National Statistics Office

9. Institutional dimension of environment statistics

Legal Framework (2)

Challenges of complex institutional context:

- Overlapping mandates
- Duplication of efforts
- Other coordination difficulties

Nevertheless, since the environment is becoming increasingly important in the development agenda, NSOs have included the production of environment statistics in their programmes though sometimes without clarity on the supporting institutional arrangements and resources.

It is often difficult to know what the official figures are on a specific statistic because different agencies are producing the same or similar statistics.

9. Institutional dimension of environment statistics

Institutional development

- A well defined mandate and a specific unit in charge of carrying out the production of environment statistics is critical for the successful organization of a national environment statistics programme within the official institutions responsible for the production of statistics.

- This unit requires a regular budget for operations and a minimum number of trained personnel for the tasks entailed.

It is important for environment statistics units to have a capacity building programme for their staff along with the financial resources to carry it out.

9. Institutional dimension of environment statistics

Inter-institutional collaboration

Institutions and people

- Environment statistics cover several topics for which the data are being generated by NSOs, specialized agencies, ministries, provincial and municipal governments and scientific institutions.
- Inherent to ES: collaboration of these stakeholders, both at the strategic and technical level.

9. Institutional dimension of environment statistics

Inter-institutional collaboration (2)

- Formalized by inter-agency platforms/committees tasked with coordinating the production of ES: brings together all institutions that produce and use environmental data and statistics
- One of the tasks of the platform is to ensure that common statistical methodology, protocols and tools are being used to ensure comparability and statistical soundness. Another relevant function is to preserve continuity over time, despite significant turnover of staff in the different partner institutions.
- Depending on the institutional set up, in many developing countries the coordination role in such platforms lies with the environmental ministry or equivalent institution.
- The NSO, if tasked with overseeing the national statistical system and coordinating these platforms, must have adequate authority, resources or capacities to lead the multi-stakeholder processes.

9. Institutional dimension of environment statistics

Institutional cooperation: national/regional/global

- The institutional challenges common in countries are also faced by international organizations that are involved in the production of environmental data and statistics.
- Consider the operational aspects that are conducive to better coordination and resource utilization among the national, regional and global levels,
  - Understand that all potential partners have different mandates, work programmes and deadlines to meet.
- Reporting requirements for certain international agreements and treaties need to be included in national environment statistics programmes.



Thank you for your attention!

For more information please contact the Environment Statistics Section at the Statistics Division of the UN:

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