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The Interface between Core Environmental Statistics and Other Information Systems: Which Interaction Is Important?

The role of sector statistics, environmental monitoring and geographical information systems

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The Environment is about interactions. The specific headings of any environment report, emissions of pollutants, pollution of air, water and soil, state of the ecosystems, impacts on human health and quality of life address all the relation between human activities and their consequences. This particularity frames the domain of environmental statistics and the tasks of the statistician. As much as collector of the data requested for national and international reporting, the environmental statistician plays the role of a hub between the many domains which interact with the environment. A hub works both ways, concentrating the fluxes and dispatching them. For environmental statistics, the main areas to connect and interact with are:

1. compliance reporting, national and international
2. monitoring networks and databases
3. scientific programmes and modelling
4. scales and the geographical information systems
5. sector statistics
6. national accounts.

1. Environmental statistics from compliance reporting

Compliance reporting based on the monitoring carried out by environmental agencies is an important data source. Three remarks: use of compliance sources, limitation regarding the assessment of environmental impacts and possible problems for integrated environmental assessments.

a. The use of administrative data is a basis for statistics development and has to be considered prior to launching any new survey, both for consistency and cost reasons. Compliance data are collected by the various agencies (sometimes grouped into one single environmental agency) in charge of the implementation of the environmental policies under the authority of environmental ministries. Compliance reporting results from national legal obligations or from international commitments (Conventions, regional regulations…). Because of their legal character, such reports must be considered carefully as statistical source. On the one hand, they are compulsory, therefore regularly updated; they are legal, therefore the variables that they monitor are precisely defined by experts committees and their monitoring is quality controlled. Compliance reports commit Governments and cannot be contradicted without care if it has to be done.

Examples of such data are collected for the reporting to UNFCCC (GHGs and the emerging LULUCF reporting on carbon sequestration and forest), to the Basel Convention (toxic waste), the Montreal Protocol (Ozone depleting substances), the Stockholm Protocol (POPs), transboundary conventions for pollution, large rivers management, conventions on sea, and regional policies…

b. The limitations of datasets compiled for legal purposes are precisely in their original purpose; assess the respect by countries of agreed target values, which don't

necessarily reflect the environmental trends that statistics should describe. Not bypassing any limit value doesn't mean that the trend is positive or that environmental impacts (direct or indirect) are avoided. Statistics cannot simply be based on such compliance data.

c. Considering the interpretation of compliance monitoring data the statistics should be able to bridge specific domains with more general issues and sector statistics.

The polemic around UNFCCC reporting and the national and environmental accounts is a well known example of a real issue. For technically (and to some extent political) reasons, the UNFCCC data refer to a criteria of territory for calculating emissions of GHGs. As long as national accounts are based on a criterion of residence, it is not possible to calculate in a correct way the ratio emissions/GDP, although it is a highly political indicator.

2. Monitoring networks and databases and environmental statistics

Although national and international compliance reporting is generally a key activity of the monitoring networks managed by the environmental agencies, their scope is going far beyond. In many countries, the technological progress has stimulated the implementation of dense and near real time monitoring systems for water and urban air quality. Other domains are less advanced like soil, biodiversity and the oceans. When such monitoring systems exist, two options face the environmental statistician. The conventional one is to send a questionnaire to the partner organisation. Another approach called "virtual private networks" (VPN) consists in establishing a convention for an access to the primary database (including its metadata) of the producer and let the responsibility of sampling and/or aggregation to the user – the statistical service. In VPN, "private" means that the user is not allowed to disseminate the data of the producer, only its own samplings. There are advantages in the second solution: fewer excuses for restricting the data supply because the burden of filling a questionnaire is no more on the shoulder of the producer. As well, the responsibility of the reported data is no more that of an environmental agency involved in official compliance reporting with possible judiciary implications. Finally, the statistician is in a better position to assess the quality of the data, considering in particular their representativeness at various levels of aggregation.

3. Scientific programmes and modelling and environmental statistics

Scientific programmes can be a source for environmental statistics, although research lacks often the required continuity over time and space. Research programmes are generally limited to a defined period or/and their methodology may change, due to progress in knowledge. As well, research is often limited to case studies designed out of any sampling protocol or to general inventories with no clear updating procedures. However this kind of information is the only one available in many domains related to climate, biomass and biodiversity. The role of the statistician in these situations is to bring its methodological requests. Stratification and ex-post sampling are possible solutions when databases are rich enough. This is more and more the case of biodiversity

where data centres such as GBIF (Global Biodiversity International Facility) and national databases run by academic institutions and NGOs start to constitute an operational resource. Of course, these data are not organised according to statistical principles and need to be reprocessed. Again, a VPN approach can be considered.

The promotion of standard statistical classifications is also a way to stabilize scientific databases and foster synergies. Candidates are the Land Use and the Land Cover nomenclatures presently discussed in the context of the SEEA revision, the use of the LCCS classification system for creating an ad hoc nomenclature in a way consistent to the international standards and CICES the draft Common International Classification of Ecosystem Services. (see annexes)

Another important interaction of the environmental statistician with research programmes and databases relates to the correct use of existing statistics. Often, modelling and analysis of the natural realm requires socio-economic data. It is even more the case for economic research. In every case, existing statistics are neglected when the research comes to aggregated values. It is the case for carbon balances involving crops and felling for which data can be derived from resp. agriculture and forestry statistics: too frequently, current models generalise locally calculated variables with little precautions when they could and should calibrate their equations with statistics. The reasons are probably for part cultural, reflect an excessive confidence in the possibility of upscaling local findings and reflect some ignorance of the statistical resource from some researchers. For the many who know where to find statistics and how to use them, another explanation is the insufficient geographical breakdown of statistics in their key domains of interest.

4. Geographical information systems and environmental statistics

GIS are today part of many domains of our life, on our computers and GPS. The historical reasons of aggregating censuses and local information don't exist anymore, which is particularly important for the assessment of the interactions between economy and nature. To a large extent the GIS dimension is present in the three previous paragraphs. It is useful however to address it in a specific way as long as two important groups of partners are involved: mapping agencies and Space agencies. Both produce the information infrastructure necessary for a correct consideration of spatial distribution issues in environmental statistics.

In addition, Earth observation programmes by satellite are now an important source of data for key climate and environment variable: land cover, biomass, aerosols, meteorological variables, soil humidity, sea characteristics such as colour, temperature and (forthcoming) acidity, level of the aquifers… Observation by satellite is now in a process of integration with in situ monitoring within in the GEOSS (Global Earth Observation System of Systems) programme. Resolution and methodologies continue improving. Global coverage is delivered on a weekly basis. And in more and more cases, data are free. It is therefore important for the environmental statisticians to use this source of data.

It is as well important that the statisticians express their requests to the scientific community of Earth observation. One of them is that statistics give high attention to change description and trends analysis, which is addressed insufficiently in current classification methodologies. Updating maps doesn't mean that comparability with the previous is sufficient for change detection; and upgrades with no backdating ruin the possibility of monitoring change. The use of the future standard land cover classification mentioned previously mentioned should help in that respect.

5. Contribution of sector statistics to environmental statistics

Mobilizing the environmental contents of sector statistics is important in the framework of environmental statistics. Most, if not all statistical domains contain important information for the environment: population censuses, national accounts (protection expenditure), health, agriculture, forestry, fisheries, transport, local settlements, tourism and other statistics. In addition, the capacity of sector statistics can be considerably increased with some limited adaptations. Firstly, the regular questionnaires can be extended on the margin to include a few focused questions related to the environment. Secondly, in many cases, more detailed geographical breakdowns are important for zonal or thematic analysis of river catchments, coastal or mountain areas etc... Geographical detail is as well often necessary for integrating statistics into the calculation of variables with high spatial variability such as "net ecosystem carbon balance", an important health indicator. Satellites supply spatial data for photo-synthesis and meteorological observation are for part spatially explicit and for part spatialised via modelling; remain data on harvesting of crops, grazing of grassland and felling of forests which require re-processing. The progress of regional statistics and the development of local databases are prone at supplying better statistics for model-based calculations. The emergence of gridded statistics is an additional step forward in that respect.

Two examples of possibly important contributions of sector statistics to environmental statistics are proposed now: household budget surveys and agriculture statistics.

a. Use of household budget surveys for environmental statistics

Household budget surveys are sample surveys broadly used to go further into the analysis of the households' condition and accounts and/or to stand in for deficient national accounts. They are in particular used in developing and transition countries[1]. The idea of making an extensive use of is well established as shown in a recent FAO report on "Deriving food security information from national household budget surveys" [2].

The household budget survey has been used for environmental statistics in Moldova, with surveys in 1999-2001.

HBS has been used as a basic survey to study ecological needs: one page has been added to the main questionnaire (see Annex).

[1] http://unstats.un.org/unsd/hhsurveys/

[2] http://www.fao.org/docrep/011/i0430e/i0430e00.htm

The first ecological survey of 1999 addressed main current ecological problems:

- Actual ecological problems of the population of the country,
- Population's attitude to problems,
- Level of environment pollution directly caused by households,
- Use of water resources by type
- Volume of consumed water
- Quality of drinking water
- Influence of water to human health status.

In December 1999, 520 households (families) were enrolled with a total number of 1,400 persons, 63% of them in rural areas. The second survey in 2001 had a similar sampling but concentrated only on water problems and other related issues: state, pollution, consumption, water supply and water management. To analyze the current trends, some questions from the first survey were included in the second survey: access to water supply, water consumption, quality of drinking water in wells and springs, influence of state of water on health status.

Findings of the 1999 and 2001 surveys regarding water:

In Moldova, the population is estimated at 4.3 million people, of whom 60% live in rural area. Only 36% of households are connected to water supply systems and 35% to sanitation, all others are drinking self-abstracted water from wells and springs. In villages, the water supply service is 3% and connection to sanitation is 2%. Households' volume of self-abstracted water is of 30 million m^3 and wastewater self-discharged to the environment 26 million m^3. In total they consume 162 million m^3 of supplied or self pumped water, in both urban and rural areas (2000 results).

The HBS results lead to some revisions of the assessment of the water situation in the country, in particular in the rural areas. At that time, this kind of information could be found in international databases on the internet, e.g. from the website www.gapminder : *"in Moldova 92% population have access to safe drink water"*. This kind of message gives a completely wrong picture about the situation in country regarding water supply and sanitation to the public, international institutions and donors, with the risk of compromising the implementation of urgent projects. A recent statement of the Ministry of Health confirms the findings of the HBS: in Moldova 44% of population or 1.8 million people has no access to safe drink water (22 March 2005)[3].

b. Agriculture statistics

[3] Jana Tafi, Ecological data, statistics and accounts of water resources. The Water Data Centre and case study on water accounts in the Republic of Moldova, Workshop on Water Statistics, Vienna, Austria, 20 – 22 June 2005

Agriculture interacts with the environment in multiple ways, illustrated by this incomplete list:

- soil conservation
- biocapacity
- carbon sequestration
- water use and conservation
- sustainable agricultural landscape
- biodiversity conservation
- conversion of marginal land to agriculture
- conversion of forest to agriculture
- conversion of agriculture land to artificial land cover
- farmland abandonment
- desertification
- dependency from inputs (chemicals, water, labour, genetic resources...)
- dependency from (external) markets
- resilience to pests
- capacity of feeding of local populations

Most areas of agriculture statistics are prone at delivering data necessary for ecosystem accounts:

Agriculture (and forest and fisheries) products
Agriculture, forest and fisheries products are (with fresh water) the main provisioning ecosystem services as defined by the Millennium Ecosystem Assessment. Production, trade and consumption by functions (food, energy, fibre products…) and by social groups are part of basic socio-economic statistics as well as ecosystem statistics and accounts key variables.

Land use
Land use is altogether source of wealth and environmental degradation. Possible uses are many on a given piece of land but because of their vital importance, productive land use by agriculture (and forestry) is given priority in statistics. It is proposed for the SEEA revision to endorse "this meaning of main productive land use and to refer to the main classifications used in international statistics: FAO statistic classifications for agriculture and forestry. This will deeply root the SEEA on a robust statistical base" (Gong & Weber, 2009). Land use tells more than which surfaces are used for which crops; it tells how efficiently and sustainably crops are obtained.

Virtual land use and footprint
International trade of food and agriculture products is certainly not a new thing, no more than distorted prices by subsidies and/or overexploitation. Foreign land grabbing via purchases or leases has existed for long, but "The sudden rush by foreign governments and companies to secure food supplies in Africa has some experts worried. Jacques Diouf, director general of the UN's food and agricultural organisation (FAO), recently spoke of the risk of a "neo-colonial" agricultural system emerging." (The Guardian, 2008). Countries importing agriculture and forest products de facto use the land

necessary for their production[4]. One way of shifting from virtual land use to real ecological footprint is using statistics of products with attributes of origin. There is more and more demand from consumers for traceability of the product they buy: controlled term of origin, organic food, fair trade, food-miles, GMO-free, or certificates or labels such as the international sustainable label of the Forest Stewardship Council for timber and non-timber forest products… Systematic recording of products ecological quality could be a major contribution of agriculture and forest statistics.

Soil resilience is capturing a large part of the issue. Uncontrolled soil erosion leads to loss in fertility, reduces the capacity of storing and sequestrating carbon. Land degradation from soil erosion is considered by many to be a problem of significant proportion, affecting some 30-50% of the earth's land surface. At the time of the first publication of this book in 1993, Pimentel estimated that 10-15 million hectares of land were being lost each year through erosion and salinisation from irrigation and that at such a rate of loss, topsoil reserves on most sloping lands would be depleted within two hundred years (Pimentel, 1993, 2006). Whatever scientific controversies on methodology, the issue is generally acknowledged as large and vital. Products from non-sustainable soils should be recorded separately.

Water use is another major issue, in relation to irrigation which doesn't respect best practices in many places despite its rank of consumer of water no 1. Virtual water embedded in trade of agriculture products should be included as well and allow the calculation of real water footprint referring to impacts on river basins, according to local conditions where irrigation is excessive regarding renewable water resource and good quality of the water ecosystems. As for virtual land and (real) landscape ecological footprint, real water footprint calculation needs the support of agriculture statistics.

Biodiversity in agriculture is a manifold issue related to soil resilience, landscape diversity and common nature, and the genetic diversity of crops. This last viable is acknowledge as important for adapting climate change and resisting pests on the long run.

By definition agriculture depends on **external inputs**, more or less, and the evolution of this dependency regarding natural thresholds is important for rating sustainability. Dependency of agro-systems from external inputs is as well an issue addressed by agriculture statistics on products (use of chemical, water, fossil energy…) and farming systems.

[4] Trends in virtual land use flows for the European Union, 1995-2005 have been assessed by the EEA and the University of Groningen (Van der Sleen, 2009). Net virtual land imports by EU range up to 15 Mio hectares for the period, out of a Gross virtual land import of circa 33 Mio hectares . It can be compared to the EU's useful agriculture area of circa 200 Mio hectares. When imported crops are produced in non sustainable conditions because of soil erosion, water depletion and pollution etc… it generates an ecological footprint for Europe or, in accounting terms a concealed transfer in capital from the exporting country.

Capacity of agro-systems to support healthy populations relates to biodiversity as well as to rural populations. An agro-system which cannot feed its own farmers and their families is obviously neither healthy nor sustainable. Farmer's income and consumption statistics is another realm of importance for environmental statistics

6. National accounts and environmental statistics

As this point is to be discussed as such, it is mentioned here per memory, with the aim of not forgetting that the core SNA includes now a lot of data which can be reused for environmental statistics.

Annex 1: Classifications

1.1 - CICES

Table E.2: Thematic, Class and Group Structure Proposed for CICES

Theme	Class	Group
Provisioning	Nutrition	Terrestrial plant and animal foodstuffs
		Freshwater plant and animal foodstuffs
		Marine plant and animal foodstuffs
		Potable water
	Materials	Biotic materials
		Abiotic materials
	Energy	Renewable biofuels
		Renewable abiotic energy sources
Regulation and Maintenance	Regulation of wastes	Bioremediation
		Dilution and sequestration
	Flow regulation	Air flow regulation
		Water flow regulation
		Mass flow regulation
	Regulation of physical environment	Atmospheric regulation
		Water quality regulation
		Pedogenesis and soil quality regulation
	Regulation of biotic environment	Lifecycle maintenance & habitat protection
		Pest and disease control
		Gene pool protection
Cultural	Symbolic	Aesthetic, Heritage
		Religious and spiritual
	Intellectual and Experiential	Recreation and community activities
		Information & knowledge

Source: **Proposal for a Common International Classification of Ecosystem Goods and Services (CICES)** for Integrated Environmental and Economic Accounting, Report to the European Environment Agency Prepared by Roy Haines-Young and Marion Potschin, University of Nottingham, UK, 21st March 2010 – Document presented to the UNCEEA meeting of June 2010.

1.2 – Land Use Classification

Table 1a: First Level of the Proposed Land Use Classification

	Code	**Item**
1	*Area in Use*	
2	A	Agricultural land
3	B	Forest land
4	C	Land with aquaculture facilities
5	D	Land used for mining, quarrying, and construction
6	E	Land used for manufacturing
7	F	Land used for technical infrastructure
8	G	Land used for transportation and storage
9	H	Land used for commercial, financial, and public services
10	I	Land developed for recreational purposes
11	J	Residential areas
12	*Area Not in Use*	
13	K	Dry open land with special vegetation cover
14	L	Dry open land without, or with insignificant, vegetation cover
15	M	Wet open land
16	N	Other land, n.e.s.
17	*Water Area*	
18	O	Inland waters
19	P	Marine waters

Table 1b: Second Level of the Proposed Land Use Classification

	Code	Item
1	A1	Land under temporary crops
2	A2	Land under temporary meadows and pastures
3	A3	Land with temporary fallow
4	A4	Land under permanent crops
5	A5	Land under permanent meadows and pastures
6	A6	Land under protective cover
7	B1	Naturally regenerated forest land
8	B2	Planted forest land
9	C1	Hatcheries
10	C2	Managed grow-out sites
11	K1	Bushes and shrubs
12	K2	Herbaceous vegetation
13	L1	Barren and sandy land
14	L2	Glaciers and perpetual snow
15	O1	Areas with aquaculture or holding facilities
16	O2	Other inland water areas
17	P1	Areas with aquaculture or holding facilities
18	P2	Other marine water

Table 1c: Third Level of the Proposed Land Use Classification

	Code	Item
1	A11	*Cereals*
2	A12	*Vegetables and melons*
3	A13	*Temporary oilseed crops*
4	A14	*Root/tuber crops with high starch or inulin content*
5	A15	*Temporary spice crops*
6	A16	*Leguminous crops*
7	A17	*Sugar crops*
8	A19	*Other temporary crops*
9	A41	*Fruit and nuts*
10	A42	*Permanent oilseed crops*
11	A43	*Beverage and permanent spice crops*
12	A49	*Other permanent crops*
13	B11	*Primary forest*
14	B12	*Other naturally regenerated forest*
15	O21	*Enhanced areas*
16	O22	*Open access waters without enhancement*
17	P21	*Enhanced areas*
18	P22	*Open access waters without enhancement*

Source: **Land Use Classification Proposed for SEEA,** Xiaoning Gong, FAO Statistics Division, 27 November 2009, paper to the 15th London Group Meeting, Wiesbaden

1.3 – Land Cover Classification

LC01	Built up and associated areas
LC02	Rainfed annual crops
LC03	Irrigated agriculture, rice fields
LC04	Permanent crops, agriculture plantations
LC05	Mosaic agriculture
LC06	Grassland and herbaceous vegetation
LC07	Forests
LC08	Transitional woodland
LC09	Shrubland, bushland, heathland
LC10	Sparsely vegetated areas
LC11	Bare land
LC12	Permanent snow and glaciers
LC13	Open wetlands
LC14	Inland water bodies
LC15	Coastal water bodies
LC16	Sea

Source: **Land cover classification in the revised SEEA,** Jean-Louis Weber, EEA, Copenhagen, 4 October 2010, Outcome paper submitted to the 16th London Group Meeting, Santiago, Chile

Annex 2:
Example of additional questionnaire embedded in the households' budget survey

Department of Statistical and Sociologic Analysis of the Republic of Moldova

Decision no. 109 of 26.11.99

Questionnaire on selective survey

"Environmental Pollution by Households"

The main purpose of this survey is to study one of the most important actual problems – environmental protection.

Your answers will contribute to a wider estimation of the impact caused by socio-economic activities of households on the environment. The results of this survey will be used only for general statistical purposes, while the value of conclusions, made on the basis of this survey depend on your openness and appropriateness of your answers.

Please, read attentively the questions and the proposed answers, then chose the answer which corresponds with the real living conditions of your family. Please mark your answer by encircling the figure from the right of each answer.

Territorial Code⊥⊥⊥ Number of the household⊥⊥⊥⊥⊥

1. What water sourse is used by your household?
   1) from central supply 1.1
   2) from dicentralised supply 1.2
   3) from well 1.3
   4) from lake, river, or other water basins 1.4
   5) use imported water 1.5
   6) from other sources (please, specify) _____ 1.6
2. Are the local wells and other water sources mentained in an adequate manner?
   1) yes 2.1
   2) not all 2.2
   3) no 2.3
   4) cannot answer 2.4
3. How much water to you use for the necessities of your household every day per person?
   1) up to 50 l 3.1
   2) 50,1-100 l 3.2
   3) 100,1-200 l 3.3
   4) 200,1-300 l 3.4
   5) 300,1-400 l 3.5
   6) more than 400 l 3.6
   7) cannot answer 3.7
4. How much of the total water used every day is used for drinking and food prepapration purposes per person ?
   1) up to 10 l 4.1
   2) 10,1-30 l 4.2
   3) 30,1-50 l 4.3
   4) 50,1-70 l 4.4
   5) more than 70 l 4.5
   6) cannot answer 4.6

5. How much garbage is thrown per day (please, specify the amount in kg)?
   1) solid_____ 5.1 2) liquid_____ 5.2
6. Is your household suppplied with a place for garbage land fill?
   1) yet, there is such a place 6.1
   2) no, there isn't such a place 6.2
   3) cannot answer 6.3

6.1. If such a place exsists, is it possible to use it?

1. Yes, there is such a posibility 6.1.1
2. No, there isn't such a possibility 6.1.2

6.2. If you do not throw the garbage in special place, please, provide the reasons for not doing so?

1) this place is situated in a long distance from the household 6.2.1
2) there access the this palce is difficult, the road is bad 6.2.2
3) there are no tranportation means for garbage removal 6.2.3
4) I throw the wastage near my household 6.2.4
5) other (please, specify)_____ 6.2.5

6.3. If there isn't such a place, where do you throw the garbage?

1) The garbage is collected in a centralized manner 6.3.1
2) The garbage is thrown in occasional garbage places 6.3.2
3) other (please, specify)_____ 6.3.3

7. Quantity of fuel used for hiting during the winter season (please, specify the quantity used per day)?
   1) coal_____ 7.1 2) fuel oil_____ 7.2
   3) wood_____ 7.3 4) other (please, specify)_____ 7.4
8. Quantity of fuel used per day for the private vehicle?
   1) 10 l 8.1 2) 20 l 8.2 3) 30 l 8.3 4) 40 l 8.4
   5) 50 l 8.5 6) more than 50 l 8.6 7) cannot answer 8.7
9. In your opinion, does the level of environmental pollution have an impact on the health status of your family?
   1) yes 9.1 2) no 9.2 3) cannot answer 9.3