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PREPARATION OF GUIDELINES ON THE APPLICATION OF THE CORE SET OF ENVIRONMENTAL INDICATORS IN EASTERN EUROPE, THE CAUCASUS AND CENTRAL ASIA

Working Document 7[1]

[1] Informal translation from Russian. Descriptions of indicators were prepared by Mr. Piotr Gorbunenko (Republic of Moldova) at the request by the UNECE Secretariat. Please send your comments to the author (Piotr.Gorbunenko@biotica-moldova.org) and the Secretariat (mikhail.kokine@unece.org).

Land Resources and Soil
TEP
Soil Pollution

PESTICIDE SOIL CONTAMINATION

1. General description

a) **Code**: TEP3.
b) **Brief definition**: Total acreage of soil contaminated by pesticides.
c) **Measurement unit**: Thousands ha.
d) **Presence in the UNCSD list of indicators**: No.
e) **Use in the *Kiev Assessment***: Used in assessments of several countries.

2. Environmental policy relevance

(a) **Purpose:** This indicator assesses toxic load on the environment and the areas affected by toxic contamination requiring rehabilitation.
(b) **International agreements in the area:** Stockholm Convention on Persistent Organic Pollutants, General Agricultural Policy (GAP) of the European Union.
(c) **International targets and recommended standards in the area:** None.
(d) **Linkage to other indicators from the core set:** This indicator is linked to other indicators of agriculture soil pollution, specifically: AGRI1, AGRI7 and AGRI8a.

3. Methodological description

(a) **Underlying definitions and concepts:** Use of pesticides (herbicides, fungicides, etc.) for crop protection or other purposes increases environmental hazards (soil pollution, toxic effect on other parts of the environment, etc.). Assessment of soil pollution by pesticides allows evaluation of potential hazards for geographic regions, specific areas and cultures. Pesticides are categorized into two groups depending on the time period of semi-decomposition in the soil (DT_{50}). According to epy UN Food and Agricultural Organization (FAO, 2000) classification, pesticides with semi-decomposition time period below 80 days are not persistent, while those with over 80 days are considered to be persistent pollutants.
(b) **Measurement methods:** Control of persistent pesticide level in soils is performed on the national level by responsible authorities by pollutant streams: insecticides, herbicides, fungicides and others. Setting of the borders of polluted areas, i.e. areas with above-permitted pesticide levels, is performed in accordance with locally-adopted methodologies.
(c) **Availability of internationally-agreed methodologies**: UN Food and Agricultural Organization (FAO, 2000) methodology for the assessment of soil contamination. EU project "Indicators of Environmental Assessment in Agricultural Policy" (IRENA) is in the process of developing an application framework for the indicator of pesticide soil contamination.

4. Primary data

(a) **Requirements to monitoring and data collection.** Monitoring is based on chemical analysis of pesticide levels in the soil. Pesticide soil contamination indicator is assessed every two years.
(b) **Difficulties and limitations:** Monitoring difficulties in the EECCA region are caused by the high cost of lab work and the scarcity of equipment required for expert analysis.

Pesticide classification by persistence mainly applies to modern pesticides, while the bulk of contamination has been caused by pesticides long out of authorized use, with much longer periods of semi-decomposition (up to 5-10 years).

(c) **Reference to international data bases (if available):** Soil databases of the European Union Joint Research Centre (JRC), European Soil Bureau, and the Institute of Applied Space Research of the European Union.

5. International bodies

(a) **Lead organization:** EU Joint Research Centre (JRC) and the European Environmental Agency (EEA), EU project "Indicators of Environmental Assessment in Agricultural Policy" (IRENA).

(b) **Other institutions and agencies:** UN Food and Agricultural Organization (FAO), Organiыation for Economic Co-operation and Development (OECD) and the Statistical Office of the European Communities (Eurostat).

6. References

(a) **Readings:**

- Assessing soil contamination. A reference manual. FAO Pesticide Disposal Series No.8, 2000, 218 p.: http://www.fao.org/DOCREP/003/X2570E/X2570E00.htm.
- Юданова Л.А. Пестициды в окружающей среде / Ред. И.Б. Кнор. - Новосибирск, 1989. 140 с.
- Lucas S., Pau-Vall M. Pesticides in the European Union // Agriculture, environment and rural development: facts and figures - The challenges of agriculture. European Union Reports, 1999. P. 181-192.
- Environmental Indicators for Agriculture. Vol. 3. Methods and Results. OECD, 2001. 409 p.
- Wascher, D.W. (ed.) Agri-environmental indicators for sustainable agriculture in Europe. Tilburg: European Centre for Nature Conservation, 2000 – (ECNC Technical Reports series). 240 p.
- Overview of pesticide data in the European Union // Statistics in Focus – Environment. – 1996. 10 p.

(b) **Internet sites:**

- UN Stockholm convention secretariat for persistent organic pollutants – http://www.pops.int/;
- PAN pesticide database – http://www.pesticideinfo.org/Index.html;
- US Environmental Agency database of toxic substances – http://www.epa.gov/tri/;
- EU project "Indicators of Environmental Assessment in Agricultural Policy" (IRENA) – http://webpubs.eea.eu.int/content/irena/index.htm;
- EU Reform of General Agricultural Policy – http://europa.eu.int/comm/agriculture/capreform/index_en.htm.

Land resources and soil
TES
Soil erosion

PROPORTION OF AGRICULTURAL LAND UNDER RISK OF WIND EROSION AND SCOURING

1. General description

(a) **Code: TES1b.**
(b) **Brief definition:** Total acreage of agriculture land affected by degradation through wind erosion and scouring.
(c) **Measurement unit**: Soil erosion is measured in terms of total area of agriculture land affected (thousands of ha.), as well as in proportion to total agricultural land.
(d) **Presence in the UNCSD list of indicators:** No. The closest related indicator in the UNCSD list is "Land Affected by Desertification".
(e) **Use in the *Kiev Assessment*:** Yes, but in very general terms (part 9 "Soil Degradation").

2. Environmental policy relevance

(a) **Purpose:** Soil erosion indicator estimates total acreage of eroded soil and the nature of erosion, erosion dynamics (where long time-series are available), and allows planning counter-erosion activities (driving forces/condition).
(b) **International agreements in the area:** United Nations Convention to Combat Desertification (New York, 12.09.94.) – in relation to land degradation. Soil erosion indicator reflects the progress achieved on the national level in fulfilling the requirements of Article 10 of the treaty on the prevention of land desertification.
(c) **International targets and recommended standards:** There are no international standards governing this area. However, science and technological committee of the UN treaty secretariat for the prevention of land desertification is in the process of developing such international standards.
(d) **Linkage to other indicators in the core set:** Soil erosion indicator is linked to indicators TES1a and TELC4.

3. Methodological description

(a) **Methodological definitions and concepts:** Soil erosion can be caused by natural soil and landscape characteristics (steepness of the hills, types of soil, amount of precipitation) which are difficult to affect, as well as by land use, which can be easily mitigated by terracing, creation of wind barriers, including forest plantations, and changes in the variety, thickness, age of vegetation, etc. Land erosion is a natural phenomenon, which, however, tends to be greatly accelerated by human activity. In most cases, erosion results from unsustainable agricultural land use, large-scale farming and over-grazing, as well as the mistakes in irrigation and water management. Systems of agricultural management are a primary factor affecting the quality of soil. In turn, erosion is an exemplary indicator of negative effects caused by unacceptable agricultural practices, leading to declines in soil fertility and often irreversible soil damage (UNECE, 2001).
(b) **Measurement methods:** Separate assessment of agriculture land affected by wind erosion and scouring. In Russia, for example, such assessment is performed on the national level and by separate economic regions (Northern, Volga, region, etc.). Soils "at risk of erosion" and "eroded" are categorized into arable land, grassland, and pasture land. Data is collected separately for land at risk of erosion and already affected by erosion.

(c) **Availability of internationally agreed methodology:** There is no common methodology in this area. Worth mentioning are wind erosion and scouring methodologies developed in the US (Universal Soil Loss Equation (USLE), Australia and EEA. There is also a methodology for the creation of global and national soil databases (Soils and Terrain Digital Databases – SOTER). Recently in South Africa was completed the development of the first scouring assessment software Africa (Water Erosion Assessment Programme – SWEAP).

4. Basic data

(a) **Requirements to monitoring and data collection:** Key data sources include multi-year government statistical reports on soil condition and inventory (compiled by government authorities, including land registrar, environmental protection, and statistical authorities). Soil erosion indicator is considered to be of a stable character and is assessed every five years.
(b) **Difficulties and limitations:** Soil erosion indicator does not take into account many important types of soil degradation, such as hardening, over-grazing, secondary salt pollution, loss of fertility and bio-diversity. It also does not take into account soil erosion beyond cultivated land (forests, state land reserves, etc.) as well as the effects of road construction and tourism on soil erosion
(c) **References to internationally agreed databases (if available):** Soil and Terrain Digital Database of the International Soil Reference Information Centre (ISRIC); Global Assessment of Human Induced Soil Degradation (GLASOD) Digital Database (same); Global database of the UN Food and Agricultural Organization.

5. International bodies

(a) **Lead organization:** European Environmental Agency (EEA), International Soil Reference Information Centre (ISRIC), the Netherlands.
(b) **Other organizations and agencies:** UN Food and Agricultural Organization (FAO), UN Environment Programme (UNEP), Organisation for Economic Co-operation and Development (OECD), World Association for Soil and Water Conservation (WASWC).

6. References

(a) **Readings:**

- A.A. Balkema. Soil Degradation/(Boels D., Davies D., and Johnston A.F., eds), Rotterdam. 2002.
- EEA (European Environmental Agency). Assessment and reporting on soil erosion. Technical report N 94. EEA, 2002.
- Down to the Earth: soil degradation and sustainable development in Europe. A challenge for 21st century. Environmental Issues Series N6, EEA, UNEP, Luxemburg. EEA-UNEP. 2000.
- Towards a strategy for soil protection. COM (2002) 179 final. European Commission. 2002.
- Assessment and reporting on soil erosion. Copenhagen, EEA, 2002.
- Grimm, M. et al. Soil Erosion Risk in Europe. 2002. 40 p.

(b) **Internet sites:**

- International soil reference information centre (ISRIC) – http://lime.isric.nl/index.cfm?fuseaction=dsp_menu&mode=&menuid=2;
- UN FAO global terrestrial observation system (GTOS): http://www.fao.org/gtos/tems/index.jsp;
- UN FAO global multi-lingual database (FAOSTAT): http://faostat.fao.org/default.jsp?language=EN

LOSS OF ORGANIC MATTER IN TOP SOILS

1. General description

(a) **Code: TES1a**
(b) **Brief definition:** Loss of organic matter in relation to type of soil and land utilization.
(c) **Единица измерения**: %.
(d) **Presence in the UNCSD list of indicators:** No.
(e) **Use in the *Kiev Assessment*:** No

2. Environmental policy relevance

(a) **Purpose:** Loss of organic matter in top soil reflects soil fertility – actual and potential level of agricultural productivity, feasibility of attaining sufficient food supply, fight against poverty, and the level of national food resources per capita of population.
(b) **International agreements in the area (if available):** United Nations Convention to Combat Desertification (New York, 12.09.94.) – in the area of land degradation. This indicator reflects the success achieved on the national level in fulfilling the requirements of Article 10 of the treaty on the prevention of land desertification.
(c) **International targets and recommended standards:** There are no international standards governing this area, however, some countries adopted national standards for the loss of organic matter in top soil. According to the "Assessment criteria used to identify environmental emergency and environmental disaster zones" adopted by the ministry of natural resources of the Russian federation on November 30, 1992 *environmental disaster* is defined as the loss of organic matter in top soil of over 7% per year, *environmental emergency* is the loss of organic matter in top soil of 3-7% per year, and *relatively moderate situation* is the loss of organic matter at the rate of under 0,5% per year.
(d) **Linkage to other indicators in the core set:** This indicator is closely linked to TES1b rev.

3. Methodological description

(a) **Underlying definitions and concepts:** Organic matter in top soil includes live mass of quasi- and micro-flora and fauna, dead remains of plants and animals which haven't been decomposed, humus (aggregate of humic substances). The level of organic matter (or "general humus") in the soil is the primary factor in soil fertility. Loss of organic matter in top soil is assessed separately for the following main types of soil and types of farming:

1. Cultivated land (irrigated and un-irrigated land);
2. Uncultivated land (pasture land and grassland, forests planted on eroded and degraded land, other forest plantations and natural forests).

(b) **Measurement methodology:** Existing chemical measurement methods estimate organic matter content of soil, excluding organic matter contained in vegetal remains. Key chemical measurement methods can be grouped into two types – first, oxidation of organic matter with anhydrous chrome and sulphuric acid (known in EECCA as Knop-Sabeanin method) and, second, bi-chrome oxidization method by calcium bi-chrome in presence of sulphuric acid (known as Turin method).
These measurement methods are based on organic matter oxidization yielding data on the content of carbon dioxide, followed by the assessment of organic matter in the soil and its trend within various soil levels. Commonly-accepted coefficient relating carbon dioxide to organic matter content is 0,58. Assessment is performed for various strata within the lower-level territorial units followed by the estimate for higher-level territorial units:

$$Iorg_i = \frac{m_i}{m_{\max}} \times 100\%,$$

where: $Iorg_i$ – the index of organic matter loss;

m_i – organic matter content in the nth sample of a specific soil type;
m_{max} – maximum content of organic matter in specific soil type observed over time.

The index of organic matter loss for the specific soil type (j) and specific type of land use (k) is calculated as a geometric average of $Iorg_i$:

$$Iorg_{jk} = \left[\prod_{i=1}^{n} Iorg_{ijk} \right]^{\frac{1}{n}},$$

where: $Iorg_{jk}$ – index of organic matter loss for specific type of soil and specific type of land use;
n – sample size.

Common index of organic matter loss for specific soil type can be calculated as a weighted average taking into account various types of land use:

$$Iorg_j = \sum_{k=1}^{n} \left(Iorg_{jk} \times \frac{S_k}{S} \right),$$

where: $Iorg_{jk}$ and n – same as above;
S_k – area used for the kth type of land use;
S – total area occupied by the country.

Similarly, one can calculate common index of organic matter loss for specific types of land use:

$$Iorg_k = \sum_{j=1}^{n} \left(Iorg_{jk} \times \frac{S_j}{S} \right),$$

where: $Iorg_{jk}$, n and S – same as above;
S_j – area occupied by the jth *type of soil*.

(c) **Availability of internationally-agreed methodology:** No common methodology is applied in this area. Presently there are several carbon-dioxide based methodologies for assessing organic matter content in various types of soil.

4. Basic data

(a) **Requirements to monitoring and data collection:** In order to assure adequate indicator assessment a set of sampling requirements should be put in place (e.g. number of soil samples), as well as the types of soils should be monitored in each country and/or regions with similar conditions. This indicator is considered to be of a stable character and is assessed every five years. In areas with problematic environmental conditions (where an environmental disaster is possible) loss of organic matter in soil should be assessed yearly.
(b) **Difficulties and limitations:** In the past 15 years some EECCA countries failed to update information on organic matter content in top soil compiled in the "Soil Affairs". Many regional agro-chemical laboratories disappeared, financial and human resources shrank. Utilized lab procedures are labor intensive, countries lack resources to apply express-methods. Lack of systematic approach to data collecting and assessment renders the application of this indicator highly labor intensive and expensive. Another problem is posed by variations in classification of soil types, which requires harmonization if monitoring is to be performed on EECCA level.
(c) **References to international databases (if available):** Soil and Terrain Digital Database of the International Soil Reference and Information Centre (ISRIC); Global Assessment of Human Induced Soil Degradation (GLASOD) Digital Database (same); Global database of UN Food and Agriculture Organization (FAO).

5. *International bodies*

(a) **Lead organization:** European Environmental Agency (EEA).
(b) **Other organizations and agencies:** UN Food and Agricultural Organization (FAO); International Soil Reference and Information Centre (ISRIC), the Netherlands, Organisation for Economic Co-operation and Development (OECD).

6. *References*

(a) **Readings:**

- Environmental assessment criteria used to identify areas of environmental emergency and disaster. Methodology of the Ministry of Natural Resources of the Russian Federation. 1992.
- Rowell D. Study of Soil. Methods and Application. Moscow. Kolos. 1998. 486 c.
- Environmental Indicators for Agriculture. Methods and Results. Vol. 3. Agriculture and Food. OECD. 2001. 400 p.
- Kuderna M. & Blum W.E.H. Soil. In: Agri-environmental indicators for sustainable agriculture in Europe. Ed: Wacher, D.W. Tilburg: ECNC. 2000. P. 47-66.
- Lynden G.W.J. van (Ed.). Guidelines for the Assessment of the Status of Human-Induced Soil Degradation in South and Southeast Asia (ASSOD). ISRIC, Wageningen, The Netherlands, 1995. 20 p.

(b) **Internet sites:**

- International Soil Reference and Information Centre (ISRIC) – http://lime.isric.nl/index.cfm?fuseaction=dsp_menu&mode=&menuid=2;
- Global Terrestrial Observation System (GTOS) of the UN Food and Agricultural Organization: http://www.fao.org/gtos/tems/index.jsp;
- Global multi-lingual database of the UN Food and Agricultural Organization (FAOSTAT): http://faostat.fao.org/default.jsp?language=EN.

Land resources and soil
TEL
Land use and land cover changes

AGRICULTURE LAND COVER CHANGES

1. General description

(a) Code: TELC4
(b) Brief definition: Change in area of a specific type of agriculture land (in accordance with adopted classification) in proportion to the total area of agriculture land.
(c) Measurement unit - %.
(d) Presence in the UNCSD list of indicators: No, but closely related to "Arable and Permanent Crop Land Area" indicator present in the UNCSD list of indicators.
(e) Use in the *Kiev Assessment:* Used partially in the assessment of semi-natural pasture land and grassland in proportion to total agricultural land (section 2.3.2.4. Biodiversity and semi-natural pasture land and grassland).

2. Environmental policy relevance

(a) Purpose: Assess agriculture load on land eco-systems at a point in time, while indicator trend, i.e. data supplied by this indicator over a period of time, allows assessing changes in the effect of agriculture on land eco-systems. The application of this indicator allows adjusting agricultural policy to reduce its load on land eco-systems and better integrating management of land resources.
(b) International agreements in the area (if available): None.
(c) International targets and standards in the area (if available): None.
(d) Linkage to other indicators from the core set: This indicator is closely linked to other spatial-planning indicators, specifically "Changes in urban sprawl" (TEU1 rev), "Land take by transport infrastructure" (TELC3a) and "Agriculture land under risk of wind erosion and souring" (TES1b rev), and helps to assess changes in agriculture land use and its effect on the environment.

3. Methodological description

(a) Underlying definitions and concepts: According to the UN FAO definition, "land cultivation is characterized by plans, activities and expenditures in relation to a territory with a specific type of soil with the purpose of food production, land change or preservation" ("Terminology for integrated resources planning and management", FAO, 1999). Hence, EECCA countries divide agricultural land into the following categories:

1. Annual sowing crops:
   - Grains
   - Rice
   - Technical crops
   - Annual bean cultures
   - Potatoes and vegetables
   - Cucurbits crop
   - Forage crops
2. Perennial bean cultures
3. Perennial technical crops
4. Perennial plantations:
   - Fruit and citrus orchards

– Vineyards
– Berry farms
– Tea plantations
5. Pastures
6. Other land

It is noteworthy, that CORINE Land Cover 2000 classification for the European Union makes a distinction between land receiving continuous irrigation and un-irrigated land. For the purposes of this indicator, it is necessary to take into account areas receiving continuous irrigation, which will harmonize the application of the above-mentioned land classification and forge a link with two other indicators from the core set: "Water use by agriculture" (AGRI1) and "Water Quantity" (WQ).

(b) Measurement methods: Agriculture land cover change is calculated as acreage of each type of agriculture land in proportion to total agriculture land of the country or bio-geographic region, expressed in percentages.

(c) Availability of internationally-agreed methodology: Several agriculture land classification methodologies are presently in use. Some of the most common methodologies include that of Eurostat, which was adopted for long-distance sounding, as well as CORINE and FAO methodologies.

4. Basic data

(a) Requirements to monitoring and data gathering: Assessment of agriculture land by category is based on data generated by agricultural authorities and information contained in land registrars. Assessment is performed every five years due to the fast-changing land use structure in EECCA countries during this transition period.

(b) Difficulties and limitations: The main difficulties in the application of this indicator are caused by variations in land classifications both on national and international levels, as well as numerous sources of information including agricultural and statistical government authorities and registrars.

(c) References to internationally-agreed databases (if available): EU countries share European Environmental Agency (EEA) database – CORINE Land Cover 2000 (CLC2000) as well as Eurostat's Regio database and the Program for Long-distance Sounding. Globally, similar databases were developed by the UN Food and Environmental Agency (FAO) – FAOSTAT and AQUASTAT, and by the US Geological Service (USGS) – Land Processes Distributed Active Archive Center (LP DAAC) etc.

5. International bodies

(a) Lead organization: European Environmental Agency (EEA), Organisation for Economic Co-operation and Development (OECD), UN Food and Agriculture Organization (FAO)

(b) Other organizations and agencies: UN Environment Programme (EUEP) – GRID, EU Project "Land Use Change Analysis System" (LUCAS), European Topic Center for Terrestrial Environment (ETCTE), Centre for International Earth Sciences Information Net (CIESIN) etc.

6. References

(a) Readings

- Agro-ecology / Chernikov V.A., Alixahin P.M. and others – Moscow: Kolos, 2000. 536 c. ISBN 5-10-003269-3.
- A Framework for Indicators for the Economic and Social Dimensions of Sustainable Agriculture and Rural Development. European Commission – Agriculture

Directorate-General, 5 February 2001:
http://europa.eu.int/comm/agriculture/publi/reports/sustain/index_en.pdf;

- Bacon Ph. (ed.) Influencing Agriculture Policy for Biodiversity Conservation. Based on Country Reports from Czech Republic, Lithuania and Poland. IUCN – The World Conservation Union and IUCN Office for Central Europe in Warsaw, 2001. 264 p. ISBN 2-8317-0640-8.
- Environmental Indicators for Agriculture. Vol. 1. Concepts and Framework. OSCD, 1999.
  45 p.
- Environmental Indicators for Agriculture. Vol. 3. Methods and Results. OECD, 2001. 409 p.
- Global Environment Outlook 3. Past, present and future perspectives. UNEP & Earthscan, 2002. 446 p. ISBN 92-807-2087-2.
- Wascher, D.W. (ed.) Agri-environmental indicators for sustainable agriculture in Europe. Tilburg: European Centre for Nature Conservation, 2000 – (ECNC Technical Reports series). 240 p.

(b) Internet sites:

- EU Environmental Information and Observation Network (EIONET): http://ims.eionet.eu.int/Topics/TE.
- Corine Land Cover 2000 at the web site of the European Topic Centre for Terrestrial Environment: http://terrestrial.eionet.eu.int/CLC2000;
- EU statistical office (Eurostat): http://europa.eu.int/comm/eurostat/;
- UN Food and Agricultural Organization (FAOSTAT) global multi-lingual database: http://faostat.fao.org/default.jsp?language=EN;
- UN Food and Agricultural Organization global database for water and agriculture (AQUASTAT):
  http://www.fao.org/waicent/faoinfo/agricult/agl/aglw/aquastat/main/index.stm;
- US Land Processes Distributed Active Archive Center (LP DAAC):
  http://edcdaac.usgs.gov/glcc/tabgeo_globe.html;
- Centre for International Earth Sciences Information Network (CIESIN) :
  http://www.ciesin.org/.

LAND TAKE BY TRANSPORT INFRASTRUCTURE

1. General description

(a) **Code: TELC3a.**
(b) **Brief definition:** Total area occupied by transport infrastructure.
(c) **Единица измерения**: Hectares, ha/driving km.
(d) **Presence in the UNCSA list of indicators:** No.
(e) **Use in the *Kiev Assessment*:** No.

2. Environmental policy relevance

(a) **Purpose:** Land take by transport infrastructure allows assessing the effect of transport infrastructure on the environment. Land use fragmentation resulting from the development of transport infrastructure and traffic growth threatens biodiversity directly and indirectly through landscape fragmentation, isolation of habitats, and the creation of artificial barriers in the wild nature. The negative effect of transport infrastructure on natural habitats has four components:

1) Motorways destroy natural habitats;
2) Traffic negatively affects the environment through chemical pollution;
3) Motorways isolate and divide natural habitats;
4) Growing traffic leads to escalating number of collusions between vehicles and animals/plants.

All of these factors should be taken into account in environmental policy development.
(b) **International agreements:** The EU common transport policy (CTP).
(c) **International targets and recommended standards:** None.
(d) **Linkage to other indicators from the core set:** Land take by transport infrastructure is linked to other indicators of natural habitats, specifically BDIV1d, BDIV9a, TELC4 and TEU1 rev.

3. Methodological description

(a) **Underlying definitions and concepts:** Direct and indirect land take by transport infrastructure is calculated as an average of total land occupied by its various components, including motorways, railroads, high-speed railways, electric lines, as well as parking lots, garages, oil stations, railway stations.
(b) **Measurement methods:** Total land take by transport infrastructure as well as per kilometer of transport infrastructure.
(c) **Availability of internationally-approved methodology:** European Environmental Agency (EEA) and Statistical Office of the European Communities (Eurostat) carry out data collection in the countries of the European Union.

4. Basic data

(a) **Requirements to monitoring and data collection:** Assessment of total land take by transport infrastructure is based on data compiled by transport authorities as well as data contained in land registrars. It is assessed every ten years.
(b) **Difficulties and limitations:** Unlike in urban areas, where transport infrastructure does not cause insurmountable problems, natural habitats are extremely sensitive to new highway and railway construction. Detailed information is needed on habitats, land use, and local environmental conditions, in order to obtain a complete picture and assess correlation between growing traffic and changes in the environment. (ОЭСР, 1997).

(c) **Reference to international databases (if available):** Databases of the Statistical Office of the European Communities (Eurostat) and European Topic Center for Terrestrial Environment (ETC-TE).

5. International bodies

(a) **Lead organization:** European Topic Center for Terrestrial Environment (ETC-TE).
(b) **Other organizations and agencies:** Organization for Economic Co-operation and Development (OECD), Centre for International Earth Science Information Network (CIESIN).

6. References

(a) **Справочная литература:**

- Spatial and ecological assessment of the TEN — Demonstration of indicators and GIS methods, European Environment Agency, Copenhagen, Denmark. 1998.
- Raster version of CLC 90 database prepared by the European Topic Centre for Land Cover. EEA–ETC/LC, 2000.
- Statistical data compilation and graphical presentation by the European Topic Centre on Terrestrial Environment. EEA–ETC/TE, 2002.
- Towards an urban atlas — Assessment of spatial data on 25 European cities and urban areas, European Environment Agency (EEA) and Joint Research Centre (JRC). Copenhagen, Denmark, 2002.

(b) **Internet sites:**

- European Topic Center for Terrestrial Environment: http://terrestrial.eionet.eu.int/;
- Statistical Office of the European Communities (Eurostat): http://europa.eu.int/eurostat/;
- International research center for social sciences (ICCR- SS): http://www.iccr-international.org/foresight/;
- Centre for International Earth Science Information Network (CIESIN): http://www.ciesin.org/.

Land resources and soil
TEU
Urban environment

URBAN SPRAWL CHANGE

1. General description

(a) **Code:** TEU1 rev.
(b) **Brief description:** This indicator describes changes in urban sprawl resulting mainly from incorporation of suburban areas. This indicator can show considerable variations depending on the type of bio-geographic region, mountains versus plains, coastal areas versus mainland, etc.
(c) **Measurement unit**: Hectares and % of total area.
(d) **Presence in the UNCSD list of indicators:** No.
(e) **Use in the *Kiev Assessment*:** Yes.

2. Environmental policy relevance

(a) **Purpose:** Urban sprawl change illustrates the intensity of urban development. When used in conjunction with population data, this indicator also illustrates the efficiency of land use per capita of population. Urban sprawl change reflects current state of urban development and its effect on the environment. Time series comparison can be used to monitor changes in the indicator and its effect on the environment.
(b) **International agreements:** None.
(c) **International targets and recommended standards:** None.
(d) **Linkage to other indicators from the core set:** This indicator is linked to other indicators of terrestrial environment: TEP3, TES1b rev, TES1a, TELC4 and TELC3a.

3. Methodological description

(a) **Underlying definitions and concepts:** Medium-term assessment of urban sprawl change is based on information contained in the EEA CORINE Land Cover (CLC) database, which includes data on 66 cities with population over 500 thousand. This analysis yields information on urban morphological zones (UMZ) allowing to assess changes in urban sprawl. Loss of land and total areas of urbanized land are determined. Data is analyzed separately for various bio-geographic regions, mountains versus plains, coastal areas versus mainland. Data is compared between cities and urban agglomerates. Population data is taken into account to assess spatial efficiency of urban sprawl. Short-term assessment of urban sprawl includes belt zones surrounding big cities where over 40% of the area can be considered urbanized. When used in conjunction with population data this indicator helps assess spatial efficiency of urban sprawl. Same analysis would apply to bio-geographic regions.
(b) **Measurement methods:** Urban sprawl expressed in square hectares is assess based on existing databases and satellite data. The proportion of newly urbanized areas relative to total urban area reflects changes in urban sprawl. Change in urban sprawl used in conjunction with population data reflects spatial efficiency of urban sprawl.
(c) **Availability of internationally-agreed methodology**: Methodology of the European Environment Agency (EEA).

4. Basic data

(a) **Requirements to monitoring and data collection:** Existing databases on urban sprawl, specifically CLC90 and CLC2000 developed by the European Environment Agency (EEA) and information on bio-geographic regions. Changes in urban sprawl are assessed every ten years.
(b) **Difficulties and limitations:** Difficulties are caused by data scarcity. CLC databases contain information on EU members and candidate countries. In 2001 EEA made its first data requester to EECCA countries.
(c) **References to international databases (if available):** European Environment Agency (EEA) CORINE Land Cover (CLC) updated every ten yeas.

5. International bodies

(a) **Lead organization:** European Topic Centre for Terrestrial Environment (ETC-TE), Institute for Regional Environmental Development Problems (Institut fur ökologische Raumentwicklung e.V), Germany.
(b) **Other organizations and agencies:** European Environment Agency (EEA), General Regional Policies Directorate of the European Union Commission (DG-REGIO).

6. References

(a) **Readings:**

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- Ewing,R. Is Los Angles-Style sprawl Desirable? // Journal of the American Planning Association, N 63(1), 1997 – p.107-126.
- Mc.Arrthur,R.H.,and e.O. Wilson The Theory of Island Biogeogrophy. Princetion University press, Princetion, N.J., 1967 – 203 p.
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- Ottensmann,J.R. Urban Sprawl, Land Values and the Density of Development // Land Economics, N53(4), ,1977 – P. 389-400.
- Measuring urban sprawl: A case study of Hyderabad / K. Madhavi Lata, Dr. V. Krishna Prasad, Dr. K. V. S. Badarinath, Dr. V. Raghavaswamy, C. H. Sankar Rao – http://www.gisdevelopment.net/application/urban/sprawl/urbans0004pf.htm

(b) **Internet sites:**

- Corine Land Cover 2000: http://terrestrial.eionet.eu.int/CLC2000/;
- Centre for International Earth Science Information Network (CIESIN): http://www.ciesin.org/;
- General Regional Policies Directorate of the European Union Commission: http://europa.eu.int/comm/dgs/regional_policy/index_en.htm.

Agriculture
AGRI

AGRICULTURE WATER CONSUMPTION

1. General description

(a) **Code AGRI1.**
(b) **Brief description:** Agriculture water consumption shows total area of irrigated agricultural land and irrigated land as a percentage of total agricultural land.
(c) **Measurement unit**: hectares, %.
(d) **Presence in the UNCSD list of indicators:** No.
(e) **Use in the *Kiev Assessment*:** Yes.

2. Environmental policy relevance

(a) **Purpose:** Assessment of agriculture water consumption reflects driving forces behind agriculture water consumption/irrigation. Monitoring of irrigated agriculture land allows assessing the load placed by agriculture on the country's water resources.
(b) **International agreements:** None.
(c) **International targets and recommended standards:** None.
(d) **Linkage to other indicators from the core set:** This indicator is closely linked to other indicators of land resources –TES1b rev, TELC4, as well as water resources indicatorse –WQ1a rev and WQ2a, allowing to assess feasibility of sufficient food supply and the fight against poverty.

3. Methodological description

(a) **Underlying definitions and concepts:** Irrigation is the key to cropping power growth in areas with insufficient or unstable precipitation. However, in the process of attaining higher levels of agricultural productivity, other problems arise, including water shortages, physical degradation of agriculture land cover, salinization, land pollution and erosion, de-humification, negative changes in land biomass. For these reasons the drive to increase land irrigation is giving place to efficient irrigation striving to mitigate its negative effects.
(b) **Measurement methods:** Agriculture water consumption is calculated as the total area of irrigated agriculture land (ha.) and irrigated land a percentage of total agriculture land (%).
(c) **Availability of internationally-agreed methodology**: A jointly-produced report of the Statistical Office of the European Communities (Eurostat) and the Organisation for Economic Co-operation and Development (OECD) contains information on yearly national water consumption by source and economic sector, including agriculture and irrigation.

4. Basic data

(a) **Requirements to monitoring and data collection:** The assessment of irrigated agriculture land is based on data collected by agricultural and water authorities. Agriculture water consumption is assessed annually.
(b) **Difficulties and limitations:** There is no common definition of irrigated land. Thus, Eurostat takes into account all land equipped with irrigation systems, whether these are used or not, while EC Farm Structure Survey includes all land which is irrigated at least one a year. Agriculture water consumption does not take into account the negative effects of irrigation. Water consumption largely depends on irrigation technology, which is also ignored by the indicator. Large volumes of water used for irrigation remain unaccounted for. In order

to assess irrigation efficiency, it is recommended to set up a sub-indicator and monitor productivity of irrigated agriculture land.

(c) **References to international data-bases (if available):** Database of the Statistical Office of the European Communities (Eurostat), FAOSTAT and AQUASTAT databases of the UN Food and Agriculture Organization (FAO).

5. International bodies

(a) **Lead organization:** European Environment Agency (EEA), UN Food and Agriculture Organization (FAO).

(b) **Other organizations and agencies:** Organisation for Economic Co-operation and Development (OECD), UE Joint Research Centre (JRC).

6. References

(a) **Readings:**

- Pierre Strosser, Maria Pau Vall, Eva Plötscher. Water and agriculture: contribution to an analysis of a critical but difficult relationship // Agriculture, environment and rural development: facts and figures – The challenges of agriculture. 1999. P. 151-166. – http://europa.eu.int/comm/agriculture/envir/report/en/eau_en/report.htm.
- Environmental Indicators for Agriculture. Vol. 3. Methods and Results. OECD, 2001. 409 p.
- Wascher, D.W. (ed.) Agri-environmental indicators for sustainable agriculture in Europe. Tilburg: European Centre for Nature Conservation, 2000 – (ECNC Technical Reports series). 240 p.
- Towards Sustainable Agriculture - A Pilot Set of Indicators. Research Report. MAFF, UK. 2000. 73 p. – http://www.defra.gov.uk/farm/sustain/pilotind.pdf.

(b) **Internet sites:**

- UN Food and Agriculture Organization global multi-lingual database (FAOSTAT): http://faostat.fao.org/default.jsp?language=EN;
- UN Food and Agriculture Organization global multi-lingual water and agriculture database (AQUASTAT): http://www.fao.org/waicent/faoinfo/agricult/agl/aglw/aquastat/main/index.stm;
- UE Joint Research Centre (JRC): http://www.jrc.cec.eu.int/.

FERTILIZER CONSUMPTION

1. General description

(a) **Code: AGR17.**
(b) **Brief description:** Total amount of fertilizers used per hectare of agriculture land.
(c) **Measurement unit**: Kilos of active substance per hectare.
(d) **Presence in the UNCSD indicator:** Yes.
(e) **Use in the *Kiev Assessment*:** Yes.

2. Environmental policy relevance

(a) **Purpose:** Fertilizer consumption allows assessing fertilizer load on the environment (accumulation of fertilizers in the soil, pollution of surface and groundwater, movement through trophic chains and other parts of the environment). Time series analysis of fertilizer consumption allows monitoring its effect on the environment depending on geography and other local conditions, types of cultivated crops, and planning strategies to offset its negative effects on the environment.
(b) **International agreements:** None.
(c) **International targets and recommended standards:** None. On September 17, 2001 the European Commission introduced draft standards for major fertilizer producers as well as utilization guidelines for consumers (COM (2001)508 final). UN CSD recommends specific standards for each country depending on its circumstances.
(d) **Linkages to other indicators from the core set:** Fertilizer consumption is closely linked to other agriculture-related indicators from the core set, such as "Use of Pesticides" AGR18a, toxic elements and environmental pollution indicators - WEU10rev, WEU1, CC1rev, APE7b and others.

3. Methodological description

(a) **Underlying definitions and concepts:** The use of mineral fertilizers in agriculture to increase cropping power simultaneously increases environmental hazards, such as waster and soil pollution, toxic effects on other environmental components, interfering with the natural balance of soil micro-flora. High level of nitrate and nitrite content in drinking water is a hazard to human health (UNEP, GEO-2000).
(b) **Measurement methods:** Total amount of used fertilizers is subdivided into tree groups based on key active nutrient components (N, K_2O, P_2O_5) and then added together. Basic data on fertilizer nutrient content can be obtained directly from producers or through chemical analysis. Agriculture land is defined as the total of permanent and temporary arable land, permanent pasture land and grassland.
(c) **Availability of internationally-agreed methodology:** None.

4. Basic data

(a) **Requirements to monitoring and data collection.** It is necessary to collect data on fertilizer sales and fertilizer basic characteristics. The indicator is assessed annually.
(b) **Difficulties and restrictions:** Technical parameters of fertilizer application, such as the amount, climate zone, season and broadcast method, type of crop and soil, etc, determine its effect on the environment. These factors, with the exception of the type of crop, are difficult to evaluate. No information is collected on natural fertilizers, such as compost, manure, bone meal, etc. Likewise, no information is collected on the use of fertilizers outside of agriculture. No consideration is given to "technical additives" normally present in fertilizers, such as radio-active content in phosphate fertilizers, which varies in degrees depending on the original source of phosphate rock.

(c) **References to international databases (if available):** UN Food and Agriculture Organization database FAOSTAT.

5. International bodies

(a) **Lead organization:** UN Food and Agriculture Organization (FAO).
(b) **Other organizations and agencies:** European Environment Agency (EEA), Organisation for Economic Co-operation and Development (OECD), Landell MillsMarket Research Ltd.

6. References

(a) **Readings:**

- Fertilizer use by crop, 3. International Fertilizer Industry Assotiation, Paris, France/International Fertilizer Development Center, Muscle Shoals AL, USA/FAO, Rome, Italy. Statistics Division, FAO, 1996. 49 p.
- Environmental Indicators for Agriculture. Vol. 3. Methods and Results. OECD, 2001. 409 p.
- Wascher, D.W. (ed.) Agri-environmental indicators for sustainable agriculture in Europe. Tilburg: European Centre for Nature Conservation, 2000 – (ECNC Technical Reports series). 240 p.
- Towards Sustainable Agriculture - A Pilot Set of Indicators. Research Report. MAFF, UK. 2000. 73 p. – http://www.defra.gov.uk/farm/sustain/pilotind.pdf.

(b) **Internet sites:**

- UN Food and Agriculture Organization (FAO) global multi-lingual database (FAOSTAT): http://faostat.fao.org/default.jsp?language=EN;
- International association of fertilizer producers: http://www.fertilizer.org/;
- European catalog of mineral fertilizers and their producers: http://www.brinkman.be/brinkcgipage.cgi?|=e&t=h.

USE/CONSUMPTION OF PESTICIDES

1. General description

(a) **Code: AGR18a.**
(b) **Brief description:** This indicator assesses pesticide load per unit of agriculture land.
(c) **Measurement unit**: Kilos of active substance per hectare.
(d) **Presence in the UNCSD list of indicators:** Yes.
(e) **Use in the *Kiev Assessment*:** Yes.

2. Environmental policy relevance

(a) **Purpose:** Consumption of pesticides assesses toxic load on the environment (accumulation in the soil, movement through trophic chains, as well as its effect on other parts of the environment). Time series analysis of pesticide consumption allows monitoring its effect on the environment depending on local geography and other conditions, types of cultivated crops, and planning strategies to offset its negative effects on the environment.
(b) **International agreements:** Stockholm Convention on Persistent Organic Pollutants.
(c) **International targets and recommended standards:** Some pesticides are banned by a series of international agreements.
(d) **Linkage to other indicators from the core set:** Use of pesticides is linked to other indicators from the core set, including agriculture-related indicators AGRI1 и AGRI7, and TEP3.

3. Methodological description

(a) **Underlying definitions and concepts:** Use of pesticides (herbicides, fungicides, etc.) for crop protection or other purposes increases environmental hazards (soil pollution and toxic effect on other parts of the environment). Data on the use of pesticides allows assessing environmental hazards posed to various regions, separate territories and crops.
(b) **Measurement methods:** On the national level government authorities monitor pesticide consumption by pesticide groups: insecticides, herbicides, fungicides, etc. Pesticide databases should describe pesticide characteristics, such as active components, toxic level, persistence, etc.
(c) **Availability of internationally-agreed methodology**: None. Presently, Organisation for Economic Co-operation and Development (OECD) collects data on the amount of active component, while European Union attempted to introduce a toxic coefficient for all types of pesticides, which would allow harmonizing analysis and applying a single indicator.

4. Basic data

(a) **Requirements to monitoring and data collection:** Data monitoring is based on the amount of pesticide sales (sales volume). Data is continuously fed into national databases on pesticide consumption. Pesticide consumption is assessed annually.
(b) **Difficulties and limitations:** Analysis of pesticide effect on the environment is incomplete when based solely on the amount of pesticide active component. It is important to take into account pesticide broadcast methods, climate, season, types of soil and cultivated crop, etc. Toxic coefficient cannot compensation for data limitations described above. As of today, there is no commonly-accepted toxic scale; besides, no data is collected on pesticide persistence and its accumulation in agriculture soil and produce.
(c) **Reference to international databases (if available):** Pesticide Action Network North America – PANNA.

5. *International bodies*

(a) **Lead organization:** UN Food and Agriculture Organization (FAO); European Environment Agency (EEA).
(b) **Other organizations and agencies:** Organisation for Economic Co-operation and Development (OECD), Statistical Office of the European Communities (Eurostat), Landell Mills Market Research Ltd., Pesticide Action Network North America.

6. *References*

(a) **Readings:**

- Udanova L.A. Pesticides and the Environment / Edited by I.B. Knor - Novosibirsk, 1989. 140 p.
- Lucas S., Pau-Vall M. Pesticides in the European Union // Agriculture, environment and rural development: facts and figures - The challenges of agriculture. European Union Reports, 1999. P. 181-192.Environmental Indicators for Agriculture. Vol. 3. Methods and Results. OECD, 2001. 409 p.
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- Overview of pesticide data in the European Union // Statistics in Focus – Environment. – 1996. 10 p.

(b) **Internet sites:**

- UN Stockholm Treaty on Persistent Organic Pollutants – http://www.pops.int/;
- PAN pesticide database – http://www.pesticideinfo.org/Index.html;
- US Environmental Agency database on toxic substances – http://www.epa.gov/tri/.