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

Working Document 3¹

Air- Ozone Depletion

OD

Depleting

Ozone

Substances

¹ Informal translation from Russian. Descriptions of indicators were prepared by Ms. Irina Atamuradova (Turkmenistan) at the request of the UNECE Secretariat. Comments should be forwarded to the author (atamuradova@yandex.ru) and the Secretariat (mikhail.kokine@unece.org).

SALES / CONSUMPTION OF OZONE DEPLETING SUBSTANCES

1. General description

- (a) **Code: OD2**
- (b) **Brief definition:** The indicator specifies total amount of the consumed ozone depleting substances (ODS).
- (c) **Unit of measurement:** Tons of ODS recalculated in ozone depleting capacity.
- (d) **Presence in the UNCSO indicator list:** The indicator is not present in the list.
- (e) **Use in the Kiev Assessment:** Has been used in it.

2. Environmental Policy Relevance

- (a) **Purpose:** The indicator expresses commitment of the countries that had ratified the Montreal Protocol on Substances Depleting Ozone Layer as well as the amendments to the Montreal Protocol in London (1990), Copenhagen (1992), Montreal (1997) and Beijing (1999) to restrict the ODS consumption with consequent full withdrawal thereof from utilization.
- (b) **International agreements:** The Vienna Convention for the Protection of the Ozone Layer (1985) (1987), the Montreal Protocol on Substances that Deplete the Ozone Layer (1987) and the London, Copenhagen, Montreal and Beijing amendments to the Montreal Protocol.
- (c) **International targets, standards or guidelines in the area:** the Montreal Protocol on Substances that Deplete the Ozone Layer sets out a time schedule for a step-by-step consumption reduction of ODS most heavily damaging the ozone layer. ODS consumption reduction process is currently at different stages of implementation in various countries. As a final goal, the ODS consumption should be terminated worldwide – it's only in this case that it would become possible to talk about the recovery of the ozone layer. The list of substances is set forth by the Protocol and by the amendments thereto.
- (d) **Linkages to other indicators:** This indicator is directly linked to the indicators specifying GHG emission, projected GHG emission, GHG emissions of key source sectors (CC1rev, CC2rev, CC5b), and it is also indirectly linked to the indicators reflecting the status and the impacts of the climate change: precipitation, snow cover, annual river discharge, forest growth, sea level rise, mountain glaciers, growing season length (CC6a, CC7c, CC10a, CC8b, CC11a, CC7a, CC9a).

3. Methodological description

- (a) **Underlying definitions and concepts:** A substance depleting the ozone layer (ODS) – is an organic substance containing chlorine or bromine that contribute to depletion of the stratospheric ozone layer. Regulated substance means any substance included in Annex A, Annex B, Annex C or Annex E to the Montreal Protocol that may exist either as a separate substance or in combination with other substances. This notion also includes isomers of such substances, with the exception of those mentioned in the respective Annex; however it does not cover any regulated substances or combinations of substances with a shape other than the shape of a container used for transportation or storage of the above substance. ODS sales mean export plus re-export. ODS consumption includes production and import less export. Please note that this notion determined by the Montreal Protocol should not be confused with the actual consumption breakdown by sector. To be able to compare environmental impact of various regulated substances, special ratios characterizing ozone depletion capacity (ODC) of each of those regulated substances are used. Ozone depletion capacity (ODC) factor is a relative index of a substance capacity to deplete ozone. Conventional level 1 has been set as an index for CFC-11 and CFC-12. If the ODC of a substance were 0.5, a given amount of this substance in the air during a certain period of time would only deplete half of the ozone, whereas the same amount of CFC-11 or CFC-12 during the same time interval would completely deplete ozone. ODC is usually calculated based on the mathematical models that account for the

factors like the product stability, diffusion rate, number of depleted atoms in a molecule, and ultra-violet and other types of radiation impact on the molecules. Tons of ODS recalculated as ODC means the amount of ODS in metric tons, multiplied by the ODC factor. Hence, to be able to make an assessment of the regulated substances impact, it is necessary to take into account ODC including data; a ton of ODS recalculated as ODC is rather a unit of measurement of the environmental damage caused by the substance than of its physical amount (weight). The Montreal Protocol stipulates a possibility to transfer part of the quota for ODS consumption to another party.

(b) **Measurement methods:** Tons of ODS recalculated in ODC for consumption is a total amount of national annual consumption (in metric tons) of each regulated substance (based on the “ozone” reporting submitted to the Secretariat in accordance with Article 7 of the Montreal Protocol), multiplied by the ozone depletion capacity factor of this particular substance.

(c) **Availability of internationally-agreed methodology:** EU provides data on the sales, whereas the UNEP provides data on the ODS consumption. EECCA countries submit national data on the ODS annual consumption in metric tons to the Ozone Secretariat. For more information, see Reviews on reporting submitted by the parties in accordance with Article 7 of the Montreal Protocol made by the Ozone Secretariat or visit the following web site <http://www.unep.ch/ozone>.

4. *Primary data*

(a) **Requirements to monitoring and data collection:** Data on the regulated substances production, import and export is required. Annual national data on most of the countries that meet their reporting obligations under the Montreal Protocol are available.

(b) **Difficulties and limitations:** Suitability and accuracy of the presented data as well as timely reporting determine the ability of a country to use the indicator. Inconsistency of the state legal system with the requirements of the international law as well as failure to observe this law is typical for some countries. Substances recommended for replacing of ODS used as refrigerants are included in the list of substances regulated by the Kyoto Protocol to the UN Framework Convention on Climate Change. Due to delay in responding by the environmental systems, the indicator itself does not show any current trends in depletion of the ozone layer.

(c) **Reference to international databases:** On the international level, the consumption data can be found at the Ozone Secretariat in Nairobi and at the Multilateral Fund Secretariat in Montreal. Data sources – the Ozone Secretariat and the National Governmental Ministry in charge of reporting under the Montreal Protocol.

5. *International bodies*

(a) **Lead institution:** UN Environment Programme (UNEP), Ozone Secretariat.

(b) **Other organisations and agencies:** Other organisations interested in further development of this indicator are as follows: the Multilateral Fund Secretariat, the Global Environment Fund (GEF), United Nations Development Programme (UNDP), United Nations Industrial Development Organization (UNIDO), the World Bank, Technology and Economic Assessment Panel of the Montreal Protocol, Parties to the Montreal Protocol, Organisation for Economic Co-operation and Development (OECD).

6. *References*

(a) **Readings:**

- Ozone Secretariat, UNEP, Handbook for the International Treaties for the Protection of the Ozone Layer, pp.367, 2000. (ISBN: 92- 807-1867-3).
- UNEP, Synthesis of the Reports of the Scientific, Environmental Effects and Technology and Economic Assessment Panels of the Montreal Protocol. A Decade of Assessments for Decision Makers Regarding the Protection of the Ozone Layer: 1989-1998, United Nations Environment Programme, pp. 161, 1999. (ISBN: 92-807- 1733-2).

- UNEP, Reports of the Technology and Economic Assessment Panel of the Montreal Protocol. Reporting of Data by the Parties to the Montreal Protocol on Substances that Deplete the Ozone Layer.
 - Ozone Secretariat, UNEP, Handbook for the International Treaties for the Protection of the Ozone Layer, p. 272, 1997. (ISBN: 92- 807-1703-0).
 - UNEP, Multilateral Foundation for Implementation of the Montreal Protocol, Handbook on Data Presentation under the Montreal Protocol, 1999, United Nations Environment Programme, p.114, 1999. (ISBN: 92-807- 1735-9).
- (b) **Internet sites:**
- <http://www.unep.org/ozone>
 - <http://www.unep.ch/ozone>
 - <http://www.unmfs.org>
 - <http://www.uneptie.org/ozonaction.html>
 - <http://www.gefweb.org>
 - <http://www.teap.org>
 - <http://www.undp.org/seed/eap/montreal/index.htm>
 - <http://www.unido.org>
 - <http://www-esd.worldbank.org/mp>

PRODUCTION OF OZONE DEPLETING SUBSTANCES

1. General description

- (a) **Code: OD1**
- (b) **Brief definition:** The indicator specifies the total amount of ozone depleting substances (ODS) produced.
- (c) **Unit of measurement:** Tons of ODS recalculated in the ozone depleting capacity.
- (d) **Presence in the UNCSD indicator list:** The indicator is not present in the list.
- (e) **Use in the Kiev Assessment:** Has been used in it.

2. Environmental Policy Relevance

Purpose: The indicator expresses commitment of the countries that had ratified the Montreal Protocol on Substances that Deplete the Ozone Layer as well as the amendments to the Montreal Protocol in London (1990), Copenhagen (1992), Montreal (1997) and Beijing (1999) to restrict the ODS consumption with consequent full withdrawal thereof from utilization.

- (b) **International agreements:** The Vienna Convention for the Protection of the Ozone Layer (1985) (1987), the Montreal Protocol on Substances that Deplete the Ozone Layer (1987) and the London, Copenhagen, Montreal and Beijing amendments to the Montreal Protocol.
- (c) **International targets, standards or guidelines in the area:** the Montreal Protocol on Substances Depleting Ozone Layer sets out a time schedule for a step-by-step consumption reduction of ODS most heavily damaging the ozone layer. ODS consumption reduction process is currently at different stages of implementation in various countries.
- (d) **Linkages to other indicators:** This indicator is directly linked to the indicators, specifying GHG emission, projected GHG emission, GHG emissions of key source sectors (CC1rev, CC2rev, CC5b), and it is also indirectly linked to the indicators reflecting the status and the impacts of the climate change: precipitation, snow cover, annual river discharge, forest growth, sea level rise, mountain glaciers, growing season length (CC6a, CC7c, CC10a, CC8b, CC11a, CC7a, CC9a).

3. Methodological description

(a) **Underlying definitions and concepts:** A substance depleting ozone layer (ODS) – is an organic substance containing chlorine or bromine that contribute to depletion of the stratospheric ozone layer. Regulated substance means any substance included in Annex A, Annex B, Annex C or Annex E to the Montreal Protocol that may exist either as a separate substance or in combination with other substances. This notion also includes isomers of such substances, with the exception of those mentioned in the respective Annex; however it does not cover any regulated substances or combination of substances with a shape other than the shape of a container used for transportation or storage of the above substance.

ODS production means the amount of produced regulated substances, less the amount of substances destroyed by using technologies to be approved by the Parties, as well as the amount of substances solely used as raw materials for producing other chemicals. The amount of substances subject to recycling and reuse shall not be considered as production. To be able to compare environmental impact of various regulated substances, special ratios characterizing ozone depletion capacity (ODC) of each of those regulated substances are used. Ozone depletion capacity (ODC) factor is a relative index of a substance capacity to deplete ozone. Conventional level 1 has been set as an index for CFC-11 and CFC-12. If the ODC of a substance were 0.5, a given amount of this substance in the air during a certain period of time would only deplete half of the ozone, whereas the same amount of CFC-11 or CFC-12 during the same time interval would completely deplete ozone. ODC is usually calculated based on the mathematical models that account for the factors like the product stability, diffusion rate, number of depleted atoms in a molecule, and ultraviolet and other types of radiation impact on the molecules. Tons of ODS recalculated as ODC means the amount of ODS in metric tons, multiplied by the ODC factor. Hence, to be able to make an assessment of the regulated

substances impact, it is necessary to take into account ODC including data; a ton of ODS recalculated as ODC is rather a unit of measurement of the environmental damage caused by the substance than of its physical amount (weight). The Montreal Protocol stipulates a possibility to transfer part of the quota for ODS consumption to another party.

(b) **Measurement methods:** Tons of ODS recalculated in ODC for consumption is a total amount of national annual consumption (in metric tons) of each regulated substance (based on the “ozone” reporting submitted to the Secretariat in accordance with Article 7 of the Montreal Protocol), multiplied by the ozone depletion capacity factor of this particular substance.

(c) **Availability of internationally-agreed methodology:** European Union and UNEP provide data on the ODS production. EECCA countries submit national data on the ODS annual consumption in metric tons to the Ozone Secretariat. For more information, see Reviews on reporting submitted by the parties in accordance with Article 7 of the Montreal Protocol made by the Ozone Secretariat or visit the following web site <http://www.unep.ch/ozone>.

4. *Primary data*

(a) **Requirements to monitoring and data collection:** Data on the regulated substances production is requested from the Parties of the Montreal Protocol. Annual national data on most of the countries that meet their reporting obligations under the Montreal Protocol are available.

(b) **Difficulties and limitations:** Suitability and accuracy of the presented data as well as timely reporting determine the ability of a country to use the indicator. Substances recommended for replacing of ODS used as refrigerants are included in the list of substances regulated by the Kyoto Protocol to the UN Framework Convention on Climate Change. Due to delay in responding by the environmental systems, the indicator itself does not show any current trends in depletion of the ozone layer.

(c) **Reference to international databases:** On the international level, the consumption data can be found at the Ozone Secretariat in Nairobi and at the Multilateral Fund Secretariat in Montreal. Data sources – the Ozone Secretariat and the National Governmental Ministry in charge of reporting under the Montreal Protocol.

5. *International bodies*

(a) **Lead institution:** UN Environment Programme (UNEP), Ozone Secretariat.

(b) **Other organisations and agencies:** Other organisations interested in further development of this indicator are as follows: the Multilateral Fund, the Global Environment Fund (GEF), United Nations Development Programme (UNDP), United Nations Industrial Development Organization (UNIDO), the World Bank, Technology and Economic Assessment Panel of the Montreal Protocol, Parties to the Montreal Protocol, Organisation for Economic Co-operation and Development (OECD).

6. *References*

(a) **Readings:**

- Ozone Secretariat, UNEP, Handbook for the International Treaties for the Protection of the Ozone Layer, pp.367, 2000. (ISBN: 92- 807-1867-3).
- UNEP, Synthesis of the Reports of the Scientific, Environmental Effects and Technology and Economic Assessment Panels of the Montreal Protocol. A Decade of Assessments for Decision Makers Regarding the Protection of the Ozone Layer: 1989-1998, United Nations Environment Programme, pp. 161, 1999. (ISBN: 92-807- 1733-2).
- UNEP, Reports of the Technology and Economic Assessment Panel of the Montreal Protocol. Reporting of Data by the Parties to the Montreal Protocol on Substances that Deplete the Ozone Layer.

- Ozone Secretariat, UNEP, Handbook for the International Treaties for the Protection of the Ozone Layer, p. 272, 1997. (ISBN: 92- 807-1703-0).
- UNEP, Multilateral Foundation for Implementation of the Montreal Protocol, Handbook on Data Presentation under the Montreal Protocol, 1999, United Nations Environment Programme, p.114, 1999. (ISBN: 92-807- 1735-9).

(b) **Internet sites:**

- <http://www.unep.org/ozone>
- <http://www.unep.ch/ozone>
- <http://www.unmfs.org>
- <http://www.uneptie.org/ozonaction.html>
- <http://www.gefweb.org>
- <http://www.teap.org>
- <http://www.undp.org/seed/eap/montreal/index.htm>
- <http://www.unido.org>
- <http://www-esd.worldbank.org/mp>

GREENHOUSE GAS EMISSIONS VERSUS TARGETS

1. General Description

- (a) **Code:** CC1rev
- (b) **Brief definition:** Total anthropogenic emissions of the greenhouse gas (GHG), included in Annex A to the Kyoto Protocol of the UN Framework Convention on Climate Change: carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulfur hexafluoride (SF₆).
- (c) **Unit of measurement:** t CO₂/year (tons CO₂ /per year) or Mt CO₂/year (10⁶*t CO₂/year)
- (d) **Presence in the UNCSO indicator list:** The indicator is not present in the list.
- (e) **Use in the Kiev Assessment:** Has been used in it.

2. Environmental Policy Relevance

- (a) **Purpose:** The indicator shows the volume of the total GHG emissions, as well as the rate of achievement by the countries of their specified goals (for instance, in regard to the countries included in Annex I of the Kyoto Protocol Goals).

The major condition for practical implementation of the provisions stipulated by the Climate Change Convention and Kyoto Protocol is to carry out the inventory and to create the anthropogenic GHG emission control system that would comply with the international requirements and that would allow for submitting quantitative reports on emissions.

Keeping records of the GHG emissions on the national level allows to ensure monitoring and planning of measures aimed at reducing emissions at the key sources of the GHG emission, thus creating the basis for the international cooperation under the projects applying the “flexibility mechanisms” of the Kyoto Protocol.

- (b) **International agreements in the area:** The major goal of the UN Framework Convention on Climate Change, adopted in 1992, is to stabilize the GHG concentration in the atmosphere at a safe level. It binds the signatory states to reduce their emissions, to ensure collection of the relevant information, to develop strategies aimed at adjusting to the climate change and at cooperation in the areas of research and development of new technologies.

The Kyoto Protocol to the UN Framework Convention on Climate Change, unanimously approved by the Third Conference of the Parties in December 1997, contains legally binding targets, set forth for the countries included in Annex I thereto. The Protocol will come into effect as of the 90th day upon its ratification by at least 55 Parties to the Convention, including by the developed countries whose cumulated share in the total emissions of the carbon dioxide of this group amounted to at least 55% for the year of 1990.

- (c) **International targets, standards or guidelines:** The Convention on Climate Change also binds the developed countries to take measures in order to go back to their emission levels of 1990. The Kyoto Protocol commits the industrially developed countries (Annex I) to reduce in 2008-2012 the total volume of their emissions of six different GHG by at least 5% compared to the level of 1990. To be able to achieve this group target, each of the countries has to accomplish its own specific task in the area of emission reduction, like Russia and Ukraine, for instance, have to stabilize their emissions level, whereas the EU countries have to reduce their levels by 8%.

- (d) **Linkages to other indicators:** Major linkages – to all the indicators specifying loads (CC2 rev, CC5b, CC5a) and Impacts of the climate change issue (CC6a, CC7c, CC10a, CC8b, CC11a, CC7a, CC9a). Supplementary linkages – those to the energy indicators (EE24, EE18, EE28 rev, EE26, EE27).

3. Methodological description

- (a) **Underlying definitions and concepts:** The levels of the main GHG increase due to anthropogenic impact (as a result of the human activities). Each of the GHG makes its own contribution to

the global warming process depending on their ability to absorb heat and on their lifetime in the air. The Global Warming Potential (GWP) describes a cumulative impact of a GHG for a certain time interval (usually, 100 years) compared with the CO₂-equivalent. For example, the methane (CH₄) Global Warming Potential is 21, which means that the impact of 1 kg of methane on the global warming is 21 times higher than that of 1 kg of carbon dioxide. Data on any activity concern data on the scope of human activities in different areas of the economy leading to the GHG emissions or absorptions within a certain time interval. For instance, annual data on the activities related to the sources of fuel burning in the energy sector shall be measured as the total volume of the burnt fuel. Annual data on the methane in agriculture in relation to the gastric fermentation shall be measured depending on the number of raised animals per each specie. Conversion factors correlate practical emissions with the data on the human activities and represent standard level of emissions per unit of activity.

(b) **Measurement methods:** The IPCC methodology is a very flexible one and, as a rule, it actually always implies a few levels of definition. The simplest level would usually require minimal data and analytical capacities. A more complicated one would be based on detailed data and would normally take into account specifics of a particular country. The highest level would usually require precise details of the data at the enterprise level and direct measurements of the most of GHG. A very general record keeping should be based on the following scheme:

$$\text{Emissions} = (\text{data on any activity}) \times \text{Conversion factors}$$

The methodology offers specific numerical values for each particular factor.

During the final stage of the inventory, special pivot tables should be used for adding up and re-estimating in CO₂ equivalents all the emissions values at all the emission sources for each particular gas. The total of all gas emissions reflects the total GHG emissions in relative units – tons of CO₂.

Should a target indicator for the country be available, expected indicators for the GHG emission reduction could be estimated for each year based on the assumption that the achievement of the target indicator by the end of the reporting period looks like a ‘line’ schedule, i.e. that the reduction would take place evenly, starting from the base year of 1990. The difference between the estimated line indicator and the actual indicator for a certain year may be both with the “+” (advance) and the “-“ (lagging behind) signs. However, it’s worth mentioning that the countries work out schedules of step-by-step emissions reductions that might differ from the line one, therefore it might make sense to compare every year’s actual achievements with the approved schedule for the GHG emission reduction.

(c) **Availability of internationally-agreed methodology:** The Intergovernmental Panel on Climate Change (IPCC) has worked out a methodology for planning, implementation and filing results on the national inventories and provided details for such inventories in the Guidelines on the best practices of conducting national inventories and uncertainty assessments.

4. *Primary data*

(a) **Requirements to monitoring and data collection:** It is necessary to prepare national inventories of anthropogenic emissions from the sources and absorption of the six main GHG by the absorbers on the annual basis, for which purpose an appropriate system of data collection and data analysis should be organized that would comply with the international requirements and annual reports on GHG emissions should be elaborated and introduced for various companies and organizations.

(b) **Difficulties and limitations:** This indicator determines the total of all GHG that have been emitted in the air of the country submitting annual reports. However, regular GHG inventories are mainly presented by the countries bound by this obligation within the framework of the Convention, i.e. by the industrially developed countries, as well as by a number of the transition economies. Emissions conversion factors suggested by the IPCC methodology do not always reflect the specifics of this or that particular region (of the country), fuel type, production process, etc. The indicator does not show the way in which the increase of GHG concentration may affect the climate change.

(c) **Reference to international databases, if available:** National communications by the Parties to the Convention, both by the developed and by the developing countries, are available with

the Secretariat of the UN FCCC. The developing countries make presentations on the limited basis. At the international level, the UN FCCC Secretariat database contains information on annual inventories held on the GHG in the industrially developed countries and in a number of the transition economies.

5. *International bodies*

- (a) **Lead institution in the development or use of the indicator:** Secretariat of the UN Framework Convention on the Climate Change (UN FCCC).
- (b) **Other organizations and agencies:** Intergovernmental Panel on Climate Change (IPCC) – special organization to carry out research on the climate change and to report on the results of the research to the politicians.

6. *References*

(a) **Readings:**

- UN Framework Convention on Climate Change. 1992.
- Kyoto Protocol to the UN Framework Convention on Climate Change, 1997.
- Revised Guidelines and Principles for National Inventories on GHG, 1996.
- Guideline on the Best Practices of the National Inventories and Uncertainty Assessment, IPCC, 2000.
- GHG indicator: UNEP Guidelines for Measuring GHG emissions for businesses and non-commercial organizations, UNEP, 2000
- National Inventories of the GHG.
- National communications concerning climate change.
- First review of information communicated by each Party included in Annex I to the Convention. UN document A/AC.237/81 and corr. 1.
- UNFCCC in-depth review reports on individual countries.

(b) **Internet sites:**

- www.unfccc.int (UN FCCC)
- www.ipcc.ch (IPCC)
- www.ipcc-nggip.iges.or.jp/public/gl/invs1 (IPCC Guidelines)
- www.unep.org (UNEP)
- www.globalreporting.org (Global Reporting Initiative)
- www.ghgprotocol.org (World Business Council for Sustainable Development / World Resources Institute)
- <http://cait.wri.org> (Database on all the GHG for any country, World Resources Institute)

PROJECTED GREENHOUSE GAS EMISSIONS IN 2010 VERSUS TARGETS

1. General Description

- (a) **Code:** CC1rev
- (b) **Brief definition:** Achievable rate of the projected greenhouse gas (GHG) emissions up to the year of 2010.
- (c) **Unit of measurement:** %
- (d) **Presence in the UNCSO indicator list:** The indicator is not present in the list.
- (e) **Use in the Kiev Assessment:** Has been used in it.

2. Environmental Policy Relevance

(a) **Purpose:** The indicator reflects deviation of the GHG emissions actual rate during the reporting year from the assumed emission values at the linear path of the emissions reduction or stabilization projected for the period between the base year and the year 2010.

The UN Climate Change Convention commits its signatory members to regularly submit “national communications” to the Conference of the Parties (CP). The national communications shall describe the work conducted by this or that Party aimed at implementation of the Convention. This work may include national programs on restriction of the GHG emission and measures targeted at adjusting to the climate changes with the account of emission values projected for the next 10 – 20 years. The policy objective is to undertake measures aimed at emissions reduction included in the national programs, as well as to comply with coordinated with the government schedules and targets on the emission reduction (if established).

(b) **International agreements:** The major goal of the UN Framework Convention on Climate Change, adopted in 1992, is to stabilize the GHG concentration in the atmosphere at a safe level. It binds the signatory states to reduce their emissions, to ensure collection of the relevant information, to develop strategies aimed at adjusting to the climate change and at cooperation in the areas of research and development of new technologies.

The Kyoto Protocol to the UN Framework Convention on Climate Change, unanimously approved by the Third Conference of the Parties in December 1997, contains legally binding targets, set forth for the countries included in Annex I thereto. The Protocol will come into effect as of the 90th day upon its ratification by at least 55 Parties to the Convention, including by the developed countries whose cumulated share in the total emissions of the carbon dioxide of this group amounted to at least 55% for the year of 1990.

(c) **International targets, standards or guidelines:** The Convention on Climate Change also binds the developed countries to take measures in order to go back to their emission levels of 1990. The Kyoto Protocol commits the industrially developed countries (Annex I) to reduce in 2008-2012 the total volume of their emissions of six different GHG by at least 5% compared to the level of 1990. To be able to achieve this group target, each of the countries has to accomplish its own specific task in the area of emission reduction, like Russia and Ukraine, for instance, have to stabilize their emissions level, whereas the EU countries have to reduce their levels by 8%.

(d) **Linkages to other indicators:** Major linkages – to all the indicators specifying loads (CC2 rev, CC5b, CC5a) and impacts of the climate change issue (CC6a, CC7c, CC10a, CC8b, CC11a, CC7a, CC9a). Supplementary linkages – those to the energy indicators (EE24, EE18, EE28 rev, EE26, EE27).

3. Methodological description

(a) **Underlying definitions and concepts:** Future GHG emissions will largely depend on the development trends in the economy, technologies and on the transformations in the social area. Economists work out “scenarios” of the future emissions to be used as guidelines by the decision-makers. Such a scenario is a specific way to analyze consequences built on this or that assumption related to the future trends as well as on the strategies concerning GHG reduction. Depending on the assumption, the emission rate increase, stabilization or decrease may be projected based on the

scenario. Scenarios implying “intervention measures” have been worked out in order to investigate possible outcome of the efforts aimed at GHG emission reduction. Not only they depend on the assumptions related to the economic development and population growth, but they also depend on the assumption related to the future reaction of the community to the strategies in the area of climate change. The projected GHG emission can be handled on several levels, i.e., on the global, regional and national levels. Global assessments are a result of calculations based on the global mathematical models, the key element of which is the analysis of the correlation between the GDP (Gross Domestic Product) growth and the fuel consumption. Emission projections on the national level are made based on the state programs for economic development with special focus on the priority sectors of the economy that are the major sources of the emissions.

(b) **Measurement methods:** First, expected indicators for the GHG emission values should be estimated for each year based on the assumption that the achievement of the projected emission values by the year 2010 is a ‘linear’ path, i.e. that the reduction or stabilization would take place evenly starting from the base year. The difference between the estimated line indicator and the actual indicator for a certain year may be both with the “+” (advance) and the “-“ (lagging behind) signs. However, it’s worth mentioning that a number of the countries independently work out schedules of step-by-step emission reductions that might differ from the line one, therefore it might make sense to compare every year’s actual achievements with the approved schedule for the GHG emission reduction.

(c) **Availability of internationally-agreed methodology:** A large number of international models aimed at projecting both short-term and long-term GHG emission evolution trends in various sectors of the economy is available. The Intergovernmental Panel on Climate Change (IPCC) has worked out recommendations on model selection and verification based on the perennial emission trends in the past.

4. *Primary data*

(a) **Requirements to monitoring and data collection:** It is necessary to prepare national inventories of anthropogenic emissions from the sources and absorption of the six main GHG by the absorbers on the annual basis.

(b) **Difficulties and limitations:** The indicator includes total value of all GHG that have been emitted in the air of the country during a certain year. However, regular GHG inventories are mainly presented by the countries bound by this obligation within the framework of the Convention, i.e. by the industrially developed countries, as well as by a number of the transition economies. The indicator does not show the way in which the increase of GHG concentration may affect the climate change.

(c) **Reference to international databases:** National communications by the Parties to the Convention, both by the developed and by the developing countries, are available with the Secretariat of the UN FCCC. The developing countries make presentations on the limited basis. At the international level, the UN FCCC Secretariat database contains information on annual inventories held on the GHG in the industrially developed countries and in a number of the transition economies.

5. *International bodies*

(a) **Lead institution:** Secretariat of the UN Framework Convention on the Climate Change (UN FCCC).

(b) **Other organizations and agencies:** Intergovernmental Panel on Climate Change (IPCC) – special organization to carry out research on the climate change and to report on the results of the research to the politicians.

6. *References*

(a) **Readings:**

- UN Framework Convention on Climate Change. 1992.

- Kyoto Protocol to the UN Framework Convention on Climate Change, 1997.
- Revised Guidelines and Principles for National Inventories on GHG, 1996.
- Guidelines on the Best Practices of the National Inventories and Uncertainty Assessment, IPCC, 2000.
- GHG indicator: UNEP Guidelines for Measuring GHG emissions for businesses and non-commercial organizations, UNEP, 2000
- National Inventories of the GHG.
- National communications concerning climate change.
- IPCC Special Report, Emission Scenarios. Summary for the decision-makers. IPCC, 2000. ISBN 92-9169-313-8

(b) **Internet sites:**

- www.unfccc.int (UN FCCC)
- www.ipcc.ch (IPCC)
- www.ipcc-nggip.iges.or.jp/public/gl/invs1 (IPCC Guidelines)
- www.unep.org (UNEP)
- www.globalreporting.org (Global Reporting Initiative)
- www.ghgprotocol.org (The World Business Council on Sustainable Development / Institute of the World Resources Initiative)
- <http://cait.wri.org> (Institute of the World Resources Database on all GHG for any country).

EMISSIONS OF CARBON DIOXIDE AND OTHER GREENHOUSE GASES

1. General description

- (a) **Code: CC5a**
- (b) **Brief definition:** The anthropogenic emissions of the greenhouse gases (GHG), included in Annex A to the Kyoto Protocol of the UN Framework Convention on Climate Change: carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulfur hexafluoride (SF₆).
- (c) **Unit of measurement:** t CO₂/year (tons CO₂ /per year) or Mt CO₂/year (10⁶*t CO₂/year)
- (d) **Presence in the UNCSO indicator list:** The indicator is not present in the list.
- (e) **Use in the Kiev Assessment:** Has been used in it.

2. Environmental Policy Relevance

(a) **Purpose:** The indicator specifies total emission volumes of the six main GHG. The existing way of handling the economic activities on the global level leads to a drastic increase in amounts of GHG emitted in the air. Extensive and relatively ineffective burning of fossil fuels, forest clearing and some other factors result in the increase of the greenhouse effect and appearance of a negative feedback – that is, to unfavorable climatic phenomena affecting economy, environmental systems and living conditions of the human being. The major condition for meeting requirements set forth by the Convention is submitting special reports – the so-called “national communications” of the Parties to the Conference. These Communications include general assessments of the GHG emissions, the detailed and accurate elaboration of which is the result of the GHG inventory. The inventory data is provided in a form of a break-down by source of each gas emission and by “absorbers” (like forests) that absorb GHG from the air with indication of the relevant quantities. This data should be collected with the use of coordinated methodology that would ensure consistency and comparability of the national data, as well as its inclusion in the sets of data concerning global situation in the area.

Annual registration on the GHG emission on the national level allows for working out strategies aimed at emission reduction both in the short-term and in the medium-term outlooks.

(b) **International agreements in the area:** The major goal of the UN Framework Convention on Climate Change, adopted in 1992, is to stabilize the GHG concentration in the atmosphere at a safe level. It binds the signatory states to reduce their emissions, to ensure collection of the relevant information, to develop strategies aimed at adjusting to the climate change and at cooperation in the areas of research and development of new technologies.

The Kyoto Protocol to the UN Framework Convention on Climate Change, unanimously approved by the Third Conference of the Parties in December 1997, contains legally binding targets, set forth for the countries included in Annex I thereto. The Protocol will come into effect as of the 90th day upon its ratification by at least 55 Parties to the Convention, including by the developed countries whose cumulated share in the total emissions of the carbon dioxide of this group amounted to at least 55% for the year of 1990.

(c) **International targets, standards or guidelines in the area:** The Convention on Climate Change also binds the developed countries to take measures in order to go back to their emission levels of 1990. The Kyoto Protocol commits the industrially developed countries (Annex I) to reduce in 2008-2012 the total volume of their emissions of six different GHG by at least 5% compared to the level of 1990. To be able to achieve this group target, each of the countries has to accomplish its own specific task in the area of emission reduction.

(d) **Linkages to other indicators:** Major linkages – to all the indicators specifying loads (CC2 rev, CC5b, CC5a) and Impacts of the climate change issue (CC6a, CC7c, CC10a, CC8b, CC11a, CC7a, CC9a). Supplementary linkages – those to the energy indicators (EE24, EE18, EE28 rev, EE26, EE27).

3. *Methodological description*

(a) **Underlying definitions and concepts:** The levels of the main GHG increase due to anthropogenic impact (as a result of the human activities). Each of the GHG makes its own contribution to the global warming process depending on their ability to absorb heat and on their lifetime in the air. The Global Warming Potential (GWP) describes a cumulative impact of a GHG for a certain time interval (usually, 100 years) compared with the CO₂-equivalent. For example, the methane (CH₄) Global Warming Potential is 21, which means that the impact of 1 kg of methane on the global warming is 21 times higher than that of 1 kg of carbon dioxide. Data on any activity concerns data on the scope of human activities in different areas of the economy leading to the GHG emissions or absorptions within a certain time interval. For instance, annual data on the activities related to the sources of fuel burning in the energy sector shall be measured as the total volume of the burnt fuel. Annual data on the methane in agriculture in relation to the gastric fermentation shall be measured depending on the number of raised animals per each specie. Conversion factors correlate practical emissions with the data on the human activities and represent standard level of emissions per unit of activity.

(b) **Measurement methods:** The IPCC methodology is a very flexible one and, as a rule, it actually always implies a few levels of definition. The simplest level would usually require minimal data and analytical capacities. A more complicated one would be based on detailed data and would normally take into account specifics of a particular country. The highest level would usually require precise details of the data at the enterprise level and direct measurements of the most of GHG. A very general record keeping should be based on the following scheme:

$$\text{Emissions} = (\text{data on any activity}) \times \text{Conversion factors}$$

The methodology offers specific numerical values for each particular factor.

During the final stage of the inventory, special pivot tables should be used for adding up and re-estimating in CO₂ equivalents all the emissions values at all the emission sources for each particular gas.

(c) **Availability of internationally-agreed methodology:** The Intergovernmental Panel on Climate Change (IPCC) has worked out a methodology for planning, implementation and filing results on the national inventories and provided details for such inventories in the Guidelines on the best practices of conducting national inventories and uncertainty assessments.

4. *Primary data*

(a) **Requirements to monitoring and data collection:** It is necessary to prepare national inventories of anthropogenic emissions from the sources and absorption of the six main GHG by the absorbers on the annual basis, for which purpose an appropriate system of data collection and data analysis should be organized that would comply with the international requirements and annual reports on GHG emissions should be elaborated and introduced for various companies and organizations.

(b) **Difficulties and limitations:** This indicator determines the total of the six main GHG that have been emitted in the air of the country submitting annual reports. However, regular GHG inventories are mainly presented by the countries bound by this obligation within the framework of the Convention, i.e. by the industrially developed countries, as well as by a number of the transition economies. Emissions conversion factors suggested by the IPCC methodology do not always reflect the specifics of this or that particular region (of the country), fuel type, production process, etc. The indicator does not show the way in which the increase of GHG concentration may affect the climate change.

(c) **Reference to international databases:** National communications by the Parties to the Convention, both by the developed and by the developing countries, are available with the Secretariat of the UN FCCC. The developing countries make presentations on the limited basis. At the international level, the UN FCCC Secretariat database contains information on annual inventories held on the GHG in the industrially developed countries and in a number of the transition economies.

5. *International bodies*

- (a) **Lead institution:** Secretariat of the UN Framework Convention on the Climate Change (UNFCCC).
- (b) **Other organizations and agencies:** Intergovernmental Panel on Climate Change (IPCC) – special organization to carry out research on the climate change and to report on the results of the research to the politicians.

6. *References*

(a) **Readings:**

- UN Framework Convention on Climate Change. 1992.
- Kyoto Protocol to the UN Framework Convention on Climate Change, 1997.
- Revised Guidelines and Principles for National Inventories on GHG, 1996.
- Guideline on the Best Practices of the National Inventories and Uncertainty Assessment, IPCC, 2000.
- GHG indicator: UNEP Guidelines for Measuring GHG emissions for businesses and non-commercial organizations, UNEP, 2000
- National Inventories of the GHG.
- National communications concerning climate change.
- First review of information communicated by each Party included in Annex I to the Convention. UN document A/AC.237/81 and Corr. 1.
- UNFCCC in-depth review reports on individual countries.

(b) **Internet sites:**

- www.unfccc.int (UNFCCC)
- www.ipcc.ch (IPCC)
- www.ipcc-nggip.iges.or.jp/public/gl/invs1 (IPCC Guidelines)
- www.unep.org (UNEP)
- www.globalreporting.org (Global Reporting Initiative)
- www.ghgprotocol.org (The World Business Council on Sustainable Development / Institute of the World Resources Initiative)
- <http://cait.wri.org> (Institute of the World Resources Database on all GHG for any country).

GHG EMISSIONS OF KEY SOURCE SECTORS

1. General description

- (a) **Code: CC5a**
- (b) **Brief definition:** Total anthropogenic emissions of the greenhouse gases (GHG), included in Annex A to the Kyoto Protocol of the UN Framework Convention on Climate Change: carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulfur hexafluoride (SF₆).
- (c) **Unit of measurement:** t CO₂/year (tons CO₂ /per year) or Mt CO₂/year (10⁶*t CO₂/year)
- (d) **Presence in the UNCSA indicator list:** The indicator is not present in the list.
- (e) **Use in the Kiev Assessment:** Has been used in it.

2. Environmental Policy Relevance

(a) **Purpose:** The indicator shows total GHG emissions in key source sectors of the economy. Provided target indicators (for instance, particular obligations under the Kyoto Protocol) are available, it can also reflect progress made in implementation of the national programme on the GHG reduction in sectors responsible for the major share of the emissions. The major condition for meeting requirements set forth by the Convention is submitting special reports – the so-called “national communications” of the Parties to the Conference. One of the key chapters of the national communication is the one concerning “Greenhouse Gases Inventory” (including with the break-down by sectors).

The indicator allows for judging of the emissions sector spectrum. The key sources of the GHG emissions that significantly contribute to the total GHG emission value should be accounted for when working out both medium-term and short-term strategies in the area of GHG emission reductions. The strategies are usually worked out based on the national (country) specifics, like political structure and general economic situation, and should therefore be aimed at ensuring both economic and environmental benefits.

(b) **International agreements in the area:** The major goal of the UN Framework Convention on Climate Change, adopted in 1992, is to stabilize the GHG concentration in the atmosphere at a safe level. It binds the signatory states to reduce their emissions, to ensure collection of the relevant information, to develop strategies aimed at adjusting to the climate change and at cooperation in the areas of research and development of new technologies.

The Kyoto Protocol to the UN Framework Convention on Climate Change, unanimously approved by the Third Conference of the Parties in December 1997, contains legally binding targets, set forth for the countries included in Annex I thereto. The Protocol will come into effect as of the 90th day upon its ratification by at least 55 Parties to the Convention, including by the developed countries whose cumulated share in the total emissions of the carbon dioxide of this group amounted to at least 55% for the year of 1990.

(c) **International targets, standards or guidelines in the area:** The Convention on Climate Change also binds the developed countries to take measures in order to go back to their emission levels of 1990. The Kyoto Protocol commits the industrially developed countries (Annex I) to reduce in 2008-2012 the total volume of their emissions of six different GHG by at least 5% compared to the level of 1990. To be able to achieve this group target, each of the countries has to accomplish its own specific task in the area of emission reduction.

(d) **Linkages to other indicators:** Major linkages – to all the indicators specifying loads (CC2 rev, CC5b, CC5a) and impacts of the climate change issue (CC6a, CC7c, CC10a, CC8b, CC11a, CC7a, CC9a). Supplementary linkages – those to the energy indicators (EE24, EE18, EE28 rev, EE26, EE27).

3. *Methodological description*

(a) **Underlying definitions and concepts:** GHG are actually a result of numerous types of anthropogenic activities. Each of the GHG makes its own contribution to the global warming process depending on their ability to absorb heat and on their lifetime in the air. The Global Warming Potential (GWP) describes a cumulative impact of a GHG for a certain time interval (usually, 100 years) compared with the CO₂-equivalent. For example, the methane (CH₄) Global Warming Potential is 21, which means that the impact of 1 kg of methane on the global warming is 21 times higher than that of 1 kg of carbon dioxide. Data on any activity concerns data on the scope of human activities in different areas of the economy leading to the GHG emissions or absorptions within a certain time interval. For instance, annual data on the activities related to the sources of fuel burning in the energy sector shall be measured as the total volume of the burnt fuel. Annual data on the methane in agriculture in relation to the gastric fermentation shall be measured depending on the number of raised animals per each specie. Conversion factors correlate practical emissions with the data on the human activities and represent standard level of emissions per unit of activity.

(b) **Measurement methods:** The IPCC methodology is a very flexible one and, as a rule, it actually always implies a few levels of definition. The simplest level would usually require minimal data and analytical capacities. A more complicated one would be based on detailed data and would normally take into account specifics of a particular country. The highest level would usually require precise details of the data at the enterprise level and direct measurements of the most of GHG. The methodology includes 6 modules used for calculation of GHG emissions in the following major sectors: energy (including transport), industrial processes; use of solvents; agriculture; change in land tenure; forestry; wastes. A very general record keeping should be based on the following scheme:

$$\text{Emissions} = (\text{data on any activity}) \times \text{Conversion factors}$$

The methodology offers specific numerical values for each particular factor.

During the final stage of the inventory, special pivot tables should be used for adding up and re-estimating in CO₂ equivalents all the emission values at all the emission sources for each particular gas. The total of all gas emissions of a certain sector (subsector) reflects the total GHG emissions in relative units – tons of CO₂.

Should a target indicator for the country be available, the countries work out their own schedules of step-by-step emissions reductions in major sectors of the economy that contribute most in the total GHG emission value. The difference between the estimated line indicator and the actual indicator for a certain year may be either with the “+” (advance) or the “-“ (lagging behind) signs.

(c) **Availability of internationally-agreed methodology:** The Intergovernmental Panel on Climate Change (IPCC) has worked out a methodology for planning, implementation and filing results on the national inventories and provided details for such inventories in the Guidelines on the best practices of conducting national inventories and uncertainty assessments.

4. *Primary data*

(a) **Requirements to monitoring and data collection:** It is necessary to prepare national inventories of anthropogenic emissions from the sources and absorption of the six main GHG by the absorbers on the annual basis, for which purpose an appropriate system of data collection and data analysis should be organized that would comply with the international requirements and annual reports on GHG emissions should be elaborated and introduced for various companies and organizations.

(b) **Difficulties and limitations:** Countries, not included in Annex I do not submit their inventories on a regular basis. Regular GHG inventories are mainly presented by the countries bound by this obligation within the framework of the Convention, i.e. by the industrially developed countries, as well as by a number of the transition economies. Emissions conversion factors suggested by the IPCC methodology do not always reflect the specifics of this or that particular region (of the country), fuel type, production process, etc.

(c) **Reference to international databases:** National communications by the Parties to the Convention, both by the developed and by the developing countries, are available with the Secretariat of the UN FCCC. The developing countries make presentations on the limited basis. At the international level, the UN FCCC Secretariat database contains information on annual inventories held on the GHG in the industrially developed countries and in a number of the transition economies.

5. *International bodies*

(a) **Lead institution:** Secretariat of the UN Framework Convention on the Climate Change (UN FCCC).

(b) **Other organizations and agencies:** Intergovernmental Panel on Climate Change (IPCC) – special organization to carry out research on the climate change and to report on the results of the research to the politicians.

7. *References*

(a) **Readings:**

- UN Framework Convention on Climate Change. 1992.
- Kyoto Protocol to the UN Framework Convention on Climate Change, 1997.
- Revised Guidelines and Principles for National Inventories on GHG, 1996.
- Guideline on the Best Practices of the National Inventories and Uncertainty Assessment, IPCC, 2000.
- GHG indicator: UNEP Guidelines for Measuring GHG emissions for businesses and non-commercial organizations, UNEP, 2000
- National Inventories of the GHG.
- National communications concerning climate change.
- First review of information communicated by each Party included in Annex I to the Convention. UN document A/AC.237/81 and corr. 1.
- UNFCCC in-depth review reports on individual countries.

(b) **Internet sites:**

- www.unfccc.int (UN FCCC)
- www.ipcc.ch (IPCC)
- www.ipcc-nggip.iges.or.jp/public/gl/invs1 (IPCC Guidelines)
- www.unep.org (UNEP)
- www.globalreporting.org (Global Reporting Initiative)
- www.ghgprotocol.org (The World Business Council on Sustainable Development / Institute of the World Resources Initiative)
- <http://cait.wri.org> (Institute of the World Resources Database on all GHG for any country).

PRECIPITATION

1. General description

- (a) **Code:** CC6a
- (b) **Brief definition:** Total water volume precipitated to a certain area surface for a given period of time (day, month, year, etc.) is usually called total precipitation.
- (c) **Unit of measurement:** The indicator is measured by the layer thickness of the precipitated water in millimeters (mm), in relation to perennial standards in percent (%).
- (d) **Presence in the UNCSA indicator list:** The indicator is not present in the list.
- (e) **Use in the Kiev Assessment:** Has been used in it.

2. Environmental Policy Relevance

- (a) **Purpose:** The indicator is used to determine the frequency and intensity of the (atmospheric) precipitation, as well as their relationship with the standards. Change of precipitation has major negative impact on water resources and soils. Analysis of the perennial sets of the main climate formation factors, like the air temperature, (atmospheric) precipitation and air humidity make it possible to judge of the precipitation structure change in a certain area, as well as to assess future climate changes and precipitation trends.
- (b) **International agreements:** The major goal of the World Meteorological Organisation Convention is to facilitate worldwide cooperation in the area of establishing a meteorological stations network, conducting meteorological observations as well as hydrological and other geophysical surveys related to meteorology. National commitments of the countries, members to the GSN and the GUAN, envision ensuring functionality of the observation stations included in the regional synoptic and aerologic support networks. General obligation for all countries, Parties to the UN Framework Convention on Climate Change, is to carry out systematic observations, create databases and conduct research related to the climate system and needed to accumulate knowledge on the system behaviour under the influence of the natural and anthropogenic factors.
- (c) **International targets, standards or guidelines in the area:** The indicator has no international targets. Climatic standards recommended by the WMO to its member-countries are calculated standards based on the thirty-years' observation data.
- (d) **Linkages to other indicators:** This indicator is linked to the river discharge (CC10a), mountain glacier ablation (CC7a), sea level rise (CC11a), snow cover (CC7c), as well as with indicators on water quantity (WQ1a rev, WQ1b, WQ4).

3. Methodological description

- (a) **Underlying definitions and concepts:** Precipitation means water, either in liquid or in solid state, falling out of the clouds or depositing from the air at the land surface, at various objects or plants. Falling out of the clouds the precipitation may be in the form of rain, drizzle, snow, sleet, snow pellets or small hail, hail or sleet. Out of all rains, it's the downpours and their intensity that are of special practical interest. Collection of data on liquid, solid and mixed types of precipitation is carried out from the meteorological stations network. Precipitation quantity measurements are conducted twice a day, simultaneously at all stations of the observation network. Data on the measured precipitation is processed by the national hydrometeorological services, where quality and uniformity of the meteorological material are verified, and where calculations are made of variation and asymmetry factors of the total precipitation quantities for each month and for the whole of the year, as well as the average monthly and annual quantities of liquid, solid and mixed precipitation, number of days with precipitation ranging depending on the precipitation quantities, and the precipitation duration (based on various quantile elements) are evaluated. To avoid losses of small quantities of water special adjustments are made for "wetting" and for "wind losses".
- (b) **Measurement methods:** Precipitation quantity shall only be measured on a daily basis. The average ten-day, monthly, seasonal and annual precipitation quantities shall be calculated by finding

the arithmetical mean value. The relation of the precipitation quantity for a certain period of time to the perennial standards shall be calculated by use of the percentage method.

(c) **Availability of internationally-agreed methodology:** WMO recommendations.

4. *Primary data*

(a) **Requirements to monitoring and data collection:** Handling systematic meteorological observations based on the principles of the best practices and concepts of the climate monitoring developed by the Global Climate Observation System (GCOS). Ensuring completeness and reliability of all types of information, providing appropriate technical level, consistency and compatibility of the measurement results, participation in the international data exchange. Following requirements of the “Observations Guidelines” for the meteorological stations worked out by the Main Geophysical Observatory in coordination with the WMO.

(b) **Difficulties and limitations:** Reduction of the observation network. Precipitation data collection in the mountains is troublesome due to the lack of the observation points.

(c) **Reference to international databases:** Databases of the national hydrometeorological services, participation of the EECCA countries in the international data exchange via the All-Russian Scientific Research Institute for Hydrometeorological Information.

5. *International bodies*

(a) **Lead institution:** the World Meteorological Organization (WMO).

(b) **Other organizations and agencies:** Global Climate Observation System (GCOS), GSN, Global Upper Atmosphere Networks (GUAN), Global Atmosphere Watch network (GAW), World Climate Programme (WCP), the Intergovernmental Panel on Climate Change (IPCC).

6. *References*

(a) **Readings:**

- National meteorological monthly and annual publications
- Scientific reference books on climate, Studies.
- Volumes of the “World Weather Records” on the regions for decades.
- The WMO Convention. 1950.
- UN Framework Convention on Climate Change. 1992.
- IPCC Special Report, Climate Change Consequences for the Regions: vulnerability assessment. Summary for the decision-makers. IPCC, 1997. ISBN 92-9169-410-4
- National Communications on Climate Change.

(b) **Internet sites:**

- www.wmo.ch (WMO)
- www.gsnmc.dwd.de/ (GSN Monitoring Center)
- www.metoffice.gov.uk/research/hadleycentre/guan/index.html (GUAN)
- www.wmo.ch/web/arep/gaw/gaw_home.html (GAW)
- www.unfccc.int (UN FCCC)
- www.ipcc.ch (IPCC)
- www.unep.org (UNEP).

SNOW COVER

1. General description

- (a) **Code:** CC7c
- (b) **Brief definition:** Snow depth and snow cover water equivalent.
- (c) **Unit of measurement:** Snow depth is measured in centimeters (cm), snow cover water equivalent is measured in millimeters (mm).
- (d) **Presence in the UNCSD indicator list:** The indicator is not present in the list.
- (e) **Use in the Kiev Assessment:** Has been used in it.

2. Environmental Policy Relevance

- (a) **Purpose:** The indicator is used for the assessment of the rivers water content, as well as for projecting dangerous hydrological phenomena like floods and mudflows. The purpose of the snow cover observation is to obtain data that might be useful to research dynamics of the snow cover formation and melting process on the larger areas.
- (b) **International agreements:** The major goal of the World Meteorological Organisation Convention is to facilitate worldwide cooperation in the area of establishing a meteorological stations network, conducting meteorological observations as well as hydrological and other geophysical surveys related to meteorology. General obligation for all countries, Parties to the UN Framework Convention on Climate Change, is to conduct systematic observations, create databases and carry out research related to the climate system and needed to accumulate knowledge on the system behavior under the influence of the natural and anthropogenic factors.
- (c) **International targets, standards or guidelines in the area:** The indicator has no international targets.
- (d) **Linkages to other indicators:** This indicator is linked to the river discharge (CC10a), mountain glacier ablation (CC7a), precipitation quantity (CC6a), as well as with indicators on water quantity (WQ1a rev, WQ1b, WQ4).

3. Methodological description

- (a) **Underlying definitions and concepts:** Snow is a type of solid atmospheric precipitation that have fell down on the land surface in the shape of branched ice crystals. Snow cover is a layer of snow on the surface of the Earth that has been formed as a result of snowfalls and snowstorms. The compactness of the snow cover is low, however it may increase in the course of time, especially in spring. Albedo of the new snow is around 70 – 90%, that of the old, melting snow is around 30-40%. Snow cover reflects solar radiation and thus protects soil from excessive cooling and winter crops from freezing; it also has a significant impact on the climate, land relief, rivers and glacier water supply, soil formation processes, flora and fauna. Two different types of the snow cover can be distinguished: the so-called temporary snow cover that can melt within hours or days after it has been formed, and a steady (or stable) one that usually stays during all winter or most of the winter with a few gaps in it. Snow cover water equivalent is the water amount of the melted snow. Snow gage is a special instrument for measuring snow cover water equivalent. Snow survey means measuring of the snow depth and of the snow cover water equivalent in certain places of water collection. Snow cover water equivalent accumulated during winter provides about 50% of the water supply for rivers. Snow melting in spring causes spring tides in the lowland rivers. The tide depth does not only depend on the amount of snow accumulated during winter but it also depends on how fast the snow melts and on the type of the soil surface. The depth of the old snow layer, the depth and compactness of the accumulated new snow, together with other meteorological factors affect avalanching. Lack of snowfalls in the mountains result in glacier ablation.
- (b) **Measurement methods:** Parameters for the measurement of the snow cover features are as follows: snow cover depth, snow cover water equivalent and its compactness. Snow cover depth can be observed with the help of stationary snow scales as well as with the help of the snow surveys.

The average value of the snow depth can be calculated by ten-day periods of winter months. Snow cover compactness and snow cover water equivalent features are usually determined based on the results of the snow surveys.

(c) **Availability of internationally-agreed methodology:** All measurements in the EECCA countries are done in accordance with the methodologies worked out by the Main Geophysical Observatory.

4. *Primary data*

(a) **Requirements to monitoring and data collection:** Regular snow cover monitoring with the use of digital satellite information is needed to determine the snow cover water equivalent. Integration to the Global Terrene Observation System (GTOS), participation in the international data exchange.

(b) **Difficulties and limitations:** Difficulties in assessment of the seasonal mountain snow resources, one of the reasons for that being the complexity of the snow cover distribution within the mountain system. Reduction of the traditional ground-based and air-based snow observations, complicated data exchange between countries.

(c) **Reference to the international databases:** Databases in the National hydrometeorological services (in paper form – KM-5 books).

5. *International institutions*

(a) **Lead institution:** the World Meteorological Organization (WMO).

(b) **Other organizations and agencies:** Global Climate Observation System (GCOS), Global Terrene Observation System (GTOS), World Climate Programme (WCP), the Intergovernmental Panel on Climate Change (IPCC), the International Commission on Snow and Ice (ICSI).

6. *References*

(a) **Readings:**

- Scientific references on climate, Studies
- National meteorological annual publications
- WMO Convention
- Scientific reference books on climate, Studies.
- Volumes of the “World Weather Records” on the regions for decades.
- The WMO Convention. 1950.
- UN Framework Convention on Climate Change. 1992.
- Kyoto Protocol to the UN Framework Convention on Climate Change. 1992.
- IPCC Special Report, Climate Change Consequences for the Regions: vulnerability assessment. Summary for the decision-makers. IPCC, 1997. ISBN 92-9169-410-4
- National Communications ob Climate Change.

(b) **Internet sites:**

- www.wmo.ch (WMO)
- www.wmo.ch/web/gcos/gcoshome (GCOS)
- www.glaciology.su.se/ICSI/ (ICSI)
- www.unfccc.int (UN FCCC)
- www.ipcc.ch (IPCC)
- www.unep.org (UNEP).

FOREST GROWTH

1. General description

- (a) **Code:** CC8b
- (b) **Brief definition:** Average annual forest surface area change.
- (c) **Unit of measurement:** km²/year
- (d) **Presence in the UNCSO indicator list:** The indicator is not present in the list.
- (e) **Use in the Kiev Assessment:** Has been used in it.

2. Environmental Policy Relevance

- (a) **Purpose:** The indicator reflects average annual change of the forest surface area in the country calculated based on the two reference periods (for instance, based on the statistics of the forest cadastres). The forests surface area is a basic feature used for assessments of the forest growth and of the forestry. The continuing decrease of the forests is an alarm signal of instability in the activities conducted in the area of forestry and agriculture. The major requirement for the policy planning purpose in the “Forestry” sector is to ensure availability of reliable data reflecting various aspects of the evolution of such forestry resources as surface and structure of the forests as well as the extent and growth of the forest resources.
- (b) **International agreements:** Convention on international trade of threatened flora and fauna species, Convention on wetlands rights of international importance as waterfowl habitats, Convention on Biodiversity, UN Framework Convention on Climate Change, Convention on Desertification Control.
- (c) **International targets, standards or guidelines:** The indicator has no international targets, standards or guidelines. However, it is well known that the higher the disafforestation rates are, the more critical the situation with the forestry in the country is. The Kyoto Protocol to the UN Framework Convention on Climate Change sets forth effluent registration mode for the Annex 1 countries: it’s only absorptions resulting from targeted actions undertaken by certain governments that should be registered, provided that during the first stage (2008 – 2012) it’s only activities related to the forestry development after 1990 should be taken into account.
- (d) **Linkages to other indicators:** Direct linkages - the indicator is linked to all indicators characterizing loads (CC1rev, CC2 rev, CC5a, CC5b) and the climate change impact (CC6a, CC7c, CC9a). Indirect linkages – those with the biodiversity indicators (BDIV10a rev, BDIV1d, BDIV3e, BDIV2a rev, BDIV2f).

3. Methodological description

- (a) **Underlying definitions and concepts:** Land surfaces covered by woods and bushes including cleared spaces, spots, waste areas without vegetation but intended for the forest growing, as well as including all water rights, lakes, wetlands located in the above areas altogether form common national (state) forest. One of the categories of the forest land surface is the forest surface area intended for the forest growing. It may be covered with woods (both of natural or artificial nature) or it may be not covered with woods. Lands with the degree of the forest canopy closing of over 10% are called forests (according to the FAO definition). In many countries there exist their own definitions of forests. Desafforestation means transfer from the forest to the non-forest or decrease of the forest canopy closing degree. Afforestation means planting of new forests on territories that historically were free of forests. Reafforestation (or forest recreation) means planting forests on lands historically covered by forests that have been cleared or utilized for some other purposes afterwards. Forest plantation is a uniform in its composition, age and growing conditions part of the forest. Forest plantation is a forest planted in the process of afforestation or reafforestation. Natural forest means plantations of natural or semi-natural origin. All work related to registration of the forests consists of the land measuring and taxation activities that are usually called forest cadastre. Forest

registration is usually conducted at forest husbandry works carried out in this or that parts of the country's forests on the annual basis.

(b) **Measurement methods:** Forest surface areas are accounted for by means of the ground-based survey, aircraft survey or remote surface sensing entailing setting forth borders of various category areas and specifying their sizes. Such works on areas that are not covered with forests is relatively easy. Whereas areas covered with forests create problems for conducting surveys and registration works since they may be covered with plants of different age, composition, density, stocks, etc. To be able to provide appropriate characteristics of such areas special approaches worked out as a result of the forest taxation (forest evaluation) need to be applied.

The forest surface area is calculated as a total of all forest plantations and natural forests with the degree of forest canopy closing of no less than 10%. Average annual forest surface area change shall be calculated based on the two reference periods data comparison. Such two reference periods data comparison also allows for calculating forest surface area change in absolute values as a percentage of the disafforestation degree.

$$DR(\%) = 100 * (1 - (\text{Forest surface area}_{\text{yearN}} / \text{Forest surface area}_{\text{yearP}})^{1/N-P})$$

(c) **Availability of internationally-agreed methodology:** N/A.

4. *Primary data*

(a) **Requirements to monitoring and data collection:** Continuous monitoring of the forests change based on application of the remote forest surface sensing technologies as well as combination of different approaches (remote forest surface sensing and the forest cadastre data).

(b) **Difficulties and limitations:** One of the problems related to the monitoring of the forests changes is the lack of compatibility between national cadastres due to inconsistency of definitions, methodologies, uncertainty assessments, etc. Also, availability of various types of forests in the country should be taken into account in order to be able to compare national data. The forest surface area does not reflect forests quality and extent, therefore the indicator would not allow for judging on the forest resources degradation level. Total forest surface area in the country may stay unchanged, however, the quality of the forests may deteriorate.

(c) **Reference to international databases:** Data on the total forest surface area for various time spans are available in many countries. National data are oftentimes just assessment data and cannot always be used for comparison. International data are available in the FAO Forest Resources Assessment Programme. National data are available at ministries in charge for the forestry and at the statistical agencies.

4. *International bodies*

(a) **Lead institution:** UNECE Committee on timber and the FAO European Forest Committee.

(b) **Other organizations and agencies:** Ministerial Conference on the Protection of Forests in Europe (MCPFE); UN Environment Programme.

5. *References*

(a) **Readings:**

- Assessment of forest resources in temperate and boreal zones in UN ECEE /FAO. Terms and definitions. UN. New York and Geneva, July 1997
- Forest resources of Europe, CIS, North America, Australia, Japan and New Zealand (industrially developed countries of the temperate/ boreal zones). UN ECEE/FAO contribution in the Global Assessment of the Forest Resources – 2000. Main Report. 2000 (ECE/TIM/SP/17).

- Global Assessment of Forest Resources: Revised, 2005. Technical description of the tables under OLR-2005 National reporting system. Forest resources assessment Programme. Working paper No.81. FAO. Rome, 2004
 - Kyoto Protocol to the UN Framework Convention on Climate Change. 1997.
 - IPCC Special Report, Land tenure, Change in Land tenure and Forestry. Summary for the decision-makers. IPCC, 2000. ISBN 92-9169-314-6
 - IPCC Special Report, Climate Change Consequences for the Regions: vulnerability assessment. Summary for the decision-makers. IPCC, 1997. ISBN 92-9169-410-4
 - National Communications of Climate Change.
- (b) **Internet sites:**
- UNECE Committee on timber: <http://www.unece.org/trade/timber/fra/welcome.htm>;
 - Global Multilanguage database (FAOSTAT) UN Food and Agricultural Organization: <http://faostat.fao.org/faostat/collections?subset=forestry>;
 - www.unfccc.int (UNFCCC)
 - www.ipcc.ch (IPCC)
 - www.unep.org (UNEP)
 - www.fao.org/forestry (Forest Resources Assessment Programme. FAO)
 - www.wri.org (World Resources Institute)

MOUNTAIN GLACIERS

1. General description

- (a) **Code:** CC7a
- (b) **Brief definition:** Mountain glaciers surface and extent change.
- (c) **Unit of measurement:** Mountain glacier surface is measured in square units (m², km²), whereas its extent – in cubic units (m³, km³).
- (d) **Presence in the UNCSD indicator list:** The indicator is not present in the list.
- (e) **Use in the Kiev Assessment:** Has been used in it.

2. Environmental Policy Relevance

- (a) **Purpose:** The indicator reflects mountain glacier mass-balance change of its conventional initial mass. Glaciers are natural regulators of the water discharge and are extremely vulnerable to unfavourable meteorological conditions. Continuous climate warming as a result of the anthropogenic effects causes respective changes in the mountain glacier systems. Mountain glacier monitoring results mainly serve to assess water content of rivers supplied from the glaciers.
- (b) **International agreements:** The major goal of the World Meteorological Organisation Convention is to facilitate worldwide cooperation in the area of establishing a meteorological stations network, conducting meteorological observations as well as hydrological and other geophysical surveys related to meteorology. General obligation for all countries, Parties to the UN Framework Convention on Climate Change, is to conduct systematic observations, create databases and carry out research related to the climate system and needed to accumulate knowledge on the system behaviour under the influence of the natural and anthropogenic factors.
- (c) **International targets, standards or guidelines:** The indicator has no international targets.
- (d) **Linkages to other indicators:** This indicator is linked to the river discharge (CC10a), mountain glacier ablation (CC7a), precipitation quantity (CC6a), as well as with indicators on water quantity (WQ1a rev, WQ1b, WQ4).

3. Methodological description

- (a) **Underlying definitions and concepts:** A glacier is a natural moving accumulation of ice on the land surface appearing as a result of accumulation and transformation of solid atmospheric precipitation at positive perennial balance. Glacier movement leads to its splitting into the areas of ice accumulation and ablation. Ablation is glacier or snow cover reduction caused by melting, evaporation and mechanical removal of ice or snow. Ablation is usually expressed in the units of the layer of water draining from the glacier and evaporating from its surface. Glaciers are moving from the area of accumulation to the area of ablation. They can be split into the cover glacier, ice shelf and mountain glaciers. Mountain glacier is a glacier occupying lower spaces in the mountain relief. Mountain glacier accumulation area is located above the snow line. Ice movement mainly happens due to the heavy weight pushing downwards to the valley or on the slope. Snow line is a line determining a certain level on the land surface above which accumulation of the solid atmospheric precipitation exceeds their melting and evaporation by the end of the ablation period. Glacier mass-balance is a correlation between accumulation and ablation of the snow and ice masses during a certain period of time. In summer, a huge number of melt water streamlets appear in the area of the ice stream and drain upon the ice surface making grooves or take the shape of post-glacial streams. Merging together these streamlets form sources for the rivers. Melting depends on the air temperature and on the glacier extent reaching its maximum point in summer. Therefore rivers supplied with water from the glaciers have the highest water content in summer.
- (b) **Measurement methods:** Calculated equation of the glacier mass-balance depending on the weather conditions index is used for measurement of the glacier surface and extent.
- (c) **Availability of the internationally-agreed methodology:** Aerophototopography survey monitoring programme has been developed to be able to judge of the current glaciation evolution.

4. *Primary data*

- (a) **Requirements to monitoring and data collection:** Regular observations involving modern observation techniques need to be carried out on a selected representative ice rock-basin to monitor the mountain glacier state. Integration in the Global Terrene Observation System (GTOS), participation in the international data exchanges.
- (b) **Difficulties and limitations:** Cutting down of the observation networks in the mountain areas.
- (c) **References to international databases:** Database of the World Glacier Monitoring System (WGMS) includes data on the world glaciers inventory (quantity and location), as well as on the current changes in the glacier mass-balance (change of glaciers mass, surface, extent).

5. *International bodies*

- (a) **Lead institution:** the World Meteorological Organization (WMO).
- (b) **Other organizations and agencies:** Global Climate Observation System (GCOS), Global Terrene Observation System (GTOS), World Glacier Monitoring System (WGMS), World Climate Programme (WCP), the Intergovernmental Panel on Climate Change (IPCC).

6. *References*

- (a) **Readings:**
- IAHS(ICSU)/UNEP/UNESCO: Glacier mass balance bulletin no. 1-7. World Glacier Monitoring Service, University and ETH Zurich. 1994-2001.
 - WMO Convention. 1950.
 - UN Framework Convention on Climate Change. 1992.
 - IPCC Special Report, Climate Change Consequences for the Regions: vulnerability assessment. Summary for the decision-makers. IPCC, 1997. ISBN 92-9169-410-4
 - National Communications of Climate Change
- (b) **Internet sites:**
- www.wmo.ch (WMO)
 - www.fao.org/gtos (GTOS)
 - www.wmo.ch/web/gcos/gcoshome (GCOS)
 - www.geo.unizh.ch/wgms/ (WGMS)
 - http://nsidc.org/data/glacier_inventory/index.html (Glacier inventory)
 - www.unfccc.int (UNFCCC)
 - www.ipcc.ch (IPCC)
 - www.unep.org (UNEP)

GROWING SEASON LENGTH

1. General description

- (a) **Code: CC9a**
- (b) **Brief definition:** Length of season favorable for vegetation growing.
- (c) **Unit of measurement:** days/year
- (d) **Presence in the UNCSO indicator list:** The indicator is not present in the list.
- (e) **Use in the Kiev Assessment:** Has been used in it.

2. Environmental Policy Relevance

- (a) **Purpose:** The indicator may be used to calculate based on the series of long-term observations change of the growing season length value during the year when meteorological conditions are favorable for growth and development of vegetation. Within the framework of preparation of the National Communications, the Parties to the Convention on Climate Change carry out assessment of the vulnerability of various sectors of economy (including agriculture) and the natural environmental systems taken into account possible climate change. Based on this assessment, the Parties shall work out effective adaptation measures that might facilitate mitigation of the climate change consequences. The policy objective in this case is to implement adaptation measures. A number of research activities are being carried out to explore the expected climate change impact on the productivity of the major agricultural crops by use of the models simulating affects caused by the climate change. Models are also helpful for analyzing major parameters of the plants productivity like sowing periods and the duration of the vegetation stages. Adaptations measures in agriculture may include introducing changes in the sowing and planting schedules.
- (b) **International agreements:** The UN Climate Change Convention commits its signatory members to reduce their emissions, collect relevant information, work out strategies on adaptation to the climate change and to cooperate in the area of research and technologies. Article 2 of the UNFCCC acknowledges the importance of the natural environment systems and food production. The UN Conventions on Biodiversity and Desertification Control are also related to the indicator.
- (c) **International targets, standards or guidelines:** N/A
- (d) **Linkages to other indicators:** Direct linkages - the indicator is linked to all indicators characterizing loads (CC1rev, CC2 rev, CC5a, CC5b) and the climate change impact (CC6a, CC7c, CC10a, CC8b, CC11a, CC7a). Indirect linkages – those with the biodiversity indicators (BDIV1d, BDIV3e, BDIV2a rev) and agriculture (AGRI1, AGRI7).

3. Methodological description

- (a) **Underlying definitions and concepts:** Vegetation (*lat.* – stimulation, revival) – vegetation, vital activity of the plant. Vegetation period is the time needed for the whole life cycle of a plant. In agricultural practice, it's a period between the germination and the harvest of the crop. Due to the nature and climate differences, the vegetation period of the same plants (crops) may vary, both in regard to its duration and to its start and end dates. The temperature factor plays the leading role in the development of the plants. Knowing the needs of the plant in warmth at any stage of its development allows for using meteorological data to determine with maximum credibility and in due time dates of the certain development stages and of its ripening in any particular area. Vulnerability predetermines the range of harm or damage that may be caused by the climate change. Adaptability indicates the degree of the system ability to adjust to the happening or expected change of conditions.
- (b) **Measurement methods:** The vegetation period for each crop can be determined based on the annual observations of the plants development and growing. For calculation vegetation period change it might make sense to carry out analysis of the data obtained as a result of perennial observations.

(c) **Availability of the internationally-agreed methodology:** The indicator has no standard methodology. However, there do exist international recommendations on how to measure the indicator as well as a great number of models used to analyze vulnerability of agriculture and environmental systems as a result of the projected climate change both in the long and in the short run. The Intergovernmental Panel on Climate Change (IPCC) has worked out recommendations on the models selection and verification based on the perennial trends in the temperature and total precipitation amount change in the past.

4. *Primary data*

(a) **Requirements to monitoring and data collection:** Annual observations are required to watch growth and development of various vegetation at the test sites.

(b) **Difficulties and limitations:** Natural environmental systems usually respond to GHG concentration change with a delay. National data comparison is not always possible due to the differences in the geographical location.

(c) **Reference to international databases:** National Communications of the Parties to the Convention (both the developed and the developing countries) are available at the UNFCCC Secretariat. The developing countries submit reporting on a limited basis. Sowing and harvesting schedules of the agricultural crops are available at the national ministries of agriculture.

5. *International bodies*

(a) **Lead institution:** UN Food and Agricultural Organization (FAO).

(b) **Other organizations and agencies:** Intergovernmental Panel on Climate Change (IPCC) – special organization involved in carrying out assessments and research of the climate change and its potential consequences, as well as in finding ways to adapt to the climate change and reduce its negative impact.

6. *References*

(a) **Readings:**

- UN Framework Convention on Climate Change. 1992.
- The Kyoto Protocol to the UN Framework Convention on Climate Change. 1997
- IPCC Technical Guidelines on Climate Change Impact Assessment and Adaptation, 1995
- IPCC Special Report, Climate Change Consequences for the Regions: vulnerability assessment. Summary for the decision-makers. IPCC, 1997. ISBN 92-9169-410-4
- National Communications on Climate Change

(b) **Internet sites:**

- www.unfccc.int (UNFCCC)
- www.ipcc.ch (IPCC)
- www.unep.org (UNEP)
- www.fao.org (UN Food and Agriculture Organization)

ANNUAL RIVER DISCHARGE

1. General description

- (a) **Code:** CC10a
- (b) **Brief definition:** Quantity of water discharging through the river outlet during a year.
- (c) **Unit of measurement:** Annual river discharge shall be measured based on the surface area of a single river basin and expressed in m³/year.
- (d) **Presence in the UNCSD indicator list:** The indicator is not present in the list.
- (e) **Use in the Kiev Assessment:** Has been used in it.

2. Environmental Policy Relevance

- (a) **Purpose:** The annual river discharge is used to determine water contents of a river, and the average perennial volume of the river discharge reflects water content of the river. The indicator is a key parameter used for projecting of the expected stream conditions. Conclusions obtained as a result of the projection are used for planning of larger water-resources development activities and working out general water-supply strategies. Determination of annual river discharge fluctuations is of great practical importance in hydrological and water-resources development measurements.
- (b) **International agreements:** The major goal of the World Meteorological Organisation Convention is to facilitate worldwide cooperation in the area of establishing a meteorological stations network, conducting meteorological observations as well as hydrological and other geophysical surveys related to meteorology. General obligation for all countries, Parties to the UN Framework Convention on Climate Change, is to conduct systematic observations, create databases and carry out research related to the climate system and needed to accumulate knowledge on the system behaviour under the influence of the natural and anthropogenic factors.
- (c) **International targets, standards or guidelines in the area:** The indicator has no international targets.
- (d) **Linkages to other indicators:** This indicator is linked to the river discharge (CC10a), mountain glacier ablation (CC7a), precipitation quantity (CC6a), snow cover (CC7c), as well as with indicators on water quantity (WQ1a rev, WQ1b, WQ4).

3. Methodological description

- (a) **Underlying definitions and concepts:** River discharge is all the water that gets into the river and drains out of the catchment basin. River discharge – in a wide sense – means movement of the water flows along the river-bed. River discharge – in a narrow sense – means water quantity discharging through the river section for a certain period of time. The river discharge value is calculated by measuring flowing water. Rivers are characteristic of very uneven water flow distribution in time. Discharge changeability means water discharge fluctuation in time. Usually perennial water discharge fluctuation values are considered. A special method aimed at researching river discharge is called stream-gaging survey, and is carried out by means of random measurements of the water discharge in the system of specially selected hydraulic gage sections. Water discharge means water volume flowing through the effective (wetted) discharge section per unit of time, where the “effective” section presents a part of the water section where the water flow can be observed. Water content of the river is water quantity carried by the river during a year on the average. Water content of the river is expressed by an average perennial water discharge or by an average perennial discharge volume per year. Water content of the river is a relative characteristic of the discharge for a certain period of time compared to the average perennial value or with the discharge value for another period of the same year. Water content may be small, medium and large. Annual discharge is the quantity of water flowing through the river-bed during a year. River discharge regulation means time redistribution of the river discharge in the closing gage section reflected in its increase or decrease at certain periods of time compared to the water flows at the catchment surface. Regulation of the river discharge may take place in a natural way or it may be performed artificially depending

on the needs of the water consumers and water users or as a measure of floods control. Streams condition is a mechanism of changes in the hydrological elements state both in time and in space caused by physical and geographical influences, primarily by climatic conditions and by anthropogenic effects.

(b) **Measurement methods:** Determination of the annual river discharge may be carried out either in case of availability of long-term discharge observation results of a particular area or in case of insufficiency or unavailability of the observation data. Indicator measurement is carried out for a particular place (sections line) – due to the fact that not all the rivers have final discharge – based on the daily observations on cumulated frequency curve. Perennial observations data are used to determine average annual river discharge. Annual discharge fluctuations are determined by means of empirical frequency curves.

(c) **Availability of internationally-agreed methodology:** Methodologies developed by the State Hydrological Institute of Saint Petersburg (Guidelines SHI-73).

4. *Primary data*

(a) **Requirements to monitoring and data collection:** Systematic hydrological observations. Data entry on measured discharges, levels and temperatures of water. Standard tables used for making entries in the State Water Cadastre are the outcomes of such databases.

(b) **Difficulties and limitations:** Reduction of the hydrological posts.

(c) **Reference to international databases:** Databases of national hydrometeorological services.

5. *International bodies*

(a) **Lead institution:** the World Meteorological Organization (WMO).

(b) **Other organizations and agencies:** Global Climate Observation System (GCOS), Global Hydrological Cycle Observation System (WHYCOS), WMO Committee on Hydrology, World Climate Programme (WCP), the Intergovernmental Panel on Climate Change (IPCC).

6. *References*

(a) **Readings:**

- Reference books on surface water resources.
- National Annual Publications on Hydrology
- Annual Reference book: the State Water Cadastre.
- WMO Convention. 1950.
- IPCC Special Report, Climate Change Consequences for the Regions: vulnerability assessment. Summary for the decision-makers. IPCC, 1997. ISBN 92-9169-410-4
- National Communications on Climate Change 1992.

(b) **Internet sites:**

- www.wmo.ch (WMO)
- www.wmo.ch/web/gcos/gcoshome (GCOS)
- www.wmo.ch/web/homs/chy/chy.html (WMO Committee on Hydrology)
- www.unfccc.int (UN FCCC)
- www.ipcc.ch (IPCC)
- www.unep.org (UNEP)

SEA LEVEL RISE

1. General description

- (a) **Code: CC11a**
- (b) **Brief definition:** Change of the water surface level in regard to conventional reference point.
- (c) **Units of measurement:** Units of length (meters, centimeters).
- (d) **Presence in the UNCSO indicator list:** The indicator is not present in the list.
- (e) **Use in the Kiev Assessment:** Has been used in it.

2. Environmental Policy Relevance

- (a) **Purpose :** The purpose of watching the sea levels is to get data to be able to study their water regime, to verify their channel data, to project possible water surface position in future, to prevent coastal floods and to plan their development and maintaining navigation.
- (b) **International agreements in the area:** The major goal of the World Meteorological Organisation Convention is to facilitate worldwide cooperation in the area of establishing a meteorological stations network, conducting meteorological observations as well as hydrological and other geophysical surveys related to meteorology. General obligation for all countries, Parties to the UN Framework Convention on Climate Change, is to conduct systematic observations, create databases and carry out research related to the climate system and needed to accumulate knowledge on the system behaviour under the influence of the natural and anthropogenic factors.
- (c) **International targets, standards or guidelines:** The indicator has no international targets. The standard requirement to be used while watching the water surface level is observation accuracy of about ± 1 cm. This means that all the devices and equipment used for the “level” observations should comply with this requirement.
- (d) **Linkages to other indicators:** This indicator is linked to the river discharge (CC10a), mountain glacier ablation (CC7a), precipitation quantity (CC6a), snow cover (CC7c), as well as with indicators on water quantity (WQ1a rev, WQ1b, WQ4).

3. Methodological description

- (a) **Underlying definitions and concepts:** Sea level is a free position of the water surface of seas and oceans, measured by perpendicular line relative to the conventional reference point. The sea level state is the result of the influence of a number of reasons on the sea and ocean water, gravity being the major of these reasons. To a little lesser extent the ocean surface is subject to the influence of the high and low tides, atmospheric pressure, solar radiation and continental water discharge. An instant, average daily, average monthly, average annual and average perennial sea levels can be distinguished. Average perennial sea level is the closest to the surface of absolutely calm water. Constant in every point, the average perennial level is used as reference point to count off all altitudes on the land surface and depths in the sea. Observations of the sea level are conducted both constantly and occasionally. There is a special offshore network of posts located close to the coastal strip that is used for regular observations. Various devices and equipment are available for such observations, the major goal of which is to ensure instant measurements of the sea level (like, tide-gauges, hydrostatic level gauges) or continuous registration of the level changes (fluviographs).
- (b) **Measurement methods:** Level calculation is carried out depending on the measurement method and on the purpose of the level calculation. At routine level measurements, held on a certain point of time, the level values are calculated as mean arithmetic values of observations for a given time span. Provided a continuous level record is available, its averaged values are calculated based on the purpose of calculation.
- (c) **Availability of internationally-agreed methodology:** Recommendations of the Intergovernmental Hydrographic Organization are used as methodological guidelines for carrying out sea level observations.

4. *Primary data*

- (a) **Requirements to monitoring and data collection:** Ensure functionality of the level gage stations. Integration in GLOSS, participation in the international data exchanges.
- (b) **Difficulties and limitations:** Since the sea level regime is not the same in different parts of the world, the reference levels in different parts of the world ocean vary also. This led to countries' using a huge variety of altitude count off systems related to the average perennial level of a particular sea or ocean part. In EECCA countries it's mainly the absolute Baltic system of altitudes that is used. Establishing linkages between all these systems might be needed to be able to carry out global assessment of the world ocean level.
- (c) **Reference to international databases:** Any information on the sea levels is available at the national and regional archives. Generalized database is available at the Intergovernmental Oceanographic Commission. (IOC).

5. *International bodies*

- (a) **Lead institution:** Intergovernmental Oceanographic Commission (IOC).
- (b) **Other organizations and agencies:** the World Meteorological Organization (WMO), Global Sea Level Observation System (GLOSS), Global Oceanographic Observations System (GOOS), Intergovernmental Hydrographic Organization (IHO), Global Climate Observation System (GCOS), UN Environment Programme (UNEP).

6. *References*

- (a) **Readings:**
- Monthly Bulletins on Seas and Oceans (IOC)
 - Marine Year-Books
 - WMO Convention. 1950.
 - UN Framework Convention on Climate Change. 1992.
 - IPCC Special Report, Climate Change Consequences for the Regions: vulnerability assessment. Summary for the decision-makers. IPCC, 1997. ISBN 92-9169-410-4
 - National Communications on Climate Change 1992
- (b) **Internet sites:**
- <http://ioc.unesco.org/iocweb/index.php> (IOC)
 - www.wmo.ch (WMO)
 - www.wmo.ch/web/gcos/gcoshome (GCOS)
 - www.pol.ac.uk/psmsl/programmes/gloss.info.html (GLOSS)
 - www.ioc.unesco.org/goos (GOOS)
 - www.unfccc.int (UNFCCC)
 - www.ipcc.ch (IPCC)
 - www.unep.org (UNEP).