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TRIAL COMPENDIUM OF SELECTED ENVIRONMENTAL INDICATORS FOR COUNTRIES IN EASTERN EUROPE, THE CAUCASUS AND CENTRAL ASIA[1]

Introduction

The purpose of this Compendium is to demonstrate the possibility of using up-to-date environmental indicators for EECCA countries' environmental reporting. Selected indicators were taken from the core set of environmental indicators for EECCA developed at a workshop held near St Petersburg (Russian Federation) on 27 to 28 July 2003 (the core set is found in a separate

[1] Prepared with the assistance of Ms. Lyubov Gornaya, UNECE consultant. This document was not formally edited.

[3] In the brackets is code (subcode) of the indicator in the draft core list of environmental indicators of EEA; index "rev" means that the name of the indicator in the list of environmental indicators was corrected to adjust to existing practices in EECCA countries; index "new" means that this is a new indicator included in the core list of indicators for EECCA countries.

document in this CD). The Compendium demonstrates the use of these indicators in EECCA countries to track interactions between economic and sectoral policy, on the one hand, and environmental policy, on the other, as well as methods to visualize them, using approaches adopted in EEA countries.

At a workshop near St Petersburg, six interested countries - Azerbaijan, Belarus, Georgia, Kyrgyzstan, Russian Federation and Tajikistan - agreed to submit data on 30 environmental indicators from the core set of EECCA indicators. It was also agreed that consideration should be limited to the time period 1999-2002. Obviously, this interval of four years (and for some of the countries, only three years) is not sufficient for solid conclusions about trends. Thus, the proposed indicators and conclusions are basically illustrative in nature.

National reporting data were gathered by the following national experts: Saadat Hudaverdieva (Azerbaijan), Lyubov Ryzhikova (Belarus), Ramaz Chitanava (Georgia), Valentina Nekrasova (Kyrgyzstan), Alexander Shekhovtsov (Russian Federation) and Timur Nazarov (Tadjikistan).

The collected data appear to be heterogeneous, both in temporal and thematic coverage, and therefore each indicator below is estimated only for those countries for which comparable source data were available. In some cases, data from national reports on the state of the environment were used.

Topic: Emissions of Air Pollutants

Indicator:

- ***Total emissions of acidifying pollutants (SO_2, NO_x) from stationary and mobile sources (APE1rev)[3]***

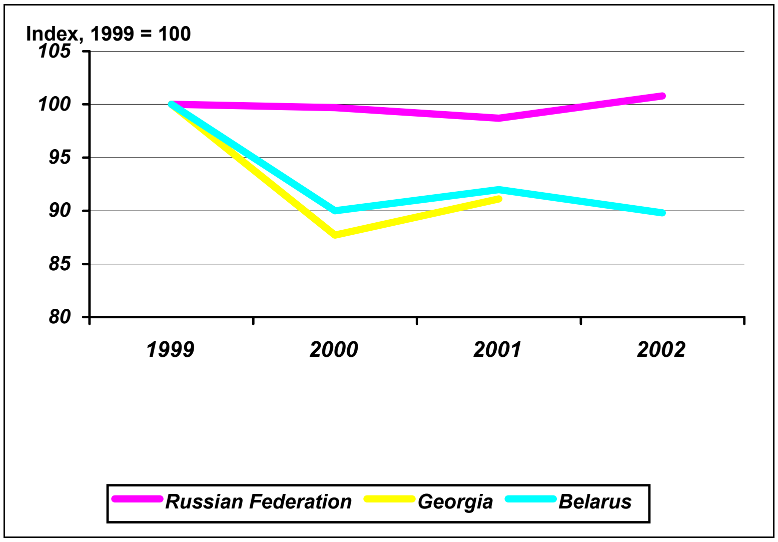
This indicator is offered as a descriptive indicator, i.e. as a linear plot showing changes in the variables with time. Table 1 contains data on total emissions of SO_2 and NO_x in 1991-2002. Considering the wide spread in absolute values of emissions (total emissions of the Russian Federation are 180 times greater those of Georgia), fig. 1 presents changes in emissions compared to a baseline year, 1999, for a clearer presentation and comparison (i.e. emission indices).

Table 1. Total emissions of acidifying pollutants (SO_2, NO_x) from stationary and mobile sources in 1999-2002

Country	1999	2000		2001		2002	
	Thousand tonnes	Thousand tonnes	% of 1999 value	Thousand tonnes	% of 1999 value	Thousand tonnes	% of 1999 value
Belarus	305.7	275	90	281	92	274.6	89.8
Georgia	55.2	48.4	87.7	50.3	91.1	n.d.	n.d.
Russian Federation	8704.5	8681	99.7	8593	98.7	8774	100.8

Note: n.d. – no data.

Fig. 1. Total emissions of acidifying pollutants in 1999-2002



Environmental indicators:

- ***Emissions of SO_2 from stationary and mobile sources (APE5a rev);***
- ***Emissions of NO_x from stationary and mobile sources (APE6a rev);***
- ***Particulate emissions of from stationary and mobile sources (APE8a rev).***

To show the interrelationships between economic and environmental policies, these indicators are presented as eco-efficiency indicators: i.e., indicators of changes in economic activity (gross domestic product in fixed prices) and in environmental pressures (total emissions of sulfur dioxide, nitrogen oxides, particulates and non-methane volatile organic compounds). Figures 2, 3 and 4 show these indicators for Belarus, Georgia and the Russian Federation. Ideally, these lines – after the period of parallel change – should diverge: i.e., increases in GDP occur with decreases in environmental pressures, as for example in Belarus in 2002.

To compare countries, another efficiency indicator was used for the relationship between economic and environmental indicators: intensity of SO_2 and NO_x per unit GDP in US dollars (see fig. 6 and 8). In fig. 5 and 7, the indicators of SO_2 and NO_x emissions are instead shown as specific emissions per capita: total emissions from stationary and mobile sources combined and only from stationary sources are both used (since for some countries only data on stationary sources were available). These indicators (specific emissions per capita) were used in the Kiev report.[4] For comparison, data on other countries, such as Denmark, Switzerland and Estonia, are included. In 2001, the highest specific emissions of SO_2 from stationary and mobile sources per capita and per unit GDP in the EECCA countries considered were found in the Russian Federation (38.04 kg per person and 17.72 kg per 1000 US$ GDP). The lowest were in Georgia (1.44 and 2.05 respectively). Specific emissions of SO_2 per capita in Estonia in 1999 were 73.56 kg per capita. In 2001 the highest specific emissions of NO_x from stationary and mobile sources per capita of the EECCA countries considered were found in the Russian Federation (25.02 kg per capita). Per unit of GDP, the highest were in Belarus (11.05 kg per 1 000 US$ GDP). By either measure, the lowest were found in Georgia (9.99 kg per capita and 3.25 kg per 1000 dollars US GDP). In comparison, specific emissions of NO_x per capita in Denmark in 1999 were 41.36 kg per capita.

[4] *Europe's Environment: The Third Assessment*, EEA. Copenhagen, 2003

Fig. 2. Indicators of GDP eco-efficiency in Belarus, 1999-2002

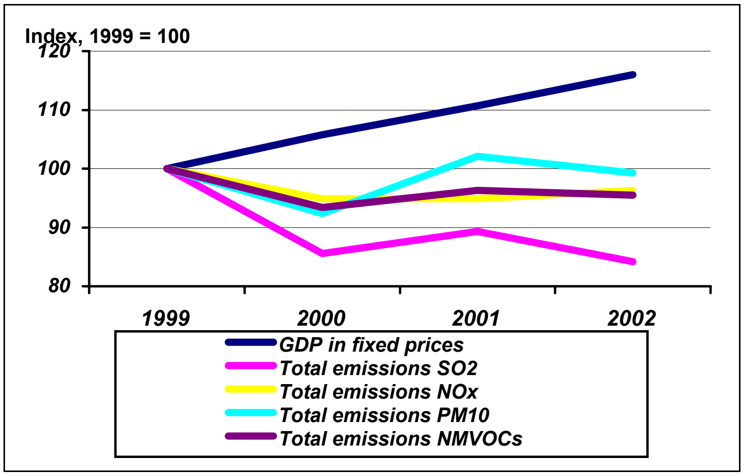


Fig. 3. Indicators of GDP eco-efficiency in Georgia, 1999-2002

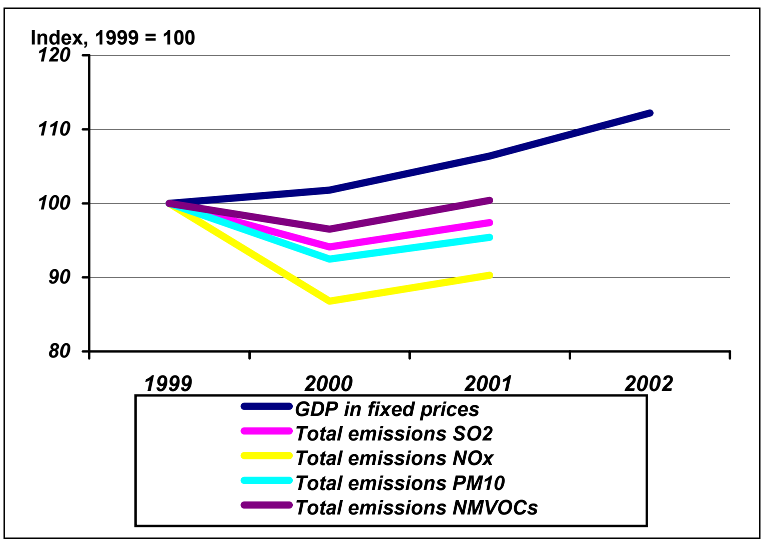


Fig. 4. Indicators of GDP eco-efficiency in the Russian Federation, 1999-2002

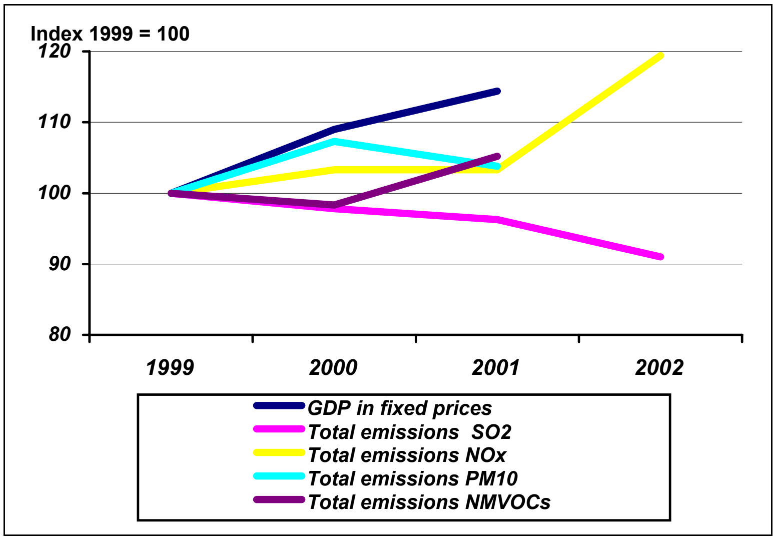
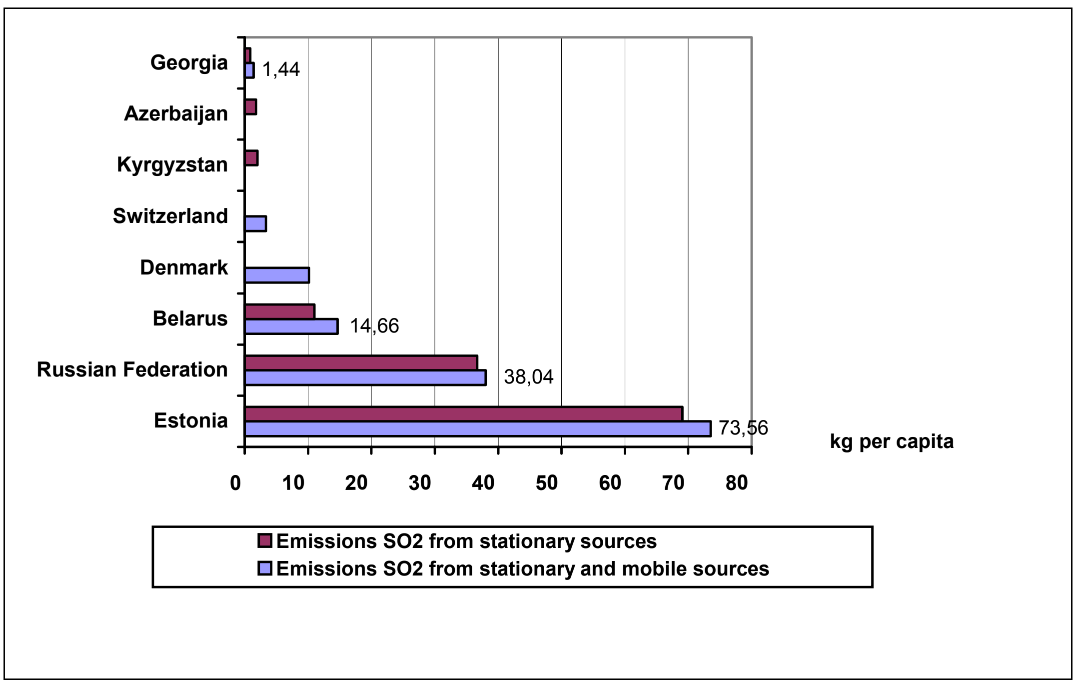


Fig. 5. SO_2 emissions per capita, 2001*



*Data for Switzerland, Estonia and Denmark refer to 1999 (Europe's Environment: The Third Assessment, EEA. Copenhagen, 2003)

Fig. 6. SO_2 emissions per unit of GDP, 2001

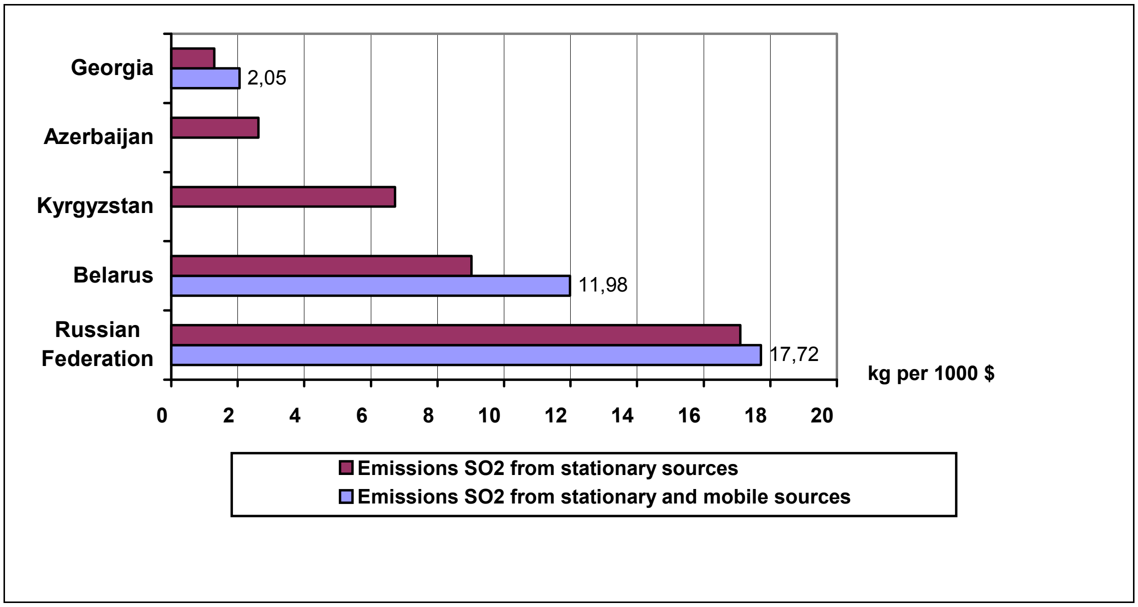
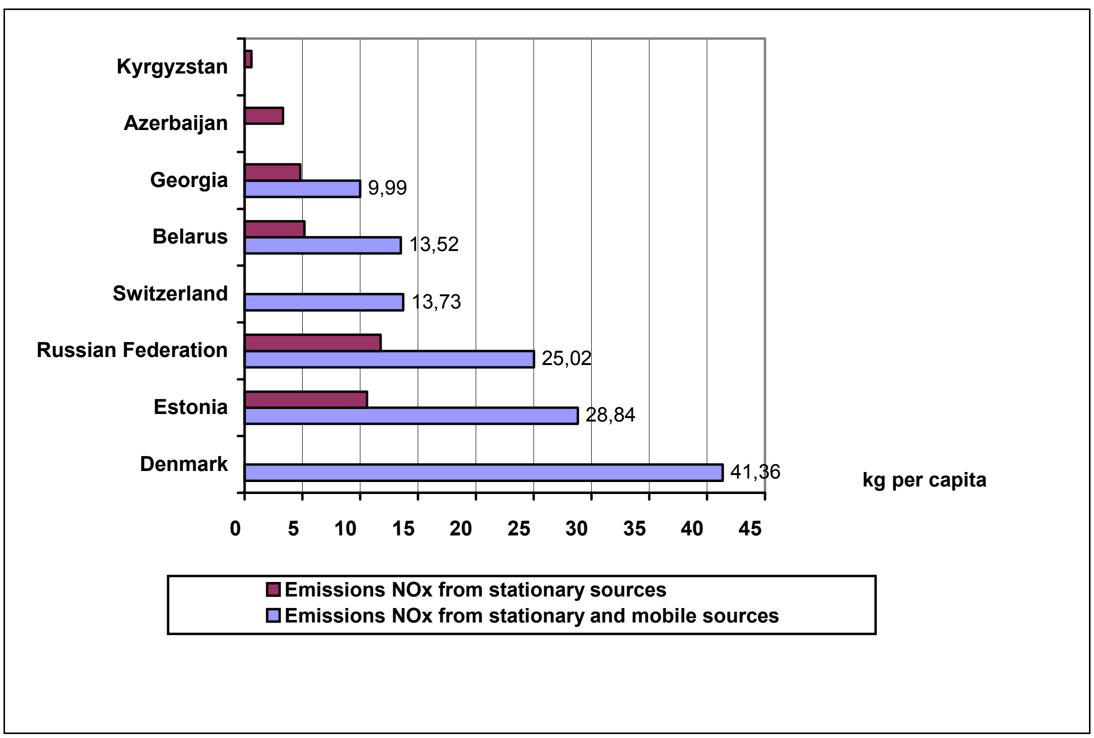
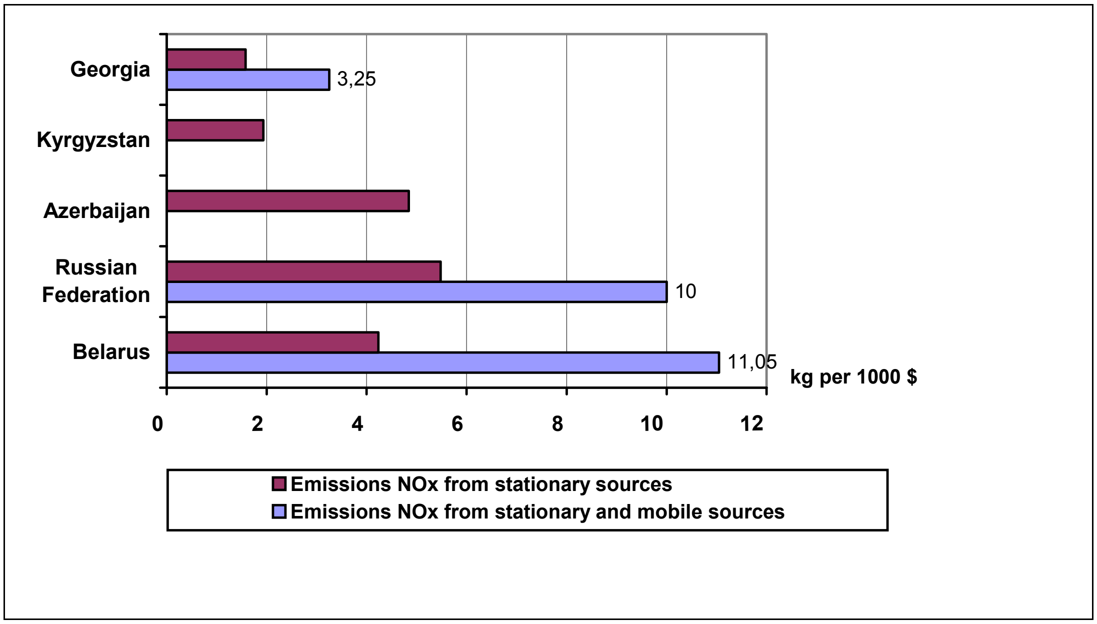


Fig. 7. NO_x emissions per capita, 2001*



*Data for Switzerland, Estonia and Denmark refer to 1999 (Europe's Environment: The Third Assessment, EEA. Copenhagen, 2003)

Fig. 8. NO_x emissions per unit GDP, 2001



Environmental indicators:

- ***Energy-related emissions of SO_2 (APE5b);***
- ***Energy-related emissions of NO_x (APE6b);***
- ***Energy-related particulate emissions (APE9c);***
- ***SO2 emissions intensity from power production (APE5c rev);***
- ***Emissions intensity of NOx from power production (APE6c rev);***
- ***Share of renewable electricity in gross electricity consumption (EE27).***

These indicators are also given in terms of eco-efficiency: specifically, the eco-efficiency of power (electricity) production (see Fig 9, 10, 11 and 12).[5]

Power utilities are among the main stationary sources of atmospheric pollution in the countries considered. For example, in Kyrgyzstan in 2002, the energy sector accounted for 93.1% of SO_2 emissions, 83.9% of NO_x emissions and 80.7% of particulate emissions from stationary sources; in Belarus - 68.3%; 78.4% and 27.6% respectively, in Russian Federation - 23.5%, 51.3% and 33.5% respectively.

As can be seen in fig. 11, the production of electric energy in Belarus is becoming cleaner: a trend of reduction in emissions of SO_2 and NO_x is observed over the whole time interval under study and the same applies to particulate emissions in 2001 and 2002. In other countries such positive trends have not occurred as yet.

[5] Data on electricity production are taken from: Commonwealth of Independent States in 2000. Statistics reference book. Intergovernmental Statistics Committee of the Commonwealth of Independent States, Moscow 2001; Commonwealth of Independent States in 2002. Statistics reference book; Intergovernmental Statistics Committee of the Commonwealth of Independent States, Moscow 2003

Fig. 9. Indicators of energy eco-efficiency in Belarus, 1999-2002

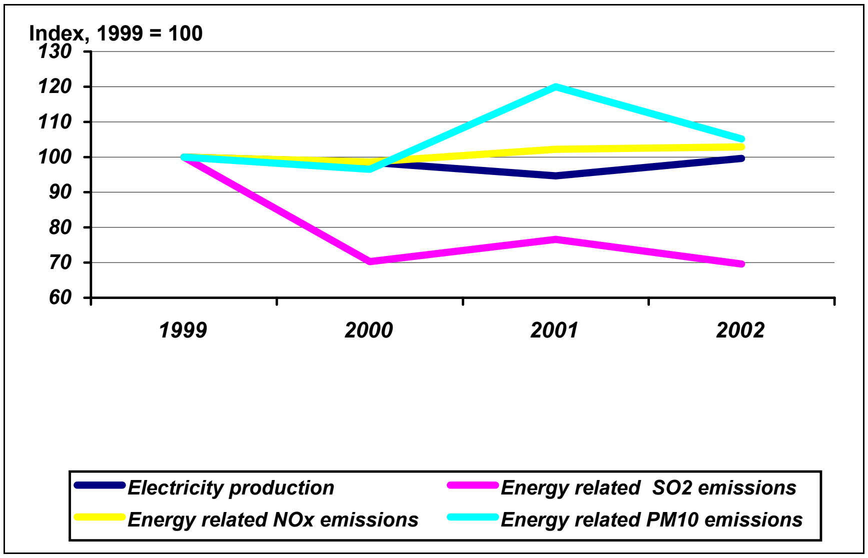


Fig. 10. Indicators of energy eco-efficiency in Georgia, 1999-2002

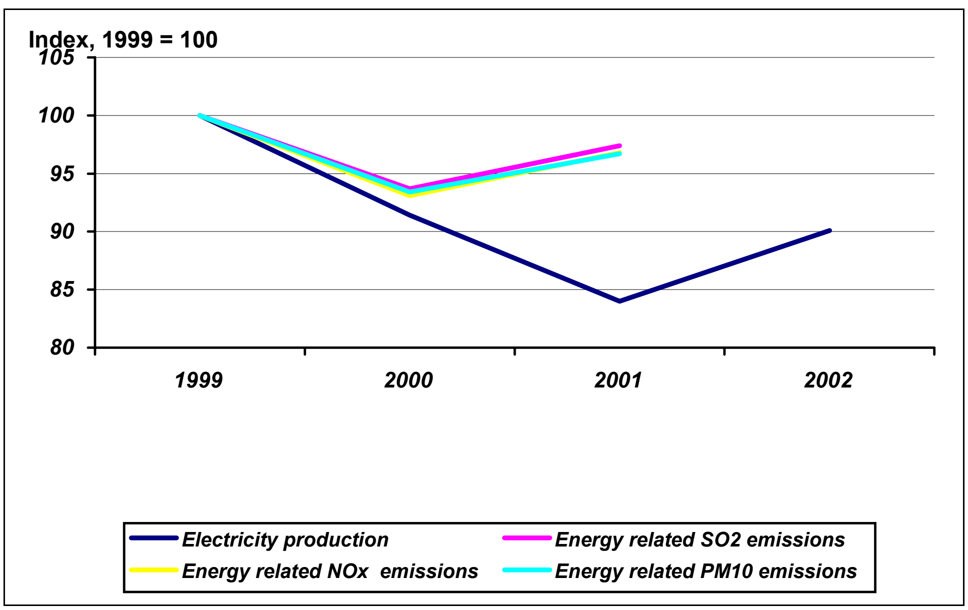


Fig. 11. Indicators of energy eco-efficiency in the Russian Federation, 1999-2002

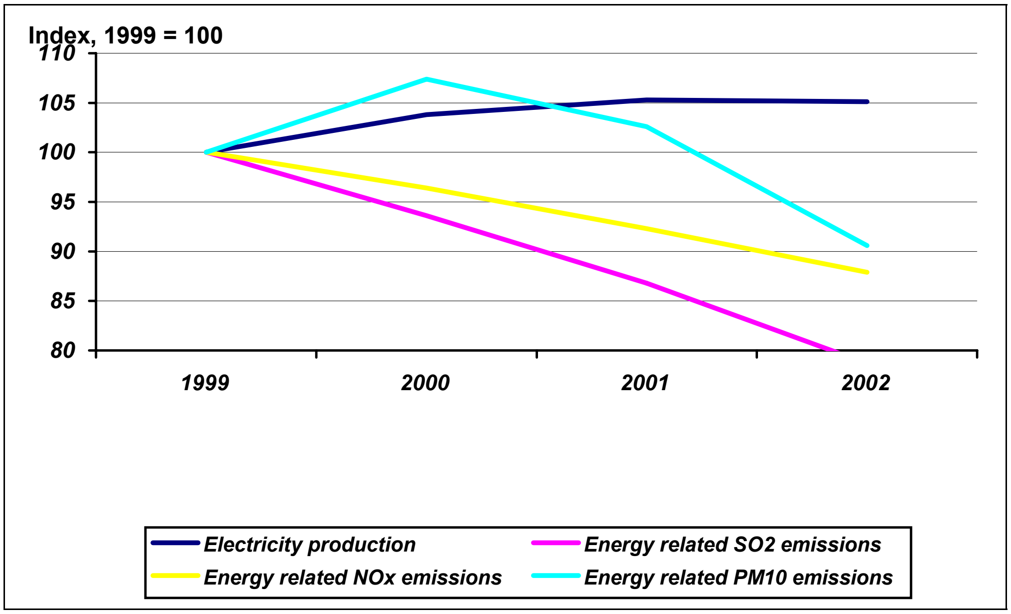
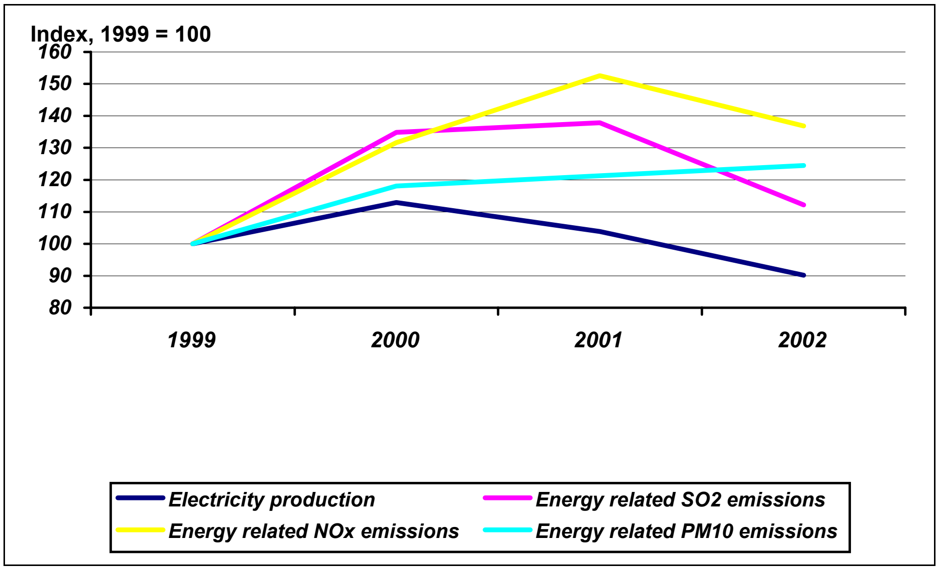


Fig.12. Indicators of energy eco-efficiency in Kyrgyzstan in 1999-2002



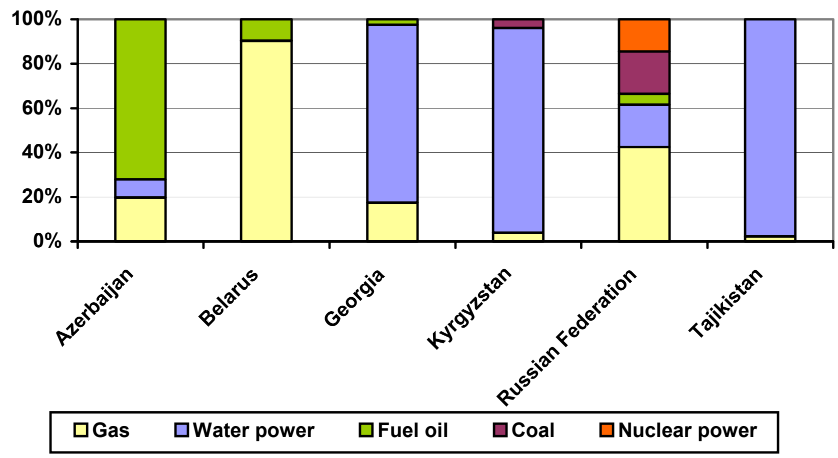
Of the countries considered, the highest proportion of renewable energy sources (hydropower included) used in electricity production in 1999 was found in Tajikistan (97.7%). The proportion is 92.3% in Kyrgyzstan, 80.1% in Georgia 19.0% in Russian Federation, 8.3% in Azerbaijan, 0.1% in Belarus (see table 2).

Table 2. Structure of electricity production in 1999, percentage

	Sources of electricity production				
	Hydro	**Coal**	**Fuel oil**	**Gas**	**Nuclear**
Azerbaijan	8,3	−	72,0	19,8	−
Belarus	0,1	−	9,6	90,0	−
Georgia	80,1	−	2,5	17,4	−
Kyrgyzstan	92,3	3,9	−	3,9	−
Russia	19,0	19,1	4,8	42,4	14,4
Tadjikistan	97,7	−	−	2,3	−

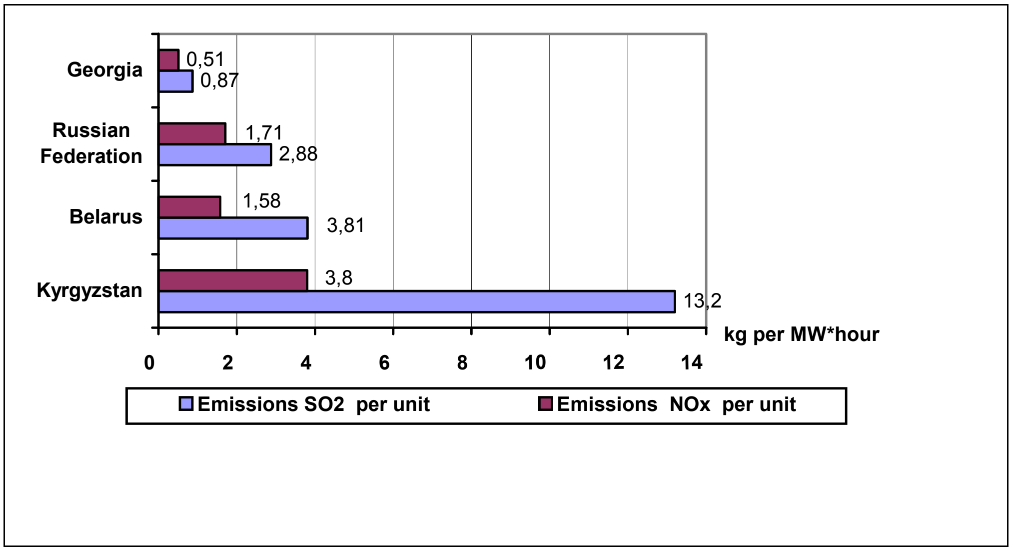
Source: World Development Indicators 2002. The World Bank.

Fig. 13. Structure of electric energy production in 1999



To calculate the intensity of emissions per unit electric power produced, it was necessary to determine the amount of electricity produced from fossil fuel. For this purpose, data on the structure of electric energy production were used (table 2 and fig. 13). Unfortunately, given the time limitations of the project, such data were available for 1999 only and therefore the intensity of energy-related emissions of SO_2 and NO_x could be calculated for this year only (see fig. 14).

Fig. 14. Intensity of energy-related NO_x and SO_2 emissions, 1999



Indicators:

- ***Transport air emissions (NOx, NMVOCs, PM10 and SO_2) (APE4arev);***
- ***Freight transport demand by mode (TERM13rev);***
- ***Passenger transport by mode (TERM12 rev).***

The share of mobile sources in total atmospheric pollution is significant. For example, in Belarus in 2002, transport accounted for 25.5% of total SO_2 emissions, 36.8% of PM10 emissions, 60.1% of NO_x emissions and 76.5% of NMVOC emissions. In Georgia in 2001, the values were 36.9% of SO_2 emissions, 31.3% of PM10 emissions, 51.6% of NO_x emissions and 89.4% of NMVOC emissions. In the Russian Federation in 2002, mobile sources accounted for 36.3% of SO_2 emissions and 54% of NO_x emissions; the data on emissions of PM10 and NMVOC refer to 2001 and are 4% and 36.1% respectively.

The indicators are expressed in terms of the eco-efficiency of transport[6] (see fig. 15, 16 and 17). For the transport development indicators, it seems most appropriate to use tonne/km for freight demand and passenger/km for passenger demand, as done for Belarus and Georgia. For the Russian Federation, however, the transport development indicators use tonnes for freight demand and total number of passengers for passenger demand.

[6] Data on transport are taken from the following sources: Statistics Annual Book of South Caucasus countries: Armenian, Azerbaijan, Georgia, 2002. Published by "Sada", Statistics of SNG,2 (305); Intergovernmental Statistical Committee of the Commonwealth of Independent States, Moscow January 2003; Republic of Belarus in numbers, Brief statistical compendium Minsk: Ministry of Statistics and analysis of the republic of Belarus, 2003; Commonwealth of Independent States in 2000. Statistical reference book; Intergovernmental Statistical Committee of the Commonwealth of Independent States in 2002. Statistical reference book. Intergovernmental Statistical Committee of the Commonwealth of Independent States, Moscow 2003

Fig. 15. Transport eco-efficiency in Belarus, 1999-2002

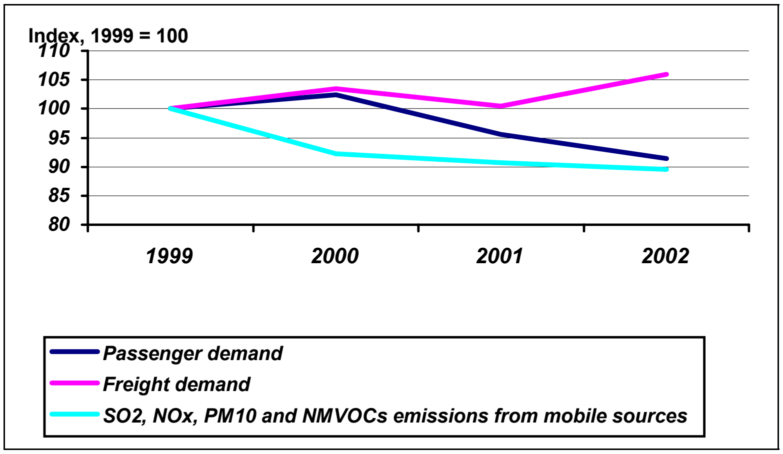


Fig. 16. Transport eco-efficiency in Georgia, 1999-2002

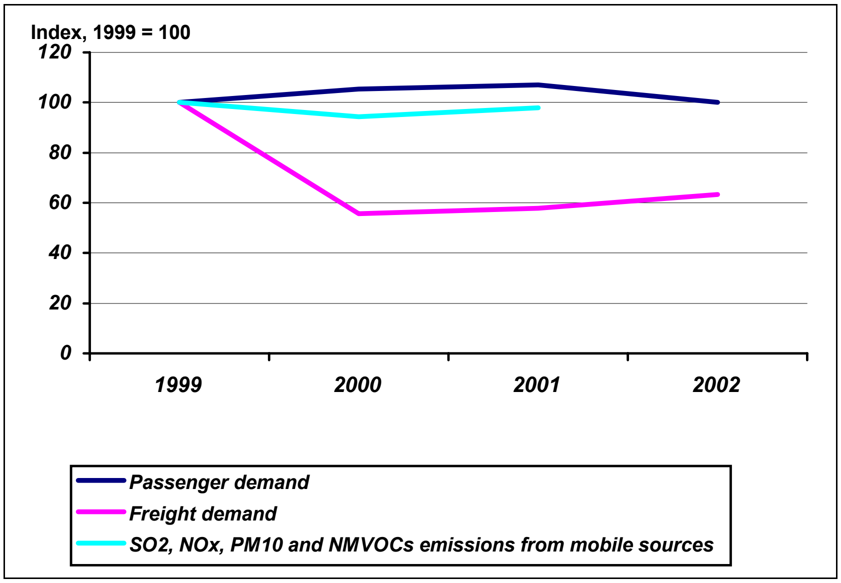
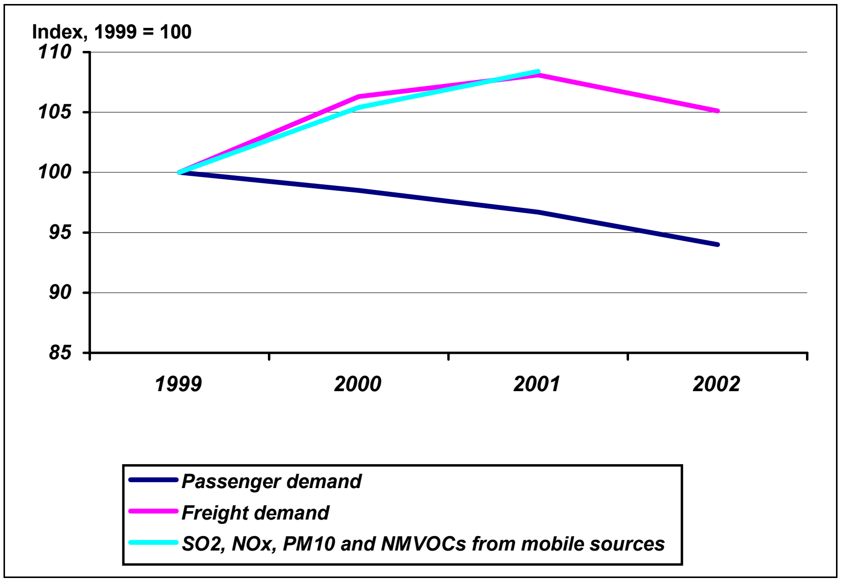


Fig. 17. Transport eco-efficiency in the Russian Federation, 1999-2002



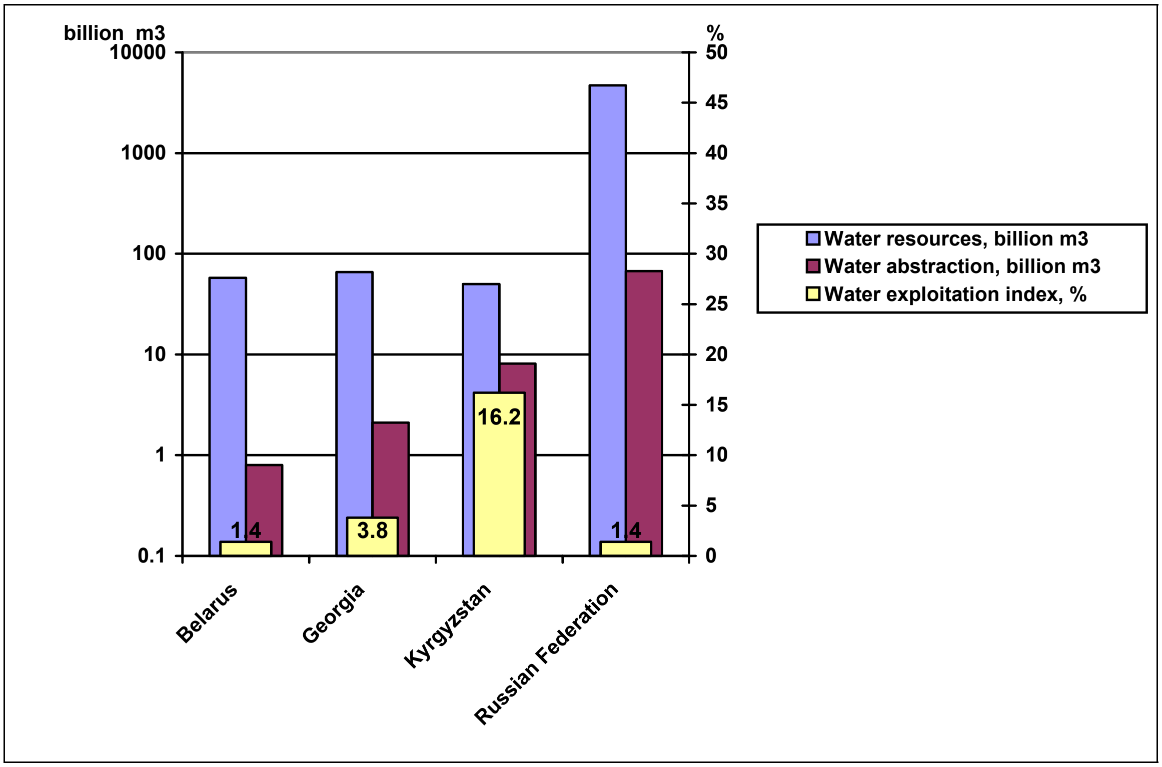
Theme: Water quantity.

Indicators:

- ***Freshwater resources (surface and groundwater) (WQ1a rev);***
- ***Total water abstraction (WQ1b);***
- ***Water exploitation rate (WQ1c).***

Water stress for surface waters is shown in fig 18. According to the classification used to characterize water balance in the Kiev report, countries with an unstressed water balance are those with a rate of water exploitation less than 10%. Countries with a water exploitation rate from 10% to less than 20% are referred to as weakly stressed and those with a rate varying from 20% and under 40% are considered to be countries with a stressed water balance. Above 40% are countries with a strongly stressed water balanced. Thus, Belarus, Georgia and Russian Federation belong to the first, unstressed, group (this does not, however, consider water stress at sub-national level); Kyrgyzstan is among those countries with a weakly stressed water balance.

Fig.18. Water stress in 1999-2002*



Note: Left vertical scale is the logarithmic scale (billion m^3).
* Belarus – for 2000, Georgia – for 2000, Kyrgyzstan and Russian Federation – for 2002.

Environmental indicators:
- ***Water use (total and by sector) (WQ02e new);***
- ***Domestic (household) water consumption per capita (WQ02f new).***

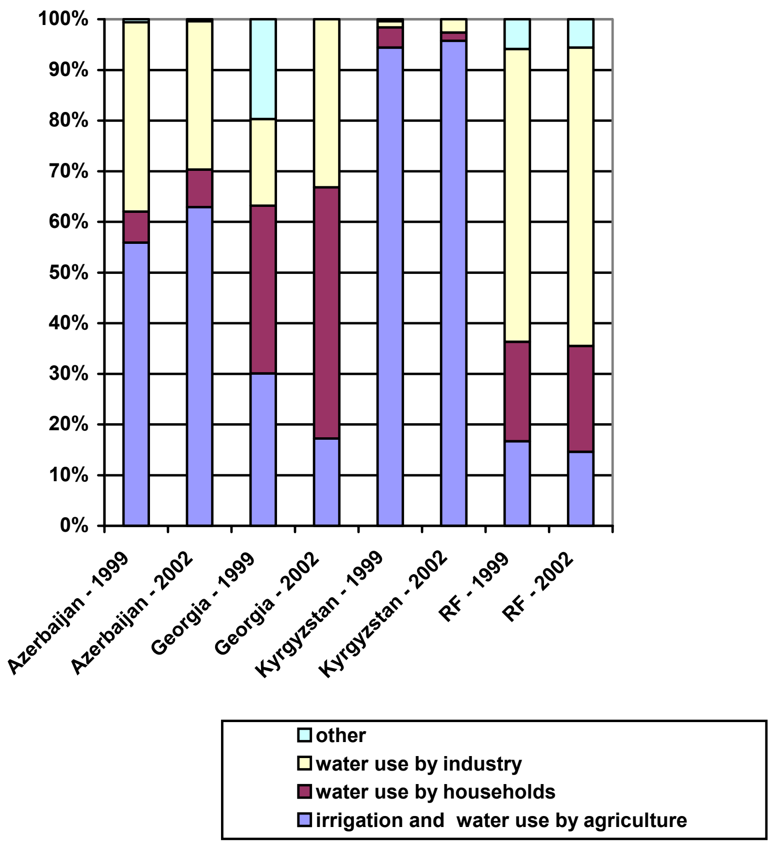
The total water exploitation index is shown as the structure of water consumption by sector in 1999 and 2002 (see Fig 19), in the form of linear plots showing changes in volumes of water consumption by sector in 1999-2002 (see Fig 20, 21, 22 and 23) and as intensity of total water use per capita in 1999 and 2002.

In the European Union, total water consumption per capita per year varies from 200 m^3 in countries in which water use by the domestic sector (households) is the primary water use mode, to 500 m^3 in the countries with a high proportion of water used by industry, energy and agriculture.[8] In the EECCA countries considered, this indicator varies from 170 m^3 in Belarus, where almost half (46%) of water was used by households in 2000, to 1091 m^3 in Kyrgyzstan, where 96% of water in 2002 was used by agriculture (including irrigation) and only 2% by households. In Azerbaijan a large share of water was used for irrigation in 2002 (63%), followed by for industry (29%); only 7.4% was used by households; and the total water exploitation index was 830 m^3 per capita per year. In the Russian Federation in 2002, about 60% of water was used by industry, 21% by households and the total water exfoliation index is 453m^3 per capita per year. In Georgia, official data include water use by hydropower, and therefore to ensure comparability with other countries,

[8] *Environmental signals 2002*, EEA, Copenhagen 2002.

water use by hydropower was not taken into account. Following this approach, in Georgia in 2002, 50% of water was used by households, 33% by industry, and the total water exploitation index was 175 m^3 per capita per year. This indicator fell significantly from its 1999 value, when it was 242 m^3 per capita per year, whereas in other countries changes were not so noticeable: in the Russian Federation, the reduction was from 464 to 453 m^3 per capita per year, in Azerbaijan and Kyrgyzstan, there was an increase, which was insignificant (see Fig 24).

Fig. 19. Water consumption structure, 1999 and 2002



Note: for Georgia, water use by hydropower was not taken into account.

[10] Europe's environment: the third assessment. EEA, Copenhagen, 2003.

Fig. 20. Water exploitation index by sector in Azerbaijan, 1999-2002

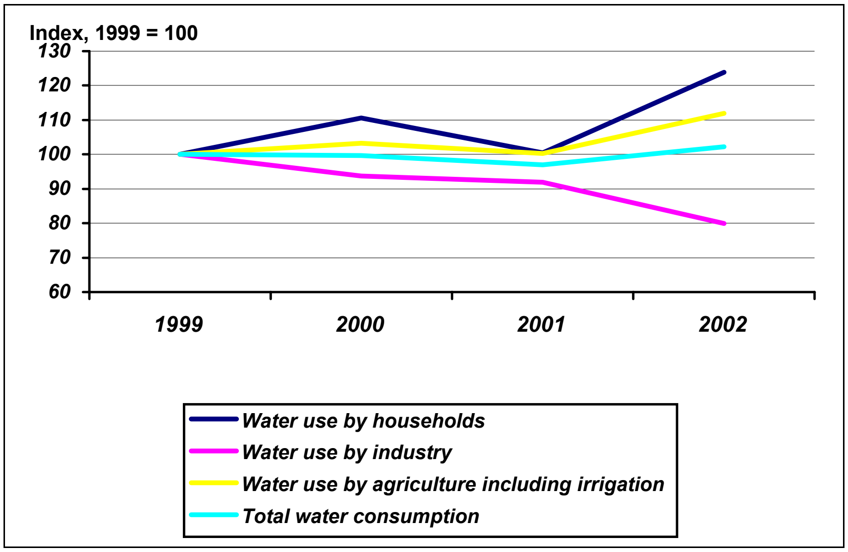
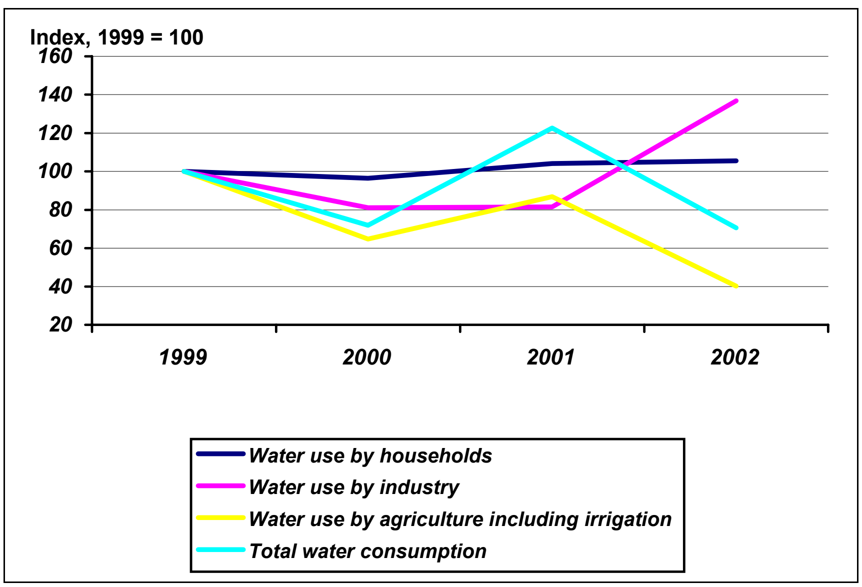


Fig. 21. Water exploitation index by sector in Georgia, 1999-2002



Note: Water use for hydropower was not included.

For four countries – Azerbaijan, Georgia, Kyrgyzstan and Russian Federation – the household water exploitation index per capita was calculated for 1999 and 2002. This indicator decreased only in Kyrgyzstan, from 43 to 19 m^3 per capita per year. In the other countries there was an increase in per capita domestic (household) water use during this time period: by 22% (from 51 to 62 m^3 per capita) in Azerbaijan, by 9% (from 80 to 87 m^3 per capita) in Georgia and by 4% (from 91 to 95 m^3 per capita) in the Russian Federation (see Fig 25). By comparison, in countries now acceding to the

European Union, urban water use (for households and enterprises using centralized water supply system) is about 100 m^3 per capita per year.[10]

Fig .22. Water exploitation index by sector in Kyrgyzstan, 1999-2002

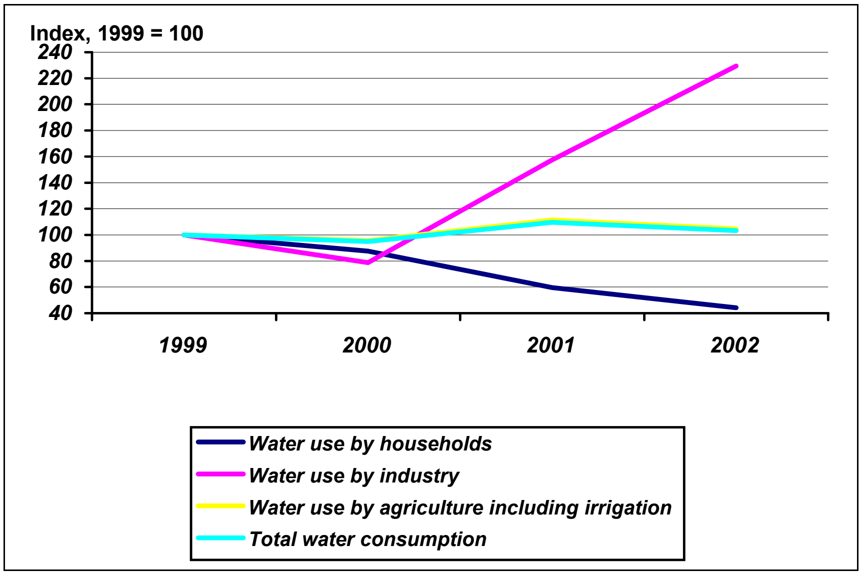


Fig. 23. Water exploitation index by sector in the Russian Federation, 1999-2002

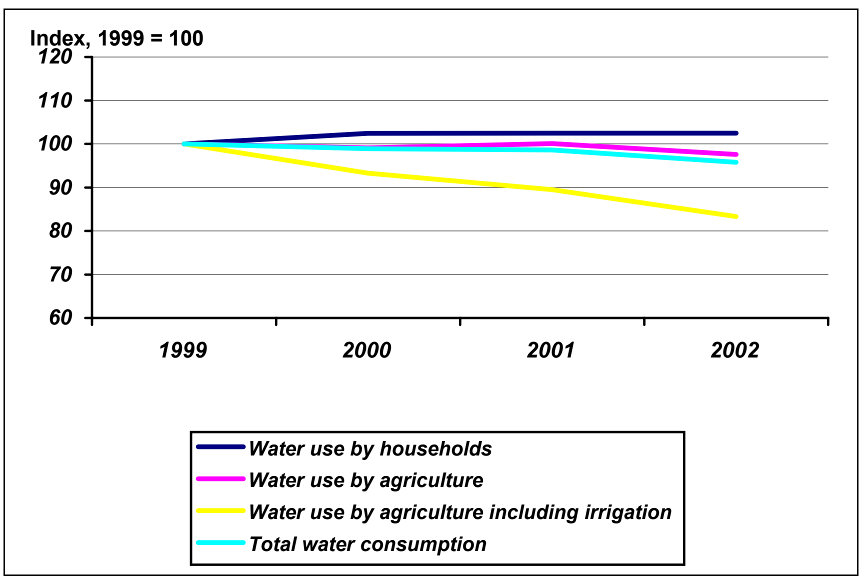
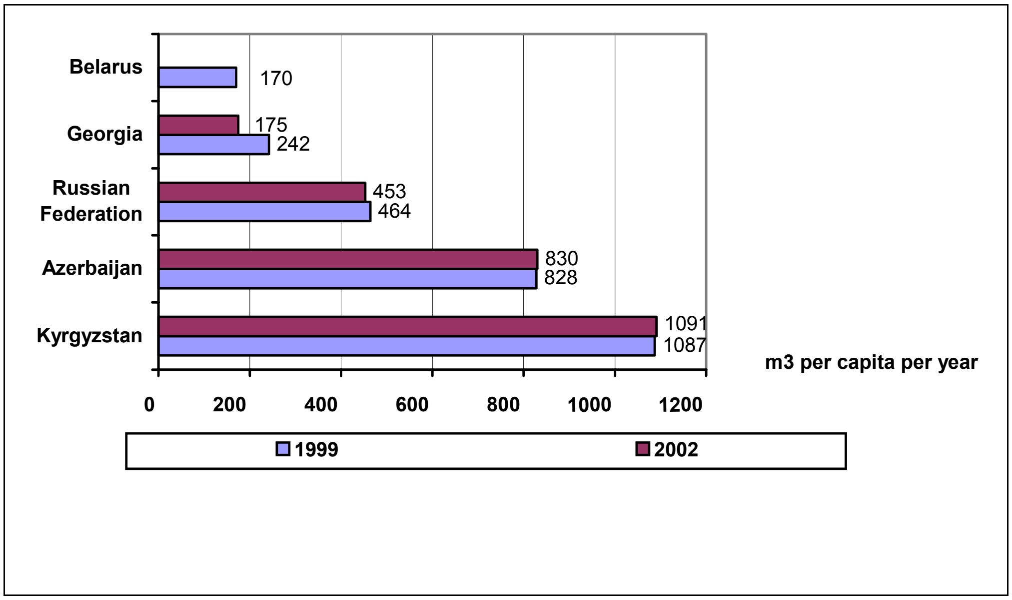
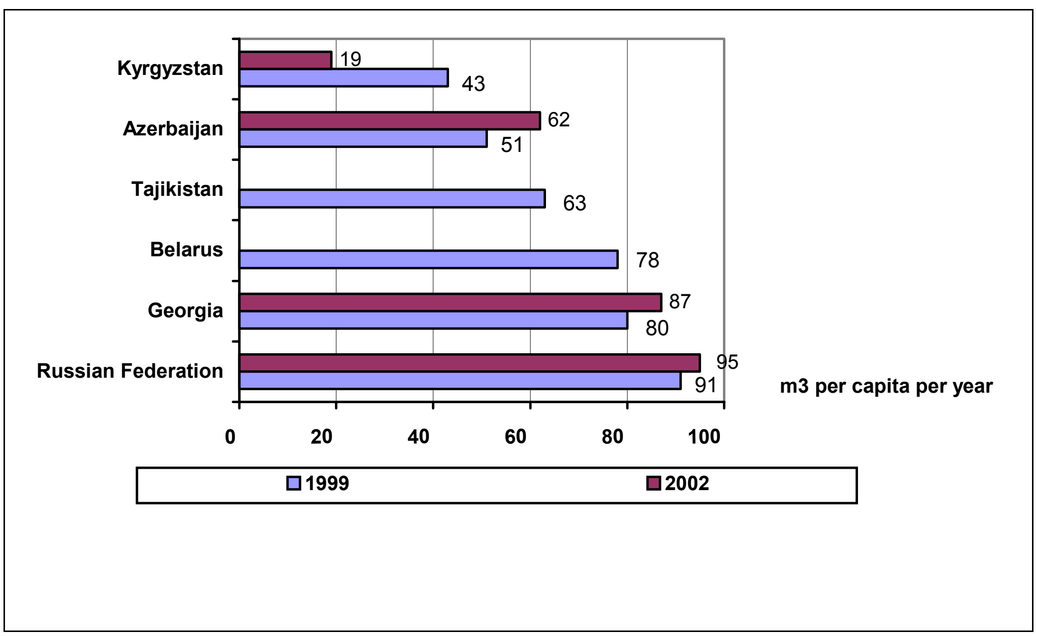


Fig. 24. Intensity of total water use in 1999 and 2002



Note: for Georgia, water use by hydropower was not included. Data for Belarus are for 2000. (Source: State of Environment in the Republic of Belarus: National Report, Ministry for Natural Resources and Environmental Protection of the Republic of Belarus, Minsk, 2002).

Fig. 25. Water exploitation index by households in 1999 and 2002



Note: Data for Belarus are for 2000 (Source: State of Environment in the Republic of Belarus: National Report, Ministry for Natural Resources and Environmental Protection of the Republic of Belarus, Minsk, 2002).

Indicators:
- ***Water use by households (WQ02c);***
- ***Water use by agriculture (WQ02a);***
- ***Water use by industry (WQ02b).***

These indicators are shown in fig. 26, 27 and 28 as linear plots of water exploitation indices by sector.

Fig. 26. Water exploitation indices by sector in Azerbaijan, 1999-2002

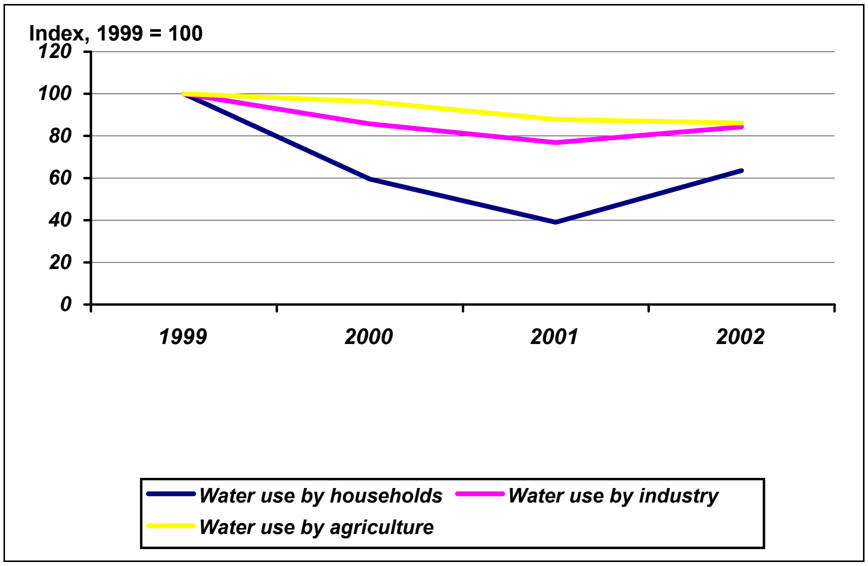


Fig.27. Water exploitation indices by sector in Georgia, 1999-2002

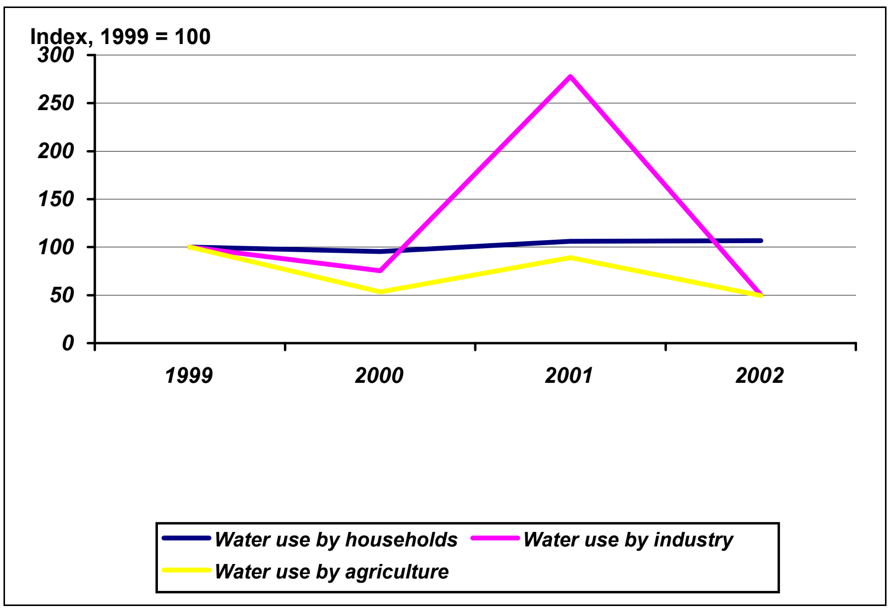
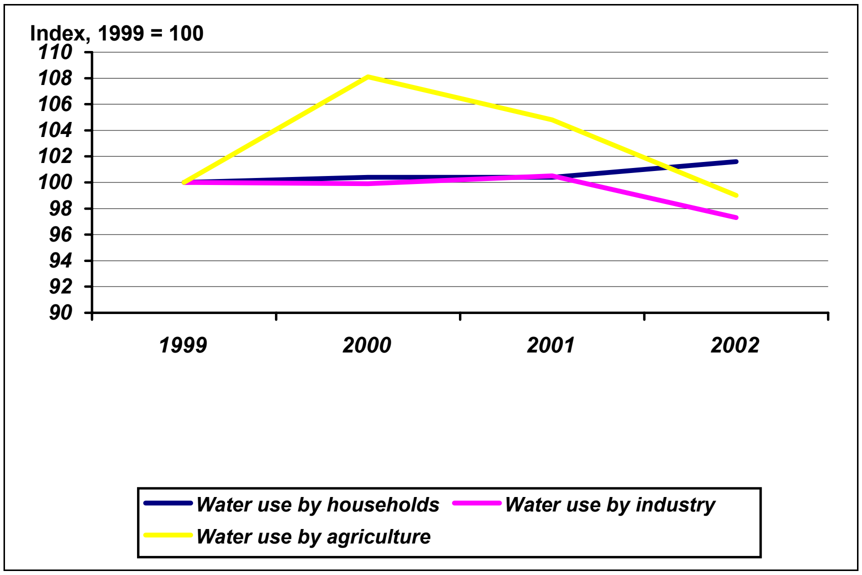


Fig.28. Water exploitation indices by sector in the Russian Federation, 1999-2002



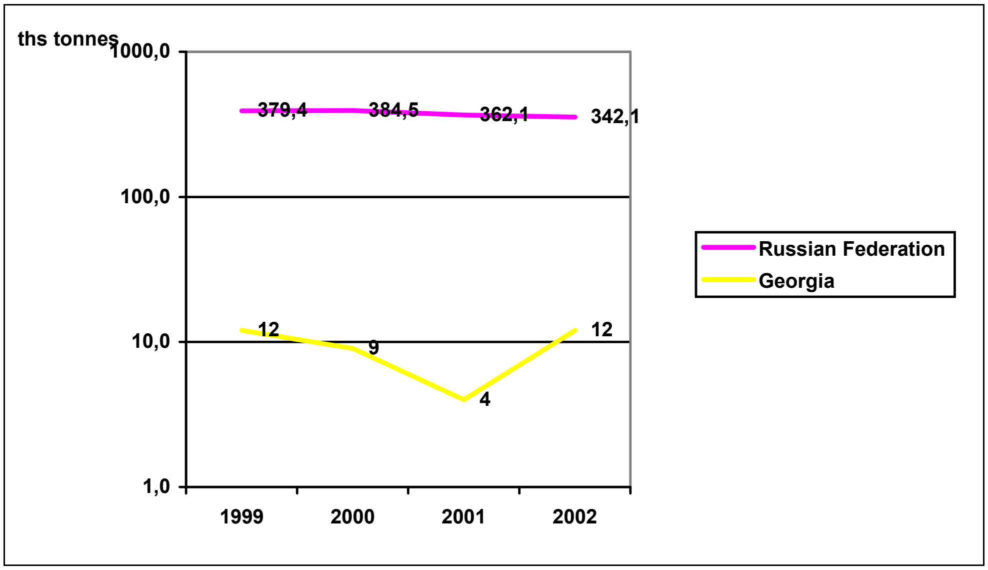
Topic: Water - nutrient and organic matter pollution

Indicator:

- ***Emissions of organic matter by BOD (WEU8 rev)***

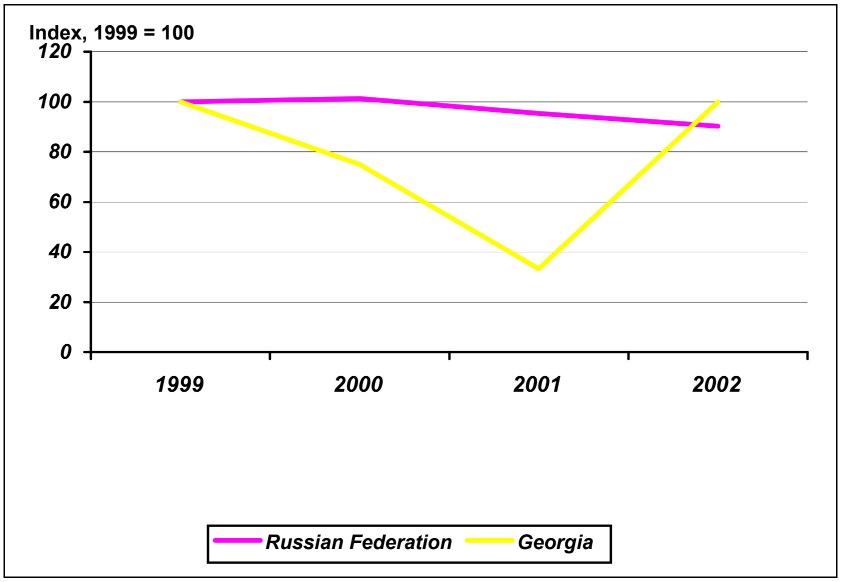
This indicator is shows trends in absolute emissions (Fig 29) and trends in emission indices (Fig 30) for two countries, Georgia and the Russian Federation.

Fig. 29. Emissions of organic matter by BOD, 1999-2002



Note: Vertical axis is the logarithmic scale.

Fig.30. Indices of emissions of organic matter by BOD, 1999-2002



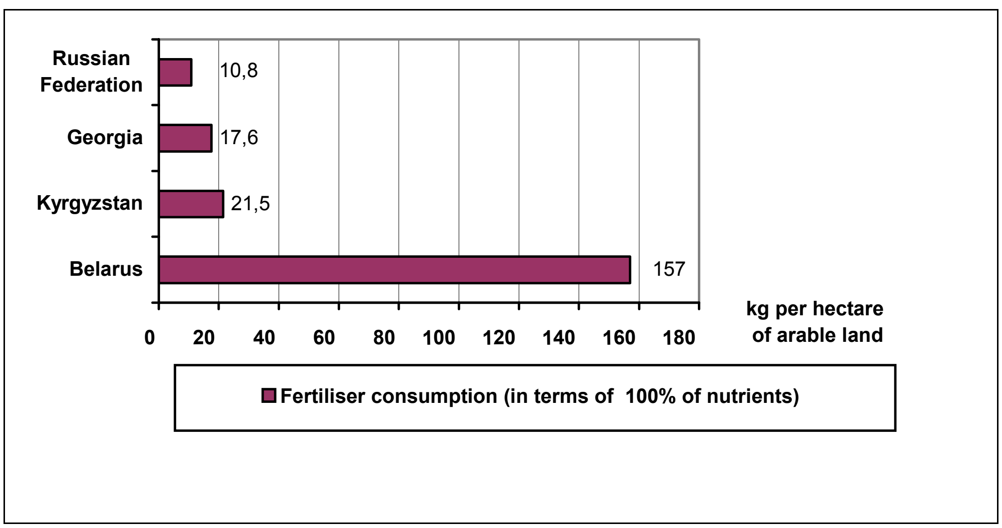
Topic: Agriculture

Indicator:

- ***Fertiliser consumption (AGRI7)***.

Fig.31 shows this indicator as the intensity of the application of mineral fertilizers in terms of active ingredient per hectare of arable land.

Fig. 31. Intensity of application of mineral fertilizers in 1999



Topic: Biodiversity –Habitat and biodiversity

Indicator:
- ***Total area of designated areas (BDIV10a rev)***

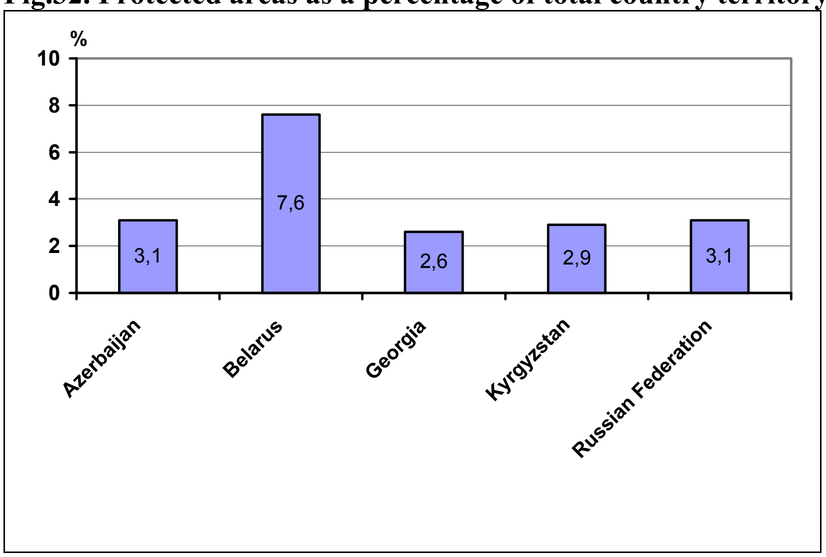
The indicator provides the total area of protected territories (see Table 3) and as percentage of these in terms of total country territory.

Table 3 Protected areas (as of 01.01.2002*)

	Area, thousand hectares	Percentage of total country territory
Azerbaijan	272,2	3,1
Belarus	1573,3	7,6
Georgia	181,2	2,6
Kyrgyzstan	576,6	2,9
Russian Federation	53049,0	3,1

* Belarus- as of 01.01.2001.

Fig.32. Protected areas as a percentage of total country territory

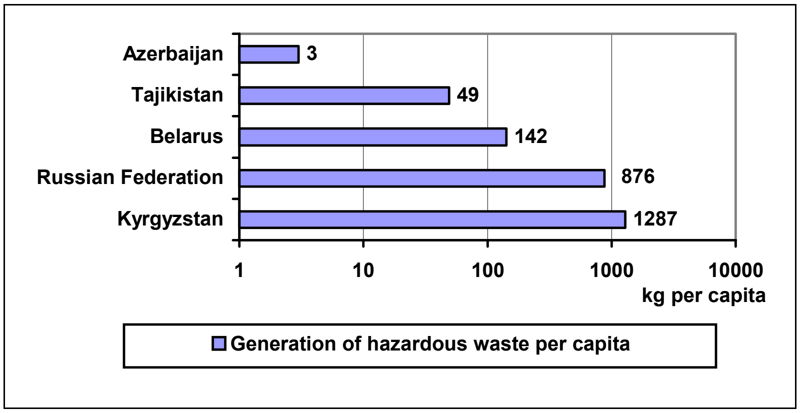


Topic: Waste

Indicator:
- ***Generation of hazardous (toxic) waste (WMF13rev).***

This indicator presents the intensity of generation of hazardous waste per capita (see Fig 33). The largest amount of toxic waste in 2000 was generated in Kyrgyzstan, 1287 kg per capita. In the Russian Federation, the value was 876 kg per capita. Of the countries considered, the least amount of toxic waste per capita was generated in Azerbaijan, 3 kg.

Fig. 33. Intensity of generation of hazardous waste in 2000

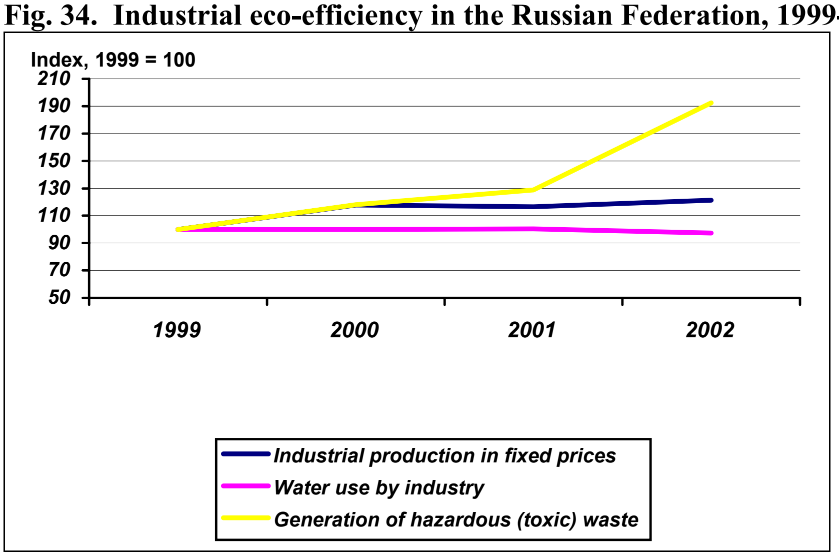


Note: The horizontal axis uses logarithmic scale

Topic: eco-efficiency

The Compendium also tested two eco-efficiency indicators. Fig. 34 shows, for the Russian Federation, an index of industrial eco-efficiency relating the environmental indicators "Water use by industry" and "Generation of hazardous waste" to the economic indicator "Industrial production in fixed prices".[11] It may be noted that in 2002, a positive trend appears in water use by industry: the industrial production index and index of water use by industry diverge. In other words, the growth of industrial production occurs with a decrease in water use.

Fig. 34. Industrial eco-efficiency in the Russian Federation, 1999-2002



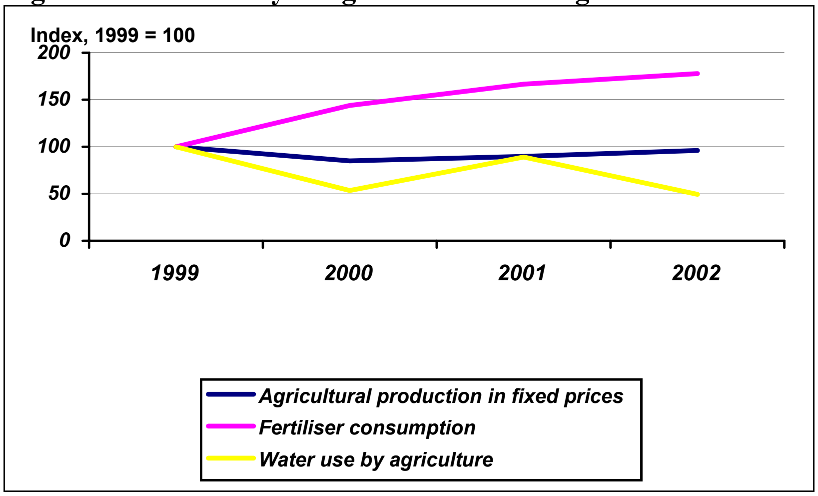
Note: The sharp increase in generation of hazardous waste in 2002 as compared to 2001 is explained by changes in the reporting system: prior to 2002, toxic waste was reported according to four classes of hazard; the new reporting form introduced in 2002 added a the fifth class, "practically non-hazardous".

Another index was developed for Georgia: an index of the eco-efficiency of agriculture. This relates the environmental indicators "Water use by agriculture" and "Use of mineral fertilizers" to

[11] It would be more appropriate to use the economic indicator of "Added value by industry"

the economic indicator "Agricultural produce in fixed prices ".[12] It should also be noted that in 2002, the value of agricultural produce grew while water use declined (see Fig 35).

Fig. 35. Eco-efficiency of agriculture in Georgia in 1999-2002.



Conclusions

The environmental indicators presented in this Compendium provide a basis for concluding that existing environmental and economic reporting in EECCA countries allows the application, even today, of some of the environmental indicators used by EEA in preparing the Kiev report and its Environmental Signals reports. These indicators are also used in other European countries. Moreover, these indicators can be presented in a comparable visual form. In order to ensure cross-country comparability of these indicators, information sheets need to be prepared with detailed descriptions of each indicator, methods for their collection, monitoring systems required for data collection, and environmental standards or policy targets for use in their comparison.

Some of the indicators considered might be used in national reports on the state of the environment, or in annexes to such reports, and specifically targeted at decision makers at the national, sub-national or sectoral level, as well as the general public. This applies particularly to the eco-efficiency indicators, which have proved to be an efficient means of communication in other countries.

[12] It would be more appropriate to use the economic indicator of "Added value by agriculture"