

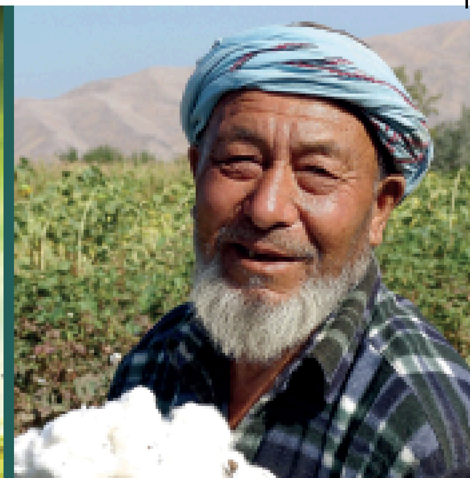

Resource Efficiency:

Economics and Outlook for Eastern Europe, Caucasus and Central Asia

UNEP

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List of contributors

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Foreword

This timely report on **"Resource Efficiency: Economics and Outlook for Eastern Europe, the Caucasus and Central Asia (REEO for EECCA)"** is one of a series of UNEP studies*, following a similar analytic methodology, that attempt to provide a greater understanding of what underlies resource efficiency issues in this large and rapidly evolving region of the world. The report is comprised of a brief executive summary and introduction to the topic; an in-depth analysis of material flows and resource efficiency at both the country and regional level; a close-up examination of water use and efficiency in the region; and finally, an analysis of policies relating to natural resource management and use across the region. As described in Chapter 2, the 12 EECCA countries covered by this report are quite diverse in terms of economic level and resource endowments, and thus exhibit different patterns of resource use (including for energy, fossil fuels and construction materials, among other natural resources), although all fall into the low- to middle-income categories.

In the broadest sense, resource efficiency can be defined as maximizing the supply of a particular asset or good, in order to function effectively and with the least wasted effort or expense. In terms of raw materials extracted from the earth and used to manufacture basic goods for human consumption and use, resource efficiency can be understood as achieving the maximum in terms of outputs, for the minimum amount of materials and energy inputs. Improving resource efficiency is inextricably connected with the concepts of a "green economy" and sustainable development (SD), as the overall goal of resource efficiency is to achieve decoupling of economic growth from resource use and environmental impacts.

There can be little doubt that one of the greatest challenges of the 21st century is to take into account the needs of an increasing - and wealthier - global population, while at the same time considering the finite limits of the planet's resource endowment (the concept of planetary boundaries). In this regard, improved resource efficiency can play a major positive role, assuring that "more can be served with less", and thus easing the pressure on our fragile environment. Given that current economic systems are both wasteful and inefficient, with production cycles leading to pollution and waste, there is much room for improvement.

We hope that you will find this "REEO for EECCA" report a useful baseline document for the ongoing discussion on resource efficiency issues and trends; how these affect the lives and livelihoods of the population within and beyond the EECCA region, as well as the physical environmental which is the basis for human well-being and sustainable development.

Ron WITT, UNEP/DEWA Regional Coordinator for Europe.

* - The other two reports in this UNEP series to date are "Resource Efficiency: Economics and Outlook for Asia and the Pacific" (UNEP and CSIRO-Australia, 2011) and "Resource Efficiency in Latin America: Economics and Outlook (case studies: Mercosur, Chile and Mexico)" (UNEP and MercoNet, 2011). It is planned to treat other regions in the coming years, and ultimately build a global reporting process covering the world as a whole, and in order to have a fuller picture of how resource efficiency issues and trends are evolving.

List of acronyms used in this report

CAREC	The Regional Environmental Center for Central Asia
DE	Domestic Extraction – Materials domestically extracted from the environment which are subsequently used in economic activity
DMC	Domestic Material Consumption (= DE – PTB)
DPSIR	Driving Forces–Pressures–State–Impact–Response framework
EECCA	Eastern Europe, the Caucasus and Central Asia
EW-MFA	Economy Wide Material Flow Accounts
FAO	Food and Agriculture Organization of the United Nations
GDP	Gross Domestic Product
GEO	Global Environment Outlook
GPP	Green Public Procurement
I	Impact (environmental), in IPAT analysis terminology. In this report, the environmental impact considered for the IPAT analyses is extractive pressure, so I = DMC
MEA(s)	Multilateral Environmental Agreement(s)
MFA	Material Flow Accounting
MI	Materials Intensity (= DMC / GDP)
NCSD	National Council of Sustainable Development
NGO	Non-Governmental Organization
PTB	Physical Trade Balance (Net Imports – Net Exports)
REEO	Resource Efficiency: Economics and Outlook
SCP	Sustainable Consumption and Production
SD	Sustainable Development
SoE	State of Environment (reports)
T	Technological coefficient, in IPAT analysis terminology. This is a measure of the environmental impact (I) generated per unit of income generated. For this study, T = DMC/GDP, and so is equivalent to MI
TACIS	Technical Assistance for the Commonwealth of Independent States (TACIS) programme
UNECE	United Nations Economic Commission for Europe
UNEP	United Nations Environment Programme

1 Summary

The report *Resource Efficiency: Economics and Outlook for Eastern Europe, the Caucasus and Central Asia* (REEO for EECCA) focuses on the demand for, and use of, selected natural resources both as drivers and as consequences of economic activity and social development. The report further analyses current state and trends in implementation of resource efficiency policies.

The report covers the period from 1992 onwards and addresses two types of resources: materials and related indicators as defined by international standards of material flow accounting (OECD 2008, Eurostat 2012), and water resources, which are of particular relevance for the EECCA region. The materials aspect is approached from a domestic resource use perspective.

The set of countries analysed in the report is quite diverse. While some EECCA countries are characterized by relatively high per capita GDP (Russian Federation, Kazakhstan), there are also some which lag considerably behind (Tajikistan, Kyrgyzstan) and the gap in income between the most developed and the poorest is high. Also, the endowment with resources and the role of natural resources in the economy differs greatly between these countries. These differences are reflected in material and water use as shown in the report.

The REEO assessment uses a pressure indicator framework for analysing interactions between socio-economic systems and their natural/physical environment. The accounts of materials and water compiled for the REEO are part of an effort to establish satellite accounts to Systems of National Accounts (SNA) on resource use. The data sets presented in this report have been established at the national economy scale on a country-by-country basis.

Natural resources form the basis of global and national economic production systems and underpin our quality of life, as they are needed to produce goods and services to satisfy human needs. One of the greatest challenges facing humanity in this century is to balance the demand of a growing and increasingly wealthy global population for natural resources with the planet's carrying capacity. Improving the efficiency with which we use natural resources plays a key role here. Improving resource efficiency means producing more amenities to increase quality of life with less resource consumption and lower environmental impacts. The concept of resource efficiency is related to the broader concept of sustainable development, which can be perceived as a desired end to achieve.

The overall goal of resource efficiency and related activities is to achieve decoupling of economic growth, or more broadly human wellbeing, from resource use and environmental impacts. Resource decoupling means reducing the rate of use of (primary) resources per unit of economic activity, while absolute impact decoupling refers to increasing economic output while reducing negative environmental impacts. The decoupling analysis has to consider a variety of factors. One of them is globalization, which leads to a growing international division of labour and spatial separation of production and consumption activities. A national economy may thus externalize particular stages of the production of its domestically consumed final goods and related environmental burden to other countries. Another issue is shared understanding that developing countries will need further economic and material growth to raise material standards of living and overcome poverty.

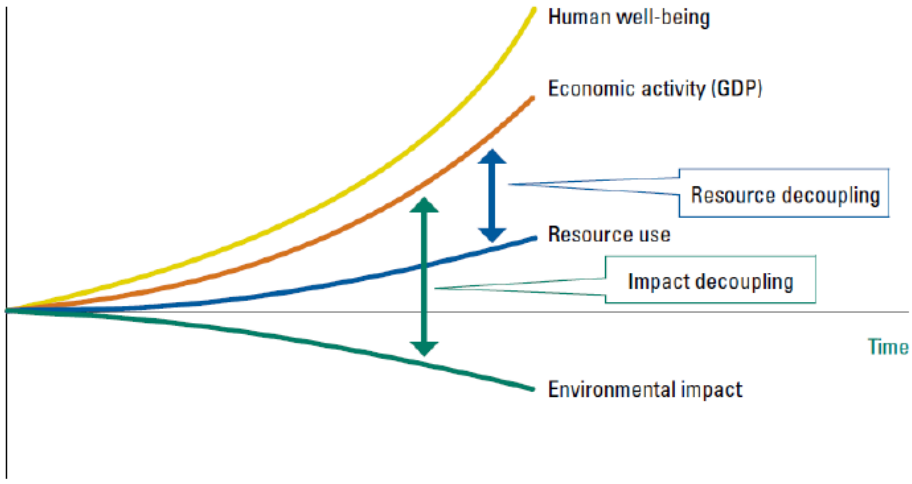


Figure 1: Stylized representation of resource and impact decoupling (Source: UNEP 2011b)

Improving resource efficiency can be beneficial both for developing and developed countries. It has the potential to (see UNEP 2011c):

- improve economic competitiveness and create new business opportunities
- preserve natural capital and local environmental quality
- ensure energy security and supply security of strategic materials
- tackle climate change, air pollution and waste problems
- help avoid social conflicts about resources
- pursue social benefits and improve living standards

EECCA countries belong to low-income and middle-income economies (WB 2013), which have recently undergone quite turbulent development, due both to the dismantling of the Soviet Union and the transition from centrally-planned to market economies. Due to these conditions, their resource-related policies have not been established or firmly settled yet. This means that there is a unique opportunity to integrate measures leading to resource-efficient solutions in policies that would respond to the observed issues.

Based on the in-depth analyses, the report conveys the following main messages:

1.1 Material flows and resource efficiency

- The EECCA region accounts for less than 6% of world consumption of primary materials, down from over 10% in 1992. This relative decrease in domestic consumption has been accompanied by a fourfold expansion of primary exports, arguably increasing the region's importance to the wider global economic system, even as its raw material inputs declined.

- All of the regional decrease in consumption of primary materials had occurred by the late 1990s, during a period of very strong economic contraction. Since that time, domestic consumption of primary materials has been growing strongly, largely driven by the input requirements of increasing primary exports. Not all EECCA countries, however, have been resource exporters and there is considerable heterogeneity within the region with regard to trade in natural resources. While Azerbaijan, Kazakhstan, the Russian Federation, Turkmenistan and to some extent also Uzbekistan have been net exporters of primary materials, many of the smaller economies depend on resource imports. This has led to differentiation among regional economies and has important implications for environmental and resource policies.

- The varying patterns of change in domestic consumption between different categories of primary materials during the post-Soviet economic contraction indicate that the full force of economic restructuring fell on those sectors which relied most on internal demand. Sectors with internationally marketable products remained relatively strong, and then led subsequent growth. It was largely primary commodities from EECCA which found international markets receptive.

- The region began the period 1992 to 2008 extremely inefficient at converting its primary resources to income, but improved its resource efficiency rapidly as the period progressed. Nevertheless, even the most resource-efficient countries in the region remain well below the World average, with some exhibiting materials intensities an order of magnitude higher than the World average.

- While depopulation in the EECCA region is among the most pronounced examples in the world, population dynamics have been relatively insignificant as a driver of total consumption.

- Changing per capita wealth was by far the strongest driver of changes in primary resource consumption during both the massive contraction of the early 1990s, and during the subsequent period of strong growth.

- Despite the region's exceptionally strong improvements in resource efficiency, and its depopulation dynamic, its consumption of primary commodities grew faster than the World average over the most recent decade examined.

- Materials freed up by gains in materials productivity within in the EECCA region are not being 'saved' as such, but rather being absorbed internationally, as EECCA becomes a much more important supplier of primary commodities, especially fossil fuels, to World markets.

1.2 Water use and efficiency

- Water withdrawals per capita differ significantly among EECCA countries. They are as high as 5.55 megalitres per capita for Turkmenistan, but only 0.41 and 0.42 megalitres per capita, respectively, for Georgia and Ukraine. While water withdrawals declined in the 1990s, the trend came to a halt or even reversed after 2000, quite similar to the development of material flows.

- 58.7% of total water withdrawals in EECCA countries were used in agriculture between 2003 and 2007, which represented 136,214 gigalitres. The second most demanding sector was industry with a share of 29.3% and a volume of 68,061 gigalitres, and the third was municipal water use with a share of 11.9% and water consumption of 27,627 gigalitres.

- The share of agricultural water use is highest in Turkmenistan, followed by Kyrgyzstan, Tajikistan and Uzbekistan. These countries are highly agrarian and their agricultural production is strongly dependent on irrigation. These countries also tend to have the highest water withdrawals per capita and by area.

- Water intensity for all EECCA countries is highest for agriculture (3102 litres per $US), followed by industry (368 litres per $US) and municipal water use (82 litres per $US). The average across all sectors is about 410 litres per $US. Water intensity in agriculture is especially high for those countries relying on extensive irrigation.

- For the entire region, the water abstraction rate is quite low at 4.6%. This is mostly due to the huge renewable water resources of the Russian Federation. Six out of twelve EECCA countries, however, suffer from water stress. It is especially severe in the arid countries of Turkmenistan and Uzbekistan where annual abstraction surpasses renewable water resources.

1.3 Natural resource policies

- Over the past decade, steps have been undertaken in the EECCA region to reform environmental institutions, policies and legislation. However, despite various strategies and action plans having been adopted, the EECCA countries have not yet developed or endorsed policies focusing on resource efficiency.

- Environmental legislation varies throughout the region, but in many cases needs further development, particularly in terms of implementation. The countries struggle with implementation and enforcement of environmental legislation due to a lack of administrative capacity and financial resources.

- Strategic planning and prioritization in natural resource management in light of scarce resources and competing needs continues to pose a challenge for all countries in the region. In developing environmental programmes, the involvement of stakeholders and building support for environmental reform are not always given sufficient attention. Implementation strategies are often missing.

- Only a few instruments for stimulating sustainable consumption and production (SCP) patterns among individual and corporate consumers exist. Despite the obvious current need and numerous international obligations, EECCA countries have no specific policies and action plans focusing on SCP issues.

- Irregular and non-systematic monitoring and data analysis are serious constraints to indicator-based reporting. Despite efforts involving a broad array of institutions, institutional coordination is weak and often results in incompatible data.

- Although many indicators exist to track resource use, only a few have been used to set targets. Similar to other countries, EECCA countries tend to set quantitative targets more often for energy programmes, than for material or water efficiency objectives.

1.4 Key policy options/recommendations

- The overall decrease in consumption of primary materials in the EECCA region peaked in the late 1990s; since that time domestic consumption of primary materials has been growing strongly. Improved material efficiency, cyclical resource use, material efficient buildings and infrastructure and changes towards sustainable lifestyles and sustainable consumption and production present key policy options that should be employed to reverse this trend.

- Resource exporters have enjoyed windfall profits over the last decade and still profit from high world market prices for many natural resources. This has contributed to overvalued currencies and has reduced the international competitiveness of the manufacturing sector in those countries. Very often, resource revenues have not been shared equally, leading to a two speed economy with some parts of society gaining and others not being included in the benefits of the resource boom. For those economies reliant on primary industries for export, revenue sharing policies will be of vital importance and measures such as sovereign wealth funds may be an appropriate mechanism to take heat out of their economies, reduce inflationary pressures and increase the viability of manufacturing businesses. Resource efficiency policies, however, are often contested in the business and policy community because of the primacy and political clout of primary industries.

- Net importers of primary materials have, since 2000, been confronted with rising prices for many natural resources that have made them less affordable and hence hampered development progress of those countries through higher resource prices. For these countries, resource efficiency policies will be instrumental in increasing their economic competitiveness and reducing dependence on increasingly constrained international markets for primary resources.

- As a consequence of the different patterns observed, different countries in the EECCA region will need to identify quite different policy responses catering to their very different respective positions in the global economy. This will make it harder to achieve a regional position to support policy proposals that address the global need for resource efficiency and low-carbon development, which will be important goals in a world that faces resource constraints and climate change.

- The EECAA region has achieved substantial improvements in resource efficiency over the past two decades, during which the material intensity of the region has almost halved. The regional economy, however, still needs three times as many primary resources per unit of GDP as the world economy, which puts it into an unfavorable position in an economic context of higher and more volatile prices for natural resources. It will require additional indicators for a consumption-based account of material use, to show global resource requirements driven by the regional material standard of living and demonstrate the full extent to which resource extraction in the region is driven by consumption outside the EECCA region.

- After a period of decline, rising per capita wealth has driven the consumption of primary resources to increase over the monitored period. Unlike in the case of most other environmental issues, the EECCA countries face very different SCP policy challenges from those in Western Europe. There is thus a need to develop targeted, country-specific SCP policies addressing energy and material consumption and intensities (e.g. energy consumption per unit output), and management of industrial waste; while on the consumption side, an increased use of resources needs to improve quality of life and allow for social changes that reduce poverty and increase material standards of living.

- While affluence has been an important contributor to rising demand for primary materials since about the year 2000, structural change and technological innovation have helped to offset some of the growth. The effect of technology is, in most cases, not powerful enough to stabilize material consumption at a level below the high resource use patterns of the former Soviet Union. The future wellbeing and competitiveness of the region will depend on the level of investment into public infrastructure and the building sector to achieve a step change in resource efficiency in the housing and transport sectors that will have a lasting legacy for decades to come and set the region on a path to achieving high standards of living while conserving the natural resources and ecosystems of the region.

- Water use in the EECCA region has been dominated by agriculture and by a significant share of population, especially in Central Asia, living in water-stressed river basins. This calls for policies supporting water use efficiency to provide a basis for future economic growth. Water reform in the agricultural sector will require improved water management that achieves high water productivity, while sustaining communities, increasing food security and maintaining rural incomes.

- Some countries in the EECCA region suffer from serious water stress. Improving water efficiency (in agriculture, industry and households) is among the key options to remedy water shortages in the region. Because the quantity and quality of water resources are positively correlated, it is important to simultaneously deal with both issues when improving efficiency in the water sector.

- Major financial and regulatory actions and policy measures applicable for the EECCA countries that can be undertaken in the water sector include determination of the appropriate scale and scope of water systems, strengthening local capacities to set contractual arrangements, tariff setting procedures, systematic planning of water-related investments and increasing overall financing to the water sector.

- Although there are many international mechanisms to address environmental concerns in the EECCA region, legislation and policies need to be completed in order to ensure the effective management of natural resources and the reform of environmental institutions. It is necessary to strengthen relevant national bodies – not just establish or appoint them – by equipping them with clearly stated responsibilities (enforcement) and supervising their performance (monitoring) at the highest level. Equally important is the demand for legislation focusing on natural resource-related activities, in particular extraction and waste disposal, as well as related social themes such as health. Relevant sectors (mining, industry, energy) should develop sectoral policies and specific tools (e.g. strategic environmental assessment, sustainability impact assessment, and economic, market-based tools) and ensure their proper implementation. Since some countries have already acquired enough practical experience with these instruments, the exchange of best practice would be an effective way to spread and align them with international standards across the region. This necessarily requires a whole-of-government approach and national–local cooperation.

- True cooperation at a regional level to reduce both environmental (resource depletion, degradation, pollution) and human risks (health impacts) is needed. There are already several platforms to analyse and deal with relevant environmental issues at both regional and sub-regional (transboundary) levels. The countries – under the supervision of international organizations such as UNEP, UNECE or within the 'Environment for Europe' process – should audit the current state of these platforms (check progress against set goals and targets) and revise them if needed. If performance is insufficient and progress slow – and national capacities already fully utilized – then assistance from international bodies and donors needs to be provided.

- Public participation in environmental decision-making should be strengthened. Since there is still a lack of public participation skills among public officials and a lack of regulations, it is necessary to build on previous successful efforts and to develop and adapt concrete tools and procedures (e.g. SEA, SIA, integrated permitting, etc.) and test them in real decision-making processes. An integral part of this is the development of specific indicators to track progress in public participation.

- In order to make natural resource policies effective, systematic evaluation is needed, and specific indicators play an important role in this. Hundreds of suitable indicators for all levels: the macro level (global, EU, national, etc.), meso level (industry sector, consumption area, region, city, etc.) and micro level (product, company, specific resource) already exist. National statistical offices and government agencies should include the most relevant indicators in their policy evaluation and reporting, set specific targets and regularly measure progress.

2 Introduction

2.1 Scope of the study

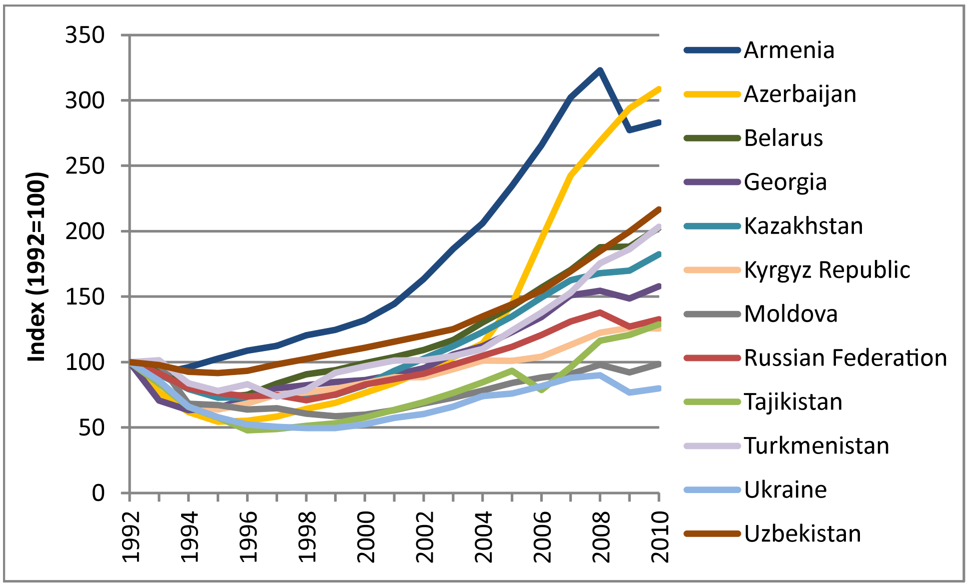
The *Resource Efficiency: Economics and Outlook (REEO) for Eastern Europe, the Caucasus and Central Asia* (EECCA) countries focuses on the demand for, and the use of, selected natural resources both as drivers and as consequences of economic activity and social development. The report further analyses current state and trends in implementation of resource efficiency policies.

Table 1: List of EECCA countries

Eastern Europe	Belarus, Republic of Moldova, Russian Federation, Ukraine
Caucasus	Armenia, Azerbaijan, Georgia
Central Asia	Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan

The report covers the period from 1992 onwards, when the EECCA countries experienced the consequences of the dismantling the Soviet Union (December 1991) of which they were part, followed by an economic crisis related to the establishment of new governance structures and transition from a centrally-planned to a market economy. All EECCA countries returned to economic growth in the second half of the 1990s; however, for many of them, the economic upswing was interrupted by the world economic crisis of 2008 (Figure 2). The turbulent development of the EECCA countries was reflected in profound changes in demand for and consumption of natural resources, in resource efficiency trends and in resource efficiency policies, as shown in this report.

Table 2 shows some basic socio-economic and resource-related indicators for EECCA countries for the latest available year. While some countries are characterized by relatively high per capita GDP (Russian Federation, Kazakhstan), there are also some which lag considerably behind (Tajikistan, Kyrgyzstan) and the gap in income between the most developed and the poorest is high. Also, the endowment with resources and the role of natural resources in the economy differs greatly: some countries are rich in agricultural land, forest land, fossil fuels and minerals, while some have hardly any resources. These differences are reflected in material and water use as is shown in the subsequent chapters.



Note: GDP index based on GDP in constant 2000 US$

Figure 2: GDP development, EECAA countries, 1992 to 2010 (Source: World Bank 2013)

	Armenia	Azerbaijan	Belarus	Georgia	Kazakhstan	Kyrgyzstan	Moldova	Russian Federation	Tajikistan	Turkmenistan	Ukraine	Uzbekistan
Population, total (thousand)	3 100	9 168	9 473	4 486	16 558	5 507	3 559	141 930	6 977	5 105	45 706	29 341
Surface area (thousand sq. km)	30	87	208	70	2 725	200	34	17 098	143	488	604	447
GDP per capita (current US$)	3 305	6 916	5 820	3 203	11 357	1 075	1 967	13 089	935	5 497	3 615	1 546
Agricultural land (% of land area)	62	58	44	36	77	55	75	13	34	69	71	63
CO_2 emissions (metric tonnes per capita)	1.5	5.5	6.3	1.3	14.0	1.2	1.3	11.1	0.4	9.7	5.9	4.2
Energy use (kg of oil equivalent per capita)	791	1 307	2 922	700	4 595	536	731	4 943	336	4 226	2 845	1 533
Fertilizer consumption (kilograms per hectare of arable land)	29	13	281	43	2	21	9	16	65	n.a.	30	193
Forest area (% of land area)	9	11	43	39	1	5	12	49	3	9	17	8
Total renewable water resources per capita (cubic metres)	2 506	3 727	6 068	14 629	6 633	4 380	3 286	31 561	3 140	4 852	3 089	1 760
Crude oil proved reserves (thousand million barrels)	-	7.0	-	-	30.0	-	-	87.1	-	0.6	-	0.6
Natural gas proved reserves (trillion cubic metres)	-	0.9	-	-	1.3	-	-	32.9	-	17.5	-	1.1
Coal proved reserves (million tonnes)	-	-	-	-	33 600	-	-	157 010	-	-	33 873	-

Note: - indicates low amounts which are not reported separately by British Petrol

Table 2: Basic socio-economic and resource-related indicators, EECCA countries, 2009 to 2011 (latest available year) (Sources: World Bank 2013, FAO 2013, British Petrol 2013)

This report focuses on two types of resources: materials and related indicators as defined by international standards of material flow accounting (OECD 2008, Eurostat 2012) and water resources, which are of particular relevance for the EECCA region. The material aspect is approached from a domestic resource use perspective. Indicators of domestic resource use comprise all resources which are directly used for domestic production and consumption activities. The focus is on domestically extracted resources, direct trade flows, apparent consumption of materials and material efficiency. Global resource demand of the EECCA economies would be another possible perspective, which would require including resources embodied in internationally-traded products and would allow for expression of material footprints of consumption of particular countries (BIS 2012). For such a perspective the available data are, however, not sufficient.

The report is structured in the following four chapters:

I. Introduction and Background: This chapter provides a general background for the report, defines resource efficiency and related concepts and argues why resource efficiency is a worthwhile investment for EECCA's future economic and human development.

II. Current trends of natural resource use and resource efficiency in the EECCA region. The two sub-chapters focus on selected natural resources and efficiency of their production and use. They cover:

a. Material flows and resource efficiency in EECCA: Using a newly constructed material flows database for the region, this sub-chapter shows that since 1992, the share of global material flows accounted for by the EECCA region declined from over 10% to less than 6%. The efficiency with which the region converts material inputs to GDP increased rapidly over the period, but resource efficiency remained poor by global standards. After an initial period of contraction in total materials use following the dissolution of the USSR, the EECCA region's growth in materials use grew faster than the world average over the last decade.

b. Water use and efficiency in EECCA: This sub-chapter shows that the EECCA region varied significantly in terms of distribution and consumption of water resources, and that six out of twelve EECCA countries suffer from water stress. This is especially high in Turkmenistan and Uzbekistan where the annual abstraction surpasses renewable water resources. This is due to unsustainable water use in the agricultural sector, which relies heavily on irrigation.

III. Natural resource policies in EECCA: This part aimed to disseminate information about national achievements in developing and implementing resource efficiency policies. Information on resource efficiency policies in the countries was collected from literature and internet surveys. Since resource efficiency has been an under-developed theme and targeted policies are mostly missing in the EECCA region, the chapter covers it broadly and includes also related policies such as national policies of sustainable resource management, sustainable consumption and production, environmental policies etc.

IV. Technical annexes: The annexes provide definitions and data sources used for calculation of the indicators analysed throughout the report.

Figure 3: Map of the EECCA region

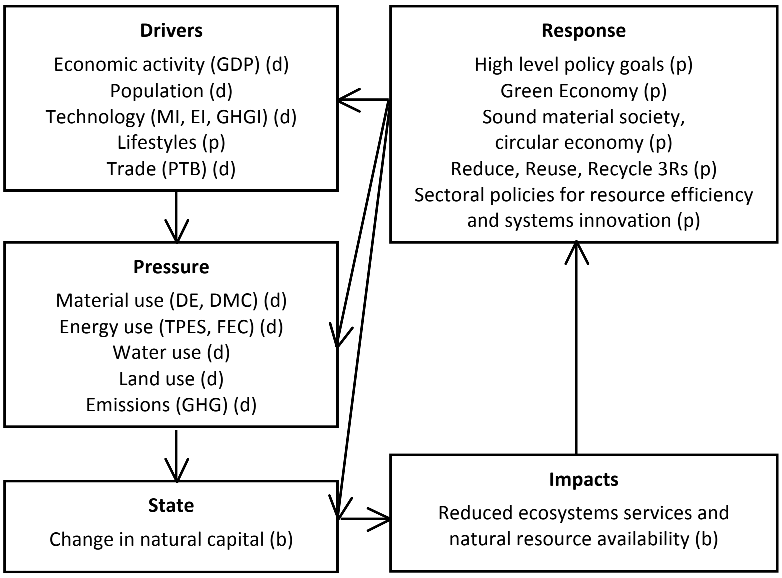
2.2 REEO conceptual framework

The REEO assessment uses a pressure indicator framework for analysing interactions between socio-economic systems and their environment. The accounts of materials and water compiled for the REEO are part of an effort to establish satellite accounts to Systems of National Accounts (SNA) on resource use. These satellite accounts have to meet a number of prerequisites including compatibility with the SNA, a sound conceptual background within the industrial metabolism concept, being based on readily available and credible data sets, and providing policy-relevant information. The data sets presented in this report have been established at the national economy scale on a country-by-country basis. Details on these accounts can be found in the technical annexes at the end of this document.

The Driving Forces–Pressures–State–Impact–Response (DPSIR) framework is based on the Pressure–State–Response (PSR) model originally developed by Statistics Canada in the 1970s (Rapport and Friend 1979). It was subsequently adapted and extended by the OECD (1994) and developed as the DPSIR framework by the European Environment Agency (EEA). The DPSIR framework has been underpinned UNEP's assessments since the first Global Environment Outlook (GEO) report (UNEP 1997) and is also used by the United Nations Commission on Sustainable Development (UNDSD 1997).

Drivers are the underlying causes, including economic activities of production, distribution and consumption, which lead to pressures on the environment. Examples of drivers include population, profits and income; and systems for the provision of energy, food, transport and housing driven by technologies and lifestyles. Pressures on the environment are operationalized as material and energy flows, water and land use, wastes and emissions. Pressures cause changes in the state of the environment such as changes in air quality, water quality and soil quality, and their ability to provide services to humans and other living beings. Changes in state may lead to impacts on human health and wellbeing, ecosystems, biodiversity, amenity value and financial value, and include changes in the global environmental system. Responses are the efforts made by society (governments, businesses, NGOs and households) to mitigate or respond to the problems identified by the assessed drivers, pressures, states and impacts and their linkages.

The preliminary satellite accounts on resource use and resource efficiency and corresponding indicators presented in this report are integrated within an assessment of possible policies, programmes and measures that may provide incentives for transition to a green economy and low-carbon development in the EECCA region. As Figure 4 shows, the REEO report focuses on drivers and pressures and their linkages, as well as on policies that respond to observed pressures and drivers. Within the DPSIR framework, it presents a set of headline indicators for environmental pressures such as domestic resource extraction or material consumption. These pressure indicators are linked to important socio-economic drivers, and an analysis of the significance of key macro-drivers of resource use such as GDP, population and technology is carried out. Finally, policy response is considered by an analysis of existing policies related to sustainable resource use in the different EECCA countries.



(d) Data sets and indicators
(b) Biophysical economic modelling
(p) Policy analysis

Figure 4: REEO conceptual framework (Source: UNEP 2011c)

This approach has the advantage of tackling problems early in the DPSIR cycle, and enables the use of available socio-economic data for environmental and resource use accounts at reasonable cost and in a timely fashion. The approach enables environmental pressures to be linked to those actors that cause them, and thereby provides valuable information for targeted policies. The approach taken in the REEO is complementary to the approach used in UNEP's GEO in assessing the state of the environment and related indicators using the DPSIR framework (UNEP 2012).

2.3 Why care about resource efficiency?

Natural resources form the basis of global and national economic production systems and underpin our quality of life, as they are needed to produce goods and services to satisfy human needs. Natural resources are transformed into economic output at varying levels of efficiency, influenced by factors such as the structure of the economy and the manufacturing technology for particular goods. In addition to resources that are directly valued by the economy, other natural resources such as ecosystems provide environmental and social services and benefits humans cannot exist without.

Until now, economic development has typically been associated with a rapid rise in the use of natural resources. Driven by scientific and technological advances, the global extraction of construction materials grew by a factor of 34, of ores and minerals by a factor of 27, of fossil energy carriers by a factor of 12, and of biomass by a factor of 3.6 over the 20th century (Krausmann et al. 2009). Apart from economic benefits related to this surge in consumption, there are also profound environmental impacts such as global climate change, disruptions in global biogeochemical cycles and biodiversity loss associated with growing resource use. Moreover, the natural resources available on this planet are limited. Some renewable resources have already been harvested beyond the planet's reproductive capacity and many non-renewable resources are becoming scarce, with resource prices rising accordingly (UNEP 2011b). This will have severe consequences for further economic development and quality of life, as the secure supply of resources for economic production influences employment, human health and other quality of life issues.

One of the greatest challenges facing humanity in this century is to balance the demands of a growing and increasingly wealthy global population for natural resources with the planet's carrying capacity. Improving the efficiency with which we use natural resources plays a key role here. Improving resource efficiency means producing more amenities to increase quality of life with less resource consumption and lower environmental impacts. The potential for improvement is large, as current economic systems are quite wasteful and inefficient, as illustrated by the amount of resources ending up as waste and pollution during the production phase of goods and services. Further potential lies in an increase in recycling and reuse of discarded products, which can reduce consumption of primary resources and bring socio-economic systems closer to natural systems where waste is non-existent, as all material is reused and recycled.

The concept of resource efficiency is related to the broader concept of sustainable development (SD), which can be perceived as an end we want to achieve. SD aims to meet human needs while preserving the environment so that needs can continue to be met not only in the present, but also for generations to come. The concept of SD also deals with social aspects of preserving human needs. These aspects are not always obvious in resource efficiency strategies, as they focus on the use of resources and how they contribute to wellbeing and the economy, and on limiting risks associated with scarcity and the security of supply of resources. Resource efficiency is a wider concept than sustainable production and consumption, as it has a stronger focus on the extraction of natural resources (beginning of the life cycle) and management of waste (end of the life cycle) (BIS 2012). Resource efficiency goes hand in hand with green growth strategies, which emphasize growth opportunities for income and employment from investments in environmental goods and services (UNEP 2011a).

The overall goal of resource efficiency and related activities is to achieve decoupling of economic growth, or more broadly human wellbeing, from resource use and environmental impacts.

The OECD was the first international body to adopt the concept of resource decoupling. The OECD defines decoupling simply as breaking the link between 'environmental bads' and 'economic goods' (OECD 2002). Similarly, the European Union (EU) in 2005 adopted the Lisbon Strategy for Growth and Jobs (Commission of the European Communities 2005a), which gave high priority to more sustainable use of natural resources. This was followed by the adoption of the EU's Thematic Strategy on the Sustainable Use of Natural Resources (Commission of the European Communities 2005b) and an initiative *A Resource Efficient Europe* under the Europe 2020 Strategy (Commission of the European Communities 2011). These strategies recognize decoupling of both resource use and its impacts from economic growth. Last but not least, International Resource Panel has recently published a flagship report on the issue of decoupling (UNEP 2011b), which plays a major role in UNEP's green economy initiative.

Resource decoupling means reducing the rate of use of (primary) resources per unit of economic activity, while impact decoupling refers to reducing negative environmental impacts per unit of economic activity. Resource decoupling primarily seeks to alleviate the problem of scarcity and reduce costs by raising resource productivity, while impact decoupling means using resources better, more wisely or more cleanly. An example of resource decoupling would be the reduction of energy consumption, while the decarbonization of the energy system by switching from fossils to carbon-free energy sources could result in impact decoupling. Both resource and impact decoupling can be relative or absolute. When relative decoupling occurs, either economic growth is accompanied by lower growth in resource use or the resource impact indicator, or a decrease in economic growth is accompanied by a larger decrease in the environmentally-relevant parameter. When absolute decoupling occurs, economic growth goes up while absolute volumes of resource use or impacts go down. A stylized representation of so-called double decoupling of resource use and impacts from economic growth as first introduced in the Thematic Strategy on the Sustainable Use of Natural Resources (Commission of the European Communities 2005b) is shown in Figure 5:

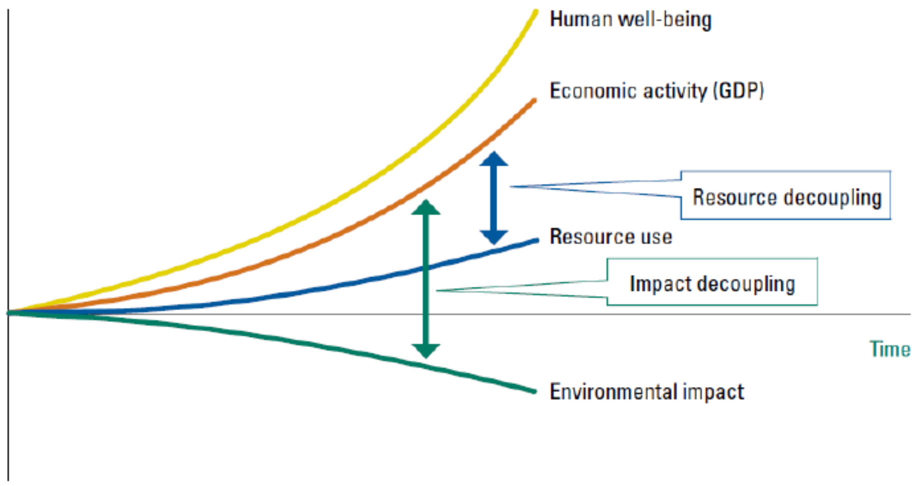


Figure 5: Stylized representation of resource and impact decoupling (Source: UNEP 2011b)

In order to achieve absolute decoupling, resource productivity (GDP/resource use or impacts from resource use) needs to grow faster than economic activity (GDP). This requirement mostly addresses environmental and economic aspects of sustainability. The social aspects focus on raising standards of living in order to lift people out of poverty and meet their aspirations. This can be achieved by a high level of employment. Overall employment will grow if economic activity (GDP) grows at a faster rate than labour productivity (GDP/employment), or if average working weeks are reduced simultaneously with labour productivity increasing. When we combine environmental, economic and social aspects of sustainability, we reach the following equation (UNEP 2011c):

$\partial(\text{GDP/employment}) < \partial\text{GDP} < \partial(\text{GDP/resource use or impacts from resource use})$

Over most of economic history, the majority of national economic development has been characterized by rapid improvements in labour productivity, which often occurred at the cost of resource productivity. In the EECAA region, however, the development was opposite and overall labour productivity grew at the slowest rate compared to material and energy productivity in 1992–

2008 (Figure 6). This was caused by a significant decline in labour productivity in 1992–1996, while in the rest of the period it caught up with energy and material productivity and showed solid growth. This overall development can be interpreted such that it still makes sense to invest in both labour and resource productivity in the EECAA region, as they can foster and reinforce each other.

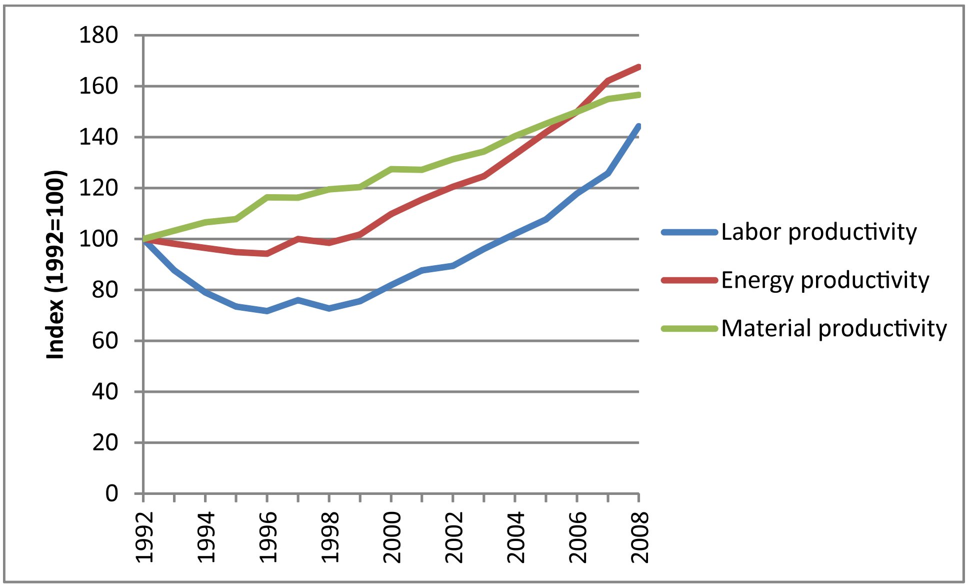


Figure 6: Labour, energy and material productivity, EECAA region, 1992–2008 (Source: World Bank 2013, International Labour Organization 2013, International Energy Agency 2013)

While it is increasingly debated whether economic growth should be the main policy objective in industrial countries (Jackson 2009), there is shared understanding that developing countries will need further economic and material growth to raise material standards of living and overcome poverty. It is argued that this additional growth in developing economies should be based on modern technologies and infrastructure in order to keep resource use and emissions as low as possible.

Resource efficiency is a multi-dimensional concept influenced by a variety of factors. One of them is globalization, which leads to a growing international division of labour and spatial separation of production and consumption activities. A national economy may thus externalize particular stages of the production of its domestically consumed final goods to other countries. This would involve externalizing the environmental burden associated with the production of such goods. At the same time, a national economy may specialize in producing specific goods for the world market and would thereby internalize the associated environmental burden of production.

The overall tendency toward increasing international division of labour and an increasing share of trade servicing consumption has important consequences for the definition of national resource use targets and indicators, if they are defined spatially. Resource flows can thus be presented in two ways: 1) as direct flows including domestic extraction and direct flows of imports and exports without assessing the embedded, upstream and downstream water and resource flows that accompany trade flows; and 2) as material footprints of a country's final consumption of goods which take materials embedded in trade flows into account. Both these approaches represent pressure indicators rather than environmental impact indicators, and are thus suitable for assessment of resource scarcities, access to resources and import dependencies. While the first approach addresses direct domestic use and has been the focus of national resource policies thus far (and is the theme of this report), the second approach targets global resource demand, which adds aspects of temporal and physical equity mostly covered by sustainability policies.

Improving resource efficiency can be beneficial both for developing and developed countries. It has the potential to (see UNEP 2011c):

- improve economic competitiveness and create new business opportunities;
- preserve natural capital and local environmental quality;
- ensure energy security and supply security of strategic materials;
- tackle climate change, air pollution and waste problems;
- help avoid social conflicts related to resources; and
- pursue social benefits and improve living standards.

EECCA countries belong to low-income and middle-income economies (WB 2013) which have recently undergone quite turbulent development, due to both the dismantling of the Soviet Union and the transition from centrally-planned to market economies. Due to these conditions, their resource-related policies have not been established or firmly settled yet. This means that there is a unique opportunity to integrate measures leading to resource-efficient solutions using policies that respond to the observed issues. This would help address many problems the EECCA countries face in this field, such as the fact that materials freed up by gains in materials productivity are not being 'saved' as such, but rather being absorbed internationally as the EECCA becomes a much more important supplier of primary commodities to world markets, and the fact that water resources continue to be over-exploited in the Caucasus and Central Asia.

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3 Material flows and resource efficiency

3.1 Main messages

- The EECCA region accounts for less than 6% of world consumption of primary materials, down from over 10% in 1992. This relative decrease in domestic consumption has been accompanied by a fourfold expansion of primary exports, arguably increasing the region's importance to the wider global economic system, even as its raw material inputs declined.

- All of the regional decrease in consumption of primary materials had occurred by the late 1990s, during a period of very strong economic contraction. Since that time domestic consumption of primary materials been growing strongly, largely driven by the input requirements of strongly growing primary exports.

- The varying patterns of change in domestic consumption between different categories of primary materials during the post-Soviet economic contraction indicate that the full force of economic restructuring fell on those sectors which relied most on internal demand. Sectors with internationally marketable products remained relatively strong, and then lead subsequent growth. It was largely primary commodities from the EECCA which found international markets receptive.

- The region began the period 1992 to 2008 extremely inefficient at converting its primary resources to income, but improved its resource efficiency rapidly as the period progressed. Nevertheless, even the most resource-efficient countries in the region remain well below the World average, with some exhibiting materials intensities an order of magnitude higher than the World average.

- While depopulation in the EECCA region is among the most pronounced examples in the world, population dynamics have been relatively insignificant as a driver of total consumption.

- Changing per capita wealth was by far the strongest driver of changes in primary resource consumption during both the massive contraction of the early 1990s, and during the subsequent period of strong growth.

- Despite the region's exceptionally strong improvements in resource efficiency, and its depopulation dynamic, its consumption of primary commodities grew faster than the World average over the most recent decade examined.

- Materials freed up by gains in materials productivity within in the EECCA region are not being 'saved' as such, but rather being absorbed internationally, as EECCA becomes a much more important supplier of primary commodities, especially fossil fuels, to World markets.

3.2 Material use patterns and material efficiency in the EECCA region

This section is based on a new material flows database which has been established for a collection of successor states to the former Soviet Union, collectively labelled as the Eastern Europe, Caucasus and Central Asia (EECCA) region. The database was created to establish an empirical basis upon which analyses specifically relating to primary material flows, and indicators of resource efficiency related to those flows, can be based. It uses the same methodologies employed in the establishment of two previous databases also commissioned by UNEP, one for the Asia and Pacific region, and another for Latin America and the Caribbean, and so enables direct comparative studies across three major world regions. As the database was designed to be consistent with the boundaries of what are considered as primary materials for material flows accounting by the statistical office of the European Union (Eurostat 2011), it also allows comparisons with studies of other regions which also used the same, largely standardized methodologies (e.g. Krausmann et al. 2009, Schandl and West 2010, UNEP 2011b, UNEP 2013b, UNEP 2013a, Weisz et al. 2004).

The rate at which humanity consumes primary materials has been rapidly escalating since the industrial revolution and especially since the rise of new material and energy-intensive lifestyles and mass consumerism in the middle of the 20th century. Until recently, growth in resources use, and especially that fraction of it involved in global trade, was dominated by demand from high-income OECD countries. This pattern is changing, with global materials consumption now driven by demand from populous developing countries which are undergoing rapid urbanization and industrialization. While most of this new dynamic is driven by countries in the Asia-Pacific region (UNEP 2011b), the increased globalization of trade means that supply pressures are transferred internationally (Bruckner et al. 2012). Where the EECCA region was partially isolated from the global economy during the Soviet period, since the 1990s it has become increasingly integrated into the global economy, increasingly as a source of raw materials for other regions. As a result, the region now finds itself incurring the extractive pressures to supply raw materials for external demand centres, in addition to domestic demand. Note that prior to the opening to the global economy, there had been considerable regional specialization in production within the Soviet Union, and the economic structures which accompanied that specialization affected the ease with which different constituent nations were able to find a niche in the global economy. For example, the transition for a region specialized in the manufacturer of (globally) non-competitive manufactured goods was likely to be more difficult than for a specialized petroleum producer.

To put the resource use patterns and trajectories observed for the region into a broader context, comparisons are generally made with world trends overall, with some more specific comparisons to findings from the both the Asia-Pacific and Latin America regions.

Box 1: Database preparation methodology and sources

A detailed Technical Annex describing the methodology and all base data sources behind the construction of the new database upon which this report is based is available at www.cse.csiro.au/forms/files/MFA-Technical-Annex.pdf. While that annex refers to the database prepared for the Asia-Pacific region, the methodology is the same.

All major base datasets used are available from publicly accessible (although often not free) sources. These sources included (EIA 2011, FAO 2011c, FAO 2011d, FAO 2011a, FAO 2011b, IEA 2011b, IEA 2011a, IEA 2011c, IEA 2011d, UN Statistics Division 2011a, UN Statistics Division 2011b, USGS 2011).

The categories of materials covered are those considered primary materials in the material flows accounting framework described by the office of statistics of the European Union (Eurostat 2011), i.e. biomass (including crops, crop residues, and grazed biomass), construction minerals, fossil fuels (including coal, petroleum, and natural gas), metal ores (ferrous and non-ferrous), and industrial minerals. Importantly, while the base datasets used were generally of high quality, they were often specified in terms of a material of value extracted, while the new database requires that they be specified on an 'as extracted' or similar basis. For example, (USGS 2011) generally gives data on mining production in terms of contained metal, whereas mine production in the new database needs to be specified in terms of ore extracted. This requires, as a minimum, the application of different assumed ore grades for different metals. For some sub-categories of materials there was little or no direct base data of any sort, so tonnages had to be determined via modeling and inference. A notable example of this is the modeling of grazed biomass.

The methodology used to compile the database complied as nearly as practicable to the guidelines set out in Eurostat (2011), however, where there have been significant departures from these guidelines, the rationale behind them and their implementation is described in detail in the Technical Annex.

The measure of GDP chosen is exchange rate based on $US, on a constant year 2000 basis.

The period from 1992 to 2008 was chosen as a compromise between the longest time series possible for the countries studied, post-USSR, and the reliability of the data. It should be noted that trade data in particular are incomplete for the earliest years, which for some sources of mineral commodities data only became consistently available from 1996.

Figure 7 to Figure 13 deal with aggregated statistics for the EECCA region. In analysing aggregated regional statistics for the EECCA region, it should be kept in mind how heavily regional aggregates are weighted towards just a few large states, most notably the Russian Federation, which accounted for 59% of regional DMC in 2008, with Ukraine accounting for an additional 13% and Kazakhstan a further 10%.

Figure 7 shows the relatively small size of the EECCA region's domestic materials consumption (DMC) in the world context. The region's share of global DMC decreased from 10.5% to 5.6% over the period, having constituted just 5.3% at the point of maximum contraction in 1998. Even though the period examined for the EECCA region is only 16 years long, material flows for the region can most sensibly be discussed by subdividing into two periods, the immediate post-Soviet era contraction, and the renewed growth period which began in the late 1990s. From almost 4.5 billion tonnes in 1992, DMC fell rapidly to just 2.6 billion tonnes at its low point in 1998, and then began to increase steadily to 4.0 billion tonnes by 2008, a contraction of some 12% when taken over the full period. This contrasts with total growth in the rest of the world of 74% over the same period, a compounding annual growth rate of 3.5%. The region's share of global DMC decreased from 10.5% to 5.6% over the period, having constituted just 5.3% at the point of maximum contraction in 1998. As the region constitutes a relatively small portion of the global total, we will see in other graphs below that there is little difference between values for the rest of the world (i.e. excluding the EECCA region), and total World figures.

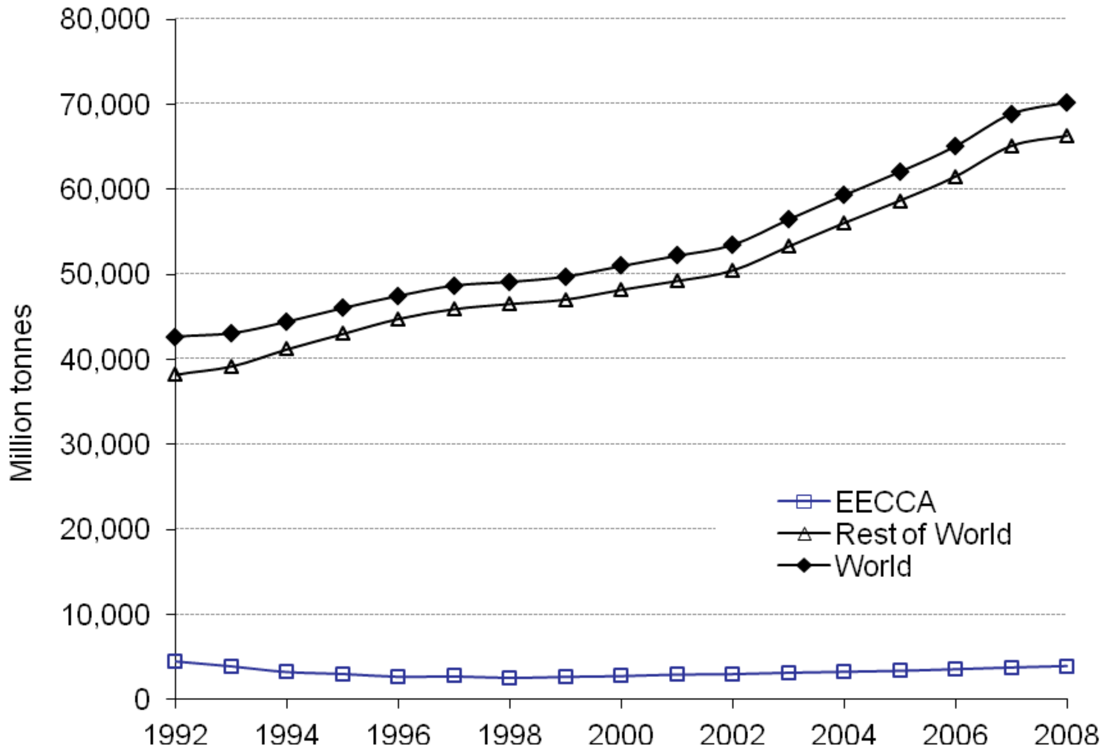

Figure 7: Domestic Materials Consumption for the EECCA region, Rest of the World, and World, for the years 1992 to 2008

In Figure 8 we see that DMC per capita for the EECCA region in 1992, at 15.8 tonnes, was twice that for the World. This level was probably already substantially down from where it had been in the late 1980s, as some restructuring had already begun prior to the dissolution, with the decline commencing before 1992[1]. During the period of contraction this fell rapidly, almost to convergence with the World by 1998, at 8.5 tonnes per capita, at which point it then steadily diverged again so that by 2008 the EECCA figure of 14.3 tonnes was 34% higher than the average for the World. While the DMC per capita remains lower than it was at the end of the Soviet era, it is perhaps noteworthy that the rate of growth over the decade from 1998 to 2008 averaged 4.4% compounding, a level almost identical to that seen in the rapidly growing Asia-Pacific region over the same period (UNEP 2013b). There is also little impact evident in the region from the onset of the Global Financial Crisis, in contrast to the marked slowdown in the rest of the world's growth. This same pattern appeared in the Asia-Pacific, and in a comparable study for Latin America (UNEP 2013a), and further supports the view of the Global Financial Crisis as an event largely confined to developed western countries, at least in its initial stage.

[1] Some yet to be published analysis by Schaffartzik et al. (of the Institute of Social Ecology, Alpen Adria University) indicates that DMC per capita for the USSR began to decline in the late 1980s and as a whole was in fact slightly lower in 1990 than it had been in 1980.

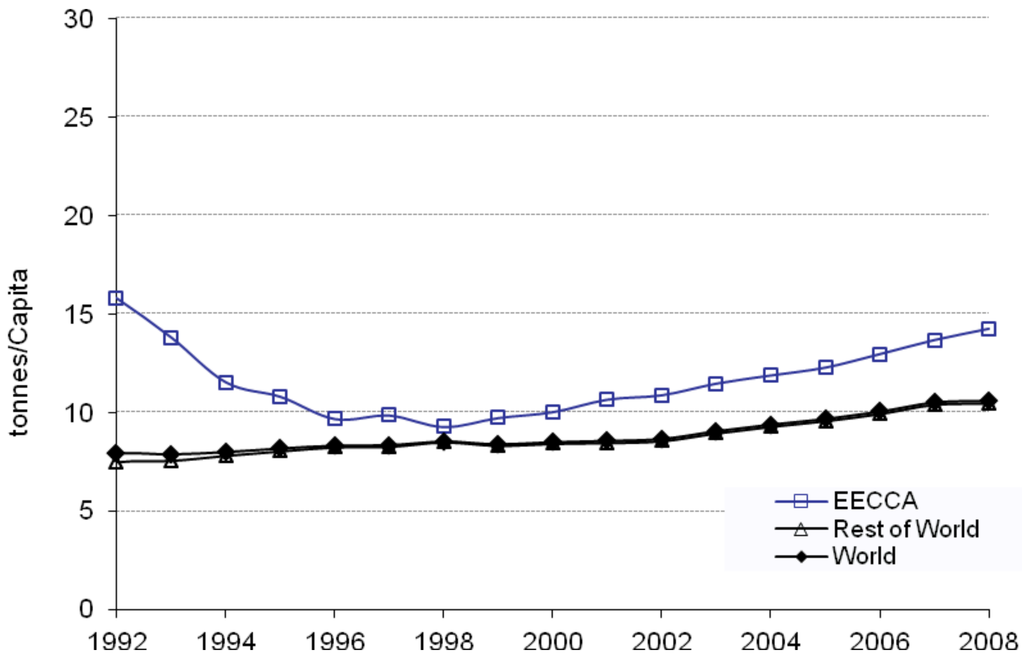

Figure 8: Domestic materials consumption per capita for the EECCA region, Rest of the World, and World, for the years 1992 to 2008

Figure 9 shows how domestic extraction (DE) of four major categories of primary materials has changed over time in the EECCA region. The impact of the post-Soviet era contraction is clearly seen, and had its strongest impact (proportionally) on construction materials, which decreased 63% between 1992 and 1997, while least affected were fossil fuels, and metal ores and industrial minerals, which decreased by only 24% and 20% respectively on 1992 levels, at their lowest points in 1998 and 1996. Biomass, by 1998, had decreased by 36%. This pattern might be interpreted as the full force of economic restructuring falling on those sectors which most rely on internal demand, while sectors with robust export demand remained relatively strong.

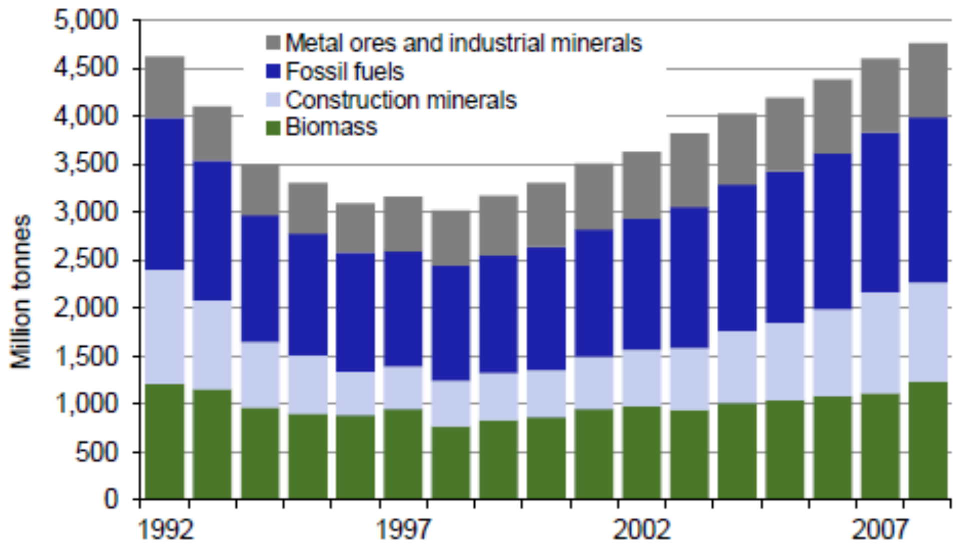

Figure 9: Domestic extraction in the EECCA region by major category of material for the years 1992 to 2008

Another interesting feature of Figure 9 is the way that the relative shares of the different major categories of materials remained broadly consistent when materials demand re-expanded. This differs from the pattern typically observed when countries experience a rapid expansion in DMC per capita as a result of transitioning from biomass-based advanced agrarian societies, to mineral and fossil fuel-based industrial societies. The classic socio-metabolic transition, described at length in Fischer-Kowalski and Haberl (2007), is characterized by a strong decrease in the relative share of biomass in the total mix. This pattern was clearly observed in earlier studies for the Asia-Pacific region (UNEP 2013b), and for the Latin America and Caribbean region (UNEP 2013a). In contrast, the observed pattern for the EECCA region is more reflective of a largely industrialized society undergoing an economic contraction, with reductions in materials demand across all categories, then subsequently re-expanding into an already established, industrialized economic structure. The nature of the mineral inputs to an industrialized society can vary quite considerably in details between different economies, depending on the mix of industries developed (including the size of the services sector), and the technologies adopted. Comparison of the EECCA region's materials mix with that of the EU-15 group, as reported for example in Weisz et al. (2004), shows the EECCA mix to be much more heavily weighted towards fossil fuels, metal ores and industrial minerals, with a much smaller relative contribution from construction materials[2].

The contraction phase can be well explained by the economic dislocation which followed the dissolution of the previously integrated Soviet economy. The degree of consistency in the shares of different material categories at the beginning and end of the period (clearest in Figure 12) is perhaps less expected, in that it does not indicate any large-scale 'reprimarization' of the region over the post-Soviet period[3]. This is despite the large-scale rationalization of state-owned manufacturing which occurred over the period. As discussed later, this perhaps unexpected outcome may just indicate the need to analyse EW-MFA measures at a higher level of resolution, and take materials efficiency gains into account. Also, as noted above, the period examined here actually starts after substantial economic restructuring had already begun in the USSR, commencing with perestroika.

Figure 10 shows very rapid growth in net exports of fossil fuels for the period 1992 to 2008, at a compounding rate of 7.3% p.a. The EECCA region also moved from being a net importer of biomass to being a net exporter, although the quantities involved are relatively small. With regard to metal ores and industrial minerals, time trade statistics prior to 1996 are insufficiently complete to include in an analysis. However, from 1996 to 2006 there was rapid growth, at 6.0% p.a. compounding, after which time there was a small decrease. Net trade in construction minerals was insignificant, as is to be expected where the main constituent construction aggregates are typically of very low unit value and so cannot usually be profitably transported over long distances.

[2] The EU-15 report referred to covers 1970–2001, and uses a 12-category breakdown of materials in figure 1, four of which can be assigned to the fossil fuels category used here, two to metal ores and industrial minerals, one to construction minerals, and five to biomass.

[3] The term reprimarization has usually been employed in the context of Latin America (e.g. UNEP, 2011a. *Eficiencia en el uso de los recursos en América Latina: Perspectivas e implicancias económicas*. Panama city: United Nations Environment Program), and refers to restructuring an economy away from import replacement/substitution manufacturing industries back towards a focus on increasing exports of primary commodities.

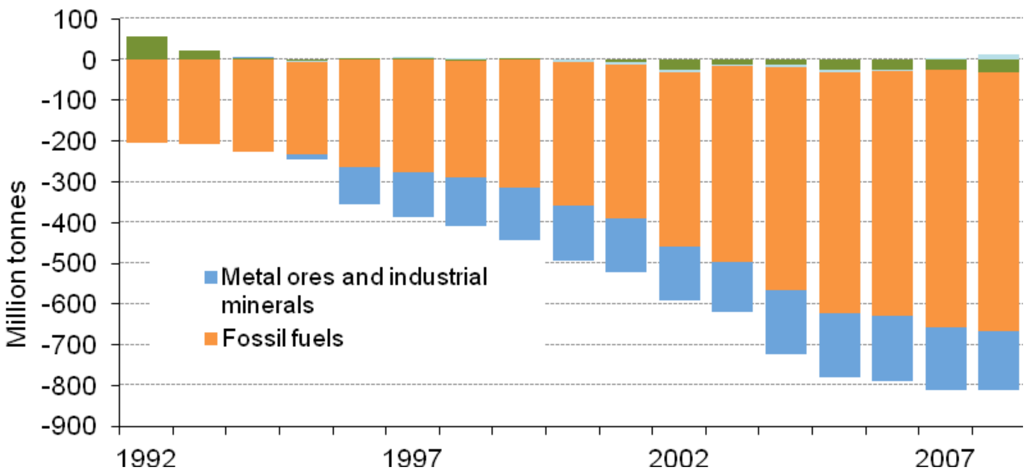

Figure 10: Physical Trade Balance for the EECCA region by major category of material for the years 1992 to 2008

Figure 10 has information important to the interpretation of the changing shares of different materials during the immediate post-Soviet era contraction. Most importantly, the low relative levels of physical trade balance (PTB) in fossil fuels over the main period of the contraction indicate that there was only a modest shift from local consumption of fossil fuels and redirection to export markets over that period. This fact, in combination with reference to Figure 11, shows that domestic extraction (DE) of fossil fuels remained relatively high through the contraction period, in comparison to other materials[4], implying domestic demand for fossil fuels was relatively inelastic. The major expansion of fossil fuel exports actually took place during the subsequent re-expansionary phase from the late 1990s. The timing of this expansion in fossil fuel exports shows complementarity with the massive growth of DMC of fossil fuels in the Asia-Pacific region, with the EECCA region placing an additional 350 million tonnes p.a. of fossil fuels onto the world market between 1998 and 2008, while the total consumption of fossil fuels in the Asia-Pacific increased by roughly 2.3 billion tonnes (of which the majority was sourced within the Asia-Pacific region). This complementarity echoes that described in West and Schandl (2013) regarding the expansion of metal ores production in Latin America, and rapid growth in metal ores demand from the Asia-Pacific region. Strong demand for primary materials from the Asia-Pacific region, and the effect this had on commodity prices, has greatly increased the attraction of pursuing a primary exports-based economic model for those regions able to do so. The EECCA region is well positioned to be a major primary resources supplier, with its huge land area and abundant mineral resources.

Table 3: Indicative degrees of concentration between raw material as extracted and traded primary commodities, after Schandl and West (2012)

	Potential for concentration in traded commodities	Indicative ratio ranges of extracted raw material to traded commodity
Construction minerals	Low, especially for the volumetrically dominant category of construction aggregates	1–2 : 1
Fossil fuels	Low (for traded fuels, excludes consideration of energy embodied in commodities such as aluminum)	1–2 : 1 for fossil fuels traded as fuels or refinery feed stocks (excludes non-conventional petroleum)

[4] The same inference cannot be made about metal ores and industrial minerals due to the incomplete nature of trade statistics for these materials during the crucial period immediately after 1992.

Biomass	Low to high. Exported crops are generally low, while animal products typically embody plant biomass one to two orders of magnitude higher	1–3 : 1 for crops and wood. 3–50 : 1 for animal products excluding whole milk
Metal ores	Medium to extremely high	1–3 : 1 for ferrous metals, 3–300 : 1 for base metals, 10–2,500 : 1 for uranium, 5,000–2,000,000 : 1 for precious metals

One factor which should be taken into account when interpreting PTB and DMC trajectories over time is that different categories of primary materials undergo very different degrees of concentration between initial extraction from the environment, and the form in which they are typically traded as crude commodities. Table 3 provides indicative levels of concentration for the different materials' categories. Metal ores in particular merit attention. Non-ferrous metals are typically traded after first being upgraded to concentrates, or crude metal ingots, rather than in the form of ore. From Table 3 we can see that the tonnage of crude metal commodity traded is likely to be one or more orders of magnitude lower than the tonnage of ore originally extracted (Schandl and West 2012). This means that the apparent consumption of ore, as measured by DMC, would be little different between a country which extracts ore and exports the metal content as concentrate, and one which extracts ore and processes it into high value final consumption products, which are then either exported and/or used domestically. This is an important consideration, and flags a major limitation on inferring detail about a nation's internal economic structure from EW-MFA indicators alone. Given this, the fact that shares of different material categories remained roughly constant between 1992 and 2008 does not necessarily preclude a significant reprimarization of EECCA economies.

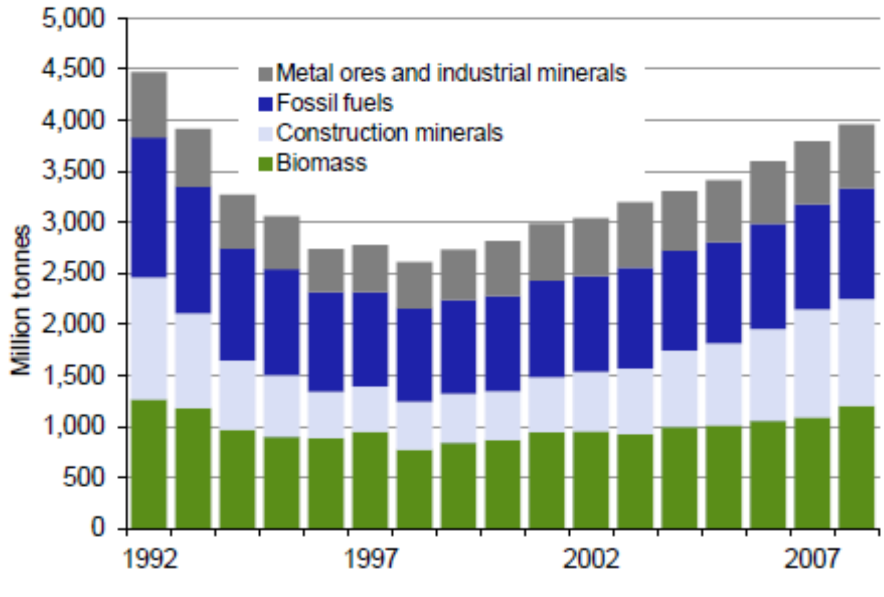

Figure 11: Domestic material consumption in the EECCA region by major category of material for the years 1992 to 2008

Figure 11 shows DMC disaggregated by the four material categories. DMC is calculated from the sum of domestic extraction (DE) and physical trade balance (PTB). While closely comparable to Figure 9 in both form and total magnitudes, where DE in 2008 exceeded that for 1992 in all categories except construction materials, DMC had still not quite recovered to the levels of 1992 in any category. Since reaching their respective lows, the compounding annual rates of growth in DMC for each category were: biomass 3.1% (1998–2008), construction minerals 8.1% (1997–2008), fossil fuels 1.7% (1998–2008), and metal ores and industrial minerals 3.3% (1996–2008).

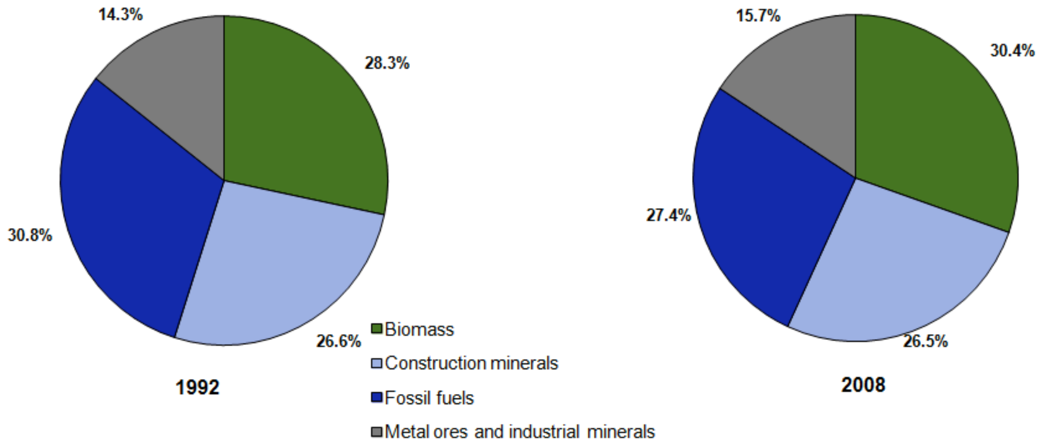

Figure 12: Change in relative shares of domestic material consumption in the EECCA region, by major materials categories between 1992 and 2008

Figure 12 gives snapshots of the material bases of the EECCA region for 1992 and 2008. It is immediately apparent how stable the different shares remained over that time. This is in marked contrast to the pattern we would expect to see if these societies were in the early to mid-stages of industrialization. Considerably more variation can be seen when individual countries are examined later. It should be remembered that aggregate regional measures include a near 60% contribution from the Russian Federation alone.

Table 4 provides detail on the changes in relative shares of eleven different sub-categories of materials, at four points in time, from 1992 to 2008. Using this higher level of disaggregation, some significant changes in the detail of materials use patterns become apparent. Perhaps most notable is that the decline in fossil fuels' share in the most recent period has been dominated by decreases in coal and petroleum use, while natural gas constituted a larger share of total DMC in 2008 than it did in 1992. Furthermore, it appears that at the time of maximum economic contraction around 1998, natural gas increased its share by a degree equaled only by non-ferrous metals. This indicates inelasticity in domestic demand for natural gas in particular was responsible for the disproportionate resilience of fossil fuel demand during the contraction. Similarly, the greater detail on metal ores shows that while this category increased its share during the contraction, and retained a higher aggregate share in 2008 than in 1992, this expansion is attributable to non-ferrous metals. In contrast, the relative share of iron ores, concentrates, iron and steel actually contracted more strongly in percentage terms than any other sector (by over 50%), and had not recovered this lost share by 2008.

Table 4: Changing shares in domestic materials consumption in the EECCA region, disaggregated by eleven material categories, over the period 1992 to 2008

	1992	1998	2003	2008
Biomass (% of total DMC)	28%	30%	29%	30%
Primary crops	10%	9%	9%	9%
Crop residues	8%	7%	8%	10%
Grazed biomass	8%	11%	9%	8%
Wood	3%	2%	3%	3%
Fossil fuels (% of total DMC)	31%	35%	31%	27%
Coal	13%	13%	11%	10%
Petroleum products	8%	7%	6%	5%
Natural gas	10%	15%	14%	12%
Metals and industrial minerals (% of total DMC)	14%	17%	20%	16%
Iron ores, concentrates, iron and steel	4%	2%	3%	2%
Non-ferrous metal ores, concentrates, metals	8%	13%	14%	12%
Industrial minerals	2%	3%	3%	2%
Construction minerals (% of total DMC)	27%	18%	20%	26%

Table 5 illustrates how the changes in share translated into different absolute levels of consumption per capita. With regard to per capita measures, it should be kept in mind that the total population of the EECCA region actually decreased over the period 1992 to 2008, (by 1.8%), so the decreases in DMC already noted are slightly less in per capita terms.

Using the eleven material sub-categories, we see that as well as the increases in non-ferrous metals and natural gas, consumption of crop residues also increased marginally between 1992 and 2008. Natural gas consumption per capita remained within a relatively narrow band, with the lowest level reached at the depths of the contraction, 1.4 tonnes per capita, only 20% lower than the highest level reached (in 2008). This contrasts with maximum contractions of 40% and 47% respectively for coal and petroleum. Iron ores, concentrates, iron and steel per capita contracted by 73% between 1992 and 1998 (from 0.62 to 0.17 tonnes per capita) with demand still 50% lower in 2008 compared to 1992. The differing trajectories of the ferrous and non-ferrous metals sectors could be suggestive of a degree of reprimarization which is not identifiable when metal ores are only viewed in aggregate. Contraction of the ferrous sector, especially where that sector is known to have been previously dominated by demand from domestic iron and steel production rather than ore exports, implies a shift away from some major activities downstream of primary materials extraction in the value-adding chain. Conversely, the increase in per capita DMC of non-ferrous metals does not imply a countervailing increase in other downstream industrial activities, as the majority of the apparent consumption in these commodities occurs early in the value-adding chain (see previous discussion of commodities' concentration prior to trade).

Table 5: Changing domestic materials consumption per capita in the EECCA region, disaggregated by eleven material categories, over the period 1992 to 2008

	1992	1998	2003	2008
Biomass (Mt)	4.5	2.7	3.3	4.3
Primary crops	1.5	0.8	1.0	1.4
Crop residues	1.3	0.7	0.9	1.4
Grazed biomass	1.3	1.0	1.0	1.2
Wood	0.4	0.2	0.4	0.4
Fossil fuels (Mt)	4.9	3.2	3.5	3.9
Coal	2.0	1.2	1.3	1.4

Petroleum products	1.2	0.7	0.7	0.8
Natural gas	1.6	1.4	1.6	1.7
Metals and industrial minerals (Mt)	2.3	1.6	2.3	2.2
Iron ores, concentrates, iron and steel	0.6	0.2	0.3	0.3
Non-ferrous metal ores, concentrates, metal	1.3	1.2	1.6	1.7
Industrial minerals	0.4	0.3	0.4	0.3
Construction minerals (Mt)	4.2	1.7	2.3	3.8
Total	15.8	9.3	11.5	14.3

Figure 13 shows the trend in materials intensity (MI) for the EECCA region. This is an indicator of the efficiency with which an economy is able to convert materials into GDP, i.e. the lower the MI, the more efficient an economy is at doing more (generating income) with less (consumption of materials and generation of associated waste products and emissions).

The EECCA region began the period with an MI of over 10 kg/$US, almost six times the World average, but experienced a consistent decrease in MI over the full study period, of approximately 2.8% compounding per annum, so that by 2008 MI was less than 6.5 kg/$US. A salient feature is that the rate of improvement, while most rapid in the immediate post-Soviet contraction, remained strong at nearly 2.6% p.a. from 2000 to 2008. This performance stands in contrast to that of the rest of the world, which was virtually static when averaged over the full period, and has been deteriorating since 2000. This achievement could in large part be due to the one-off opportunities available to increase efficiency in economies which may have started the period with widespread negative value-adding[5] in major industrial sectors (Thornton 1996, Simon 1996). Despite the rapid improvement in the EECCA region's performance, by 2008 it still consumed roughly 3.7 times the world average DMC per $US of GDP generated. Furthermore, there was no single year over the period 1992 to 2008 where the regional GDP grew while total DMC decreased. The simultaneous existence of very strong improvements in materials productivity and economic growth may be indicative of a strong rebound effect[6] in operation, but this would require a separate investigation to confirm.

[5] Negative value adding refers to the situation where the value of the inputs and components used in a production process are worth more than the resulting final product.

[6] Rebound effect is the tendency of efficiency gains to generate further demand, which in turn reduce the persistence any initial reduction in materials or energy demand which resulted from the initial efficiency gains. A good literature review of the different types and degrees of rebound is contained in *Jenkins, J., T. Nordhaus & M. Shellenberger. 2011. Energy Emergence: Rebound and Backfire as Emergent Phenomena. Breakthrough Institute.* Although that work deals with rebound as it applies to energy consumption, the underlying principle should in large part be directly applicable to materials consumption as well.

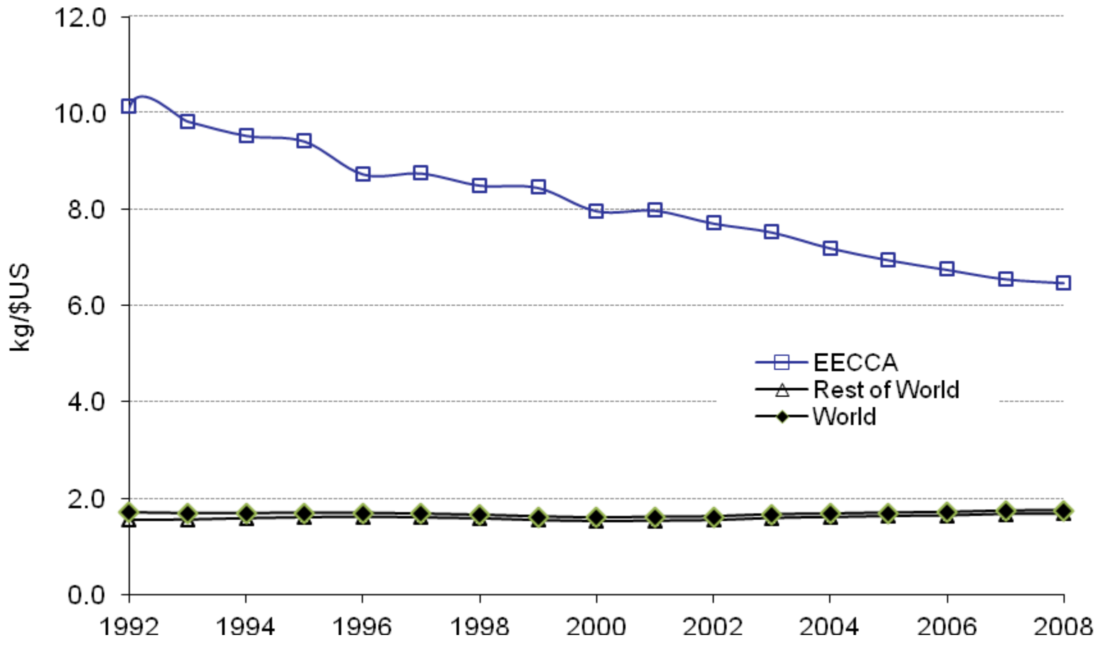

Figure 13: Domestic materials consumption per $US of GDP (exchange rate based, constant year 2000) for the EECCA region, Rest of the World and World, for the years 1992 to 2008

While the region's MI is dominated by that for the Russian Federation, and the trajectory of MI for individual countries is often much more volatile than the regional trend, every one of the region's constituent nations decreased their MI between 1992 and 2008, albeit in some cases only marginally. Individual country level analyses for the region reveal a high degree of heterogeneity in material flows between the different constituent countries. These results are given in detail in section 5. MI performance within the region varied widely, ranging in 2008 from less than 3 kg per US$ for Georgia to approximately 24 kg per US$ for Kyrgyzstan.

3.3 Material use patterns and efficiency for individual countries

In this section, material use patterns and material efficiency are reviewed for all twelve constituent countries of the EECCA region. These twelve countries fit into two classes of the six-type country classification set out by Krausmann et al. (2008), used as guidance to a country's socio-metabolic profile[7].

The classifications represented include: low population density industrial countries of the Old World, and high population density industrial countries. It should be noted that the allocation of all 'transition' countries to the industrial classification derives in large part from the industrialized nature of the former Soviet Union; however, the socio-metabolic profiles of some of the states examined here call this classification into question. Some of the Central Asian and Caucasus members have biomass-to-mineral ratios that would appear to put them in the developing category. The total levels of DMC are also often far lower than would be consistent with industrialized status,

[7] Social metabolism is analogous to the biological concept of metabolism. Like biological organisms, socio-economic systems depend on throughputs of materials and energy for their continued existence and growth. Much as different plants and animals occupying different biological niches have very different requirements for materials and energy (compare the nutritional requirements of a small bird and a large fish), the material and energy requirements of nations which occupy different niches in the global economy vary widely. A socio-metabolic profile refers to the size and make-up of the material and energy flows specific to a particular country.

and the high MI of some of these states further reinforces the case for further individual reclassification.

Table 6: Country classification system of Krausmann et al. (2008)

	Industrialization	
	Industrialized countries	**Developing countries**
High population density	High-density industrial *Armenia, Azerbaijan, Georgia, Moldova, Tajikistan, Ukraine, Uzbekistan*	High-density developing e.g. Mexico, Guatemala
Low population density		
New World	Low-density industrial – New World e.g. Australia, Canada	Low-density developing – New World e.g. Argentina, Brazil,
Old World	Low-density industrial – Old World *Belarus, Kazakhstan, Kyrgyzstan, Russian Federation, Turkmenistan*	Low-density developing – Old World e.g. Mongolia

Note: Industrialized countries include OECD countries and transition markets; developing countries include developing and least developed countries based on the classification of UNSD (2006). Countries with a population density above 50 persons per km^2 are considered high-density.

Figure 14 shows the degree to which the region's DMC is dominated by a few large countries, with the three largest consumers accounting for 82% of total DMC in 2008, and the smallest five accounting for 3%. The Russian Federation accounts for the largest share of the total by far, and this share remained relatively constant over the period, from 58% of the total in 1992 to 59% in 2008. Of the three largest consumers, Ukraine had its share of total EECCA consumption decrease by most, from 18% to 13% of the total (a 27% decrease in relative share), while Kazakhstan's relative share decreased by 6%. The largest change in relative share was for Azerbaijan and Turkmenistan, where their relative shares grew by 109% and 102% respectively. However, their absolute shares of total EECCA consumption remained very small, growing from approximately 1% to 2% of the regional total in both cases.

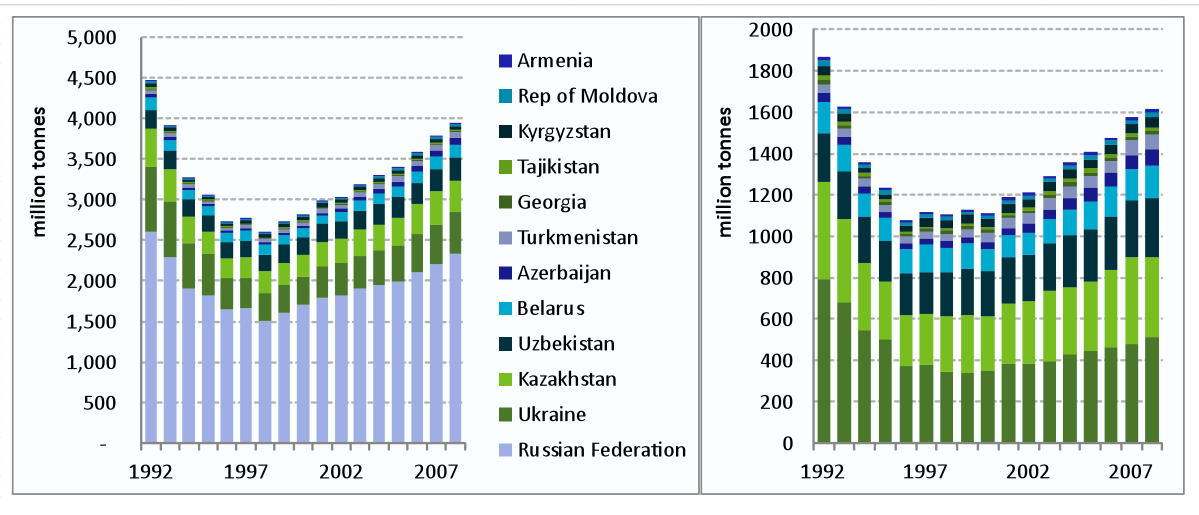

Figure 14: Cumulative graph of Domestic Material Consumption of individual countries in the EECCA region, for 1992 to 2008, with panel on right excluding the Russian Federation

While the EECCA region can be divided into the sub-regions implied in its name, and countries are grouped according to these sub-regions in Table 1, no independent analyses at sub-regional level are performed here.

3.3.1 ARMENIA

Armenia began the period 1992 to 2008 with a low DMC per capita of 4.4 tonnes per capita, which was only slightly more than one-quarter of the regional average. The period of post-Soviet contraction in DMC was much shorter than for the region as a whole, with DMC per capita exceeding 1992 levels by 2001, and 30% higher by 2008, although at 5.7 tonnes per capita this was still only 40% of the regional average (Figure 15). Armenia's relatively rapid rebound in DMC was accompanied by a much faster decrease in MI than observed for the region, so that by 2008 Armenia's MI, at 3.8 kg/$US, was less than 60% of the regional average. Growth in DMC was in large part led by large increases in biomass, such that biomass considerably increased its share of total DMC between 1992 and 2008, from 37% to 50% in a reversal of usual pattern of societies becoming more dependent on mineral resources. Around one-half of this increase in biomass DMC is accounted for by increased grazed biomass for ruminant animals, with the bulk of the remaining increase due to increased production of crops in the FAO categories of vegetables and melons, tubers and fruit. Metal ores and industrial minerals also expanded their share strongly over the same period, from 7% to 23%, so it was fossil fuels and construction minerals which accounted for the decrease in minerals' share of DMC. Both of these materials categories actually decreased in absolute terms as well as relative terms, with construction minerals decreasing by 32% and fossil fuels by 42%. The decrease in fossil fuels could in large part be explained by Armenia's heavy reliance on imports for its needs in this category, and transition to having to pay market prices for those imports. The contraction in construction minerals comes after this category had actually recovered to near-1992 levels in 2002 and 2003. The overall magnitude and relative shares of different DMC components in Armenia is more consistent with a developing rather than industrialized economy.

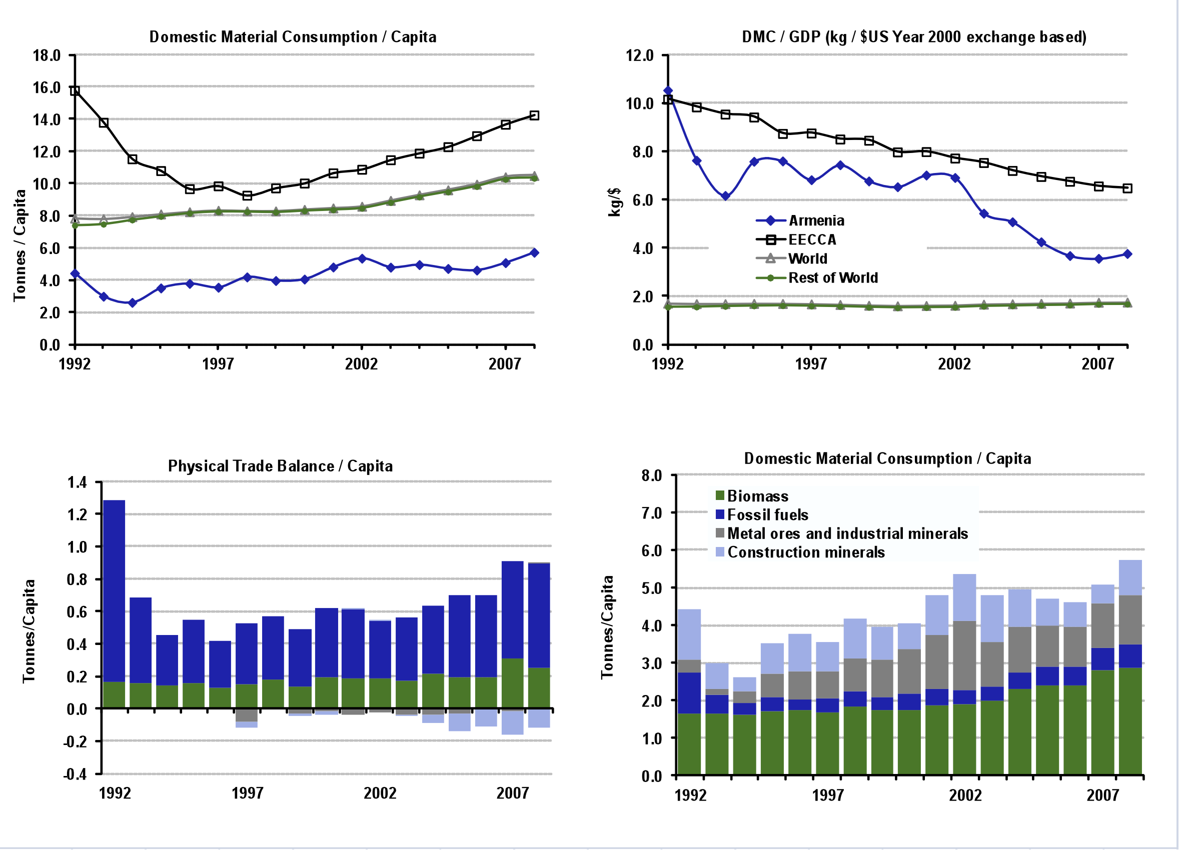

Figure 15: Summary panel of material flows and materials intensity for Armenia

3.3.2 AZERBAIJAN

In 1992, Azerbaijan's DMC of 5.8 tonnes per capita was only 36% of regional and 73% of World averages (Figure 16). Azerbaijan's rebound from the post-Soviet contraction was faster than the regional average, growing at 8.3% compounding p.a. from 1995 to 2008. DMC per capita regained the 1992 level by 2003, and was 57% higher by 2008. Azerbaijan's rate of MI decrease was slower than that achieved by the region over this period, at 2.3% compounding p.a. However, as Azerbaijan began the period with much lower MI than the region, it retained this lead in materials productivity over time, requiring only 65% of the regional average DMC per $US of GDP generated in 2008. In contrast to the region, all of Azerbaijan's decrease in MI took place in recent years. This coincides with the greatly increased fossil fuel exports. As discussed previously, different commodities are subject to different degrees of concentration prior to trade. Fossil fuels, especially petroleum and natural gas, are not subject to much concentration, so only a small fraction of any fossil fuels exported will register on a nation's DMC account. The income generated will thus come with little apparent materials consumption. Interestingly, we can see that while net exports of fossil fuels increased dramatically, DMC of fossil fuels actually decreased by 44%. It was the only materials category to exhibit a sustained decrease, with all other categories growing. The fossil fuels outcome would be consistent with negative value-adding activities being abandoned, in a traditionally fossil fuel-rich area. While it is not possible to conclude that this is the explanation, we know that the decrease in DMC of fossil fuels was not attributable to decreasing affluence, as GDP per capita increased quite strongly. Investment of increasing income might also account for sustaining the very strong growth in construction minerals that commenced with the new millennium. However, the initial growth in construction minerals preceded the expansion in exports, and so pre-2004 probably reflects investments in extractive infrastructure.

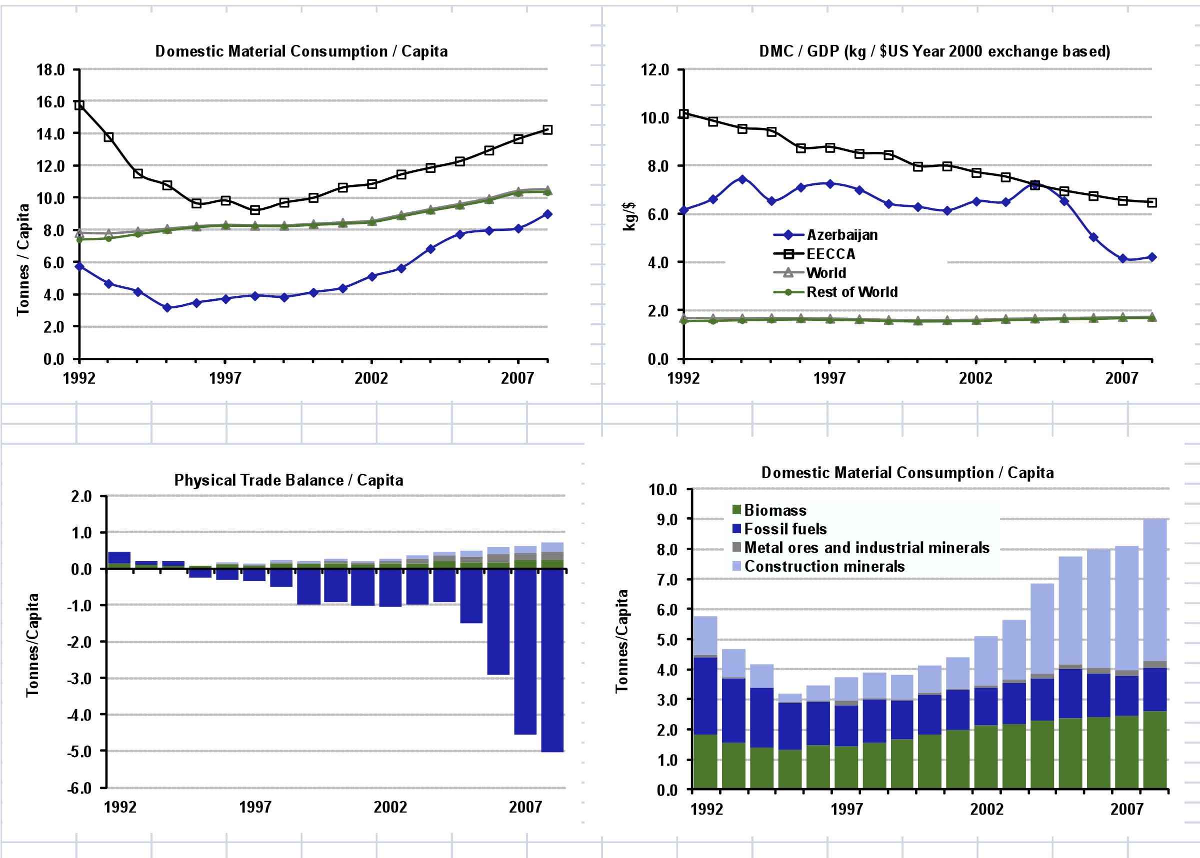

Figure 16: Summary panel of material flows and materials intensity for Azerbaijan

3.3.3 BELARUS

Figure 17 shows Belarus' DMC approximately equal to the regional average in 1992, at 15 tonnes per capita. While this remained broadly comparable, it has steadily increased at a faster rate since 2003, so that by 2008 it was 16% higher than the regional average. There was an apparent rapid but temporary rebound in DMC per capita from 1994 to 1997, followed by another decline, but this may be in part due to erratic statistics availability on trade for Belarus over this period, rather than reflecting real underlying dynamics. Belarus' longer term trends for both DMC and MI reflect those of the region well, with Belarus performing slightly better than the region as a whole in reducing MI.

Belarus is another country in the region to display a pattern of posting better-than-average performance in relative decoupling, while simultaneously exhibiting greater-than-average increases in DMC per capita. This may indicate a relatively strong rebound effect. Looking at the more detailed four-category disaggregation of DMC, it can be seen that fossil fuels was again the only category where consumption decreased (by 26% from 1992 to 2008), with biomass increasing marginally (5%), metal ores and industrial minerals by 40%, and construction minerals 35%. Fossil fuels were also the category to change its share of total DMC by the greatest amount, decreasing from 24% to 16%. However, this share was overwhelmingly taken up by the other minerals categories, with biomass' share declining marginally from 36% to 35%. There was thus no significant change in Belarus' relative dependence on biomass versus mineral resources, which remained indicative of an industrialized country.

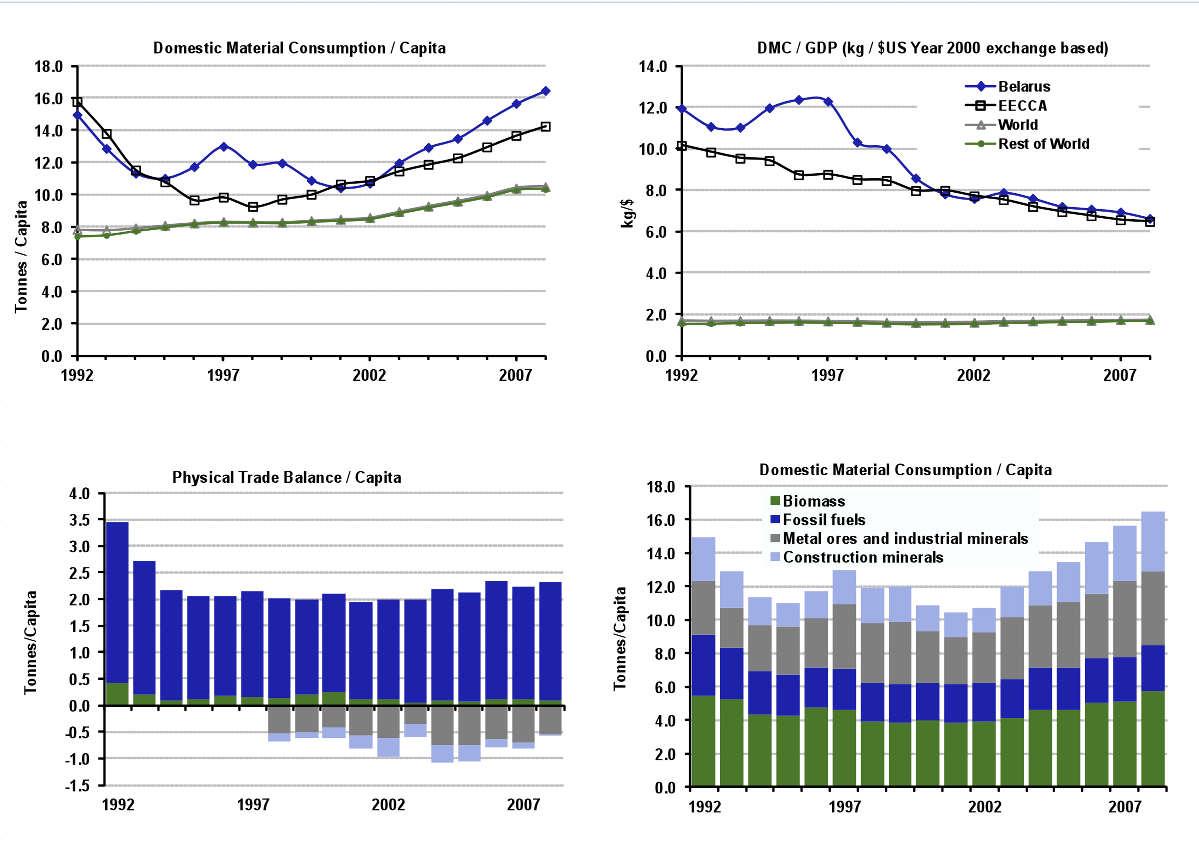

Figure 17: Summary panel of material flows and materials intensity for Belarus

3.3.4 GEORGIA

Georgia's DMC per capita in 1992 was only a quarter of the regional average, and this relationship remained unchanged by 2008, with Georgia's decline in DMC over the period, from 4.1 to 3.7 tonnes per capita, proportional to that of the region as a whole (Figure 18). Georgia began the period with low MI by regional standards, 6.2 kg/$US in 1992, then improved more rapidly than the region as a whole, decreasing by 4.7% compounding p.a., so that by 2008 Georgia required only 43% of the regional average DMC per $US of GDP generated. The panel on PTB shows a large and persistent contraction in net imports of fossil fuels, while the only significant net exports recorded for Georgia were for metal ores and industrial minerals, and those were largely restricted to a window from 2000 to 2005, with a steady decline in recent years. The four-category disaggregation of DMC shows that decreased imports of fossil fuels were not replaced by domestic production, so Georgia's economy in 2008 was much less fossil fuels-intensive than it was in 1992. Again, fossil fuels were the only category to decline strongly then remain depressed, at only 33% of their 1992 level in 2008. Construction materials were moderately below 1992 levels (95%), while biomass increased 19% and metal ores and industrial minerals increased 80%. The increase in DMC of metal ores and industrial minerals took place contemporaneously with the steady decrease of exports in the same category noted previously, possibly indicating a move up the value chain prior to export. Biomass increased its share of total DMC from 33% to 44% between 1992 and 2008. Over the same period, metal ores and industrial minerals increased their share from 8% to 16%, while construction minerals' share increased marginally from 26% to 28%. Despite the increase in non-fossil fuel minerals, the overall magnitude and pattern of DMC exhibited in Georgia is more indicative of a developing economy than an industrialized one.

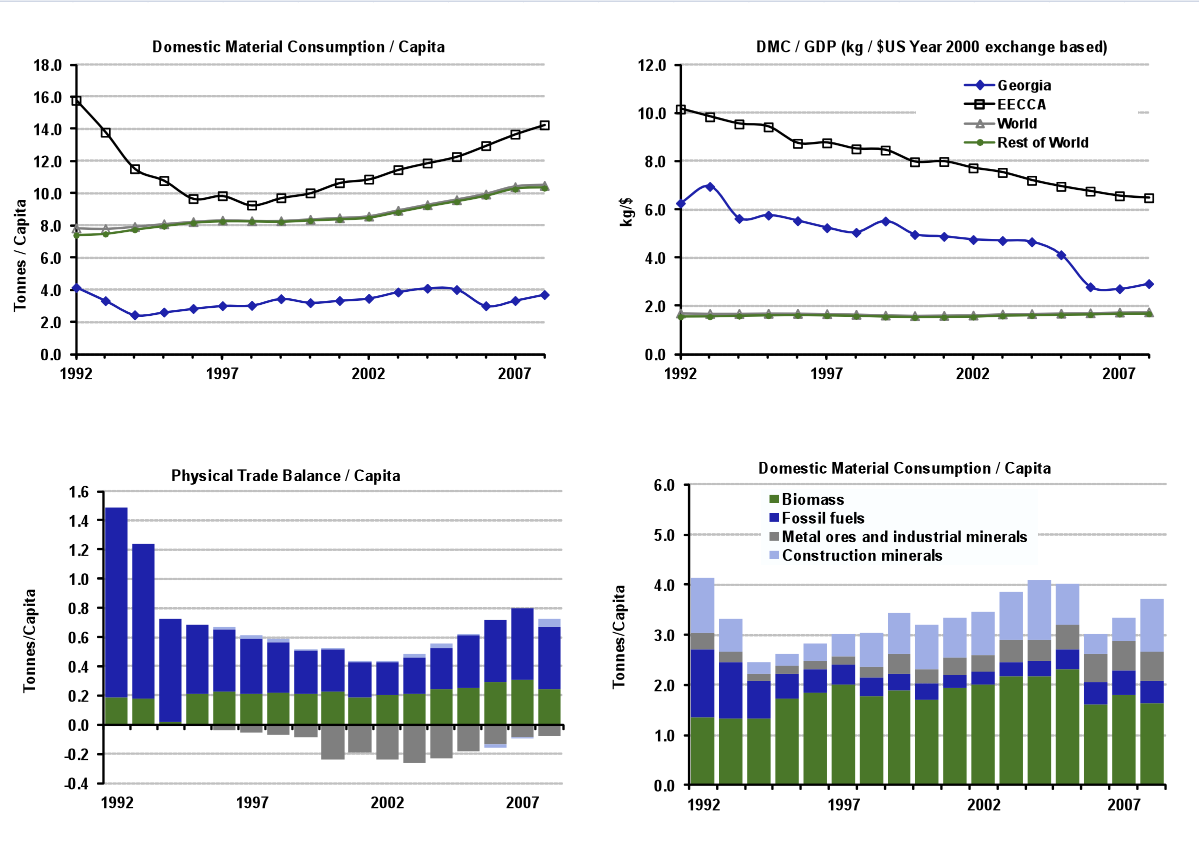

Figure 18: Summary panel of material flows and materials intensity for Georgia

3.3.5 KAZAKHSTAN

Kazakhstan's DMC per capita was the highest of all the countries in the region by a large margin. It decreased from 28.5 tonnes per capita in 1992 (81% above the regional average), to 24.8 tonnes per capita in 2008 (74% above the regional average), after reaching a low of 15.9 tonnes per capita in 1997 (Figure 19). MI was also consistently much higher than the regional average, but improved at a slightly faster rate. MI was 21.1 kg/$US in 1992, 110% higher than the regional average, but decreased at a compounding annual rate of 4.3% p.a., so that by 2008 it was 10.4 kg/$US, only 60% higher than the regional average. The change in PTB over the period is dominated by a very large increase in net exports of fossil fuels per capita, which roughly tripled between 1992 and 2008. Net exports of metal ores also expanded considerably over this period. The four-category disaggregation of DMC shows that the relative share of biomass decreased markedly between 1992 and 2008, from 36% to 27%, while the shares of all other categories increased, most strongly for metal ores and industrial minerals, which increased from 21% to 26%. In absolute tonnage terms, DMC of biomass contracted by 35% and fossil fuels also contracted by 9%. The result for fossil fuels is a relatively small contraction compared to most of the other countries studied, and Kazakhstan remained a highly fossil fuel-intensive economy in 2008. Metal ores and industrial minerals increased by 6% on a per capita basis between 1992 and 2008, but the 2008 value of 6.5 tonnes per capita was only two-thirds the highest level of 9.6 tonnes per capita reached in 2003. There is no corresponding change in net exports, so the decline between 2003 and 2008 marks a decrease in domestic extraction. DMC per capita of construction minerals was 3% higher in 2008 than 1992, having peaked in 2007 at 6.5 tonnes per capita. The overall magnitude of DMC per capita and the relative shares of different categories for Kazakhstan are consistent with the socio-metabolic regime of an industrialized county.

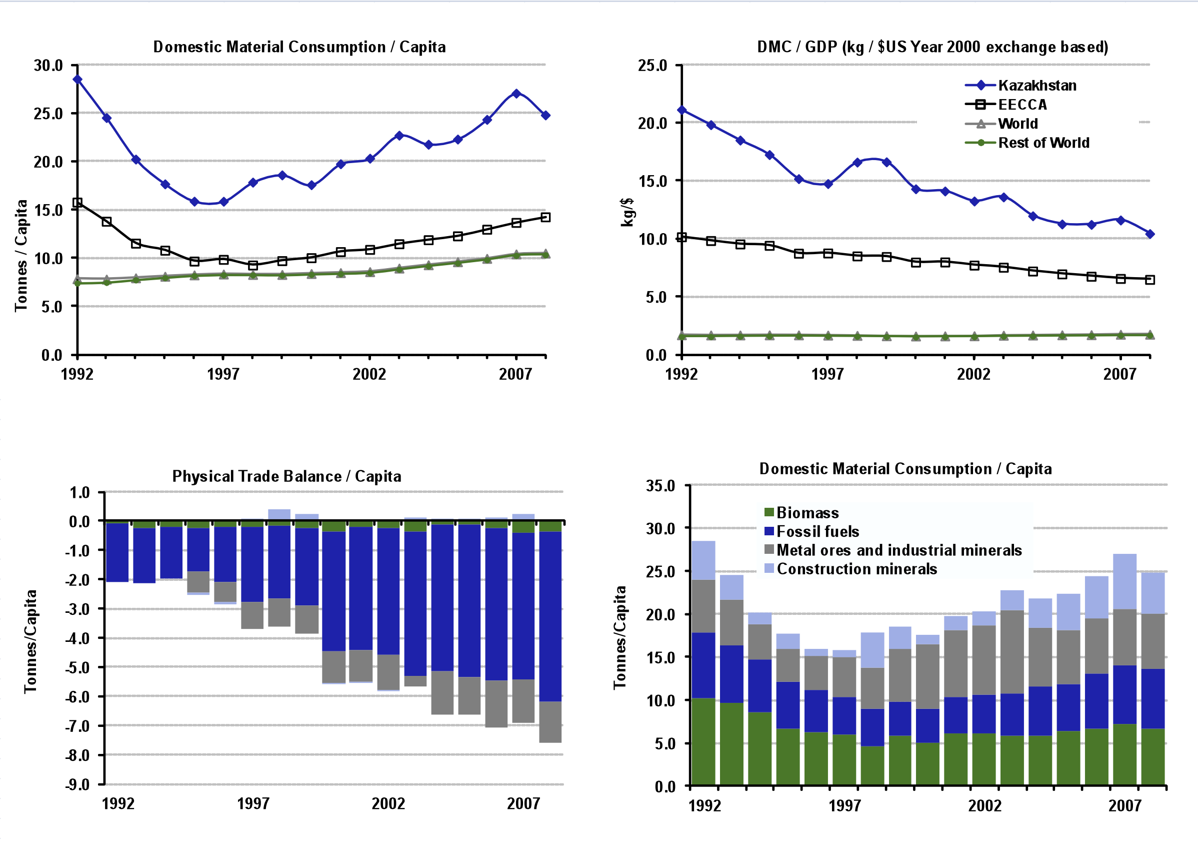

Figure 19: Summary panel of material flows and materials intensity for Kazakhstan

3.3.6 KYRGYZSTAN

Figure 20 shows Kyrgyzstan's DMC per capita in 1992 at 9.8 tonnes, which was 62% of the regional average. This decreased marginally by 2008, to 9.1 tonnes and 64% of the regional average. While this decrease was roughly proportional with the decrease for the EECCA region as a whole, the path followed was markedly different, with the post-Soviet era contraction more rapid and the rebound to near 1992 levels also much more rapid. Total DMC per capita had already rebounded to over 90% of 2008 levels by 1997. Kyrgyzstan's MI, at 27.2 kg/$US in 1992 and nearly three times the regional average, decreased much more slowly that the rest of the region, so that by 2008 material productivity was only a quarter that of the EECCA region, and 7% of the world average. The PTB panel highlights that Kyrgyzstan does not appear to have been a consistent net exporter in any material category, and that it has been continued to be reliant on net imports of fossil fuels. While total net fossil fuel imports decreased from 0.74 tonnes per capita in 1992 to 0.41 tonnes per capita by 2008, the ratio of net imports to DMC of fossil fuels rose from 60% to 80% over the same period. Kyrgyzstan's DMC of fossil fuels decreased strongly over the period, from 1.3 to 0.5 tonnes per capita. All materials categories decreased their share of total DMC with the exception of metal ores and industrial minerals, which increased from 2% to 20% between 1992 and 2008, much of which can be attributed to the commissioning of the Kumtor gold mine in the late 1990s. Biomass decreased from 57% to 52%, fossil fuels from 13% to 6%, and construction minerals from 29% to 22%. Both the total quantity, and the relative shares of different categories in 2008 are more consistent with the socio-metabolic profile of a developing country than an industrialized one, roughly comparable to Bolivia, for example (UNEP 2013a).

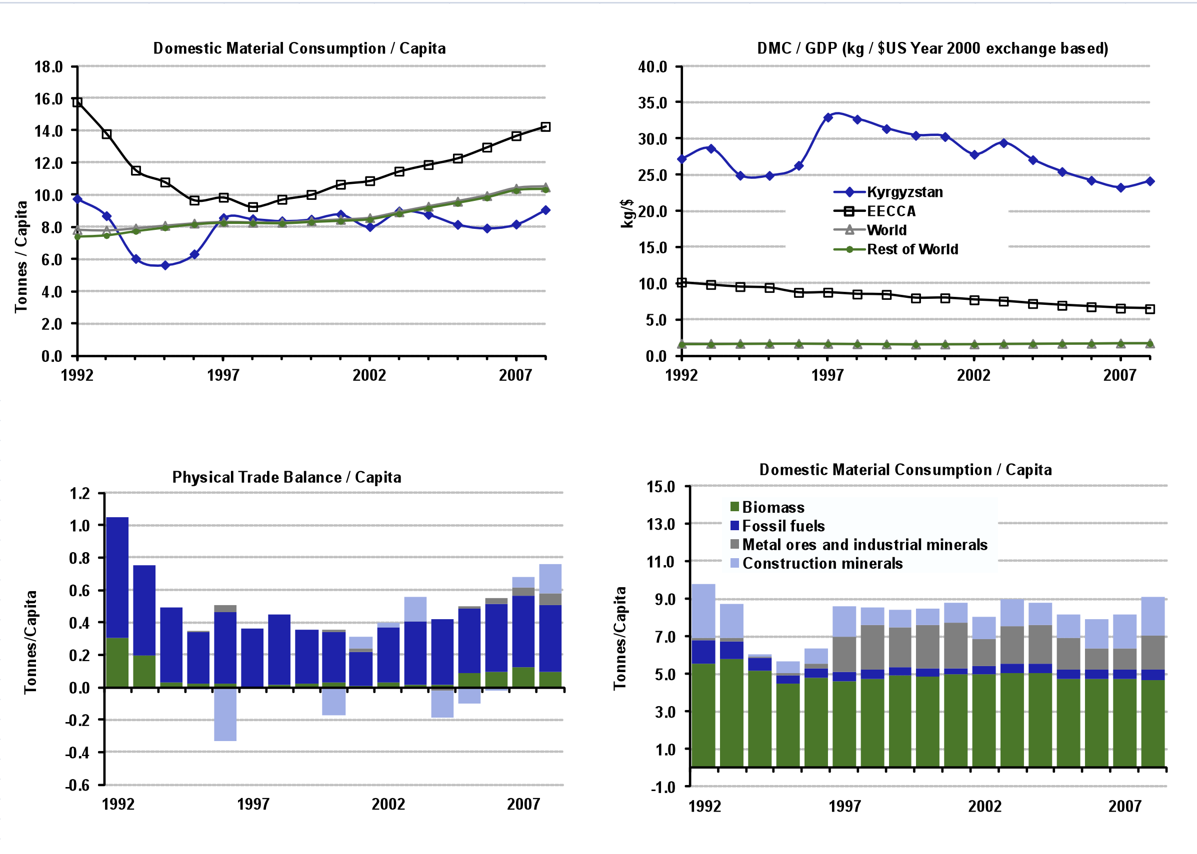

Figure 20: Summary panel of material flows and materials intensity for Kyrgyzstan

3.3.7 REPUBLIC OF MOLDOVA

Moldova's DMC per capita in 1992 of 6.7 tonnes was much lower than the regional average, but still greater than 85% of the World average. By 2008, after first slumping as low as 2.9 tonnes per capita, and remaining below 4.0 tonnes per capita for most of the period 1994 to 2003, DMC had again recovered to 6.7 tonnes per capita (Figure 21). MI was higher than the regional average, and the trajectory over the period was quite volatile. From 13.7 kg/$US in 1992, MI had gone as low as 8.7 kg/$US in 2007, before deteriorating again to 11.5 kg/$US in 2008.

The PTB panel shows that Moldova's only consistent net exports over the period were small quantities of biomass. Moldova's PTB is dominated in all years by net imports of fossil fuels, and these imports account for virtually all of the country's DMC of fossil fuels, which decreased by 59% on a per capita basis between 1992 and 2008. Construction minerals increased strongly both in absolute tonnage per capita, and as a share of total DMC from 2004 to 2008, indicating stronger investment in fixed infrastructure. Biomass actually increased its share of total DMC from 46% in 1992 to 51% in 2008, and so the socio-metabolic pattern indicated is very much that of an agrarian/developing country rather than an industrialized one, with a DMC profile quite comparable to Colombia, for example (UNEP 2013a).

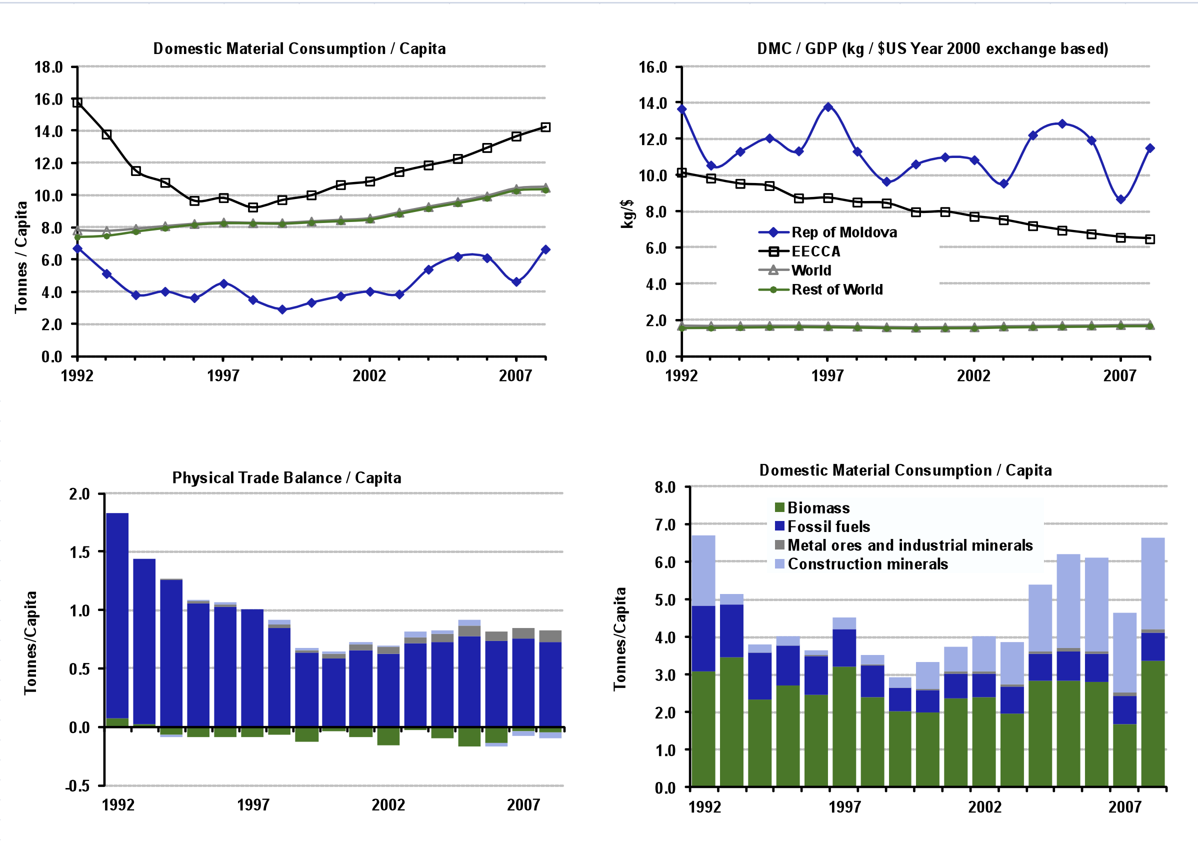

Figure 21: Summary panel of material flows and materials intensity for the Republic of Moldova

3.3.8 RUSSIAN FEDERATION

The degree to which aggregate regional indicators are determined by results for the Russian Federation alone is clearly illustrated in Figure 22, with regional trends tracking that for the Russian Federation very closely. Overall, it can be seen that DMC per capita for the Russian Federation stays roughly 10% to 15% higher than the regional average for the whole period 1992 to 2008, with MI tracking 15% to 20% lower. There is little volatility in the trajectory of either DMC or MI over time compared to many of the smaller countries studied, with a smooth but rapid post-Soviet contraction, with DMC decreasing at 8.4% compounding p.a. from 1992 to 1997, followed by an extended period of growth in DMC, averaging 4.9% p.a. from 1998 to 2008. Improvement in MI is strong and relatively consistent across the whole period. The main feature of PTB is the near doubling of net fossil fuel exports between 1992 and 2008. Note that the absence of any net trade in metal ores and industrial minerals prior to 1996 reflects poor data availability rather than reflecting the true state of trade at that time. The four-category disaggregation of DMC shows the Russian Federation's contraction in demand rebounding by 2008 to a very similar profile to the one that it had in 1992, with changes in relative shares restricted to fossil fuels (contracting from 33% to 31%), and metal ores and industrial minerals (expanding from 13% to 15%). The total magnitude and relative shares of different categories of DMC is consistent with an industrialized country. However, its MI (5.4 kg/$US in 2008) is not typical of an industrialized country, being more comparable with that of countries such as India or Indonesia as reported in UNEP (2013b). For comparison, even Australia, an 'industrialized' country which is nonetheless heavily reliant on exports of primary commodities, had an MI in 2008 of 2.0 kg/$US. The resilience in fossil fuel DMC across time noted earlier at the regional level was in fact largely restricted to the Russian Federation and Belarus. Contractions in fossil fuel demand in the other countries were generally much more pronounced, and often sustained.

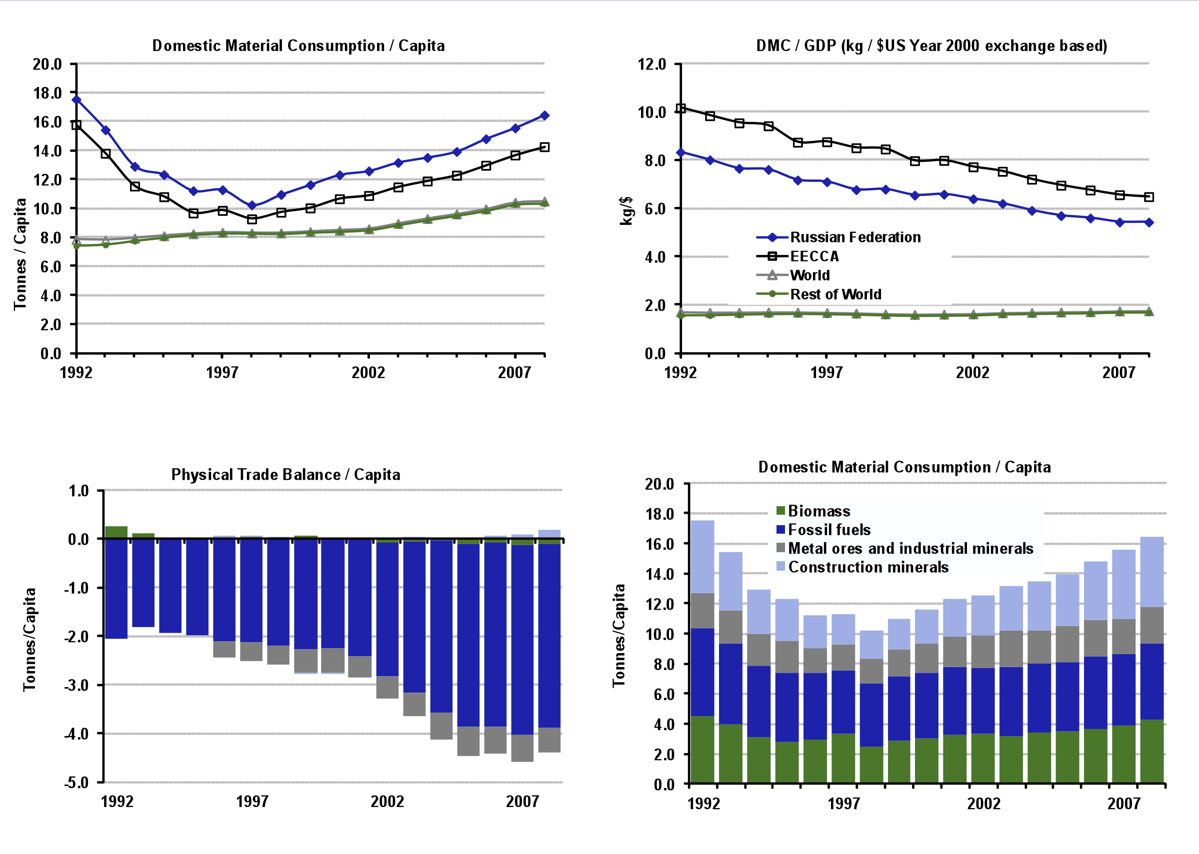

Figure 22: Summary panel of material flows and materials intensity for the Russian Federation

3.3.9 TAJIKISTAN

Tajikistan's DMC per capita was the lowest for any of the EECCA countries, decreasing from 3.8 to 2.8 tonnes per capita between 1992 and 2008, 24% and 20% of the corresponding regional averages (Figure 23). The contraction in DMC was not followed by a rapid or sustained rebound, with DMC per capita remaining below 2.0 tonnes for all years from 1995 to 2001. MI of 14.0 kg/$US was 38% higher than the regional average, and by 2008 had decreased to 11.5 kg/$US, 77% higher than the regional average and over 6.5 times the World average. This high MI, combined with extremely low levels of DMC, implies a very low material standard of living. There is a question mark over the completeness or accuracy of the available base data for Tajikistan with regard to PTB, as no net imports or exports of any metal ores, industrial minerals or construction minerals are recorded. The large (70%) reduction in net imports of fossil fuels from 1992 to 2008, combined with a decrease in biomass imports of 56% at the same time, might indicate a country less able to afford imports. Certainly, while biomass can be seen to dominate DMC, the total levels of biomass DMC per capita even at their highest point (2.2 tonnes/capita in 1992 and 2008) are not high. Biomass, always dominant in share, increased from 60% to 80% of total DMC between 1992 and 2008, while only metal ores and industrial minerals maintained share (5%). Fossil fuels decreased from 14% to 6%, while construction minerals decreased from 22% to 10%, illustrating that investment in fixed infrastructure declined strongly. Both the total magnitude of DMC, and the relative shares of different materials categories, is consistent with those of developing countries such as Cambodia and Nepal (UNEP 2013b), while material productivity is even lower than for those countries. Tajikistan is perhaps the most extreme example of an EECCA nation that combines both low DMC and very low material productivity. Moldova is similar, whereas Armenia and Georgia, while sharing low DMC with Tajikistan, have achieved much higher material productivity and so considerably higher GDP per capita.

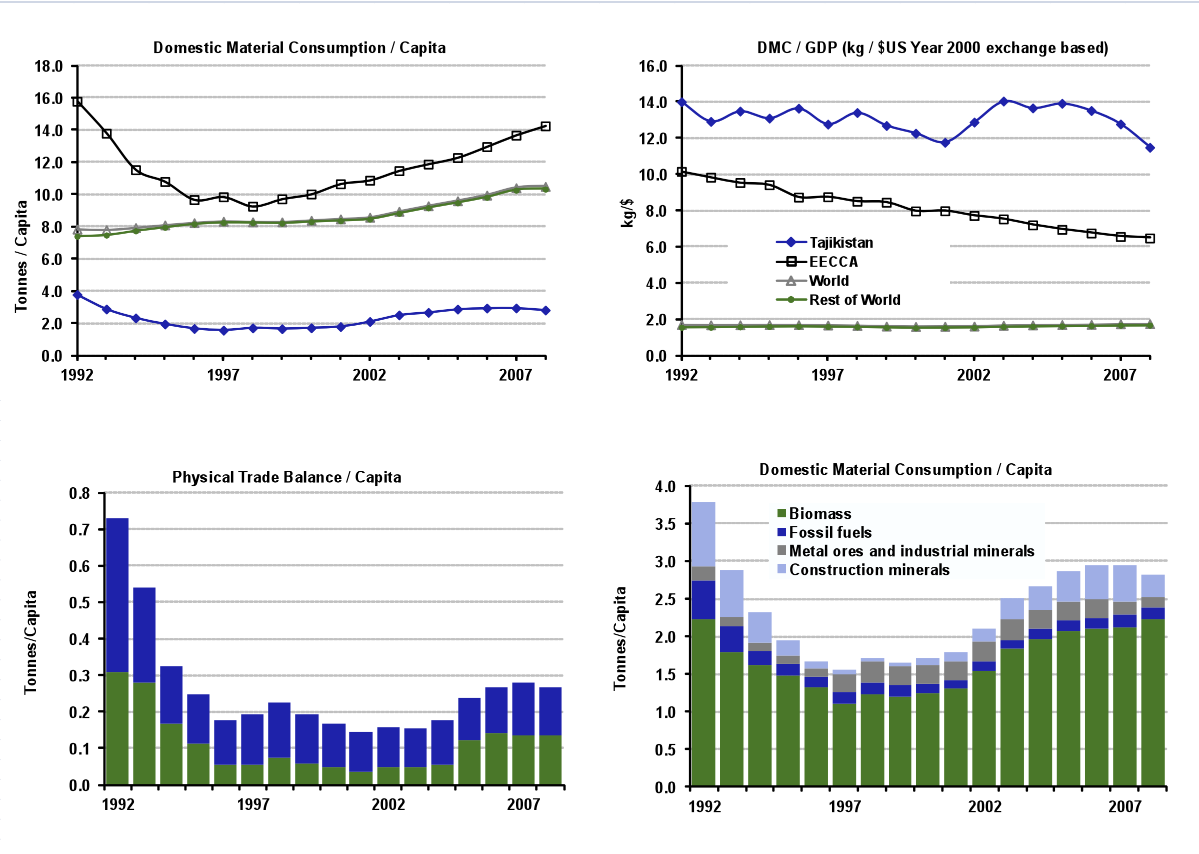

Figure 23: Summary panel of material flows and materials intensity for Tajikistan

3.3.10 TURKMENISTAN

In 1992, Turkmenistan's total DMC of 10.5 tonnes per capita was only 66% of the regional average (Figure 24). In 1996, at its point of maximum contraction, this had decreased by 25%. However, growth in DMC from 1997 to 2008 averaged 5.6% p.a. compounding, so that DMC per capita exceeded 1992 levels by 2002. By 2008, at 14.4 tonnes per capita, it was slightly higher than the regional average, and 38% higher than it was in 1992. While MI improved markedly between 1992 and 2008, there was an extended period from 1992 to 2002 where it increased greatly, then gradually regained the level already achieved in 1992. Two dynamics are likely to explain the trajectory of MI over this period. For most of 1992 to 1999 one sees a major decline in fossil fuel exports, which in Turkmenistan's case are dominated by natural gas, with some petroleum. As outlined previously for Azerbaijan, exports of fossil fuels add to GDP while adding relatively little to the DMC account, so the exports forgone by Turkmenistan would increase apparent MI. The restoration of fossil fuel exports coincides with a return to lower MI. The continued improvement in MI after exports plateaued around 2002 through to 2008, can be explained by major increases in world prices for both natural gas and petroleum over this period. The four-category DMC panel shows that the increase in DMC has been dominated by very strong growth in the biomass component between 1992 and 2008, from 4.0 to 8.8 tonnes per capita, with a corresponding increase in share of total DMC from 40% to 60%. Over 85% of the increase in biomass was accounted for by the increase in grazed biomass, required to meet the three- to fourfold increases in production of milk and meat from ruminant animals which took place over the period. Fossil fuels maintained share at 28%, while construction materials decreased from 32% to 11%.

Turkmenistan's DMC pattern is quite unusual. It is certainly not consistent with an industrialized country, with almost no DMC of metal ores and industrial minerals at all, but has very high fossil fuel consumption (i.e. not just exports) for a developing country. It should be noted that Turkmenistan heavily subsidizes domestic gas consumption. The absolute level of biomass DMC per capita is also very high, mostly accounted for by grazed biomass.

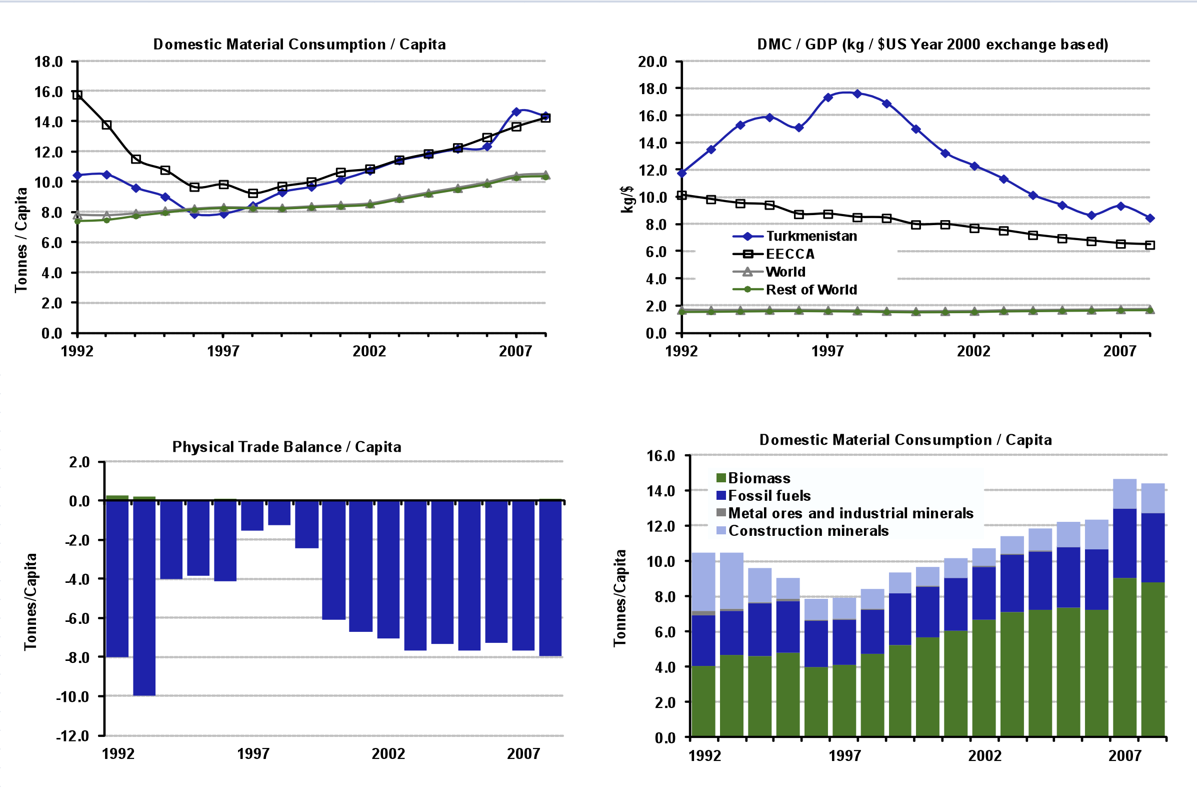

Figure 24: Summary panel of material flows and materials intensity for Turkmenistan

3.3.11 UKRAINE

Total DMC in Ukraine decreased more rapidly than the EECCA region as a whole during the post-Soviet contraction, and has rebounded more slowly (**Figure 25**). In 1992 DMC per capita, at 15.2 tonnes, was very close to the regional average. By 2008 it had decreased to 11.1 tonnes, only 78% of the regional average, but comparable to the World average of 10.5 tonnes. MI, 31% higher than the regional average in 1992, decreased less rapidly over time, so that by 2008 it was 48% higher than the regional average, despite decreasing from 13.3 to 9.6 kg/$US. The PTB panel shows that net fossil fuel imports per capita have remained relatively stable after the initial contraction, while Ukraine maintained fairly consistent growth in net exports for all other categories over the post-contraction period (the absence of metal ores and industrial minerals pre-1996 is due to lack of data). Of the four categories of DMC, only biomass increased in tonnage per capita terms, from 3.95 to 4.25 tonnes, which given annual variability could be considered effectively constant. Given the decrease in all other categories, this modest increase led to a major expansion in biomass' share of total DMC, from 26% in 1992 to 38% in 2008. All other categories appear to have decreased their shares by 4 percentage points each over the period, although the lack of trade data for metal ores and industrial minerals in 1992 renders the DMC result for that category uncertain. The DMC pattern for Ukraine is thus one which might indicate a country becoming less industrialized, with a higher proportion of its DE apparently being exported at an earlier stage in the value-adding chain, and less being either retained locally in infrastructure, or transformed into more elaborately transformed manufactured goods for export or local consumption. The DMC of fossil fuels remained at levels typical of industrialized countries even after strong decreases in the post-Soviet contraction. It may be that the earlier high levels resulted from low or negative value-adding activity, so the apparent de-industrialization may be more a reflection of increasing material productivity.

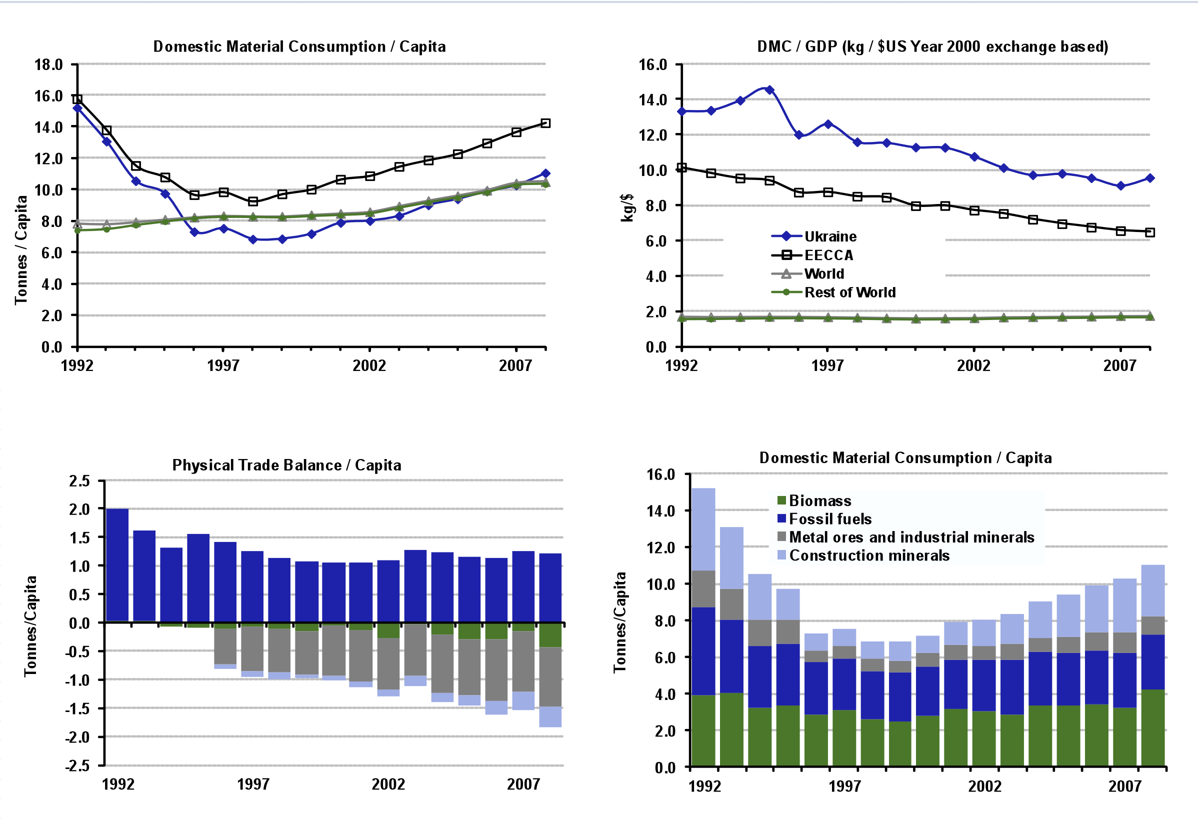

Figure 25: Summary panel of material flows and materials intensity for Ukraine

3.3.12 UZBEKISTAN

DMC per capita for Uzbekistan in 1992 was 11 tonnes, 70% of the regional average. During the post-Soviet contraction, DMC decreased proportionally less than the EECCA region as a whole, so that by 1998 they were approximately equal at around 9 tonnes, but unlike the EECCA region, Uzbekistan did not enter a sustained growth phase until 2003 (Figure 26). This prolonged plateau meant that Uzbekistan's DMC per capita diverged once more from the region, while simultaneously converging with the World average, which it then tracked closely from 2003 until at least 2008, by which time it was 10.3 tonnes. While DMC per capita is near the World average, Uzbekistan suffers from chronically low material productivity, with a MI of 12.3 kg/$US in 2008, seven times the World figure and exceeded only by Kyrgyzstan among the EECCA countries. This is despite reducing its MI by 35% since 1992. PTB shows that Uzbekistan changed from being a net importer of fossil fuels to a modest exporter of fossil fuels over the course of the contraction. The net quantities involved are relatively small compared to domestic consumption, with imports always accounting for less than 15% of Uzbekistan's fossil fuel requirements. The relative stability in total DMC per capita is also largely reflected in the four-category disaggregation. The largest change in share was for biomass, which increased from 31% in 1992 to 38% by 2008, with construction minerals decreasing from 29% to 24%, fossil fuels from 19% to 16%, and metal ores and industrial minerals static at 19%. The balance between different DMC categories is consistent with the socio-metabolism of a partially industrialized country that also retains a large agricultural base.

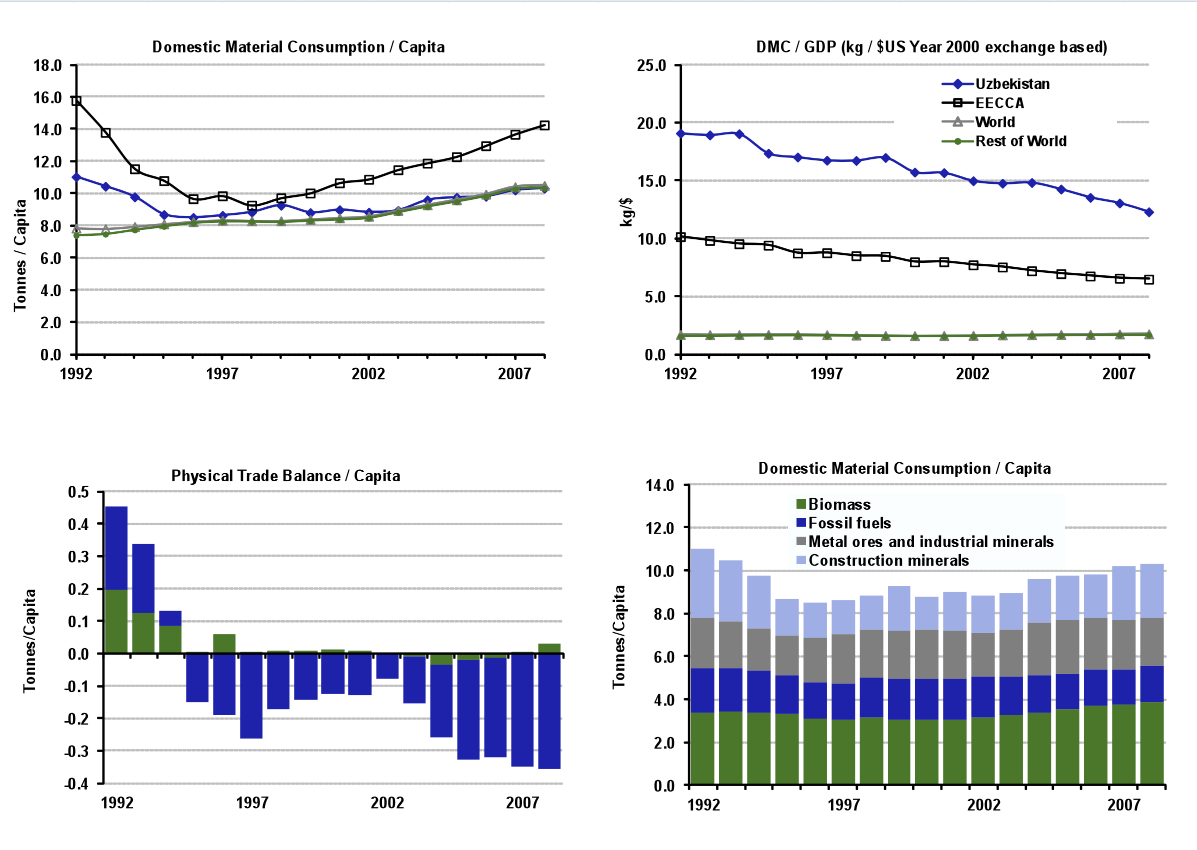

Figure 26: Summary panel of material flows and materials intensity for Uzbekistan

3.4 Drivers of material use patterns and material efficiency

The level of resource use in a region is driven by a number of factors. To better understand how resource use has developed to the present, and what trajectory it might take in the future, it can be helpful to identify and analyse key drivers independently. One widely used analytical framework to achieve this is the IPAT equation (I = P × A × T) This equation in its original form proposed by Ehrlich and Holdren (1971) conceptualizes total impacts on the environment (I) as the product of population (P), multiplied by the level of affluence of that population (A), multiplied by a technological coefficient (T).

While the (I) stands for impacts on the environment in the original version of the equation, aggregate impacts are difficult to measure and indicators for environmental pressures are used in the analysis. In this sense, I might be defined as an emission of interest, such as CO_2, or an extractive pressure on the environment, such as DMC. A is often taken to be GDP/capita, and then T could be defined as the intensity of I per unit GDP generated. Here, I = DMC, A = GDP/capita, and T[8] = DMC/GDP (which is the same as materials intensity, MI).

Using this framework in its original form, determining the effect on I of changing an individual driver in isolation is straightforward. A 10% increase in P will, all other things being equal, lead to a 10% increase in I. The situation becomes less clear where two or more of the drivers vary simultaneously, due to the multiplicative nature of the equation. A quick inspection of the percentage changes in drivers (ΔP, ΔA, and ΔT) in Table 7 shows that the change in impact (ΔI) cannot be calculated by adding these changes. More importantly, it is difficult to allocate proportional responsibility for ΔI to the different drivers using IPAT in this form, and have the components add up to 100%.

One solution to this allocation problem is via a transformation of the IPAT factors to logarithmic form, giving an additive form of the IPAT equation, which is amenable to allocating percentage contributions to the different drivers, which will add up to 100%.[9] The results of applying this technique are shown in the last three columns of Table 7 to Table 9.

Table 7 shows changes over the full study period. A distinguishing feature of this study which contrasts with comparable studies for the Asia-Pacific and Latin American regions is that the EECCA region as a whole was characterized by a contraction in population, so that population change over time acted to reduce environmental pressures. The effect of this decrease in population was relatively small compared to the other main drivers, affluence and T. At an individual country level, five out of 12 countries, mainly in Central Asia, went against the depopulation trend, and all of those five countries saw their DMC increase. In contrast, of the seven countries which had falling populations, only two saw total DMC grow over the period. The effect of increasing affluence outweighed the effects of a modest decrease in population by a factor of nearly 20; however, there was an even more powerful effect from T acting to reduce DMC. It can be clearly seen in Table 7 that a profound improvement in material productivity, as reflected by the regional change in T of –36%,

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[8] The use of the term T in the original IPAT formulation is perhaps unfortunate, as people often equate an increase in 'small t' technology with an improvement in efficiency. In the IPAT context, T stands for a 'technological coefficient', which is then typically defined as whatever the environmental impact of interest is, divided by GDP. *T can thus increase or decrease according to such things as changes in exchange rates, even if the underlying technologies used remain identical.* This point is important. As we are interested in DMC, then T here is simply DMC / GDP, which is equivalent to MI. As a reminder, we do not use the word 'technology' interchangeably with T to remind the reader of this highly specific and perhaps counterintuitive definition.

[9] Details on the formulation of the log transformation of IPAT and a discussion of some limitations of the technique can be found in Herendeen (1998). The values for Belarus in Table 7 provide an illustration of one shortcoming. In cases where there have been changes in drivers, of opposite signs, which result in a small net change in I, we end up with very large percentage changes of opposing signs (which still add to 100%) to explain the small ΔI. In such cases, the raw percentage changes in P, A, and T provides a much clearer representation of the dynamics over the period.

was overwhelmingly responsible for the region's decrease in DMC. An improvement in T was experience by every one of the region's constituent countries. While the effect of T was not always powerful enough to yield decreased DMC in every individual country, most notably in Central Asia and the Caucasus, it did precipitate large material savings in the key countries of the Russian Federation, Ukraine and Kazakhstan.

Table 7: Major drivers of the change in domestic material consumption for all countries in the EECCA region over the period 1992 to 2008

							Share contribution using log transforms		
	ΔI%	ΔI(tonnes)	$\Delta I_c/\Delta I$	ΔP	ΔA	ΔT	P	A	T
Armenia	15.2%	2,325,412	1.00	-10.8%	261.6%	-64%	-81%	907%	-726%
Azerbaijan	84.2%	35,727,205	1.00	17.6%	128.7%	-32%	27%	135%	-62%
Belarus	4.3%	6,502,783	1.00	-5.2%	98.3%	-45%	-	1644%	-
Georgia	-28.0%	-6,204,160	1.00	-19.4%	91.5%	-53%	66%	-198%	232%
Kazakhstan	-17.1%	-80,362,193	1.00	-4.6%	76.1%	-51%	25%	-301%	376%
Kyrgyzstan	8.0%	3,539,993	1.00	16.1%	4.8%	-11%	194%	61%	-156%
Rep of Moldova	-17.8%	-5,228,578	1.00	-17.0%	17.6%	-16%	95%	-83%	88%
Russian	-10.4%	-272,118,969	1.00	-4.5%	43.9%	-35%	42%	-330%	388%
Tajikistan	-7.8%	-1,626,522	1.00	23.8%	-9.3%	-18%	-	120%	244%
Turkmenistan	78.8%	31,998,329	1.00	29.9%	91.3%	-28%	45%	112%	-57%
Ukraine	-35.5%	-281,995,760	1.00	-11.3%	1.3%	-28%	27%	-3%	76%
Uzbekistan	19.4%	45,864,582	1.00	27.6%	45.2%	-36%	138%	211%	-248%
EECCA	-11.4%	-510,000,000	1.00	-1.8%	41.5%	-36%	15%	-290%	375%
World	64.7%	27,500,000,000	0.98	22.9%	28.9%	3%	42%	52%	6%

Table 8 and Table 9 divide the study period into two periods, with Table 8 dealing with the post-Soviet contraction period (1992 to 1998), and Table 9 the subsequent period of renewed growth from 1998 to 2008. This division of time yields some important information which is not apparent from the single combined time period.

Table 8: Major drivers of the change in domestic material consumption for all countries in the EECCA region over the period 1992 to 1998

							Share contribution using log transforms		
	ΔI%	ΔI(tonnes)	$\Delta I_c/\Delta I$	ΔP	ΔA	ΔT	P	A	T
Armenia	-14.8%	-2,253,435	1.00	-9.9%	33.9%	-29%	65%	-183%	218%
Azerbaijan	-27.1%	-11,523,508	1.00	7.2%	-40.1%	13%	-22%	162%	-40%
Belarus	-21.7%	-33,214,549	1.00	-1.4%	-8.1%	-14%	6%	34%	60%
Georgia	-33.5%	-7,422,756	1.00	-9.0%	-9.3%	-19%	23%	24%	53%
Kazakhstan	-42.7%	-200,258,759	1.00	-8.3%	-20.4%	-21%	16%	41%	43%
Kyrgyzstan	-8.0%	-3,532,089	1.00	5.5%	-27.3%	20%	-65%	385%	-220%
Rep of Moldova	-49.6%	-14,564,754	1.00	-3.7%	-36.7%	-17%	6%	67%	28%
Russian Federation	-42.3%	-1,103,114,827	1.00	-1.2%	-28.2%	-19%	2%	60%	38%
Tajikistan	-50.8%	-10,593,350	1.00	9.1%	-52.9%	-4%	-12%	106%	6%
Turkmenistan	-8.8%	-3,591,931	1.00	13.0%	-46.1%	50%	-132%	668%	-436%
Ukraine	-56.8%	-450,303,605	1.00	-3.8%	-48.3%	-13%	5%	79%	17%
Uzbekistan	-10.2%	-24,218,035	1.00	12.1%	-8.7%	-12%	-106%	84%	122%

EECCA	-41.6%	-1,860,000,000	1.00	-0.4%	- 29.9%	-16%	1%	66%	33%
World	14.8%	6,300,000,000	1.01	8.9%	8.9%	-2%	57%	57%	-13%

It is apparent from Table 8 that the post-Soviet contraction accounted for the entire regional decline in DMC, which endures to this day, and that most of that reduction in DMC was attributable to a decrease in affluence. This may seem to contradict the observation made above that, over the full time period from 1992 to 2008, it was changes in T which determined the decrease in DMC; however, it really just results from appropriate resolution of the time scale in a region which experienced two very distinct phases. At a regional level, GDP per capita declined by almost 30%, with four countries (Azerbaijan, Tajikistan, Turkmenistan, and Ukraine) experiencing declines of 40% or more, and only Armenia appears to have increased its GDP per capita over the course of the contraction. While T also made a significant contribution to reducing DMC over this period, its effect was only one-half as great as the decline in affluence at the regional level. Changes in T were more important than affluence for a few individual countries, the most significant of which (with regard to weighting of regional volumes) was Kazakhstan.

Table 9: Major drivers of the change in domestic material consumption for all countries in the EECCA region over the period 1998 to 2008

							Share contribution using log transforms		
	ΔI%	**ΔI(tonnes)**	**$\Delta I_c/\Delta I$**	**ΔP**	**ΔA**	**ΔT**	**P**	**A**	**T**
Armenia	43.7%	5,349,675	1.00	-0.4%	159.5%	-44%	-1%	263%	-162%
Azerbaijan	156.1%	47,645,796	1.00	8.7%	258.2%	-34%	9%	136%	-45%
Belarus	32.8%	39,377,297	1.00	-3.5%	107.8%	-34%	-13%	258%	-145%
Georgia	-3.6%	-592,686	1.00	-10.3%	103.1%	-47%	299%	-1942%	1743%
Kazakhstan	40.1%	111,228,867	1.00	5.0%	112.5%	-37%	14%	224%	-138%
Kyrgyzstan	17.5%	7,135,136	1.00	8.5%	40.7%	-23%	51%	212%	-162%
Rep of Moldova	98.5%	11,991,972	1.00	-12.7%	90.8%	19%	-20%	94%	26%
Russian Federation	45.7%	731,690,390	1.00	-3.0%	87.9%	-20%	-8%	168%	-60%
Tajikistan	90.7%	9,147,050	1.00	12.1%	87.9%	-9%	18%	98%	-15%
Turkmenistan	75.4%	31,208,598	1.00	13.5%	208.3%	-50%	23%	200%	-123%
Ukraine	50.1%	170,575,610	1.00	-6.9%	94.6%	-17%	-18%	164%	-47%
Uzbekistan	25.0%	56,597,766	1.00	12.2%	54.0%	-28%	51%	193%	-145%
EECCA	45.1%	1,230,000,000	1.00	-1.1%	91.3%	-23%	-3%	175%	-72%
World	41.1%	20,400,000,000	0.97	11.5%	16.1%	7%	34%	46%	20%

In Table 9 we see a strong resurgence of affluence in the EECCA region, which increases at more than five times the World average over the same period, and would have driven DMC far higher than it was in 1992 had it not been for the strong improvements in material productivity, which saw T decrease by 2.6% compounding p.a. The decrease in T was sufficient to restrain growth in DMC to just slightly more than the World average over the same period, and maintain regional DMC at a level below that of 1992, although DMC levels have recovered to above 1992 levels more recently. Where the impact of decreasing affluence seems to have made a huge, one-off contribution to reducing DMC during the contraction period, and was crucial to achieving the absolute dematerialization witnessed over the study period, the improvement in T appears to be ongoing. The rate of improvement in T slackened only slightly from the compounding rate of –2.9% p.a. seen during the post-Soviet contraction. While this exceptionally strong performance in improving material productivity is encouraging, it should be noted that it still falls short of what would be required to maintain the achievement of absolute dematerialization, which has probably already reversed at the time of writing. The rate of depopulation of the region actually increased during the growth phase, but was not of sufficient magnitude to contribute significantly to the decrease in DMC. Changes in population have had a significant impact on DMC for some individual countries, both in decreasing it in the case of rapidly depopulating countries, e.g. Moldova, or increasing it in the case of Uzbekistan, where population growth was over 25% and was as important in driving DMC growth as increasing affluence was.

3.5 Concluding remarks

In observing how the relative importance of population, affluence and technology changes over the different periods outlined above, several key points emerge. Firstly, in contrast to other regions studied, T served as a powerful restraint on growth in materials consumption in the region for a prolonged period. The EECCA region as a whole achieved strong relative decoupling of materials from economic growth, and most countries also achieved this on an individual basis. More profoundly, they achieved absolute decoupling, at least on a temporary basis, and this decoupling appears to have been 'real' in the sense that it was not achieved by increasing imports of concentrated forms of primary commodities and substituting them for domestic production. The degree of economic dislocation and hardship endured by the former Soviet states during the period where they achieved the initial large decreases in DMC is widely known, and perhaps stands as an indicator of the sort of extreme conditions required to yield absolute dematerialization in the current global economic system.

While it is possible that the strong improvements in material productivity achieved may be largely a result of the special conditions in which these countries found themselves in 1992, most importantly with widespread negative value-adding in industry, the persistence of these improvements over the full study period is encouraging. Also, while material productivity has increased greatly, MI is still very high by World standards, suggesting that there is great scope for continued rapid improvement.

Some of the countries studied are relatively extreme examples of depopulation, but even in those cases we see that changes in population tend to have only marginal effects of the trajectory of DMC in comparison to affluence and T. In short, population growth is the least significant short-term driver of sustainability problems, and depopulation the least effective short-term restraint.

The twelve countries analysed also provide a unique opportunity to study the development of material flows when an integrated and relatively self-sufficient economy is dissolved into a number of different territorial units, each required to make its own way in the global economy. While there are studies on countries which are making the transition from centrally-planned to market economies, these typically deal with much smaller subsets of ex-Come-on countries (e.g. Kovanda and Hak 2008). Where some countries appear to have grown back into roughly the same, largely industrialized socio-metabolic structure they had in 1992, e.g. Belarus, others such as Turkmenistan and Tajikistan have seen a marked shift towards increasing biomass and lower mineral inputs, in an apparent reversal of the usual socio-metabolic progression. This latter may reflect the loss of any imperative to distribute industrial activity more evenly across the former economic whole, with the development of successor states more constrained by the local availability of resources. In the case of the Russian Federation and Kazakhstan, one observes a major expansion of the primary exports (fossil fuels and metal ores) contemporaneous with growth back into industrialized DMC patterns similar to those of 1992. With the possible exception of Ukraine, there is no real analogue to the pattern exhibited by the Czech Republic, another post-centrally-planned economy, which in Kovanda, Weinzettel and Hak (2010), shows the typical rapid decrease in DMC during the contraction phase, but where rebound in DMC remains subdued as GDP re-entered a strong growth phase. This further indicates that the period of dematerialization seen for the EECCA region was probably a temporary phenomenon.

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4 Water use and efficiency

4.1 Main messages

- Water withdrawals per capita differ significantly among EECCA countries. They are as high as 5.55 megalitres per capita for Turkmenistan, but only 0.41 and 0.42 megalitres per capita, respectively, for Georgia and Ukraine. While water withdrawals declined in the 1990s, the trend came to a halt or even reversed after 2000, quite similar to the development of material flows.

- 58.7% of total water withdrawals in EECCA countries were used in agriculture between 2003 and 2007, which represented 136,214 gigalitres. The second most demanding sector was industry with a share of 29.3% and a volume of 68,061 gigalitres, and the third was municipal water use with a share of 11.9% and water consumption of 27,627 gigalitres.

- The share of agricultural water use is highest in Turkmenistan, followed by Kyrgyzstan, Tajikistan and Uzbekistan. These countries are highly agrarian and their agricultural production is strongly dependent on irrigation. These countries also tend to have the highest water withdrawals per capita and by area.

- Water intensity for all EECCA countries is highest for agriculture (3102 litres per $US), followed by industry (368 litres per $US) and municipal water use (82 litres per $US). The average across all sectors is about 410 litres per $US. Water intensity in agriculture is especially high for those countries relying on extensive irrigation.

- For the entire region, the water abstraction rate is quite low at 4.6%. This is mostly due to the huge renewable water resources of the Russian Federation. Six out of 12 EECCA countries, however, suffer from water stress. It is especially severe in Turkmenistan and Uzbekistan where annual abstraction surpasses renewable water resources.

4.2 Water resources in EECCA countries

Water is essential to life, meeting human needs and maintaining ecosystems for all living species. Water resources are important to socio-economic development, providing material input to production and consumption activities and acting as sinks for waste material. Consequently, water resource systems are closely linked to the economic use of resources. This section of the report investigates water resources and water use patterns, trends in water use and resultant stresses on water systems in EECCA countries. It is understood that it is difficult to present and assess national aggregates and indicators, as water availability and use are very region-specific, also given the different biophysical conditions of particular countries. Regional data on water are not available, however, so the indicators used are related to certain regional water issues, such as the Aral Sea disaster.

While water is a material of high significance for socio-economic metabolism, water is not included in material flow accounts but presented separately, as water flows exceed other material flows by several orders of magnitude (Schandl et al. 1999). Water use varies between 500 to 5000 t/cap/y, while domestic material consumption ranges between 10 and 20 t/cap/y in the region. The aggregation of water to all other materials would therefore lead to an effect where everything would be 'diluted' by water flows and any details in development of other materials would be barely visible.

The EECCA countries are characterized by a broad range of different climates which leads to a very uneven distribution of water resources in the region. The Russian Federation is endowed with 31.5 thousand m^3 of renewable water resources per capita per year, followed by Georgia with 14.3 thousand m^3 per capita per year, but Uzbekistan has at its disposal only 1.8 thousand m^3 per capita per year (FAO 2013). While total water withdrawals in the EECCA region represent only about 6% of total global withdrawals (UN-WATER/WWAP 2012, FAO 2013), some countries in the region suffer from severe water stress[10], and the issue of water availability and use is an important policy issue for them, which justifies including a section on water in this report.

The Eastern European countries of Ukraine, Belarus and the Republic of Moldova have a temperate continental climate and varying topography including fertile plains (steppes), highlands and mountains. They are also endowed with relatively abundant precipitation of 450 to 650 millimetres per year, which is reflected in a dense river network. There are seven major rivers in Ukraine: Desna, Dnipro, Dnister, Danube, Prypiat, Siverian Donets and Southern Buh. Major rivers in Belarus include the Western Dvina, Nyoman, Dnipro, Berezina, Sozh and Prypiat, while most territory of the Republic of Moldova lies between the area's two main rivers, the Dnister and the Prut. Sufficient precipitation and the fact that this region hosts the world's most fertile soils – Ukrainian 'chernozem' (FAO 2001) – implies that there is very limited need for irrigation in agricultural production.

The Russian Federation is a huge country with many climatic types, topographies and biomes, but its vast expanses lie in continental and sub-Arctic climate regimes, with enough precipitation to host the world's largest rivers such as Volga, Ob, Yenisei, Lena, Kolyma and Amur. It also contains Lake Baikal, which is the most voluminous fresh water reservoir in the world (UNESCO 2013). Thus, the Russian Federation has the largest total renewable water resources per capita of all EECCA countries (FAO 2013).

The Caucasus countries of Armenia, Georgia and Azerbaijan contain mountain ridges, crests and plateaus, but also plains and lowlands. These countries in general lie in the subtropical region, but host semi-desert and dry steppe climates, moderate climates, cold climates and also mountainous tundra in places. The average yearly precipitation ranges from more than 1000 millimetres in Georgia to 450 millimetres in Azerbaijan, but the rivers are mostly short and fast flowing due to mountainous terrain. They include, for instance, the Akhurian, Vorotan and Araks rivers in Armenia, Mtkvari and Chorokhi rivers in Georgia and the Kur, Araz and Ganikh rivers in Azerbaijan.

The Central Asian countries of Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan are covered by high passes and mountains, vast deserts and treeless, grassy steppes. The climates are mostly dry, semi-arid and arid, but also cold in the mountains. Average yearly precipitation is as high as 700 millimetres in Kyrgyzstan and Tajikistan due to their highly mountainous topography. The remaining three countries, however, experience only 160 to 250 millimetres. The two main rivers of the region are the Amu Darya and Syr Darya and their tributaries, which drain all five countries and flow to the remnants of the once-famous inland Aral Sea (Rudenko and Lamers 2010). Other major rivers include the Irtysh, Ural and Emba in Kazakhstan and the Naryn, Talas and Chui in Kyrgyzstan.

[10] Water stress is measured by means of Water Exploitation Index, which denotes the portion of the available freshwater resource that is used. Countries with a Water Exploitation Index between 20 and 40% are considered stressed, while those with a Water Exploitation Index above 40% are considered to be under severe stress (EEA 2013).

Due to the semi-arid and arid climate, agriculture in Central Asia is sustained by massive irrigation (Bucknall et al. 2003).

The interdependence among EECCA countries for water resources management is high, as more than 50% of the EECCA countries share transboundary river basins. Some basins are shared by three or four countries, such as the Amu Darya, which provides water to Kyrgyzstan, Tajikistan, Uzbekistan and Turkmenistan (OECD 2011). Table 10 and Table 11 summarize the relative importance of pressures on water resources in EECCA countries and provide response measures depending on external drivers (UN-WATER/WWAP 2012). With the revival of the economy in this region, a shift in the relative importance of some pressure factors might occur. Concrete examples of possible problems, drivers and solutions, related both to water quantity and quality in the EECCA region, are shown in Box 2 and Box 3 (UN-WATER/WWAP 2012).

Table 10: Main pressures on water resources in order of priority (from high to low) (Source: UN-WATER/WWAP 2012)

Countries in Eastern Europe, the Caucasus and Central Asia
Pressures on water quality: Municipal sewage treatment, non-sewer population, old industrial installations, illegal wastewater discharges, illegal disposal of household and industrial wastes in river basins, tailing dams and dangerous landfills
Abstraction pressures: Agricultural water use
Hydro-morphological alterations: Hydropower dams, irrigation channels, river alterations
Other pressures: Agro-chemical pollution (becoming more severe), mining and quarrying

Table 11: Selected water management issues and responses (Source: UN-WATER/WWAP 2012)

Main issues	**Possible water management responses**
Pressures by nutrients and pesticides from agriculture with economic development as main driver	Coordination of objectives, coordination of measures and combined approach for pollution control from agriculture (e.g. good agricultural practice, payments for ecosystem services)
Pressures by specific substances from manufacturing industries with economic development as main driver	Inventory of existing and potential polluters, coordination of objectives, coordination of measures and combined approach for pollution control from industrial installations (e.g. best available technology for hazardous substances, pollution reduction through installation of closed water systems)
Pressures by organic matter and bacteriological pollution with economic development, demographic patterns and migration as main drivers	Inventory of existing and potential polluters, coordination of objectives, coordination of measures and combined approach for pollution control from municipal wastewater treatment plants (at least biological treatment or equivalent processes)
Flooding with climate change and economic development as main drivers	Climate change adaptation, holistic approach to flood management (combination of non-structural and structural measures)
Pressures due to hydro-morphological alterations with economic development as main driver	Re-naturalization of small and medium-sized rivers, payment for ecosystem services
Water scarcity and/or abstraction pressures with economic development, demographic patterns, migration and climate change as main drivers	Climate change adaptation, conjunctive management of surface waters and ground waters, licensing groundwater use
Water management in a transboundary context with political transitions and security concerns, economic development, demographic patterns, migration and climate change as main drivers	Transboundary cooperation as stipulated by applicable bilateral and multilateral agreements, implementation of the UNECE Water Convention (UNECE 1992) and its protocols

Note: Terminology according to the Water Framework Directive (European Commission 2000) and UNECE (2007a, 2007b)

Box 2: Agriculture and water use in Central Asia (Source: UN-WATER/WWAP 2012)

In Central Asia, the agricultural sector accounts for more than 90% of surface water extracted and 43% of groundwater extracted. Irrigated agriculture and the entire water-based sector contribute about 40% to 45% of regional GDP (Stulina 2009). Central Asia comprises 50% of the total irrigated area of the regions of the former Soviet Union (FAO 2011). Agricultural water pollution, sedimentation and algal blooms have had some serious and well-documented impacts. These have included loss of biodiversity, the extinction of whole ecosystems, deterioration in drinking water quality, human health problems, declining crop yields, poverty, unemployment, migration and the risk of conflict (Yessekin et al. 2006). Although many measures have been proposed to address the situation, scarce financial resources have led to delays in implementing them. The importance of stakeholder involvement in negotiating water allocation, especially in transboundary situations, has only recently been recognized. The International Fund for Saving the Aral Sea is steering a process to improve conditions.

Box 3: Wastewater treatment infrastructure in the Republic of Moldova (Source: UN-WATER/WWAP 2012)

The economic downturn in the 1990s resulted in a huge decline in the operational capacity of Moldova's municipal wastewater treatment plants. By 2010, only 24% were still operating and only 4% of these were adhering to legal requirements for the disposal of wastewater. In rural areas, 70% of homes were not connected to the sewerage system. As a result, an increasing amount of untreated wastewater was discharged into rivers. The EU and other funds began supporting an enormous assistance program to rehabilitate municipal infrastructure and improve rural sanitation. New wastewater treatment legislation, modeled on EU laws and drawn up under the National Policy Dialogue process, came into force in October 2008, replacing outdated Soviet-style law. Existing plants can now be rehabilitated and new ones constructed according to state of the art treatment technology (UNECE 2011a).

4.3 Water use patterns

4.3.1 TRENDS IN WATER WITHDRAWALS

Figure 27 shows the total water withdrawals in EECCA countries for 1995, 2000 and 2005[11].

[11] Although national data on water withdrawals are available for some years, large uncertainties remain about the computational methods used to develop the statistics. In this report, water data have been derived from FAO Aquastat data, which deals with a series of five-year time intervals where the value given for any interval may come from any single year within it. Here, either the full interval is quoted, such as 1998–2002, or the midpoint of the time interval is given. For example, where the year 2000 is quoted, the value may actually have been recorded for any year within the period 1998–2002. This latter convention is important mainly where an intensity such as water withdrawals per $US GDP is given, as the GDP data are for the exact year nominated.

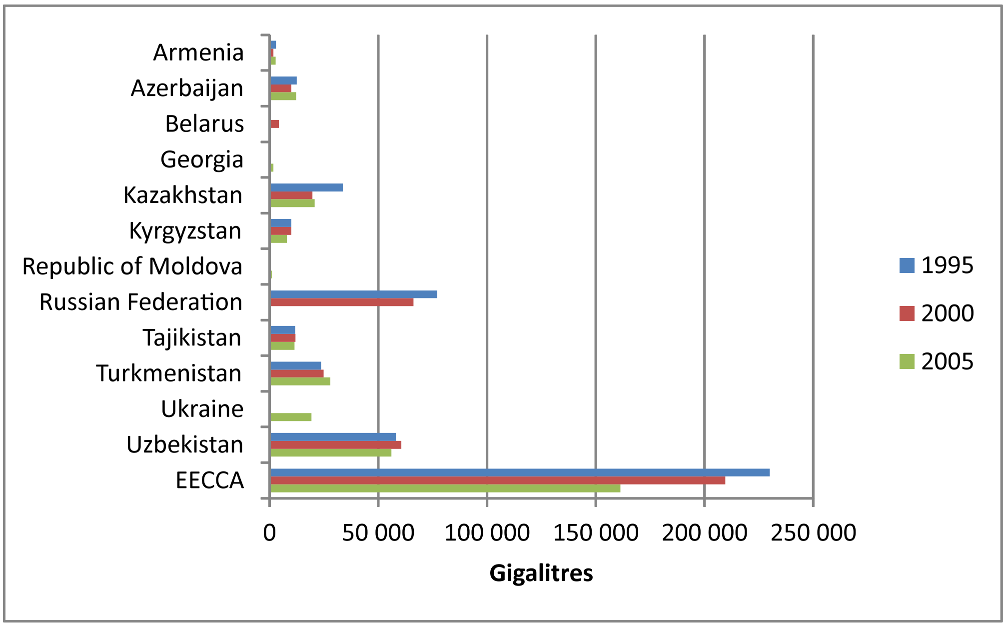

Figure 27: Total water withdrawals, EECCA countries, 1995, 2000, 2005 (Source: FAO 2013)

The highest total water withdrawals (average for 1995, 2000 and 2005) were recorded for the Russian Federation, followed by Uzbekistan, Turkmenistan, Kazakhstan, Ukraine, Tajikistan and Azerbaijan. The total water withdrawals in other EECCA countries were comparatively low. Reliable information on long-term trends of water withdrawals are scarce, but the data shown in Figure 27 indicate that the Russian Federation decreased its water withdrawals by 14% or 10,900 gigalitres between 1995 and 2000, and Kazakhstan by 38% or 12,950 gigalitres between 1995 and 2005. Some minor decreases in water withdrawals were further recorded in Uzbekistan and Kyrgyzstan, while water withdrawals remained more or less the same in Tajikistan and Azerbaijan. In contrast, Turkmenistan was the only country which experienced an increase in total water withdrawals (18% or 4170 gigalitres) between 1995 and 2005. The trends in total water withdrawals for the whole EECCA region must be interpreted with care: while the decrease of about 9% or 20,424 gigalitres between 1995 and 2000 seems to be well supported by data, the low value for 2005 is due to missing data for the Russian Federation, the country with the highest total water withdrawals in the region. It is more likely that total withdrawals in the region remained more or less constant between 2000 and 2005.

Figure 28 shows total water withdrawals per capita in particular EECCA countries.

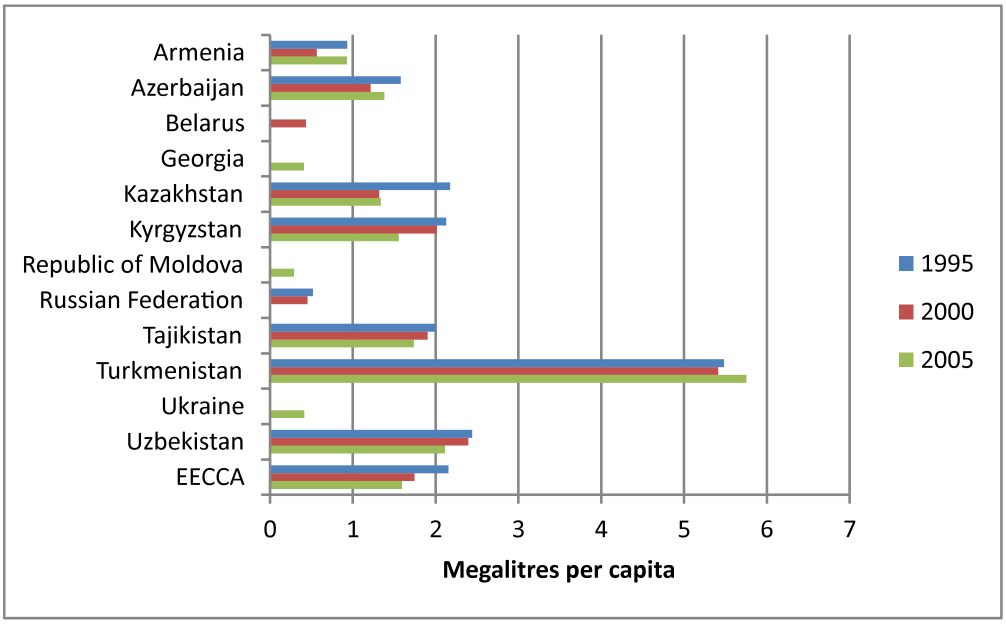

Figure 28: Water withdrawals per capita, EECCA countries, 1995, 2000 and 2005 (Source: FAO 2013)

Water withdrawals per capita differ significantly among EECCA countries. They are as high as 5.55 megalitres per capita for Turkmenistan, but only 0.41 and 0.42 megalitres per capita, respectively, for Georgia and Ukraine. These differences are, among other factors, related to extensive use of water for irrigation in some EECCA countries as shown below.

The highest water withdrawals per capita were recorded for Turkmenistan, followed by Uzbekistan, Kyrgyzstan, Tajikistan and Kazakhstan. There was a favorable decrease in per capita water withdrawals in many EECCA countries in the period 1995 to 2005. They decreased by 38% or 0.84 megalitres per capita in Kazakhstan, 27% or 0.57 megalitres per capita in Kyrgyzstan and about 12% or 0.26, 0.2 and 0.66 megalitres per capita, respectively, in Tajikistan, Azerbaijan and the Russian Federation. This downward trend slowed after 2000 and in several countries even reversed, such as in Armenia, Azerbaijan and Turkmenistan. Water withdrawals per capita for the entire EECCA region[12] recorded a decrease of 26% or 0.56 megalitres per capita between 1995 and 2005. This decreasing trend was mostly related to declining agricultural/irrigation activities during the transition to a market economy, a trend which is also reflected in the material flow data for biomass (see chapter on material flows). Moreover, water prices have been heavily subsidized and have until relatively recently not reflected the real costs of supply and maintenance of water supply and sewerage systems. This was due to the need to keep these services affordable. Economic restructuring, however, led to water companies increasing prices. As a result both households and industrial sectors used less water (EEA 2007). Further investments in water infrastructure, and thus an increase in water prices, can be expected in the near future. For instance, Russia needs to spend hundreds of billions of $US in order to upgrade or build infrastructure for water and sanitation. The water treatment sector is therefore considered one of the most promising sectors of Russia's economy, with large potential for growth (Piskulova 2012).

The pronounced differences in water withdrawals per unit area shown in Figure 29 are related to the extent of irrigated land in particular countries. The highest withdrawals were found for Azerbaijan

[12] The water withdrawals per capita for the entire EECCA region were calculated as an arithmetical average of per capita water withdrawals in particular countries available for particular years. It was not possible to base the figures on available data on water withdrawals and population in respective countries. In that case, there would have been an apparent population drop of approximately 50% due to missing data for the Russian Federation in 2005, and water withdrawals per capita would appear to have risen rapidly in that year.

and Uzbekistan (both around 130 megalitres per km^2), Armenia (84 megalitres per km^2), Tajikistan (83 megalitres per km^2), Turkmenistan (52 megalitres per km^2) and Kyrgyzstan (47 megalitres per km^2). In comparison, withdrawals are low for the Russian Federation (4 megalitres per km^2) and Kazakhstan (9 megalitres per km^2).

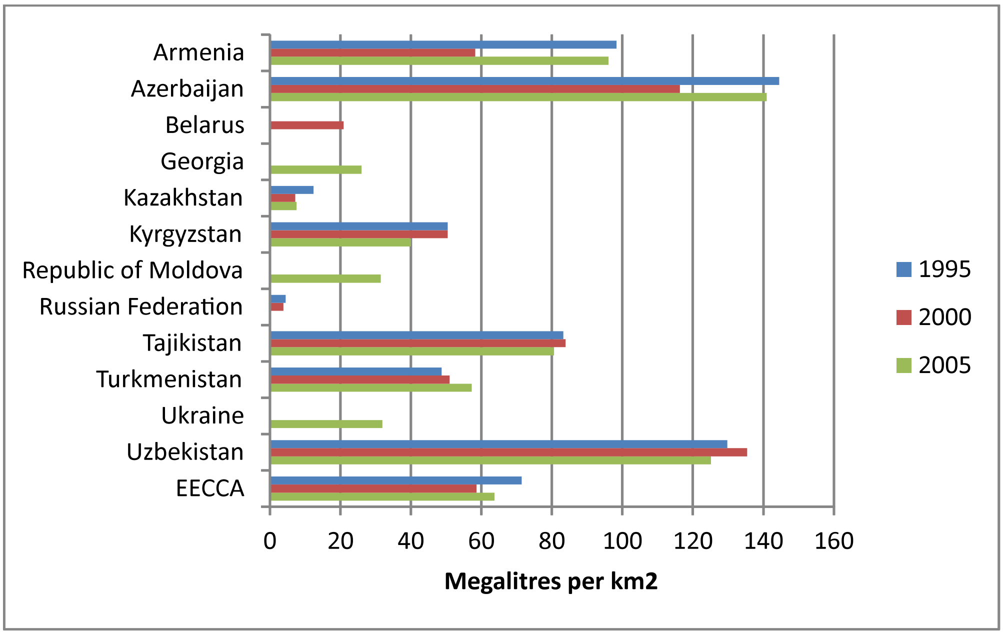

Figure 29: Water withdrawals per area, EECCA countries, 1995, 2000 and 2005 (Source: FAO 2013)

4.3.2 SECTORAL WATER WITHDRAWALS

Error! Reference source not found. shows annual water withdrawals by sectors and shares of particular sectors in total water withdrawals for EECCA countries between 2003 and 2007[13].

Table 12: Annual water withdrawals by sectors and shares of particular sectors in total water withdrawals, EECCA countries, 2003 to 2007 (Source: FAO 2013)

Country	Agriculture (GL)	Percentage of total withdrawal	Industry (GL)	Percentage of total withdrawals	Municipal (GL)	Percentage of total withdrawals	Total withdrawals
Armenia	1 890	66.1	125	4.4	843	29.5	2 858
Azerbaijan	9 330	76.4	2 360	19.3	521	4.3	12 211
Belarus	840	19.4	2 332	53.8	1 166	26.9	4 338
Georgia	1 055	58.2	400	22.1	358	19.7	1 813
Kazakhstan	14 030	67.7	5 839	28.2	853	4.1	20 722
Kyrgyzstan	7 447	93.0	336	4.2	224	2.8	8 007
Republic of Moldova	36	3.4	883	82.9	146	13.7	1 065
Russian Federation	13 200	19.9	39 600	59.8	13 400	20.2	66 200

[13] Data for Russian Federation and Belarus refer to the period 1998 to 2002.

Tajikistan	10 440	90.8	408	3.5	647	5.6	11 495
Turkmenistan	26 360	94.3	839	3.0	755	2.7	27 954
Ukraine	1 186	6.2	13 440	69.9	4 614	24.0	19 240
Uzbekistan	50 400	90.0	1 500	2.7	4 100	7.3	56 000
EECCA	136 214	58.7	68 061	29,3	27 627	11.9	231 902

Agriculture is the largest consumer of water in most countries of the region. The sector used 136,214 gigalitres or 58.7% of the total withdrawals in the period 2003 to 2007. The second most demanding sector was industry, with a share of nearly 29.3% and a volume of 68,061 gigalitres, and the third was municipal water use with the share of 11.9% and water consumption of 27,627 gigalitres. These figures for the entire EECCA region, however, hide significant differences at country level.

The share of agricultural water use is highest in Turkmenistan followed by Kyrgyzstan, Tajikistan and Uzbekistan. These countries are highly agrarian, with agricultural value added to GDP as much as 31% in the case of Kyrgyzstan and over 30% of the population active in agriculture in some cases (FAO 2013). By far the two most significant crops in these countries are cotton and wheat. As these Central Asian countries are largely characterized by an arid or semi-arid climate, agricultural production is strongly dependent on irrigation and requires large amounts of water (Bucknall et al. 2003). The high levels of water extraction and irrigation lead to depletion of water resources, salinization and further desertification. A well-known example of the environmental problems connected to the excessive use of water for irrigation in the region is the Aral Sea disaster. The Aral Sea, once the world's fourth largest lake, has shrunk by 90% due to continuous growth of cotton production in this arid region, ruining the once-thriving fishing economy and leaving fishing trawlers stranded in sandy wastelands (Rudenko and Lamers 2010).

The above-average share of industrial water use is typical for countries which inherited significant industries from the Soviet era. These include Ukraine with its iron mining, steel production and chemical industry, the Republic of Moldova with its wine industry, Belarus with its metallurgy and mechanical engineering and the Russian Federation with its various resource-mining industries and automobile, aircraft and space industries.

With respect to municipal water use, its share is as high as 29.5% in Armenia, 26.9% in Belarus and 24% in Ukraine, but only 2.7% in Turkmenistan and 2.8% in Kyrgyzstan. In per capita terms, Armenia withdraws 274 thousand litres of municipal water yearly, but the Republic of Moldova only 40 thousand litres. Even though the share of municipal water use in Turkmenistan is only 2.7%, per capita use of municipal water is above average at about 155 thousand litres per year. This is because water has been free to households up to 250 litres per capita per day after which minimal prices are charged (IWPR 2013). In most countries, yearly per capita withdrawals of water for municipal use have been growing since 1995 (FAO 2013), which can be attributed to GDP growth and thus improved living standards over this period.

4.3.3 WATER INTENSITY

The overall water intensity of an economy refers to the total water consumed in that economy, divided by economic output per dollar (US) of GDP. Sectoral water intensities refer to the water used by that sector per dollar of value added by that sector, such as water withdrawals for agriculture divided by value added from agriculture.

Figure 30 shows water intensity for EECCA countries between 2003 and 2007[14].

[14] Data for Russian Federation and Belarus refer to the period 1998 to 2002.

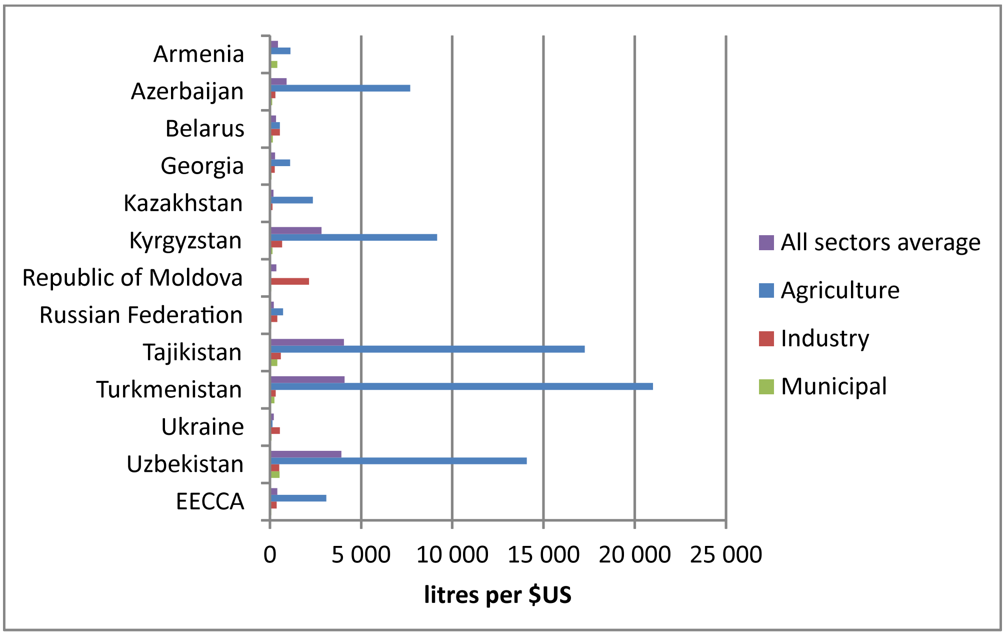

Figure 30: Water intensity, EECCA countries, 2003 to 2007 (Source: FAO 2013)

The water intensity for all EECCA countries is highest for agriculture (3102 litres per $US), followed by industry (368 litres per $US) and municipal water use (82 litres per $US). The average for all sectors is about 410 litres per $US. Water intensity in agriculture is especially high for those countries relying on extensive irrigation practices: Turkmenistan, Tajikistan, Uzbekistan and Kyrgyzstan. This indicates that agriculture based on irrigation not only burdens the environment with serious pressure, but also that the use of irrigation water and related pressures are not adequately reflected in agricultural commodity prices. Water intensity in industry is highest in the Republic of Moldova, Kyrgyzstan and Tajikistan; and the lowest industrial water intensities are in Armenia, Kazakhstan and Georgia. The highest intensities of municipal water use were recorded for Uzbekistan, Tajikistan and Armenia; the lowest ones for Kazakhstan, the Republic of Moldova and the Russian Federation.

4.3.4 WATER ABSTRACTION RATES AND WATER STRESS

High water abstraction and high water intensity are a serious problem, especially if water resources are constrained and water quality is poor. The water abstraction rate denotes the portion of the available freshwater resource that is used, and is an indication of pressures on water resources. Figure 31 shows water abstraction rates (sometimes called Water Exploitation Index) for EECCA countries for 2003 to 2007[15].

[15] Data for Russian Federation and Belarus refer to the period of 1998 to 2002.

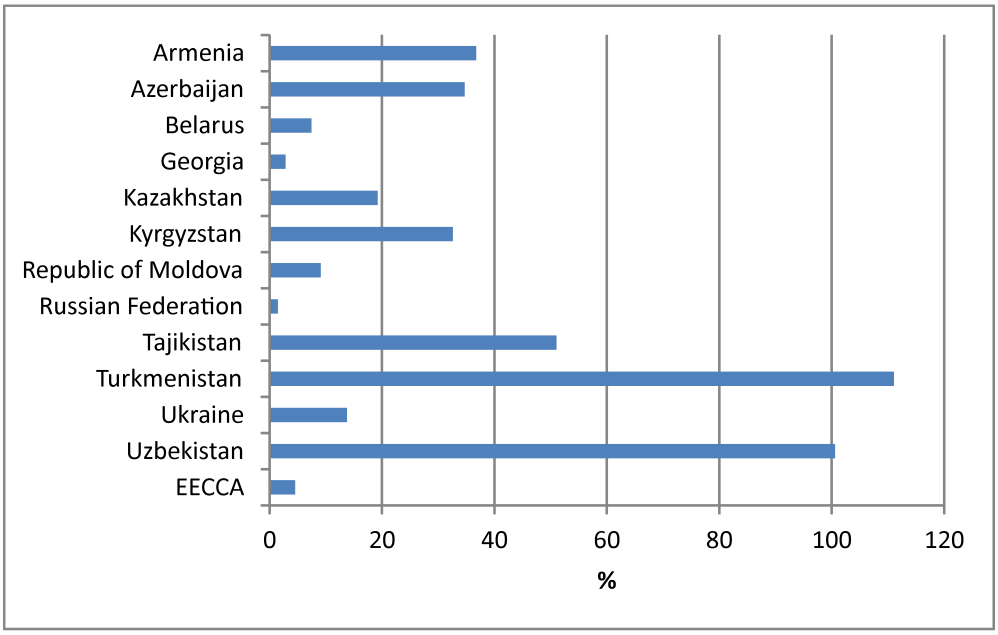

Figure 31: Total withdrawals as a share of renewable water resources, EECCA countries, 2003 to 2007 (Source: FAO 2013)

For the entire region, the water abstraction rate is quite low at 4.6%. This is due to the huge renewable water resources of the Russian Federation, which amount to 4.5 million gigalitres (the country with the second highest renewable water resources is Ukraine, but they amount to only 140 thousand gigalitres). From Figure 31 it is evident that the low regional average does not hold true for most countries: An index of over 20% usually indicates water scarcity, relative to the amount required. Accordingly, countries between 20 and 40% are considered stressed, while those with a Water Exploitation Index above 40% are considered to be under severe stress (EEA 2013). Only six countries in the region are below the 20% threshold. Three out of 12 EECCA countries are classified as stressed and three others as severely stressed. Water stress is especially high in Turkmenistan and Uzbekistan where annual abstraction surpasses renewable water resources. This leads to depletion of available water resources as documented by the Aral Sea disaster (see above) and can have various severe consequences such as disruption to food production and economic development, unless the region is wealthy enough to apply new technologies for water use, conservation or reuse.

4.4 Concluding remarks

This chapter proves that water is an important topic in the EECAA region and should be tackled accordingly in the water management policies. Astana Water Action (UNECE 2011b) and the note on Sustainable Management of Water and Water-related Ecosystems (UNECE 2011c) prepared for the seventh 'Environment for Europe' Ministerial Conference held in Astana in 2011 as well as Second Assessment of Transboundary Rivers, Lakes and Groundwaters (UNECE 2011d) proposed a collection of possible actions for improving the status of water, water-related ecosystems and water management in the wider UNECE region. OECD (2011) identified a number of financial and regulatory actions and policy measures applicable for the EECCA countries in particular that can be undertaken in the water sector:

- Determine the appropriate scale and scope of water systems

Several EECCA countries are still searching for the optimal scale of operations of water supply and sanitation systems. Regional operators are not necessarily the optimal option here, as economies of scale and scope have to be considered. Overcoming the effects of over-fragmentation can take different forms: e.g. permanent grouping with transfer of asset ownership to a single new operator, or temporary grouping and no asset transfer.

- Strengthen local capacities to set contractual arrangements

Contractual arrangements can be powerful tools to regulate providers of water supply and sanitation services, be they public or private, to improve performance monitoring and to increase transparency. EECCA governments would benefit from preparing model contracts at national level which can be used and adapted at the local level. They can then provide guidance and support to local authorities in charge of contracting, particularly in countries where the water and sanitation sector remains highly decentralized. The objective should be to strengthen the capacity of local authorities to carry out water service regulation, with a focus on both tariffs and service quality regulation.

- Fix tariff setting procedures and explore alternative tariff structures

Tariffs and tariff setting are areas where regulation can be improved. Tariff setting methodologies should be developed and applied, considering estimates of the overall revenue requirements to cover all costs, alternative sources of finance, and capacity to pay from different user groups. Different tariff structures can be considered to meet specific objectives. In particular, tariff structures can be designed so as to allow for tariff increases without negatively affecting the poor.

- Plan and invest wisely

Water-related investment planning in EECCA countries should be more systematically based on sound technical and financial analyses. Investment plans can be designed strategically so as to avoid 'disbenefits' along the way. Preventive maintenance and depreciation allowances are cost effective ways to avoid large investments in the future. From an economic and financial perspective, there is some benefit in prioritizing investment in service levels and regions that generate the highest benefits at least cost. For example, generalizing improved sanitation in rural areas could be done at low cost.

- Increase overall financing to the sector

There is room to attract more funding from central budgets. First, the water sector may receive increased attention from finance ministers when it has strong linkages with the Medium-term Expenditure Framework planning process. Second, finance ministers may be sensitive to the costs of 'non-investment' and the actual impact on the economy of poor water-related services. Therefore, water authorities would gain from assessing such costs, in a reliable and convincing way, in order to trigger a policy response from other parts of governments. Repayable financing to the sector can be increased by enhancing transparency based on audited accounts and getting water companies listed on local stock exchanges where they are in place.

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5 Natural Resource Policies

5.1 Main messages

- Over the past decade, steps have been undertaken in the EECCA region to reform environmental institutions, policies and legislation. Various strategies and action plans have been adopted. However, strategic planning and prioritization in light of scarce resources and competing needs continues to pose a challenge for all countries in the region. Realistic implementation strategies are often missing. In developing environmental programmes, the involvement of stakeholders, including gender-sensitized civil groups, and building support for environmental reform are not always given sufficient attention.

- Environmental legislation varies throughout the region, but in many cases needs further development, particularly in terms of implementation. The countries struggle with implementation and enforcement of environmental legislation due to a lack of administrative capacity and financial resources.

- The capacity of institutions to respond to resource use challenges appears weak. Many competent officials have left ministries, resulting in conditions favorable to corruption. Also, the low level of public awareness across the region hinders institutional reform. Therefore – and because most EECCA countries have low income levels – the environment is rarely a top priority for citizens or decision makers.

- The low level of public participation and awareness of environmental issues in the region limits civil society actors in fully assuming roles in developing and implementing environmental policy and legislation. Regional Environmental Centres (RECs) in the region aim to help address environmental issues through the promotion of cooperation between various stakeholders, NGOs including gender-sensitized civil groups, government bodies, local communities and the business sector. They also aim to promote public participation in the environmental decision-making process.

- Integrating environmental considerations into other policy areas is also a challenge. In order to ensure implementation and enforcement of environmental legislation and multilateral environmental agreements (MEAs), countries in the region need to strengthen administrative capacities and improve their strategic planning, data collection and monitoring.

- The EECCA region as a whole has not yet developed or endorsed policies focusing on resource efficiency. In comparison, a range of European policies are already in place, e.g., 'Thematic Strategy on the Sustainable Use of Natural Resources', a 'Europe 2020 strategy', and 'Roadmap to a Resource Efficient Europe' (EC 2005, EC 2010, EC 2011).

- In EECCA countries, few instruments for stimulating sustainable consumption and production (SCP) patterns among individual and corporate consumers exist. Survey results indicate that in the opinion of national NGO experts, the real situation on SCP differs from that declared in state policies. Despite the obvious current need and numerous international obligations, EECCA countries have no specific policy focusing on sustainable development (SD) and SCP issues. In developing socio-economic strategies, SD goals and priorities are either completely absent or included in declarative form. SCP principles are rarely mentioned.

- Irregular and non-systematic monitoring and data analysis are serious constraints to indicator-based reporting. Despite efforts involving a broad array of institutions, institutional coordination is weak and often results in incompatible data.

- Although many indicators exist to track resource use, only a few have been used to set targets. Similarly to other countries, EECCA countries tend to set quantitative targets more often for energy programmes, than for material or water efficiency objectives.

- Addressing transboundary pollution is a complex and often problematic issue, requiring institutional and legal frameworks. Many EECCA countries need to strengthen procedures for implementing commitments under MEAs, and to increase their capacity for implementation of multi-country projects financed by international organizations and donors. Support to secretariats of international conventions can facilitate this process.

- In summary, the EECCA region needs to urgently invest in resource efficiency measures. Countries in the region must establish (or strengthen) policies and targets, ensure these are implemented and monitored, and increase awareness of environmental issues so that stakeholders and the general public understand and support the process of change.

5.2 Sustainable resource management: the context

5.2.1 EECCA: A REGION OF SLOW CHANGES AND BIG DIFFERENCES

The region has changed in many ways since the 1990s. Energy and material use have been decoupled from economic growth in several EECCA countries during the past decade. This has been due to structural economic changes and increasing production efficiency in certain sectors. However, energy intensity in EECCA economies remains significantly higher than in the EU. Carbon emissions (per capita) in the fossil fuel-rich countries of the region are comparable to or higher than in the EU, despite much lower levels of economic activity. The benefits of economic growth since the late 1990s have not been distributed evenly in the region. The gap between the wealthiest and poorest groups of society has increased, and there are also significant income differences between urban and rural areas. In many EECCA countries, the share of the population living below the poverty line is still considerable and many people, particularly in rural areas, do not have access to basic needs such as clean water, clean fuel and sufficient food (EEA and UNEP 2007).

Box 4: The economic transition's impact on the environment

The transition had a large impact on environmental conditions and management. By drastically reducing the level of economic activity, the crisis of the 1990s reduced some environmental pressures. The reduction in industrial output reduced emissions of air and water pollutants by industry. Agricultural producers could no longer afford to use agrochemicals to the same extent. Forests also experienced reduced pressures from industrial logging. At the same time several environmental problems intensified. First, the budgetary crisis of the central governments resulted in difficulties maintaining environmental infrastructure under the prevalent management model – water-related infrastructure is a major case in point. Second, the emergence of poverty has raised the importance, although not always the profile, of poverty-environment issues such as soil productivity loss and indoor air pollution from reversion to fuelwood. Third, the dissolution of the

Soviet Union and the need to work out new arrangements for shared environmental resources – most prominently water in Central Asia – has brought a security dimension into environmental management (UNECE 2006, EEA and UNEP 2007).

Despite positive transformation efforts, the Soviet legacy is still present in the region. The transition has complicated environmental rehabilitation, the environment is low on the political agenda, and weak institutions fail to have much implementation impact. The rule of law is still limited, as are public participation in environmental decision-making, ensuring compliance with environmental regulations, and the introduction of property rights-based environmental management instruments.

EECCA countries have differing natural capital endowments, economic structures and associated pressures on the environment, and degrees of urbanization. In the more urbanized countries of western EECCA, pollution issues tend to be more important, while in the poorer Central Asian countries natural resource management linked to agricultural productivity tends to be more prominent. Some Central Asian republics have plenty of water, while others have more sub-soil resources. The countries differ also in their response capacity – Kazakhstan and Belarus have better developed environmental institutions and policies than Tajikistan and Turkmenistan, for example (UNECE 2003a).

5.2.2 A NEED FOR SUSTAINABLE MATERIAL MANAGEMENT AND RESOURCE EFFICIENCY POLICIES

The EECCA region has many natural resources and abundant reserves of hydrocarbons. Both the public and policy-makers may ask why resource productivity/efficiency and sustainable resource management are important issues and whether there are plausible policy instruments at hand to achieve the goals and targets.

There are sound reasons for developing and implementing sustainable material management and resource efficiency policies. Simply put, the environmental situation in the region is not very positive. Resources are abundant but neither evenly distributed nor infinite. For example, while half the EECCA countries are net energy exporters, several of them are highly dependent on energy imports, with Moldova importing 97% of its energy (Reegle 2013). Furthermore, it has been recognized that current models of growth – globally, not just in the EECCA region – continue to exploit stocks of natural assets and undermine services provided by ecosystems (MA 2005, OECD 2012a). An even more urgent risk is pollution as an unavoidable consequence of any production or consumption process. The Earth's resources are finite and the Earth's capacity for self-regulation has boundaries. Defining the limits to our existence and development on this planet is an extremely difficult task, but also required information for policy-makers. Resource-oriented policies and management seek to assess the input and the output sides of the system and define a safe operating space for humanity with respect to the Earth's biophysical systems and processes (Rockström et al. 2009).

Box 5: Natural resource endowment in the EECCA countries

The Russian Federation holds the world's largest reserves of natural gas and eighth largest reserves of oil. Siberia contains approximately 20 per cent of the world's forests, and Russia is so richly endowed with mineral deposits that it is nearly self-sufficient in industrially important minerals. The Kursk Magnetic Anomaly alone contains up to one-sixth of the world's known iron ore deposits.

Central Asian countries have significant oil, gas and coal reserves. The vast majority of the oil and coal reserves are located in Kazakhstan, while Turkmenistan leads in gas reserves, followed closely by Kazakhstan and Uzbekistan. The Caspian Sea has estimated oil reserves of 75 billion barrels, nearly as much as currently estimated Russian oil reserves, and 6.9 trillion cubic metres of natural gas. Kazakhstan is a major global producer of many minerals, including copper, gold, iron, lead, manganese, zinc and rare earth elements. Kyrgyzstan has important mineral resources. Turkmenistan is the fourth largest producer of natural gas in the world, with vast untapped reserves. Uzbekistan is the world's fourth largest producer of cotton, and it also produces a range of minerals and metals, of which gold and uranium are globally significant. Uzbekistan has important gas reserves, as well as reserves of copper, zinc, lead and uranium. In the Caucasus region, Azerbaijan holds the most economically valuable natural resources. Azerbaijan produces metals and minerals but its primary resources are oil and gas. Since independence, the focus of the mineral fuels industry has been to develop fields in the Caspian Sea. Armenia is the sixth largest producer of molybdenum in the world. It possesses significant deposits of copper, gold, iron, lead, molybdenum, rhenium and zinc, as well as raw construction materials. In addition to minerals currently produced, Armenia has the potential to produce uranium. Georgia produced many minerals during the Soviet period, including arsenic, copper, lead, manganese and zinc. While production dropped dramatically after independence, investment is intended to revive production. At the same time, Georgia's current role is to serve as a transport route, with three major oil and gas pipelines running across its territory (OECD 2012b).

In the past many EECCA countries have intensively and often unsustainably tapped into their natural capital. The continuing environmental degradation, high carbon emissions and pervasive energy inefficiency, obsolete and wasteful production technologies, increasing water scarcity and important water losses, particularly in agriculture, as well as costs associated with these concerns, all point to the need to act more firmly on mainstreaming environmental goals into a coherent framework and sectoral policies. Addressing problems related to climate change vulnerability, water, food and energy security will be critical in the EECCA region (OECD 2011).

5.3 Policy measures to foster sustainable material use and resource efficiency

5.3.1 INTRODUCTION

The policies, measures and examples presented in this chapter are based on a literature review. The report does not attempt to provide an exhaustive account of all policy measures in the entire EECCA region but showcases some inspiring examples, as well as providing a basis for further analysis.

Good environmental policies benefit society by protecting human health and the environment. Laws and regulations need to be clear, achievable and enforceable. Policy instruments need to be well-designed and packaged. Implementation needs to be supported by adequate compliance assurance strategies. All this requires effective supporting institutions. Good environmental regulation also has important consequences in terms of achieving political, economic and public administrative goals. For countries seeking to make the most of globalization, environmental regulation plays an important role in supporting a level playing field for businesses in the global marketplace. For countries aiming to strengthen the rule of law and improve governance, effective environmental compliance assurance systems help reinforce the credibility of regulations in general.

The Rio+20 Declaration affirmed that there were different approaches, visions, models and tools available to each country, in accordance with national circumstances and priorities, to achieve sustainable development (UN 2012). For example, policies for green economy in the context of sustainable development should be guided by and in accordance with all the Rio Principles, Agenda 21 and the Johannesburg Plan of Implementation. While each country has national sovereignty over its natural resources, it is recognized that green economy principles could enhance their ability to manage natural resources sustainably and with lower negative environmental impacts, increased resource efficiency and reduced waste outputs.

Six years ago, the OECD (2007a) and the EEA and UNEP (2007) reported that the EECCA countries were still facing a major environmental policy and institutional reform agenda. Institutions suffered from weak authority, scarcity of resources, outdated management approaches, high turnover of professionals and frequent restructuring, thereby lacking both incentives and the means to ensure good environmental results. Policies were not generally aimed at achieving specific targets; they relied on unreformed or poorly combined instruments and were often dominated by revenue-raising objectives. Environmental legislation was extensive but inconsistent and unenforceable, and compliance levels were very low.

5.3.2 OVERALL STRATEGIES AND ACTION PLANS TO PROMOTE EFFICIENT AND SUSTAINABLE USE OF RESOURCES

Agenda 21 (UN 1992) required, among other things, integration of environment and development at the policy, planning and management levels; and more specifically, integration of environmental aspects into sectoral and other relevant policies and programmes. Section Two (Conservation and Management of Resources) emphasized the importance of sustainable use of natural resources. The document also called for interaction between national and local governments, industry, science, environmental groups and the public in developing effective approaches.

Box 6: Kazakhstan 2030

The cornerstone of strategic planning in Kazakhstan is the 'The Strategy for Development of the Republic of Kazakhstan until the year 2030' launched by the President in October 1997. It serves as the central reference document for all specific strategies and related action plans for achieving a wide range of policy goals. A major overarching objective is to double the level of economic activity between 2001 and 2010. Kazakhstan 2030 contains goals regarding environment protection and sustainable development (SD) including, for example, stabilization of environmental quality, ensuring a favorable environment for human activity, and the protection of natural resources for future generations.

The second stage of the Kazakhstan 2030 Strategy developed more detailed goals and measures and formulated major strategic documents on sustainable development and environmental protection as, for example, an environmental security concept for 2004 to 2015, a strategy for territorial development until 2015, a concept of transition to sustainable development for the period 2007 to 2024, etc.

The 2006 Concept of Transition to Sustainable Development (CTSD) is the main framework for achieving SD in Kazakhstan. A general goal is to achieve an adequate balance of economic, social and environmental needs. A main focus of the CTSD is to improve the efficiency of resource use in the production process, gauged by a Resource Use Efficiency Index (RUEI)[16]. Another main focus is on improving quality of life, which is still low in Kazakhstan. This will be measured by indicators such as life expectancy, per capita income, educational achievement and environmental safety (Ministry of Environment of the Republic of Kazakhstan 2006). In 2012, the Kazakhstan 2050 Strategy was introduced. It builds on tasks set by the Kazakhstan 2030 Strategy, and explicitly covers natural resource use. Export of mineral resources will speed up in order to satisfy world markets in exchange for access to advanced technologies and the creation of new industries in the country. Thus Kazakhstan hopes to boost its transition to a green development path (Government of Kazakhstan, 2012).

[16] For details see the section on Objectives, indicators, and targets in this Chapter

It has been generally recognized that the responsibility for bringing about changes needed for sustainable development lies with governments in partnership with the private sector and local authorities, and in collaboration with national, regional and international organizations. Over the last ten years, important steps have been taken in EECCA countries to reform policies, laws and institutions related to natural resource use. EECCA countries have relatively well-developed legal frameworks (see e.g. Ministry of Natural Resources and Environmental Protection 2001, UNECE 2010, Government of Armenia 2012). Policy development, however, lacks prioritization and pragmatism. Furthermore, policy implementation lags well behind legislation. This is not surprising, given the weaknesses displayed by environmental institutions. Regulatory instruments are better developed than economic ones, but very weak enforcement renders them ineffective. Policy development reflects overall levels of country progress. There seems to be a clear divide between the more advanced set of countries (Western EECCA, Armenia, Georgia and Kazakhstan) and others (Azerbaijan and Central Asia) (UNECE 2006).

Box 7: A general framework for environmental protection and resource management in Kyrgyzstan

Kyrgyzstan's legislation has been entirely renewed since its independence in 1991, as stipulated in the Constitution. The Kyrgyz Republic Country Development Strategy (CDS) outlines a mid-term vision for the country. It is regularly updated (the current version covers 2012 to 2014) and covers all aspects of the country's development (Government of Kyrgyz Republic 2007). Climate change and degradation of natural resources are recognized as having a detrimental effect on citizens' quality of life and the CDS demands that urgent action be taken. The Kyrgyz Republic is party to 13 international environmental treaties and conventions; however, the environmental sector in Kyrgyzstan is influenced by economic difficulties in the country (it also has a significant foreign debt), which restrict financial resources. Lack of funding is due not only to the limited state budget, but also because of poor promotion of initiatives for conservation and sustainable use of natural resources in relation to economic development, and the poverty level in the regions.

The general legal framework for comprehensive environmental protection and the use of natural resources is established by the Law on Environmental Protection. It covers a wide range of issues including environmental standard-setting, legal regimes around specially protected areas, rules and procedures for natural resource use, and procedures for dealing with emergencies. Natural resources can be used in accordance with established limits and environmental standards (UNECE 2000).

Despite a remarkable effort in securing environmental sustainability, the recommendations in the Millennium Development Goals (UNDP Kyrgyzstan 2010) still specify a need to further improve legislation in the area of environmental management and environmental protection, including environmental regulatory regimes of environmental management, regulatory functions for the possession, use and disposal of natural resources, and harmonization with international agreements.

On a global level, there has been a shift in policy-making toward environmental sustainability and the green economy. The interest in adopting a greener, environmentally-oriented model of growth reflects concerns about scarcities and increasing prices of natural resources, the cost of past patterns of development and ecosystem degradation, and aspirations for a better quality of life beyond material wellbeing. Lately, green growth has received high-level political support because of its potential to support short-term recovery from the global economic crisis, while simultaneously preparing for low-carbon, resource-efficient and socially-inclusive economies in the longer term. From an economic point of view, the pursuit of green growth requires structural changes to increase the share of cleaner industries, goods and services and to stimulate new job creation, as well as efforts to improve the environmental performance of traditional industries (OECD 2012b, UNEP

2013). The need for further socio-economic improvements in EECCA countries provides a strong argument for implementing green growth policies. Policy action is needed because (OECD 2012c):

- The value of natural capital in EECCA countries continues to erode while the countries' economic growth relies too heavily on natural assets and ecosystem services. A lack of action is likely to impede growth, sometimes severely.
- Economic competitiveness of EECCA countries is hindered by low resource productivity.
- Environmental quality of life is degrading as well, with many people being exposed to health risks because of pollution and having poor access to basic services such as water supply and sanitation or waste management.

In 2011, Kazakhstan launched the development of a National Green Growth Strategy with support from international partners (GGGI 2012). Its development was preceded by the abolition of the country's Sustainable Development Strategy, a step that contradicted the exhibited political will to strongly move on the green growth path. Several other countries in EECCA, including Kyrgyzstan and Uzbekistan, have embarked on developing green growth policy packages. National-level policy dialogues on green growth have been launched in Armenia, Georgia and Moldova, though they are not yet well-structured. Many EECCA countries rely on donor assistance for the development and implementation of green growth policies. More evidence needs to be collected on implementation aspects to make sure that important developments are not overlooked (OECD 2012c).

5.3.3 NATIONAL PROGRAMMES AND ACTION PLANS ON SUSTAINABLE CONSUMPTION AND PRODUCTION (SCP)

Sustainable consumption and production (SCP) is a practical approach to achieving sustainable development (SD) which addresses the economy, society and environment. It aims to reduce emissions, increase efficiencies and prevent unnecessary wastage of resources through the stages of material extraction, production, distribution and consumption, to waste management. At the United Nations Conference on Sustainable Development (Rio+20) in June 2012, the Heads of State reaffirmed that promoting sustainable patterns of consumption and production is one of the key overarching objectives of, and essential requirements for, SD. They also reiterated that fundamental changes in the way societies consume and produce are indispensable for achieving global SD. Furthermore, they strengthened their commitment to accelerate the shift towards SCP patterns with the adoption of the 10-Year Framework of Programmes on Sustainable Consumption and Production Patterns (10YFP) – as stated in the document 'The Future we Want' (UN 2012a).

The 10YFP is a global framework of action to enhance international cooperation to accelerate the shift towards SCP in both developed and developing countries. Among the key elements of 10YFP are promotion of more efficient use and protection of natural resources, products and recovered materials, and promotion of life cycle approaches, including resource efficiency and sustainable use of resources, science-based and traditional knowledge-based approaches, cradle-to-cradle and the 3R concept (reduce, reuse and recycle) (UN 2012b).

UNEP, well before Rio+20 and with the support of the UK Government, followed up the key recommendation of the Marrakech Process by developing Guidelines for National Programmes on SCP (UNEP 2008). More than 30 countries have developed specific SCP programmes, included SCP in their development plans or are developing country-wide SCP strategies. While SCP needs to address high levels of consumption in Western Europe, SCP policies and action in the EECCA region may need to concentrate more on improving efficiencies in production, consumption and resource use (EEA and UNEP 2007).

The low material productivity of industry has been a matter of policy debate and action for at least a decade. To address this problem, reforms of regulatory instruments, primarily the introduction of integrated permitting based on best available techniques, were launched in Armenia, Belarus, Georgia, Kazakhstan, Kyrgyzstan, Moldova, the Russian Federation and Ukraine. Complementary instruments such as environmental management and audit systems, or industrial environmental performance ratings, have been put in place. With substantial international help, national cleaner production centres have been established in Armenia, Moldova, the Russian Federation, Ukraine and Uzbekistan. These initiatives have helped reduce energy and raw material wastage (OECD 2012b).

Box 8: SCP policy development in the Russian Federation

UNEP (2006) supported the first attempt to review existing policies on sustainable consumption in Russia. This wasn't intended to provide a comprehensive analysis of the problem, but to provide impetus for further in-depth studies and multi-stakeholder discussions about ways Russia might transition to sustainable production and consumption. Besides analytical work, the report looked into measures Russia takes to achieve sustainability of production and consumption. There are many SCP-related polices and tools, however, a targeted SCP policy is absent. Thus, the Russian Federation misses goals, targets and indicators to measure achievements in this particular field of sustainable development. The existing sectoral and other policies are not sufficient to address serious existing problems (e.g. problems with water resources, health risk, pollution, etc.). The key issue to be addressed by SCP policy and actions in Russia – and the EECCA region in general – is improving efficiencies in production, consumption and resource use. There are very few analyses giving a complex picture but some show an unsatisfied state: natural resources are used less efficiently in the current market economy than they were in the generally inefficient planned Soviet economy. Causes and consequences of this situation include low resource use efficiency due to a lack of advanced technologies, decreasing quality of raw materials with economic consequences, and environmental damage to both human and ecosystem health (increased pollution, diminished level and quality of remediation etc.) (Fedorenko and Simchera 2005).

However, the absence of economic incentives and lack of social pressures still provide substantial obstacles to sustainable production and consumption. Producers prefer to stick to traditional technological processes and do not seek to introduce innovative ones, even if they are familiar with the modern technologies, best practices, etc. On the consumers´ side, the problem lies in the mental stereotypes of the Russian society: it has always paid little attention to efficiency and prevention (nature belongs to humans; we are rich in natural resources and we are capable to handle our environmental problems – if there are any) (Sergienko et al. 2011).These stereotypes also exist in politics where lack of or inadequate policies hamper needed changes, as evidenced by the fact that fossil fuel-rich nations (Russia, plus Kazakhstan, Uzbekistan, Turkmenistan, Azerbaijan and Ukraine) tend to have low shares of renewable energy.

The keys for future success of SCP policies include development of national SCP strategies and programmes reflecting countries' priorities and focusing on the improvement of quality of life, strengthening institutional capacity for SCP, and raising public awareness about SCP (EEA and UNEP 2007).

Despite policy declarations, framework strategies or policies specifically targeting SCP have not yet been developed in EECCA countries. Possible reasons for this are that SCP is not yet a high priority on the political agenda and/or that there is weak intersectoral and inter-ministerial coordination. According to Agenda 21, SCP principles should be reflected in countries' National Sustainable Development Strategies. However, this is not the case in most EECCA countries. The exception is Belarus, which does not explicitly use the term SCP, despite including some aspects (shift toward resource preservation in economy, use of secondary resources etc.). Similarly, Ukraine has adopted a new Concept of National Environmental Policy until 2020, which includes a number of SCP issues without specific reference to the concept (Mama-86 2008).

When governments choose to buy goods and services that are more environmentally-friendly, they support sustainable production and consumption. Governments thus exercise great influence as major consumers of goods and services, spending large amounts of money every year on public procurement. Application of green public procurement (GPP) can benefit the environment by:

- reducing GHG emissions and air contaminants;
- improving material, energy and water efficiency; and
- reducing waste and supporting reuse and recycling.

Box 9: Public procurement in EECCA

Public procurement in EECCA is estimated at around €100 billion, and thus offers substantial potential for environmental and economic benefits, including the development of eco-industries, and contribution to economic growth and job creation. A stronger eco-industry sector in EECCA countries would greatly facilitate the implementation of environmental policies and improve dissemination of environmental technologies in local markets.

Thus far, however, there has been very little progress in implementing green public procurement (GPP). It is a new concept in the region and no single country yet has a national GPP policy in place. There appears to be little understanding of environmental and social aspects in procurement in national public procurement institutions (regulatory, supervisory and supporting bodies) or at an operational level. For example, except for Uzbekistan, none of the countries has introduced eco-labels and ISO 14001 is not yet widely used in public tendering. Despite considerable improvements in recent years, national public procurement systems in most EECCA countries require additional efforts to achieve good international practice (EEA and UNEP 2007). A good example to follow might be the approach of the EU, with agreed criteria to define relevant GPP products and services, as well as impact-oriented indicators that would allow assessment of environmental and financial gains delivered by GPP (EC 2008).

5.3.4 NATIONAL ENVIRONMENTAL POLICIES AND STRATEGIES

In general, environmental policy should provide a framework and guidelines for decision-making and activities at the international, national, regional and local levels aimed at further improvements in environmental quality as a whole, and in particular environmental compartments (air, land, water, biodiversity etc.) Environmental policy focuses on enforcement of SD principles, integration of the environmental perspective into sectoral policies, and increasing economic efficiency and social acceptability of environmental protection programmes, projects and activities.

Over the past ten years, important steps have been undertaken to reform environmental policies, laws and institutions in the EECCA region. Most countries now have some type of environmental policy or strategy. Besides general environmental policies and strategies aiming at the environment as a whole, there are sector- or media-oriented policies as well. They focus on a particular sector and its environmental relevance (e.g. energy or agriculture) or on environmental media or ecosystems (e.g. water or forests). However, environmental policies are often developed and implemented separately, mainly directed toward ecosystem preservation and not coordinated with development strategies of key economic sectors. For instance, of the countries shown in Box 10, only Russia and Ukraine have declared the necessity of decreasing resource use and energy efficiency improvement among their environmental policy priorities. Environmental protection is mostly considered an obstacle to economic growth. Not surprisingly, there is then little or no political will to integrate environmental policy into development priorities, and the overall status of the environmental pillar of sustainable development remains low (Mama-86 2008).

Box 10: Environmental policy priorities in EECCA countries

Armenia
- Rehabilitation of ecological balance (stability) in Lake Sevan;
- Regeneration of forests;
- Municipal and toxic waste management;
- Biodiversity preservation etc.

Azerbaijan
- Preservation of biodiversity in the Caspian Sea;
- Municipal and toxic waste management;
- Clean-up and recultivation of oil-contaminated land;
- Soil degradation and ecosystems loss reduction;
- Integration of cleaner technologies into industry.

Belarus
- Biodiversity preservation;
- Water sources protection;
- Air protection;
- Waste management.

Georgia
- Biodiversity preservation;
- Nature Reserves and Nature Protected Areas management;
- Water resources protection.

Moldova
- Prevention of ecological crisis in the country;
- Reinforcement of environmental security potential and intersectoral cooperation;
- Introduction of environmental management and certification in industry.

Russia
- Ensuring stability and sustainability of natural ecosystems;
- Formation of environment-oriented economy characterized by minimal environmental impact, high energy efficiency and low resource intensity;
- Creation of a healthy environment as a factor for human life improvement.

Ukraine
- Integration of environmental issues in sectoral (economic) policies with equal priority;
- Decreasing resource intensity in industry;
- Ensuring an environmentally sound system of resource use;
- Incorporation of environmental priorities and technical upgrade of industry on a basis of innovative projects implementation, energy efficiency and resource preservation.

(UNECE 2007a, UNECE 2007b, Mama-86 2008, UNECE 2010, UNECE 2011)

The reforms undertaken or ongoing have not yet achieved the main goal of significantly reducing risks to human health and degradation of ecosystems. Most existing environmental plans and strategies suffer serious shortcomings. They need prioritization, clear timetables and financial support. Environmental agencies lack highly qualified human, financial and technical resources, and existing fundamental regulatory instruments are not sufficiently effective. Finally, compliance with domestic and international environmental requirements needs effective enforcement (UNECE 2003b, Mama-86 2008).

Box 11: State environmental policy of the Russian Federation

In 2010, President Medvedev called for an improved, consolidated environmental policy, since it was not well-integrated in mainstream policy and environmental laws were often contradictory. Another problem is that fines for violation of environmental laws and permit conditions are too low, and enforcement is frequently flawed. In addressing the challenges of providing ecologically-oriented growth and of introducing environmentally efficient innovation, the draft law approved in 2012 lists the following mechanisms:

- formation of an effective, competitive and environmentally-oriented economic development model that provides the greatest effect, while preserving the natural environment, its rational management and minimization of negative impacts on the environment
- introduction of innovative energy-saving, environmentally-friendly and efficient technologies on the basis of a unified technology platform with the active participation of the State, the business community, science and education, public associations and non-profit organizations
- accounting for absolute and specific indicators of efficiency in the use of natural resources and energy, as well as assessing the efficiency of the economy as a whole and by industry branches.

This new policy assumes that quantitative targets for the implementation of the main objectives of State policy in the area of environmental protection are determined in the main government documents. The head of Greenpeace Russia's energy programme welcomed the policy in general, but noted that it did not envisage transitioning to a low-carbon economy. According to its critiques, the document is very weak, in particular because it lacks concrete steps on how to achieve the goals set. Thus, despite being generally perceived as a leader in environmental policy-setting by other EECCA countries, the Russian Federation seems to lag behind the group of advanced EECAA countries in this realm.

(OECD 2006b, EEL Network 2012, President of the Russian Federation 2012)

Despite being national in focus, the development of environmental policies has often been a subject of international cooperation and assistance. The 'Environment for Europe' process provides a framework for improving environmental policies and conditions in the UNECE region. One of the objectives is to manage natural resources in a sustainable manner. Cooperation and partnership between EECCA and other UNECE countries is one of the priorities within the process due to the severity of existing environmental challenges, and the need to reform policy frameworks and strengthen institutional capacity to address them in EECCA countries (UNECE 2003b).

EECCA countries are at different stages in the transition to market economies and democracies and these processes have consequences for future environmental policy and management. For example, opportunities for introducing effective market-based (economic) instruments will expand. The Environmental Strategy for EECCA built within the Environmental Partnership in the UNECE region has provided a basis for further developing and improving national policies in individual countries. The focus should be shifted from policy development to implementation, and the development of coherent implementation regulations, approximation of EECCA and European legislation and effective policy instruments (UNECE 2013).

Environmental policies are often accompanied by State of Environment (SoE) reports. SoE reports – called different things in different countries (e.g. 'Environmental situation and utilization of natural resources' in Uzbekistan) – are often descriptions of the state of the environment, but lack direct links to national environmental policy. Also, there are difficulties with data collection procedures, capacity for analytical work and coordination among different agencies (UNECE 2003c, UNECE 2013, for SoEs of Azerbaijan, Kazakhstan, Kyrgyzstan, Russia, Tajikistan, Turkmenistan, and Uzbekistan, see

UNEP/GRID-Arendal[17]). For example, Armenia´s report 'The State of Armenia's Environment' (PFA 2010) includes an overview of the environmental challenges facing Armenia and highlights the severity of the current situation. The report argues that improving environmental governance requires increased transparency and public participation in key policy decisions, as well as the effective implementation and enforcement of existing environmental laws. The open-pit mining operations in northern Armenia are an example of one facility where both urgent policy changes and adequate enforcement of existing policies are needed.

5.3.5 OBJECTIVES, INDICATORS AND TARGETS

Without clearly defined and stated objectives with short-, medium- and long-term targets, it will be difficult to monitor and evaluate programmes and policies. When developing national resource efficiency policies, governments – at appropriate levels – should include provisions for measuring baselines, defining critical or sustainable levels, setting targets and monitoring progress towards achieving them. Quantitative indicators and targets are useful in trend analysis and comparisons among subjects analysed (whether countries, regions, cities or companies) and if targets are set, in determining the level of change required (distance-to-target assessment) (OECD 2003).

The EECCA countries currently use a wide variety of environmental indicators when publishing government SoE reports and compendia of environmental statistics. Experts from EECCA countries in the UNECE Working Group on Environmental Monitoring and Assessment, in close cooperation with the European Environment Agency (EEA), selected a core set of 36 environmental indicators for application in EECCA (UNECE 2007). There are several indicators which are highly relevant for resource efficiency assessment, e.g. greenhouse gas emissions, renewable freshwater resources, freshwater abstraction, household water use per capita, reuse and recycling of freshwater, total energy consumption, energy intensity, waste generation, waste reuse and recycling, final waste disposal, fertilizer and pesticide consumption etc. This is in line with findings of the EEA and UNEP (2007) that the most commonly reported resource efficiency indicators are related to waste, energy and material use. The guide (EEA and UNEP 2007) includes recommendations for the preparation of indicator-based environment assessment reports for assessing the efficiency of environmental protection measures and for comparing national indicator values against those of other countries. Ideally, the indicators would cover a broader range of resources such as, for example, forests, land, soil, fisheries etc., and they would also look into resource-intensive sectors such as industry, transport, construction etc. The other missing aspect of this set of indicators may be its focus on domestic situations (that is, considering what is happening within national borders), although there are methodologies that take account of materials or energy embodied in imported products and raw materials, for example material flow analysis and footprint analysis.

Regardless of the composition of the indicator set, what seriously undermines any indicator-based reporting is that in most EECCA countries there is no regular, systematic monitoring and data analysis. These efforts involve a broad array of institutions – such as hydro-meteorological and geological services, environmental inspectorates, water and forestry committees, and health ministries. But institutional coordination is weak at best, and often results in incompatible data. Inter-agency monitoring commissions have been established in Belarus and Ukraine to start solving this problem.

Without accurate data, there is no reliable information for either decision-making or reporting. It is also impossible to comply fully with laws that, for example, call for maintaining registers and cadasters (these tools are reliable only if a reliable monitoring system is in place). Thus basic data and indicators based on them will serve as tools for public information. The countries are aware of this difficult situation; for example, the Ministry of Environment and Natural Resources Protection in

[17] UNEP/GRID-Arendal: State of Environment Reports. Online http://enrin.grida.no/soe.cfm?country=KZ

Georgia has drafted a programme to re-start efficient monitoring (UNECE 2010). The resulting indicators are to assess progress towards objectives and goals. Even where targets are not available, indicators may prove their usefulness: they may reveal gaps by pointing out missing or deficient policies. For example, the Georgian Ministry of Fuel and Energy could draw up a clear strategy for the energy sector, including a strong focus on demand-side management, energy efficiency and environmental impacts (UNECE 2003b). The following steps are necessary to improve the information base:

- Provide incentives to companies for voluntary reporting on their environmental performance;
- Harmonize definitions, classifications and procedures of environmental monitoring with international standards;
- Promote exchange of environmental data and information between relevant government institutions;
- Improve information quality, focusing on development of core sets of indicators with application of international experience;
- Improve methodologies around setting limits for economic pressures on the environment and natural resources, resource rent and regulation of procedures of environmental planning;
- Improve inventory systems for natural resources; and
- Publish regular SoE reports, and make them accessible to the public.

Box 12: Resource efficiency-relevant indicators in Georgia

Atmosphere
- Emissions of pollutants into the atmosphere (total, per capita, per unit of GDP, by sectors – energy, industry, transport)

Living resources
- Industrial fish catch (from farming, natural water bodies)

Forests
- Volume of wood harvested

Waste management
- Waste generation
- Waste reuse and recycling
- Final waste disposal
- Waste intensity (total waste generated per unit of GDP)

Water management
- Renewable freshwater resources
- Freshwater abstraction
- Intensity of water usage (water abstraction/accessible resources)
- Household water consumption index
- Water losses
- Reuse and recycling of freshwater
- Nutrients in freshwater and in coastal waters

Land resources and soil
- Land uptake
- Cultivated land (thousand hectares)
- Pesticide consumption
- Fertilizer use per hectare of cultivated land

Energy
- Total primary energy supply
- Total final energy consumption

- Energy intensity TPES/GDP (PPP) - Energy productivity GDP (PPP)/TPES (UNECE 2010)

Targets should be specific and realistic. They should be linked to the objectives and priority areas being pursued in the strategy or plan. Each priority area may require several targets at different time periods (e.g. short-, medium- and long-term goals). Targets can be adjusted through the policy-making cycle – a target should be realistic but should also provide some scope to challenge society to make appropriate efforts on resource efficiency. Targets need to address the political and economic conditions of the country and should be linked to any related targets included in other national policies and strategies (e.g. targets on resource efficiency may be linked to targets for economic performance or environmental security). Based on the precautionary principle, the setting of targets also defines acceptable levels of risk and what level of environmental quality is desired in society. In the field of resource use, two main types of targets can be distinguished:

1. Absolute or per capita targets (e.g. decrease of waste by 50 kg per person)
2. Efficiency targets, which maximize the output per input (e.g. resource productivity in €/kg).

A review of indicators of resource use and efficiency shows that hundreds of indicators already exist. These range from well-developed indicators that are part of national accounts and statistical offices, to research projects. Although many indicators exist to track resource use, only a few have been used to set targets (BIO Intelligence Service, Institute for Social Ecology and Sustainable Europe Research Institute 2012). Surveys in other regions (EU, Asia-Pacific) have shown that countries set quantitative targets more often for energy programmes than for material or water efficiency objectives. Within this trend, some EECCA countries have declared indicators with set objectives; for instance, increased renewable energy use, decreased energy intensity and increased energy efficiency in industry (e.g. Government of Kazakhstan, 2013). However in practice, these targets are not taken seriously. For instance, the Energy Strategy until 2030 in Ukraine assumes a two-fold decrease of energy intensity by 2030 (which will still be higher than energy intensity e.g. in Poland in 2005) and Russia plans to achieve 2 per cent renewable energy use by 2020, while its energy consumption is expected to increase much more (Mama-86 2008).

Box 13: Target indicators for energy efficiency and renewable energy use in energy policy for selected countries

Country	Targets for energy efficiency	Targets for energy from renewable sources (RES)
Armenia	Energy intensity of GDP, energy use per capita, energy losses in transport network (in kWh) and other	Share of RES in energy generation by 2020 to be 12%
Azerbaijan	None	By 2010, RES to be > 15% in energy generation
Georgia	Reduction of GDP's energy intensity by 30% by 2007	25% in energy production: biomass + wood + peat At the present hydro + solar + wind < 1% of energy generated, but there are no targets for alternative RES
Belarus	None	None
Kazakhstan	Reduction of GDP´s energy intensity by	Share of RES in Total Primary Energy

	25% by 2020 (compared with 2008)	Supply to be 0.5% by 2012 and 5% by 2018
Moldova	Expected annual energy and energy resources saving (thousand tonnes of coal equivalent): • energy sector – 21 to 28 • industry – 10 to 13 • agriculture – 8 to 10 • construction – 4 to 5 • transport – 7 to 8 • communal services – 2.5 to 3 • government services – 2.0 to 2.5	By 2010, RES to comprise 5 to 6% of energy generation
Russia	Reduce energy intensity of GDP by 2 to 2.2 times	By 2020 RES to be 1.1 to 1.6% of energy generation
Ukraine	Reduce energy intensity of GDP by two times by 2030	By 2030 RES to be 8% of energy generation

Box 14: Concept on the efficient use of energy in Kazakhstan

Based on a request from the National Council of Sustainable Development (NCSD), the Ministry of Environment Protection and its Research Institute of Ecology and Climate (KazNIIEK) have elaborated a 'Concept on the efficient use of energy and the development of renewable energy sources'. The Concept sets targets for saving energy through increased energy efficiency until 2024, while the new Green economy concept calls for reduction of GDP´s energy intensity by 25% by 2020 (compared with 2008) (Government of Kazakhstan 2013). There are also medium- and long-term targets for developing renewable energy sources (e.g. the share of alternative energy sources in Total Primary Energy Supply (TPES) to be 0.5% by 2012 and 5% by 2018). Development of renewable energy will focus on wind and solar energy, and heat pumps.

There are pilot projects to demonstrate the feasibility and advantages of the different energy options. To illustrate, a pilot project for a wind energy farm has been developed in Almaty with the support of the international community; there are also demonstration projects showing the benefits of heat pumps for home heating. The Concept calls for the creation of a legal framework for renewable energy as well as incentives for increasing the uptake of these technologies (UNECE 2008).

5.3.6 INSTITUTIONAL SETTING AND INTERNATIONAL COOPERATION TO PROMOTE MATERIAL MANAGEMENT AND RESOURCE EFFICIENCY

Strengthening institutional governance for environmental protection is a long-term process. The Rio+20 Conference in 2012 re-emphasized that SD depends on an effective framework of institutions and decision-making processes at local, national, regional and global levels. In reality, however, the norm is often one of fragmented institutions established around single-issue 'silos'; deficits in terms of both leadership and political space; lack of flexibility in adapting to new kinds of challenges and crises; and a failure to anticipate and plan for both challenges and opportunities. This all undermines both policy-making and implementation of policy measures (UN Secretary-General's High-level Panel on Global Sustainability 2012).

The institutions in charge of environmental management have not been able to cope with all these changes. This radically new context has experienced both a failure to adapt, and adaptations that have failed. An example of the first type of problem is the maintenance of unattainable standards and the resulting emergence of a culture of non-compliance. An example of the second is the use of economic instruments for revenue-raising purposes, resulting in no environmental alterations and a fundamental alteration, in practice, of the role of public environmental officials (UNECE 2006).

Despite all the deficiencies, environmental institutions today are stronger, both in terms of legal mandate and in their capacity, than they were a decade ago. But they are still weak in a relative sense. Particularly important is the high turnover rate of environmental professionals in ministries and related agencies. Demand for environmental specialists by the private sector – in itself a welcome development – combined with low salaries is a major driver, but instability due to political changes also contributes (OECD, 2005; UN 2012c).

Box 15: Institutional framework for environmental protection in Turkmenistan

The institutions involved in environmental protection in Turkmenistan are government bodies (ministries) and various interdepartmental commissions interacting with other state bodies. It is also common to assign the management of sectoral issues to state concerns, which are central executive bodies under the Cabinet of Ministers. Some state functions are also delegated to state enterprises and agencies, for instance the State Agency for the Management and Use of Hydrocarbon Resources under the President of Turkmenistan. There is a system of local self-governments formed by 'gengeshes' (local councils) and bodies of territorial public self-government (gengeshes have the right to determine the basic directions of economic, social and cultural development of their territories, and to define measures for appropriate use of natural resources and environmental protection). In addition to these traditional executive bodies, there are also State Commissions – intersectoral government bodies. They work on a non-permanent basis and focus on problems of an intersectoral nature, such as climate change and the Caspian Sea.

The effectiveness of interdepartmental State Commissions in dealing with environment-related concerns is far from satisfactory. Their legal status and the rules for their operation are unclear. Coordination of the work of different ministries and committees relating to different sectors of the economy is impeded by insufficient exchange of information. The State Committee on Statistics is not able to ensure effective provision of information to decision makers to ensure that environmental protection and the rational use of natural resources are considered on a daily basis. The institutional framework undergoes constant change, seeking to separate monitoring and permit-issuing powers and to clarify functions among central executive bodies (UNECE 2012).

The EECCA region's common legacy of the Soviet era (high pressure on natural resources and the environment, the poor state of environmental components and ecosystem services, extensive but expensive-to-operate environmental infrastructure, ineffective management, etc.) seems to call for common policy and management approaches and solutions. There are several environmental objectives that require regional-level cooperation and assistance, e.g. developing transnational corridors, the management of cross-border rivers and basins, and the fight against environmental crime. Moreover, borders between EECCA countries after 1992 divided many ecosystems and basins which had previously been managed as integral units.

A series of regional declarations and agreements on regional cooperation in regard to the environment and sustainable development have stressed the importance of regional cooperation in Central Asia. These include the Almaty, Kyzyl-Orda, Issyk Kul, Nukus, Cholpon-Ata and Ashgabad declarations. A regional institutional structure was established in the region and includes, among others, the International Fund for Aral Sea (IFAS), the Interstate Committee for Water Coordination (ICWC) and the Interstate Sustainable Development Commission (ISDC). The countries in the region participate in the Forest Law Enforcement and Governance (FLEG) process concerning the protection and sustainability of forests in Eastern Europe and the South Caucasus. Russia, Ukraine, Moldova and

Georgia are members of the Danube-Black Sea (DABLAS) Task Force, which provides a platform for water protection and water-related issues of the Danube and the Black Sea.

The EECCA countries differ greatly in their capacity to respond to these challenges. Kazakhstan and Belarus have better developed environmental institutions and policies than Tajikistan and Turkmenistan, for example. Major differences in EECCA landscapes and growing political, social and economic heterogeneity often hinder cooperation on common transboundary environmental problems. The Regional Environmental Center for Central Asia (CAREC) was established by Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan, as well as the United Nations Development Programme (UNDP) and the European Commission (EC) in 2001 to maintain links between civil society organizations and governments at the regional level (RRCAP 2001, CAREC 2013). It was instrumental in preparing a comprehensive Regional Environmental Action Plan (REAP) based on individual National Environmental Action Plans (NEAP) developed by interested countries. However, the REAP only addressed certain problems with a focus on pollution and environmental degradation, disregarding resource use and resource efficiency issues. The current status of the Plan is not clear; whether it has been implemented and what the results may be are not known.

Another important step for regional coordination was the EECCA Environment Strategy. Initiated at the 5th Kiev 'Environment for Europe' Conference in May 2003, the overall objective of the Strategy is to contribute to improving environmental conditions and facilitate partnership and cooperation between EECCA countries and other countries of the UNECE region. It should have learned from the successes and failures of environmental reforms in EECCA in recent years and focus on a few principal objectives, each addressing a common environmental problem in EECCA. Managing natural resources in a sustainable manner is one of the key objectives. However, the Strategy assessment (OECD 2006a) concluded that none of the seven objectives had been fulfilled (a partially positive assessment was given to the resource management objective due to positive efforts in integrated water resources management by some countries). Recently, the ministers have been more explicit about the natural resource use: a new economic reality implies that eco-efficient economic growth and investments in natural and human capital to reduce risk and to strengthen human wellbeing improvements are strategic priorities. Strategies for managing resources should be rethought in the context of increasing scarcities and impacts on access to resources, and should also promote equitable access to resources (UN 2010).

Box 16: Cooperation on the Caspian Sea – limited success to date

The Caspian region produced 1.9 million barrels of oil per day including natural gas liquids in 2005, or 2% of total world output. Caspian Sea region countries are potentially large exporters of oil and gas. Caspian Sea oil and gas have several markets and a wider variety of potential markets. These include nations trying to meet their economies' demand for energy and those that wish to reduce their dependence on Persian Gulf energy. This problem became more urgent when Azerbaijan began production of oil and natural gas on the Caspian shelf. Kazakhstan, whose production has risen rapidly since the late 1990s, accounts for 67% and Azerbaijan for 22% of regional crude oil output (Gelb 2006).

Massive exploitation of oil and gas resources in this region, accompanied by construction of pipelines, will directly and adversely affect the environmental situation around the Caspian Sea. Aside from pollution and accidental spills from the oil industry, the Caspian Sea is threatened by pollution from the Volga and other rivers, uncontrolled poaching of sturgeon, and concerns over the impacts of the alien species *Mnemiopsis leidyi (*warty comb jelly or sea walnut). Some anticipate a further escalation of conflicts of interests over division of the Caspian shelf as rental incomes from oil and gas production and transportation will grow considerably (Diba 2010).

Several unresolved disputes over utilization of natural resources of the Caspian Sea and the Sea's shelf require elaboration of effective mechanisms of economic and political cooperation. Without such mechanisms, it will be very difficult to develop and negotiate mutually acceptable intergovernmental agreements (OECD 2006a). Russia, Iran and Kazakhstan, on one side, and Azerbaijan and Turkmenistan on the other side, have opposing interests with regard to exploitation of the Caspian shelf. The first group of countries has suggested dividing the bottom of the sea, while water resources remain common property. The second group of countries has proposed dividing the Caspian Sea into national sectors. Although the two groups of countries have been negotiating these issues for several years, little progress has yet been made. Thus far only Azerbaijan, Kazakhstan and Russia among the littoral states have reached agreement on delineating ownership of the Sea's resources and rights to development. The concrete result of many negotiations was the adoption of the first multilateral international legal document (Framework Convention for the Protection of the Marine Environment of the Caspian Sea) in November 2003, based on which conservation activities are currently underway in the Caspian Sea, as well as the Agreement on Security Cooperation in the Caspian Sea (signed in 2010). Another cooperative mechanism was proposed at the UN Conference Rio+20 in 2012 – the Caspian Environment Forum. It is envisaged to be a permanent platform for addressing environmental issues of the Caspian Sea Basin.

The countries in the region have ratified relevant international and regional conventions (regionally, UNECE conventions are of particular importance) to which they are signatories, with some exceptions such as the Espoo Convention on Environmental Impact Assessment (Russia), the Strategic Environmental Impact Assessment Protocol (Georgia, Armenia), the Aarhus Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters (Russia), the Stockholm Convention on Persistent Organic Pollutants (Ukraine) and the Framework Convention for the Protection of the Marine Environment of the Caspian Sea (Azerbaijan). Due to these commitments on one hand and unclear vision and development in cooperation among EECCA countries on the other, the role of international organizations is vital. Historical experience shows that international organizations may act as catalysts for international cooperation and development of equitable and fair solutions. Such organizations provide impartial platforms to build mutual understanding and confidence, and even act as guarantors of agreed-upon solutions. They also provide independent expertise and experience in solving similar problems. The urgency of many environmental problems and exacerbation of transboundary conflicts often require intervention and assistance from the international community.

EU cooperation in the EECCA region has been extensive. The regional strategies and programmes financed under the Technical Assistance for the Commonwealth of Independent States (TACIS) programme during the past decade have proved to be a valuable tool in tackling challenges with a regional dimension and for promoting inter-State cooperation on regional issues. TACIS has been working with countries in the region on the environment since 1992. At the regional level, the main focus has been on water issues, in particular regional seas, followed by support for environmental policy and plans, environmental education and awareness and environmental non-governmental organizations, through regional environmental centres (see above). Over ten years, environmental cooperation has accounted for a quarter of the €484 million spent. Another initiative has been the Eastern Regional Indicative Programme 2007–2010, coordinating the EECCA countries' needs from a regional perspective and supporting several priorities; e.g., transport and energy networks, environment and forestry, information, etc. The subsequent Strategy (2007–2013) covers seven countries: Armenia, Azerbaijan, Belarus, Georgia, Moldova, Russia and Ukraine. Since each of these countries has its own National Indicative Programme, this Regional Strategy covers only specifically cross-cutting, regional issues, challenges and responses (EC 2006). The ongoing assistance 'Central Asia DCI Indicative Programme for 2011–2013' covers Kazakhstan, the Kyrgyz Republic, Tajikistan, Turkmenistan and Uzbekistan with the priorities of poverty reduction, sustainable development and stability (EC 2009). Unlike energy and energy efficiency, the issue of material (resource) use and efficiency is not sufficiently developed in the EU-supported strategies.

EECCA countries have been a partner in the 'Environment for Europe' process that provides a framework for improving environmental policies and conditions in the UNECE region (a total of 55 countries cooperating on environmental matters.) They include the EU Member States, the Western Balkan countries and EECCA, along with the USA and Canada. Developing cooperation and partnerships between EECCA and other UNECE countries is one of the priorities within the 'Environment for Europe' process, due to the severity of existing environmental challenges, and the need to reform policy frameworks and to strengthen institutional capacity to address them in EECCA countries. It also provides a framework for action to address the World Summit on Sustainable Development (WSSD) Plan of Implementation in this region on Water and Sanitation, Energy, Health, Agriculture and Biodiversity, including the universally-agreed Millennium Development Goals (UNECE 2003a), as well as the call for transition to resource-efficient economies (UN 2012b). EECCA countries would like to see renewal or redirection of the process to solving transboundary environmental problems in the EECCA region. There are several opportunities that the 'Environment for Europe' process may use to strengthen partnerships among the participants (RREC 2007). Examples include:

- Shared inland water reservoirs (the Black Sea, the Sea of Azov, the Caspian Sea, the Aral Sea);
- Coordination of water users of different countries, situated within one artesian basin (Dnepr-Donetsk, Syr Daria, Irtysh, etc.); and
- Division of single habitats between independent states, which hinders migration of species (sturgeon, saiga, swan, falcon, etc.).

6. CONCLUDING REMARKS

The available studies show that although the twelve EECCA countries are different in many aspects, they share common problems. Analytical work based on quantitative data and described in previous chapters provides a clear picture of the past trends and the current situation: although most countries in the region have been becoming more material, energy and water efficient, the environmental infrastructure and resource base of the region is deteriorating and induced pressures are likely to persist or even increase due to renewed economic growth. The policy analysis has revealed another commonality of the EECCA countries – a weak institutional framework for environmental protection including resource management (see Table 14 showing results of assessing environmental legislation, policies and institutions (scores – 1=worse, 5=best – denote progress made by individual countries in strengthening environmental management) (OECD, 2005).

	Armenia	Azerbaijan	Belarus	Georgia	Kazakhstan	Kyrgyzstan	Moldova	Russian Federation	Tajikistan	Turkmenistan	Ukraine	Uzbekistan
Legislative framework and environmental policy development	**2.3**	**2**	**2.3**	**2.3**	**2.3**	**2.3**	**2.3**	**2.3**	**1.3**	**1.3**	**2.3**	**1.7**
Policy and regulatory programme implementation	**1.6**	**1.2**	**1.6**	**1.8**	**1.8**	**1.2**	**2**	**1.5**	**1.2**	**1.1**	**1.8**	**1.1**
Institutional framework	**2**	**1.3**	**2.3**	**1.2**	**2.2**	**0.8**	**1.5**	**1**	**1**	**1.2**	**1.8**	**0.8**

Table 13: Assessment of environmental legislation, policies and institutions in EECCA countries (Source: OECD, 2005)

The countries should build their institutional capacity to effectively tackle their own as well as transboundary and regional problems. They need to identify fewer and clearer priorities and set realistic targets (it seems that there exists a proliferation of various strategies and plans, which are however contradictory and without any implementation or enforcement).

Policy analysis shows that resource efficiency does not receive the priority it deserves in both environmental and SD and/or overall economic policies. Resource efficiency and resource use is not just an issue for environment agencies, but for the government as a whole. The lack of solid evidence fully revealing the economic consequences of natural capital depletion and environmental degradation is often a barrier in promoting the environmental transformation of production and consumption. The countries are encouraged to apply economic principles to resource use; e. g., to transfer the tax burden from the traditional areas of taxation such as labour and capital taxes to unsustainable activities such as waste generation and inefficient use of natural resources; or to adopt and use new economic instruments as natural capital accounting or payment for ecosystem services, building on a successful experience in Kyrgyzstan (UN 2010b, CAREC 2012). Despite financing of various programmes and projects being an important aspect of the whole reform, EECCA countries have recognized that additional financing without policy and institutional reform would probably lead to wasted resources (OECD 2012c).

One of the as yet underused opportunities for better resource management is cooperation. While there is no clear outlook about the economic cooperation within the EECCA region (mechanisms for economic integration as e.g. the Eurasian Economic Community, common free market zone etc. are not progressing well), the EECCA Environment Strategy provides a common ground for environmental improvements, including resource efficiency strategies and programmes. However, due to ineffective national structures, many aspects of regional cooperation are not up to performing complex or difficult tasks. In order to use this potential, the EECCA countries need effective national institutions to be able to cooperate on resource use, as well as to develop cooperation at multi-state and international levels. The two most likely future development scenarios concerning environmental cooperation in the EECCA region may be:

1) Continued weakening of environmental cooperation in EECCA as a single region, and focusing on bilateral cooperation with the European Union and neighbouring countries; or
2) Germination and development of new specific regional and sub-regional initiatives, proposed by the strongest political and economic partners at first, and extension of target programmes which have been successfully implemented at the national level.

The recent development shows there is good will to cooperate on the transition to a green economy: The 'Green Bridge' Astana Initiative (UNECE 2011) identified a few thematic areas that may serve in planning for resource efficiency improvement. It asks governments to:

- Create a legal framework to phase out inefficient production and consumption, and to promote eco-efficiency;
- Incorporate green procurement and prioritize the channeling of government investments and incentives to sectors that facilitate the greening of energy, industry and agriculture;
- Reduce support for spending in areas that deplete natural capital;
- Improve the use of strategic and integrated environmental assessments at the level of national planning;
- Apply taxes and market instruments to encourage purchasers to choose green activities, and facilitate green investments and innovation; and
- Provide support for capacity building and green projects in priority sectors such as sustainable energy, agriculture, urban infrastructure and transport, and enhancement of ecosystem services and promotion of sustainable human settlements.

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6 Technical Annex 1: Assembling the EECCA MFA Reference Database (2013)

6.1 Introduction

This Annex aims to record the data sources and methods used to compile the reference database of material flows in the Eastern Europe, Caucasus and Central Asia (EECCA) region for the period 1992 to 2008.

Twelve countries are dealt with in the database. These are listed in Table 14.

Table 14: Set of nations included in the material flows database for the EECCA region

Armenia	Republic of Moldova
Azerbaijan	Russian Federation
Belarus	Tajikistan
Georgia	Turkmenistan
Kazakhstan	Ukraine
Kyrgyzstan	Uzbekistan

The methodology used was identical to that used for similar databases created previously for the Asia and Pacific and the Latin America and Caribbean regions, and was a refinement of the methodology trialled previously in creating the REEO report for Asia and the Pacific (UNEP 2011). The database deals with four major materials categories, which can be further resolved into 11 sub-categories. These are presented in Table 15, and the base data source used and any data modeling applied are discussed in the relevant sections below. The basic category structure used was generally in line with that recommended in Eurostat (2011), with the rationale for any significant departures from this explained below.

Table 15: Materials categories and sub-categories used in reference database

Category	Sub-category
Biomass	Crops
	Crop residues
	Grazed biomass
	Wood
Fossil fuels	Coal
	Petroleum
	Natural gas
Metal ores and industrial minerals	Ferrous ores
	Non-ferrous ores
	Industrial minerals
Construction minerals	Construction minerals

6.2 Methods and data for measuring material use and resource use efficiency

The final reference dataset upon which the report is based resolves material flows into 11 different materials sub-categories, which are then generally dealt with after further aggregation into four categories (Table 15).

Resolving materials at higher disaggregation than this is not possible using the reference dataset, as the 11 sub-categories are pieced together from a variety of different data sources which have, in many cases, been run through a variety of data cleaning, filtering, infilling and calculation processes. This process has been performed almost exclusively in a series of R language scripts. The disparate base data sources and processes employed to arrive at the 11 sub-category reference dataset is the main subject of this technical annex.

For base data, well accepted and accessible international data sources were used where possible. The period for which data coverage was sought was from 1992 until 2008. In compiling these data, the methodological guidelines set out in Eurostat (2011) were adhered to as much as practicable. One significant departure from the MFA category structure is in using a four-category breakdown of material flows into biomass, fossil energy carriers, metal ores and industrial minerals, and construction minerals. This differs from the four-category disaggregation at 1 digit level in Eurostat (2011) mainly in splitting the non-metallic minerals into separate industrial and construction minerals categories. This way, the volumetrically very significant but very inadequately reported construction minerals are separated from the better reported but generally volumetrically insignificant industrial minerals. The construction minerals can then be modeled via an entirely separate process from the industrial minerals, while industrial minerals are aggregated with metal ores as a single category (this latter due to the relatively insignificant tonnages of industrial minerals).

6.2.1 BIOMASS

Biomass flows[18] were determined for four sub-categories: primary crops, crop residues, grazed biomass and wood.

Base data for the DE of primary crops is from FAO (2011c), while exports and imports of crops at a national level are taken from FAO (2011d) . Domestic material consumption (DMC) for crops was calculated as:

DMC = Production – Exports + Imports.

To calculate crop residues, harvest factors and recovery rates for specific crops and sub-regions within the EECCA region were sourced from Haberl et al. (2007) and applied to the FAO crop production figures for each country. There were only 17 specific harvest factors and 11 recovery rates to apply to over 100 different crops reported under production in the region, so crops which did not map directly to a recovery/harvest factor were allocated one from apparently similar crops which did have a factor. Where a crop could not be linked to a factor with any degree of confidence, the residues for that crop defaulted to zero, so the crop residues estimate can be seen as conservative. No significant trade in crop residues was recorded in FAO data.

Estimating grazed biomass was a multistage process. First, the total amount of animal products 'grown' in a country was calculated, starting with animal products recorded in FAO (2011c), then subtracting/adding to this the animal product equivalent of live animals imported/exported. This

[18] Note that while data on animal products was used extensively in calculation of the grazed biomass sub-category, flows of animal products themselves do not directly feature anywhere in these MF accounts. This is because the animal products themselves, apart from wild catch (which is volumetrically insignificant), are neither primary extraction, nor do the traded goods retain a significant portion of the mass of primary plant biomass required to produce them

correction was not performed in UNEP (2011). Feed energy required for each country's animal products production was then estimated by applying feed energy requirements per kg of animal product, resolved on a regional basis in Wirsenius (2000) to the corrected production of each corresponding animal product. Tonnages for the primary crops recorded as being used for animal feed in FAO (2011a) for the region were then converted to their equivalent in feed energy available to each class of animal. The conversion factors used were also derived from Wirsenius (2000). To this available energy was added the energy available from fish used as feed, another refinement over the model used previously for UNEP (2011). This total available energy was then hierarchically allocated to different classes of animals, i.e. first claim on compatible crops was given to poultry, until their requirements were met. Pigs had second claim, then if any crops remain, ruminants received the remainder. Any deficit between the energy available from crops and the requirements of ruminants is assumed to be filled entirely from grazed biomass (i.e. no role for crop residues has been considered[19]). This energy deficit is then converted to tonnes of grazed biomass required, using the energy content for 'permanent pasture, over sown' for the relevant region for each country derived from Wirsenius (2000) as a conversion factor, and assuming a 15% moisture content.

Where feed energy deficits occurred for poultry or pigs, this was reported in the R programme, but did not enter into further calculations. There are many possible causes of an energy deficit occurring early in the allocation process, e.g., energy requirements of animals being overstated, and animal products being over-reported. However, we feel that the simplest explanation in most cases is that crops ultimately used as feed (either directly or via some processing step) are under-reported or otherwise not being captured.

DMC for grazed biomass is assumed to be equal to DE.

For wood, DE tonnages were calculated by applying the default densities supplied in Eurostat (2009) for coniferous and non-coniferous woods at 15% moisture content, to the appropriate volumes of all round-woods extracted by each country and reported in FAO (2011b). As there is a large trade in wood products, DMC could not be assumed equal to DE. All data required to calculate DMC was sourced from FAO (2011b), and calculated as:

DMC = DE + Imports of all wood products – Exports of all wood products.

There is an intentional mismatch between the scope of products included in calculating DE tonnages, and that for traded tonnages. Changing product scope is necessary to avoid multiple counting of tonnages in on the DE side (e.g., first as production of round wood, then as pulp, then again as paper), while simultaneously maintaining good attribution of wood mass to its final point of consumption. Exclusion of woodchips, pulp and paper is thus necessary for DE. However, they should be counted on the traded side of the equation, where the risk of multiple counting does not apply, and because these constitute the major inputs of wood products for many countries. These processed products generally retain a large percentage of the initial mass of the roundwood extracted for their production.

6.2.2 METAL ORES AND INDUSTRIAL METALS

Calculation of metal ores and industrial minerals used data from a variety of sources. Where possible, DE of a specific metal ore was calculated by applying a grade factor to data on the primary production of that metal for each country. The preferred source of data on primary metal production

[19] Substitution of crop residues for grazed biomass was not estimated due to the lack of sufficient data on the proportions of each specific crop residue going to feed. Good data on this would be required to make reasonable estimates of the remaining 'grazing gap' due to the highly non-linear response of ruminant productivity to feed energy density at lower values. The energy available for growth (i.e. beef production) can vary up to eightfold, depending on whether the crop residue is a higher energy variety like sugar beet tops, or low energy variety like rice straw. Where a tonne of sugar beet tops would substitute for a tonne of the reference grazed pasture used in this study, over six tonnes of rice straw would be required to produce the same beef output as one grazed tonne.

was Matos (2009). This covered extraction of aluminum, arsenic, asbestos, bromine, cadmium, cement, clay, copper, fluorspar, gold, gypsum, iron, lead, mercury, nickel and zinc up to 2006. The additional years to 2008 for these commodities were individually sourced from USGS (2011). For other mineral commodities, a hierarchical selection process was applied to other data sources, with next priority given to data on contained metal production sourced from the UN Statistics Division (UNSD 2011b), then to data on simple metal compound production e.g. Cr_20_3 from UNSD (2011b). These data were all amenable to having a grade factor applied to calculate DE of ore. If no data on metal content or simple compounds were available, the combined 'Ores and Concentrates' category in data was used without applying grade factors. This source had lowest priority, as the DE of ore implied by a tonne of concentrate is typically one or more orders of magnitude higher than for ore. The UNSD practice of reporting ores and concentrates aggregated into one category, followed since 2004, is a retrograde step and a major barrier to accurately calculating underlying DE. To minimize the impact of this, data for some volumetrically significant mineral commodities not included in Matos (2009), notably ilmenite, rutile, zircon, silver and salt, had data post-2004 added from USGS (2011).

With the exception of copper, grade factors applied to convert the primary metal content to DE of ore were derived from Mudd (2007a), who dealt with Australian ore grades, and their variation over time. These grades have been applied to all countries. It is openly acknowledged here that these grades and their evolution over time may not be a good reflection of grades for other countries. However, obtaining such time series data for other countries would involve a similar level of detailed work (with mining data resolved at the individual mine level) as that underlying Mudd (2007b). This was not practical for this exercise. Details on industrial minerals were generally not available from Mudd's work; however, this was not a significant problem as the final tonnages for most were taken directly as the tonnage reported, i.e. grade factors were generally not applied. The exceptions to this were phosphate and potash.

Another important issue in calculating DE of metal ores is multiple counting of ore from poly-metallic deposits. Three *ad hoc* measures employed in this study to reduce the effect of multiple counting were:

1. Excluding altogether some metals which are largely produced as by-products.
2. Deriving representative grades for some major metals from subsets of the individual mine data in (Mudd 2007a), where one metal alone clearly underpins the viability of those mines.
3. Proportional reductions in tonnages of ore for metals which were typically co-products.

An example of (1) is the exclusion of cobalt, as much of its production comes from very low (in Co) grade ores which are mined primarily for other metals such as nickel or copper. An example of (2) is deriving the grades for gold from mines which are heavily biased to gold, thus avoiding the lower average grades (and so inflated ore tonnages) which would result if the more mixed product mines in the continuum from Au-Cu to Cu-Au mines were included. An example of (3) was dividing by three the individual tonnages of ores calculated separately for lead, zinc and silver, as these metals typically occur as important co-products in a mixed ore. Multiple counting is of less concern for industrial minerals, as their production is dominated by single commodity mines.

As copper is such an important commodity globally, in terms of ore tonnages mined, and a time varying graph of estimated global average grades was available from Gerst (2008), these values were digitized and used in preference to grades derived from Mudd (2007a). Equivalent global grades for other major metals were not found.

To estimate PTB in metal ores and industrial minerals, net trade was determined from data in the United Nations Comtrade database, UNSD (2011a). As with wood products, there was an intentional mismatch between categories used for DE and PTB. Where only calculated ore volumes were counted for DE, PTB Net trade encompassed ores and concentrates, and also some large tonnage items of relatively simply transformed metal products e.g. crude metal, ingots, billets and pipes. The mismatch between the set of commodities included in the DE and net trade calculations is for the same reasons outlined in the section on wood biomass.

Net trade was determined using UNSD (2011a) , matching the SITC rev1 version categories to our 11-category scheme. This was done at the 3, 4, and 5 digit SITC code level. Subtotals for each country-year were then calculated for each of the 11 categories independently for each different level of resolution (SITC 3, 4 then 5 digit). The highest subtotal out of the three calculated for each country-year-category point was taken to be the appropriate figure for that point. This was to reduce the problem of data dropping out at successively higher levels of aggregation in the base UNSD (2011a) data. This was done for imports, exports, re-imports and re-exports. PTB was then calculated as:

PTB = Imports – Exports + Re-imports – Re-exports.

The base Comtrade data were subject to some ad hoc cleaning and infilling. However, as metal ores and industrial minerals can in reality be subject to very large year-to-year fluctuations, when large individual mines open or shut, these errors had to be very obvious to be corrected. Examples that warranted correction were where a nation showed unfeasible increases or decreases in one material, or a systematic change which appeared due to an error in units from one year to the next. These errors would be corrected by interpolating values from more reasonable values 'to either side' where available, or sometimes filled from an adjacent value where no upper or lower point to use for an interpolation was present.

6.2.3 CONSTRUCTION MINERALS

This is the single largest category of material flows, and also one of the most poorly recorded for many of the main constituent materials. Databases such as UNSD (2011b) and UNSD (2011a) usually contain fields for major construction minerals; e.g., sand, clay, gravel and crushed rock. However, these fields are frequently empty or grossly under-reported. An exception to this is data on cement, with good statistics on production recorded in Matos (2009) and USGS (2011), and reasonable trade statistics reported in UNSD (2011a).

As a result, the method used to calculate DE of construction materials here applies multipliers to DMC of cement, to derive estimates for overall construction minerals extracted. DMC of cement was calculated by using UNSD (2011a) to estimate net trade, and subtracting that directly from production data given in Matos (2009) and USGS (2011). The multiplier applied to cement to account for construction minerals associated directly with cement is 7.9, which reflects the 1.4 tonnes of limestone required to produce one tonnes of cement, and the 6.5 tonnes of construction aggregates to every one tonne of cement used in making concrete (Krausmann et al. 2009).

Construction minerals not associated with cement were accounted for by adding an extra component calculated from the ratio of cement-related construction minerals (asphalt-related + all other construction minerals). This ratio was derived from Krausmann et al. (2009). As the World ratio changed over time, from 60:40 in 1975 to 74:26 in 2005, a simple linear trend was calculated to determine appropriate factors for each year. The trend was then extended to 2008. This simple method has the disadvantage of applying a global average to each individual country, where in reality differences in factors such as the level of development, population density and topography will generate variations between countries. Methods for obtaining country-specific estimates are given in Eurostat (2011). However, the chains of data necessary to perform detailed calculations at the level of individual countries (e.g., road network lengths, classes of road and the materials embodied in each class of road for different countries) were not sufficiently well-recorded or available to pursue this approach here.

PTB of construction minerals was determined from UNSD (2011a) in the same manner outlined for metal ores and industrial minerals. This is one area were the allocation of SITC categories to the 11 and four-category classes used here varied somewhat from that advocated in Eurostat (2011). All ornamental and building stone type materials were mapped to the construction minerals category, as were virtually all calcareous materials including chalk and dolomite. Under the Eurostat (2011) scheme, they would be allocated to a category which includes the main industrial minerals.

Calculating DE of construction materials rather than relying on reported extraction should generally give far superior estimates; however, it can encounter problems when an individual country actually does record its usage of construction materials more accurately. An example of this from another region was Singapore, which has kept track of its total usage of construction aggregates in recent decades, by virtue of the fact that it imports most of them. In this case, adding calculated DE to PTB probably over-estimates DMC for that country. There are no obvious cases of this for the EECCA region.

6.2.4 FOSSIL FUELS

Data for this category are usually very reliable, with IEA (2011a) and IEA (2011b) generally providing high-quality data for all of the period required. The IEA data cover all of the nations in the region. DE, Trade and DMC were determined relatively directly, with only straightforward transformations or aggregation of this base data; e.g., application of conversion factors to convert energy values for natural gas to tonnes.

As with wood and metal ores, the scope of products included was different for DE and PTB calculations. DE was limited to primary resources, whereas net trade included the more processed products, most notably the various petroleum refinery products. This attributes the essential act of consumption to where the refinery product is burned as fuel, rather than where the crude oil enters the refinery process. Fossil fuels offer the best case of where the bulk of the original extracted mass of the resource can be effectively traced and attributed to the nation of final consumption. This is in stark contrast to the situation for non-ferrous metals, for example, where the great bulk of the natural resource is removed well before the material of value is incorporated into an end product (consumer good). Of the 66 product categories listed in IEA (2011a) and IEA (2011b), 39 were mapped to the three fossil fuel categories used in the reference database to determine PTB, whereas only 13 products counted for DE purposes.

6.2.5 MATERIAL INTENSITY AND PER CAPITA MEASURES

As a measure of resource efficiency we calculate material intensity; that is, DMC/GDP. The GDP figure used is sourced directly from the World Bank (2012) and denominated in exchange value-based GDP (at constant 2000 prices).

Population figures were also sourced from the World Bank (2012). Again, no significant transformations were performed on these data. Note that the raw population and GDP figures, as opposed to the ratios they were used to calculate, are not retained in this database. The user is directed to the appropriate World Bank website at http://data.worldbank.org/data-catalog/world-development-indicators to access their copyrighted data.

Where ratios such as material intensities or per capita values were calculated for individual nations, the operation was simple division of that nation's materials account value for each year by the relevant population or GDP figure. Missing or zero values for a year in either numerator or denominator flow through directly to either 'NA' or zero values in the result.

Calculating the values given for the EECCA region as a whole was more complex. Where a country was missing a data point for a year in either the numerator or the denominator, both values were set to zero. The data were then summed and converted to the appropriate ratios after this operation. This procedure was followed to avoid situations where, for example, there may be no data on materials for a relatively populous country, but population data are available. Not zeroing both values could lead to a large underestimate of DMC/capita for that sub-region for that year. Where non-ratio values have been stated for the EECCA region in the report, e.g. total DMC, they use raw totals which have not undergone this procedure. For non-ratio values this maximizes the data used, without running the risk of distorting the final result. For ratios for the World, a different approach again was necessary, largely due to data complications associated with the dissolution of the USSR. Here all available material flows data were summed, and the 'world' figures for population and GDP from World Bank (2012) used directly as denominators.

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7 Technical Annex 2: Water Use and Efficiency

7.1 Definitions of the water-related indicators

The chapter on *Water use and efficiency* is based on data from the Aquastat database of the Food and Agricultural Organization (FAO 2013). Complete metadata for the database can be found at http://www.fao.org/nr/water/aquastat/metadata/index.stm and includes information on quality assessment, comparability (geographical and over time), coherence, collection methods and validation of water data.

This Technical Annex provides definitions of the water-related indicators used throughout the chapter. These definitions originate from the Aquastat database:

Total water withdrawal

Annual quantity of water withdrawn for agricultural, industrial and municipal purposes. It includes renewable freshwater resources as well as potential over-abstraction of renewable groundwater or withdrawal of fossil groundwater and potential use of desalinated water or treated wastewater. It does not include in-stream uses, which are characterized by a very low net consumption rate, such as recreation, navigation, hydropower, inland capture fisheries, etc.

Total water withdrawal per capita

Total annual amount of water withdrawn per capita. The population usually refers to the present-in-area (de facto) population which includes all persons physically present within the present geographical boundaries of countries at the mid-point of the reference period.

Total water withdrawal per area

Total annual amount of water withdrawn per total area. The total area of the country includes area under inland water bodies.

Annual water withdrawals by sector

This indicator is composed of three sub-indicators: Agricultural water withdrawal, industrial water withdrawal and municipal water withdrawal

Agricultural water withdrawal

Annual quantity of self-supplied water withdrawn for irrigation, livestock and aquaculture purposes. It includes water from primary renewable and secondary freshwater resources, as well as water from over-abstraction of renewable groundwater or withdrawal of fossil groundwater, direct use of agricultural drainage water and (treated) wastewater, and desalinated water. Water for the dairy and meat industries and industrial processing of harvested agricultural products is included under industrial water withdrawal.

Industrial water withdrawal

Annual quantity of water withdrawn for industrial uses. It includes renewable water resources as well as potential over-abstraction of renewable groundwater or withdrawal of fossil groundwater and potential use of desalinated water or treated wastewater. This sector refers to self-supplied industries not connected to the public distribution network. The ratio between net consumption and withdrawal is estimated at less than 5%. It includes water for the cooling of thermoelectric plants, but it does not include hydropower.

Municipal water withdrawal

Annual quantity of water withdrawn primarily for direct use by the population. It includes renewable freshwater resources as well as potential over-abstraction of renewable groundwater or withdrawal of fossil groundwater and the potential use of desalinated water or treated wastewater. It is usually computed as the total water withdrawn by the public distribution network. It can include that part of industry which is connected to the municipal network. The ratio between net consumption and water withdrawn can vary from 5 to 15% in urban areas and from 10 to 50% in rural areas.

Water intensity

On a nationwide level, this indicator is calculated as total water consumed in the economy divided by economic output (GDP). Total water consumption is identified with total water withdrawal and GDP is accounted for in current prices (for one year comparison) or in constant prices (for a comparison of a trend). Sectoral water intensities refer to the water used by that sector (for definition of sectoral water withdrawals see above) per gross value added by that sector in current prices (for one year comparison) or in constant prices (for comparison of a trend). Water intensity is the inverse of water productivity, so lesser values for water intensity reflect higher water productivity.

Water abstraction rate (Water exploitation index)

Water abstraction rate is equal to the share of total water withdrawal in total actual renewable water resources. These resources are defined as the sum of internal renewable water resources and external actual renewable water resources and correspond to the maximum theoretical yearly amount of water actually available for a country at a given moment.

Internal renewable water resources

Long-term average annual flow of rivers and recharge of aquifers generated from endogenous precipitation. Double counting of surface water and groundwater resources is avoided by deducting the overlap from the sum of the surface water and groundwater resources.

External actual renewable water resources

That part of the country's annual renewable water resources that are not generated in the country. It includes inflows from upstream countries (groundwater and surface water), and part of the water of border lakes and/or rivers. Contrary to natural external renewable water resources (i.e. the situation without human influence), this indicator takes into account the quantity of flow reserved by upstream (incoming flow) and/or downstream (outflow) countries through formal or informal agreements or treaties, and possible water abstraction occurring in the upstream countries. It may therefore vary with time. In extreme cases, it may be negative when the flow reserved for downstream countries is more than the incoming flow.

7.2 Reference for the technical annex on water efficiency

FAO (Food and Agricultural Organization) (2013) Aquastat online database. Retrieved 24 January 2013, from http://www.fao.org/nr/water/aquastat/data/query/index.html?lang=en.

The first "Resource Efficiency: Economics and Outlook (REEO) for Eastern Europe, Caucasus and Central Asia (EECCA)" report focuses on demand for and use of natural resources, as drivers and as consequences of economic activity and social development. This report provides an overview of resource use patterns in the EECCA region and countries, explains why sustainable resource use and resource efficiency will become an economic and social imperative for the region, and presents information on how these objectives might be achieved through careful policy design. It aims to inform policy-makers and practitioners working on integrated environment and development strategies in particular, as well as sustainability policies more generally.

For continued economic development in the EECCA countries to be achieved within the limits of natural systems, it must be based on resource efficiency. Therefore, this report is one essential guide to responsible development and as such, should be on the desk of every decision-maker in the region.

Linking environmental and economic concerns in the medium- and longer-term makes this a timely and valuable report, being a source of expert-analysed information and recent data on the rapidly growing Eastern Europe, Caucasus and Central Asian countries to create awareness of the resource challenges ahead and of ways to deal with them.

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