



Resource use and resource efficiency in Central and Eastern Europe and the Newly Independent States

A pilot study on trends over 13 years



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**Resource use and resource efficiency in Central and
Eastern Europe and the Newly Independent States**

A pilot study on trends over 13 years

Stefan Giljum, Barbara Lugschitz, Christine Polzin, Stephan Lutter
Sustainable Europe Research Institute (SERI)
Vienna, Austria

Monika Dittrich
Independent Scientist
Heidelberg, Germany



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Abstract

This paper provides a comparative assessment of material consumption and material productivity in Central and Eastern Europe (CEE) and the Newly Independent States (NIS) in the Caucasus and Central Asia between 1995 and 2008. The analysis is based on the methodological framework of economy-wide material flow accounting and analysis (MFA). 30 countries were selected for the analysis. To facilitate comparison, the region was divided into three geographical groups: New EU Member States (NMS), South East Europe (SEE) and Eastern Europe, Caucasus and Central Asia (EECCA). The results show that material extraction in the 30 countries grew significantly between 1995 and 2008, most notably of construction minerals; the volume of material trade doubled; per capita consumption increased by 25%, from 9.8 tonnes in 1995 to 12.2 tonnes in 2008 and was thus above the global average of 10.4 tonnes but below EU-15 average of 18.6 tonnes per capita in 2008. Material productivity rose by 42 per cent between 1995 and 2008, and most of countries experienced a relative decoupling between per capita GDP and per capita material consumption.

1. Introduction

Current trends in global consumption of natural resources, including materials, energy, water and land, are not sustainable. Industrialised countries with high levels of per-capita resource consumption must decrease their share in global resource use in absolute terms, while developing, emerging and transition countries will need further economic growth in the future in order to satisfy demand for higher consumption, economic welfare and higher quality of life. However, in light of increasing resource scarcities, intensifying international competition over resources, rising resource prices and growing environmental problems related to resource use, economic growth will have to follow new patterns that are significantly more resource efficient than in the past.

The transition economies in Central and Eastern Europe (CEE) and the Newly Independent States (NIS) in the region still require industrial growth to realise their national development objectives and to reduce the income gap compared to the industrialised countries. The challenge for them is to find and implement a model of industrial growth that is more resource and energy efficient, low carbon and low waste (OECD, 1999; Schäfer, 2005; Ürges-Vorsatz et al., 2006; Buchan, 2010; Memedović, 2011). At the same time, those countries are in need of creating jobs, and raising the productivity and welfare of their societies. In order to monitor progress on this way and to find appropriate policies, it is essential to create a first benchmark for analysis with regard to resource use and resource efficiency. This is the aim of this study.

In contrast to many industrialised countries, where national statistical offices and agencies have increasingly collected and published data and indicators on resource consumption and resource efficiency in the past 10 years, a comprehensive empirical basis for performing comparative assessments of resource efficiency is still missing for CEE and the NIS. So far, material flow data only exists for the New EU Member States for the period of 2000 to 2007, available from EUROSTAT.¹

In order to fill this gap, this study for 30 countries in CEE and the NIS in Asia was undertaken by the Sustainable Europe Research Institute (SERI) and the independent scientist Dr. Monika Dittrich. It builds on two previous studies on resource use and efficiency in Asia and in the emerging economies, which were also commissioned by UNIDO as part of the Green Industries Programme. These projects were able to provide the first comprehensive indicators for resource consumption and resource efficiency for Asian countries and emerging economies by integrating the global database on resource extraction developed and maintained by SERI (www.materialflows.net) and the global database on resource trade developed by Dr. Dittrich at the Wuppertal Institute in Germany, which establishes global accounts of imports and exports in physical (weight) units (see Methodology section below for details).

¹ See appsso.eurostat.ec.europa.eu/nui/show.do?dataset=env_ac_mfa&lang=en.

In this study, the same methodology was used as in the previous studies in order to calculate national resource consumption indicators and resource efficiency indicators for 30 countries in CEE and the NIS (henceforth called the “Group of 30”), covering the years 1995, 2000, 2005 and 2008. In order to allow a comparative assessment, the respective numbers for the aggregated EU-15 is also provided.

The paper will answer the following questions:

- How have resource extraction and consumption developed between 1995 and 2008?
- How much and which types of resources do different economies extract and consume, in absolute and per capita numbers?
- How has the physical trade volume in CEE and the NIS developed between 1995 and 2008?
- To what extent does the Group of 30 depend on imports of different types of resources to maintain national production and consumption?
- What types of resources do CEE and NIS supply to the world markets?
- How has resource efficiency developed between 1995 and 2008?
- To what extent are income and material consumption linked to each other?

The region is interesting to look at, as it comprises a large number of countries which have undergone the challenging process of transition from centrally planned to market economies. This process happened at different speeds and with varying success across the region, which is not only reflected in economic indicators, such as GDP per capita, but also in terms of material flows (as exemplified through extraction, consumption and physical trade data).

For analytical purposes, CEE and the NIS are divided into three sub-regions. These regions were not chosen on the basis of structural similarities but rather on the basis of their geographical position and historical situation after the collapse of Communism. Thus, the groups are rather heterogeneous in their economic situation and in terms of resource use.

1. New EU Member States (NMS): Bulgaria, Cyprus, Czech Republic, Estonia, Latvia, Hungary, Lithuania, Malta, Poland, Romania, Slovakia, and Slovenia. These countries have managed the transition most successfully – largely due to their geographic position, relative stability, relatively large flows of foreign direct investment (FDI) and support from the European Union, which they joined in 2004 (Bulgaria and Romania joined in 2007). These countries are marked in orange in the figures and tables of this paper.

2. South East Europe (SEE): Albania, Bosnia and Herzegovina, Croatia, FYR Macedonia, Serbia and Montenegro, and Turkey. With the exception of Turkey, this group of countries has experienced great difficulties after the 1990s, often marked by (ethnic) conflicts and

national break-up processes. Their possible entry into the European Union has only become a topic for discussion in recent years. These countries are marked in green in the figures and tables of this paper.

3. Eastern Europe, Caucasus and Central Asia (EECCA): Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Kyrgyzstan, Moldova, the Russian Federation, Tajikistan, Turkmenistan, Ukraine, and Uzbekistan. This group comprises countries with very different levels of development. Moldova, for example, was considered to be the poorest country in Europe in terms of GDP in 2009, while Russia's per capita GDP is significantly higher than that of the other countries in this group (up to factor 13). Many of these countries have been facing strong growth in emigration due to problems of unemployment. Some of them aspire to join the European Union. These countries are marked in purple in the figures and tables of this paper.

For clarity and easy comparisons, the figures and tables in the paper will only comprise these three groups as well as the EU-15, the global average and the average across the Group of 30. For each of the three sub-regions, two representative countries were chosen to illustrate certain developments. Croatia and Turkey represent South East Europe; the Russian Federation and Ukraine represent the group of Eastern Europe, Caucasus and Central Asia; and Lithuania and Hungary represent the developments in the New EU Member States.

The paper has the following structure: section 2 briefly summarises the methodology that was used to compile the resource use and resource efficiency data as well as the main data sources used. Section 3 illustrates and analyses resource use in terms of material extraction, material trade and material consumption and resource efficiency. Section 4 concludes and provides a short outlook to future research.

2. Methodology

This pilot study is based on the methodological framework of material flow accounting and analysis (MFA). MFA (see Box 1) builds on earlier concepts of material and energy balancing, as introduced already in the 1970s. The MFA concept was developed as a reaction to the fact that many persistent environmental problems, such as high material and energy consumption and related negative environmental consequences (such as climate change), are determined by the overall scale of industrial metabolism rather than toxicities of specific substances.

Box 1 Material flow analysis (MFA) and Industrial Metabolism

The principal concept underlying the economy-wide MFA approach is a simple model of the interrelation between the economy and the environment, in which the economy is an embedded subsystem of the environment and – similar to living beings – dependent on a constant throughput of materials and energy. Raw materials, water and air are extracted from the natural system as inputs, transformed into products and finally re-transferred to the natural system as outputs (waste and emissions). To highlight the similarity to natural metabolic processes, the terms “industrial metabolism” (Ayres, 1989) and “societal metabolism” (Fischer-Kowalski, 1998) have been introduced.

According to those concepts, society and the economic system are social units functioning to reproduce the human population, in physical, economic and cultural terms. Besides the human population itself, societies and economic systems comprise bio-physical structures that “belong” to them and also have to be reproduced. Examples of such bio-physical structures are livestock, built infrastructure or man-made capital, such as machines and manufacturing sites. In order to perform this reproduction, metabolic exchange with the environment is a basic requirement.

The scale and composition of industrial metabolism of a country is determined by a large number of factors (see UNEP, 2011), including demography, economic structures (main sectors contributing to a countries’ GDP), eco-efficiency of the technologies applied in key sectors such as energy, transport and manufacturing as well as integration in the global economic system (patterns of imports and exports).

Material flow analysis (MFA) is so far the most widely applied methodology to operationalise the concepts of industrial or societal metabolism and to quantify trends and analyse developments in countries around the world.

Since the beginning of the 1990s, when first material flow accounts on the national level were presented (for example, in Japan, Environment Agency Japan, 1992), MFA has been a rapidly growing field of scientific and policy interest and major efforts have been undertaken to harmonise methodological approaches developed by different research teams. Today, the MFA methodology is internationally standardised and methodological handbooks are available, for example from the European Statistical Office (EUROSTAT, 2007) and the OECD (2007).

For MFAs on the national level, two main boundaries for resource flows can be defined. The first is the boundary between the economy and the domestic natural environment from which raw materials are extracted. The second is the frontier to other economies with imports and exports as accounted flows.

In general, four major types of resources are considered in MFA studies. All types of resources are accounted in terms of their weight (tonnes). This pilot study will thus also present data in this level of aggregation.

- Biomass (from agriculture, forestry, fishery, and hunting).
- Fossil energy carriers (coal, oil, gas, peat).
- Minerals (industrial and construction minerals).
- Metal ores.

A large number of resource use indicators can be derived from economy-wide material flow

accounts. These comprise indicators on material inputs, material outputs, material consumption and physical trade. In this pilot study, we will mainly use the following MFA-based indicators:

- Domestic extraction (DE), reflecting all raw materials extracted within the boarder of a country.
- Domestic Material Consumption (DMC), which is calculated as DE plus imports minus exports.
- Physical Trade Balance (PTB), which is calculated as imports minus exports.

The compatibility of MFA with data from the System of National Accounts (SNA) enables direct relation of material flow indicators with indicators of economic performance, such as GDP. These interlinkage indicators quantify the eco-efficiency (or resource efficiency) of an economic system by calculating economic output (measured in monetary units) generated per material input (in physical units), for example GDP/DMC. Resource efficiency indicators are thus suitable tools to monitor processes of de-linking or de-coupling of resource use from economic growth.

The calculations illustrated in this study build on the integration of two databases. First, the global database on resource extraction developed and maintained by SERI, which is based on international statistics including the International Energy Agency (for fossil fuels), the UN FAO (for biomass) and the US and British Geological Surveys (for metals and industrial minerals). This database is accessible in an aggregated form at the webpage www.materialflows.net, where a detailed technical report can also be downloaded (SERI, 2010). Data quality varies for the different types of materials. It is generally good for the extraction of fossil fuels and metal ores, however, in some cases, estimations have to be applied regarding the concentration of metals in crude ore extraction. It can be assumed that parts of the biomass extraction for subsistence purposes is not covered in official statistics, so biomass values might be underestimated, particularly for the poor countries. It is important to note that statistics about mineral use are poor in nearly all investigated countries. Thus, for the estimation of the extraction of construction minerals an estimation method was used, where the physical production of cement and bitumen was used to estimate overall levels of extracted construction minerals, in particular limestone, sand and gravel. Where no reliable data on cement and bitumen production was available the estimations were carried out using per capita income as proxy, assuming that demand for construction minerals per capita increases when countries become richer. The exact amounts of mineral extraction may therefore be over- or underestimated in some of the countries. A more detailed study would be needed to develop more accurate estimation methods.

As the second major data source, the global database on resource trade developed at the University of Cologne and the Wuppertal Institute in Germany is applied, which is based on UN Comtrade data and includes global accounts of imports and exports in physical (weight) units. All missing weight values in UN Comtrade have been filled using the global annual price for each commodity group starting with the most differentiated level, then summed up according to the classification structure, and repeated at the next higher differentiation level

up to the total sum. Values of direct trade flows of major outliers are corrected by adjusting the concerned values with regard to global prices, amount of global imports and exports and – as far as available – bilateral trade data as well as with regard to national sector statistics. A detailed methodological description is given by Dittrich (2010, in press) and Dittrich and Bringezu (2010). With regard to the investigated countries it is important to note that trade information in UN Comtrade mostly begins some years after formation of countries; first reported years are predominantly more incomplete and less reliable than trade data of later years. Thus, trade data of the EECCA countries and most of Eastern European countries in 1995 are of minor quality: a remarkable amount of physical values had to be filled with the explained method and a notable amount of outliers had to be corrected; in some cases, when trade data started in 1996 data had to be extrapolated using, as far as possible, available bilateral data of importing countries and/or further statistics. The most important data of trade with fossil fuels is provided by IEA. In the year 2000 and later, the data quality of almost all investigated countries is good or even excellent with the exception of Tajikistan and Turkmenistan where trade data are available only for a few years.

Integrating these two components allows calculating national resource consumption, considering both the domestic extraction and use of resources as well as imported and exported resources. Based on these resource consumption indicators, which include international trade, proper indicators on resource efficiency were calculated. This was for the first time performed for the selected countries in Eastern Europe and the region of the Newly Independent States in the scope of this pilot study.

3. Results

This section presents the main results of the calculations and is divided into chapters on material extraction, material trade, material consumption and material productivity.

Material extraction

The extraction of used materials in the Group of 30 grew by 33 per cent between 1995 and 2008 and therefore slower than the global average in the same period (42 per cent) (see Table 1). Between 1995 and 2000, however, there was almost no growth in extraction at all, as in the EU-15 (in both regions extraction grew by 1 per cent). This rather sluggish growth in the region is largely a result of the decline in Eastern Europe, Caucasus and Central Asia (EECCA) (-2 per cent). Both South-East Europe (SEE) and the New EU Member States (NMS) experienced positive growth in extraction (7 per cent and 4 per cent respectively). The growth in extraction between 2000 and 2008 of one third, by contrast, was much larger in the Group of 30 than on average globally. This increase was again driven by EECCA, where extraction increased by 38 per cent during that time, followed by SEE (31 per cent) and the NMS (18 per cent). As global growth in extraction was higher over the entire period between

1995 and 2008, in large part caused by the emerging economies, in particular in Asia (see Dittrich et al., 2011), the share of the Group of 30 in global resource extraction fell slightly from 10.2 per cent to 9.6 per cent.

Table 1 Used material extraction – globally and in the Group of 30 (1995-2008)

	Global extraction, billion tonnes	Global extraction, 1995 = 100	Group of 30, billion tonnes	Group of 30, 1995=100	Share of Group of 30 in global extraction
1995	47.9	100	4.9	100	10.2%
2000	52.7	110	4.9	101	9.4%
2005	61.6	129	5.9	120	9.5%
2008	68.1	142	6.5	133	9.6%

Source: SERI (2011)

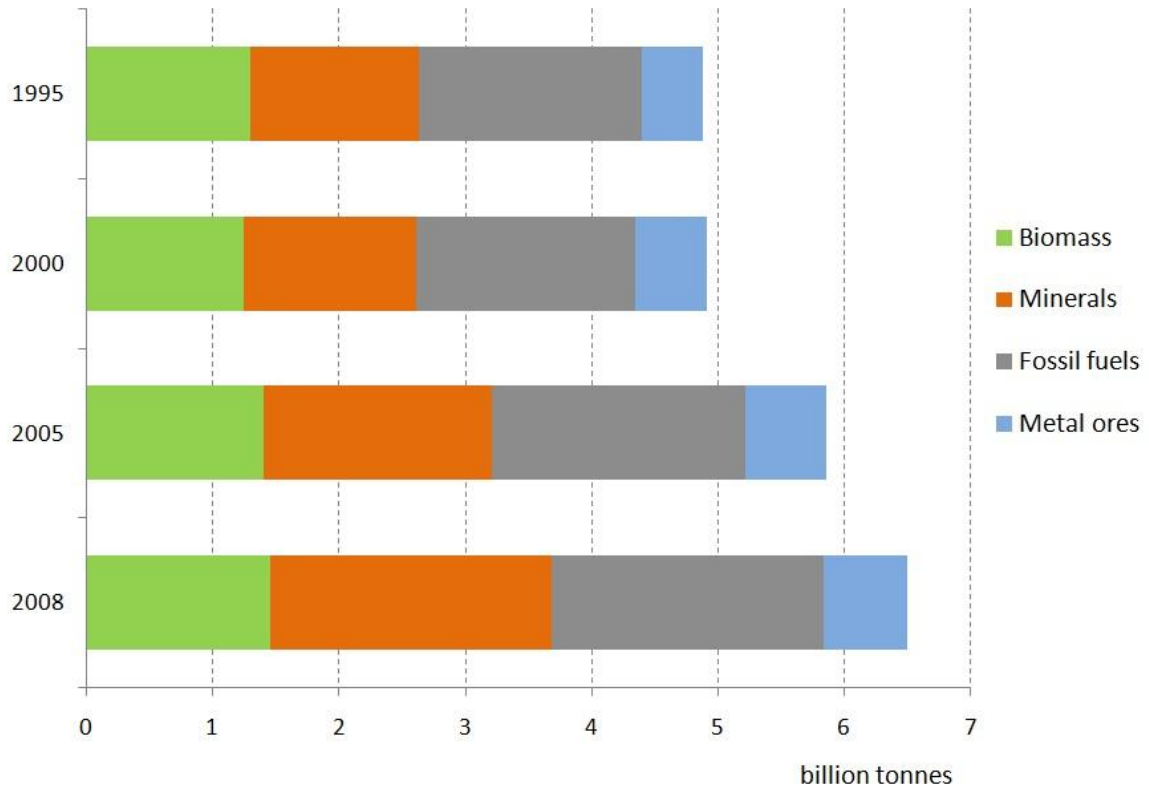
The composition of used material extraction for the Group of 30 has changed over the years under consideration. Figure 1 illustrates the development of domestic extraction in more detail, divided into the categories of used biomass, minerals, fossil fuels and metal ores for the Group of 30 between 1995 and 2008. Between 1995 and 2008, the share of biomass (from agriculture, forestry and fishing) shrank from 27 to 22 per cent, the share of mineral extraction in overall material extraction increased from 27 to 34 per cent, the share of metal ores remained constant at 10 per cent, and the share of fossil fuels shrank slightly to 33 per cent. Patterns of extraction are thus slightly different than the ones observed in the EU-15 countries, which have a share of 23 per cent for biomass, a huge fraction of 65 per cent of minerals (which is remarkably higher than in the other three regional groups), only 1.4 per cent for metal ores and 10 per cent for fossil fuels in the year 2008. In the EU-15, the composition and amount of extraction hardly changed between 1995 and 2008.

In the Group of 30, the extraction of construction and industrial minerals increased by 67 per cent between 1995 and 2008, which is also reflected in the three regional groups; metal ore extraction increased by 35 per cent. Apart from fossil fuels, minerals not only constitute the second largest category of extraction in the Group of 30, their extraction also experienced a very remarkable growth, especially for construction purposes.

Figure 2 illustrates the development of domestic extraction of used biomass, minerals, fossil fuels and metal ores for the different regional groups between 1995 and 2008. The strongest growth in extraction between 1995 and 2008 took place in mineral extraction in the New EU Member States (104 per cent). In 2008, almost half of their overall material extraction was in minerals, largely dominated by extraction activities in Poland. This share of minerals in overall material extraction is even higher for South East European countries with 56 per cent. In SEE, mineral extraction, mostly construction minerals, increased by 67 per cent between 1995 and 2008. In this group, the extraction of construction minerals is clearly dominated by Turkey, which is also responsible for the significant increase. The share of minerals in total material extraction in the groups of NMS and SEE is therefore comparable to the share observed in the EU-15. In the Commonwealth of Independent States, mineral extraction increased by 78 per cent between 1995 and 2008, and minerals made up a quarter of overall

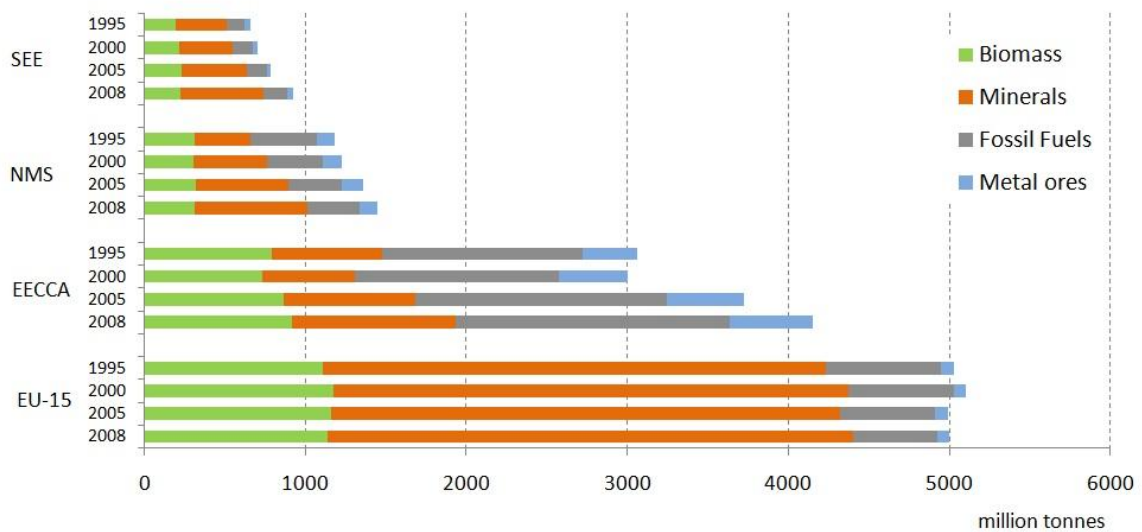
extraction in 2008. This increase was mostly driven by the Russian Federation, which at first (from 1995 to 2000) experienced a decline in minerals extraction, followed by a remarkable increase by 75 per cent between 2000 and 2008. By 2008, Russia extracted about 600 million tonnes of construction minerals.

Figure 1 Material extraction by material category in the Group of 30 (1995-2008)



Source: SERI (2011)

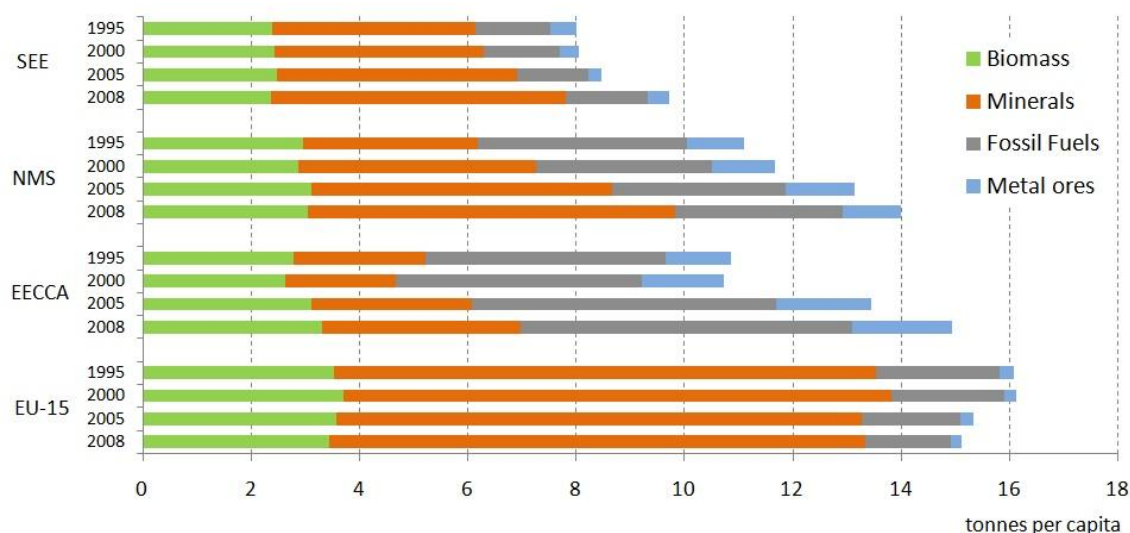
Figure 2 Materials extraction by material category in South-East Europe, the New EU Member States, EECCA and EU-15 (1995-2008)



Source: SERI (2011)

The share of biomass in overall material extraction shrank in all three country groups between 1995 and 2008 (e.g. from 27 to 22 per cent in the New EU Member States). Fossil fuel extraction differs significantly in the different groups. In the New EU Member States, fossil fuel extraction, which is almost exclusively coal, decreased by 22 per cent. Here, the share of fossil fuel extraction in overall extraction dropped from 35 to 22 per cent between 1998 and 2005, mostly due to the decrease in the extraction of hard coal in Poland and the Czech Republic, a consequence of the restructuring in the energy and electricity generation sectors in those countries. In the EECCA and South East Europe, the share of fossil fuel extraction in overall extraction hardly changed over the same period of time (41 and 16 per cent respectively). The share of metal ore extraction did not change markedly over time, with increases only observed for the group of EECCA (+34 per cent). Figure 3 shows the material extraction of the different regions in per capita terms.

Figure 3 Per capita material extraction by material category in South East Europe, the New EU Member States, EECCA and EU-15 (1995-2008)



Source: SERI (2011)

The biggest increase of material extraction per capita (by approximately 4 tonnes) between 1995 and 2008 could be observed in EECCA, with a general increase throughout all material categories, especially in minerals and fossil fuels. By 2008, the EECCA countries thus extracted about the same quantity of materials per capita as the EU-15. The NMS also increased their per capita material extraction considerably (from 11 to 14 tonnes) over the same period.

Resource trade

Between 1995 and 2008, the Group of 30 doubled its material trade volume in physical terms from almost 664 million tonnes in 1995 to more than 1.3 billion tonnes in 2008 (see Table 2). During the same period, world trade volume increased by a factor of 1.7, resulting in an overall increase of the share of the Group of 30 countries in global trade volume from 10.8 per cent in 1995 to 13.0 per cent in 2008. Growth in the physical trade volume of the NMS was lower than the global average but higher in South East Europe and even more so in the EECCA (see Table 3). The relatively high share of the former Soviet states in the global trade volume (8 per cent) is mainly due to the Russian Federation, which alone holds a share of 4.8 per cent of material trade volume in 2008.

Table 2 Trade volume¹ globally, of the EU-15 and of the 30 selected countries (1995-2008)

	Global trade volume	Global trade volume	EU-15 trade volume	EU-15 trade volume	Group of 30 trade volume	Group of 30 trade volume	Group of 30 share in global trade volume
	Bn tonnes ¹	1980=100	Bn tonnes	1980=100	bn tonnes	1980=100	%
1995	6.11	100	1.67	100	0.66	100	10.8
2000	7.60	124	1.95	117	0.81	123	12.1
2005	9.64	153	2.18	131	1.14	171	11.8
2008	10.32	169	2.31	139	1.34	202	13.0

Source: Dittrich, 2011a; ¹Trade volume = (imports+exports)/2

Table 3 Trade volume of the three country groups (1995-2008)

	New EU-Member States			South East Europe			EECCA-countries		
	million tonnes ¹	1980=100	Share in global trade (%)	million tonnes	1980=100	Share in global trade (%)	million tonnes	1980=100	Share in global trade (%)
1995	220	100	3.6	67	100	1.1	377	100	6.2
2000	232	105	3.0	82	121	1.1	501	133	6.6
2005	307	140	3.2	130	193	1.4	698	185	7.2
2008	360	164	3.5	161	238	1.6	823	218	8.0

Source: Dittrich, 2011a; ¹Trade volume = (imports+exports)/2

Both imports and exports increased in the 30 countries between 1995 and 2008. Export growth was stronger than import growth, with exports more than doubling (by 111 per cent, from 803 million tonnes in 1995 to 1.69 billion tonnes in 2008), and imports growing by 89 per cent (from 526 to 995 million tonnes). Imports are similar in all the three country groups, but exports differ significantly both in size and composition. Figure 4 shows that the NMS had the highest imports in 2008 of 425 million tonnes (1995: 234 million tonnes; + 82 per cent), followed by EECCA with 375 million tonnes (1995: 196 million tonnes; +91 per cent)

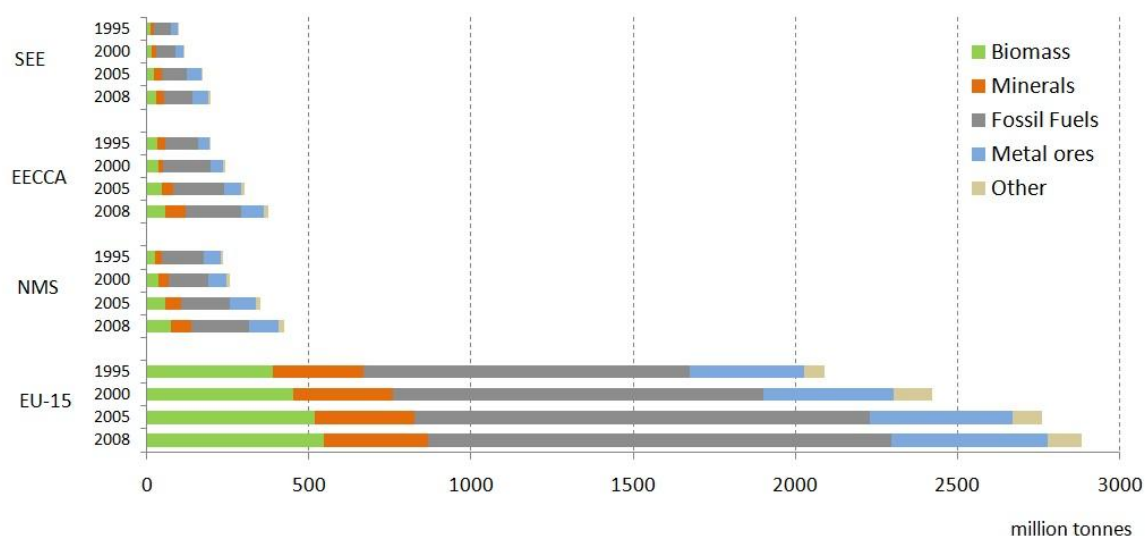
and South East Europe with 196 million tonnes (1995: 96 million tonnes; +104 per cent). By contrast, the EECCA had by far the highest exports with almost 1.27 billion tonnes in 2008 (1995: 557 million tonnes; +128 per cent), followed by the NMS with 295 million tonnes (1995: 206 million tonnes; +43 per cent) and SEE with 125 million tonnes (1995: 39 million tonnes; +219 per cent).

Fossil fuels, which include petroleum, gas, coal and products mainly made of fossil energy carriers, are the dominant imported product group in all three country groups. Although imports of fossil fuels increased by more than half (53 per cent, from 285 to 435 million tonnes in absolute terms), the share of fossil fuels in total imports of the 30 countries declined continuously from 54 per cent in 1995 to 44 per cent in 2008. In 2008, the NMS had the lowest share of imports of fossil fuels in total imports of around 42 per cent compared to 44, 46 and 50 per cent in SEE the EECCA and the EU-15, respectively. In 2008, Ukraine and Turkey were the largest importers of fossil fuels among the selected 30 countries with around 65 million tonnes each, followed by Poland (44 million tonnes) and the Russian Federation (41 million tonnes).

Metals, including ores and concentrates, semi-manufactures and products mainly made of metals, constitute the second highest share in total imports in the 30 countries together (1995: 20 per cent, 2008: 21 per cent). In 2008, the new EU-Member States had the highest metal imports (92 million tonnes), followed by the EECCA (71 million tonnes) and South-East Europe (50 million tonnes). From 1995 to 2008, metal imports grew strongest in South-East Europe (147 per cent), followed by the EECCA (118 per cent) and the NMS (78 per cent). The main importers are the Russian Federation with 40 million tonnes in 2008 (1995: 20.6 million tonnes; +94%) and Turkey with 39 million tonnes (1995: 17 million tonnes; +132 per cent). Dominating products of both countries are iron and steel as well as motor vehicles, including parts thereof. In the Russian Federation, metals are used to a large extent in the basic metals industry, one of its main industries of specialisation (alongside non-metallic mineral products, energy sources, and to a lesser extent, the food sector). Real value-added data shows a relative stability of Russia's manufacturing sector between 1995 and 2007, after the transition to a market economy (Memedović and Iapadre, 2009).

In 2008, the 30 countries imported around 159 million tonnes of biomass, including products mainly made of biomass. Biomass thus makes up a share of 16 per cent of total imports (1980: 70 million tonnes or 13 per cent of total imports). The NMS were the largest importers of biomass with 73 million tonnes in 2008 (1995: 25 million tonnes; +191 per cent), followed by the EECCA with 56 million tonnes (1995: 33 million tonnes; +68 per cent) and by SEE with 30 million tonnes of imported biomass (1995: 12 million tonnes; +160 per cent). The main importers in 2008 were the Russian Federation, Poland and Turkey with imports of around 29, 24 and 20 million tonnes, respectively (1995: 22, 7, and 8 million tonnes, respectively). The dominant imported biomass products of the Russian Federation were fruits, meat and paper, including pulp and paperboard. Poland's main biomass imports are cereals, timber and beverages, and Turkey imports mainly cereals, paper including pulp and paperboard, and timber.

Figure 4 Physical imports of SEE, EECCA, NMS and the EU-15 (1995-2008)



Source: Dittrich, 2011a

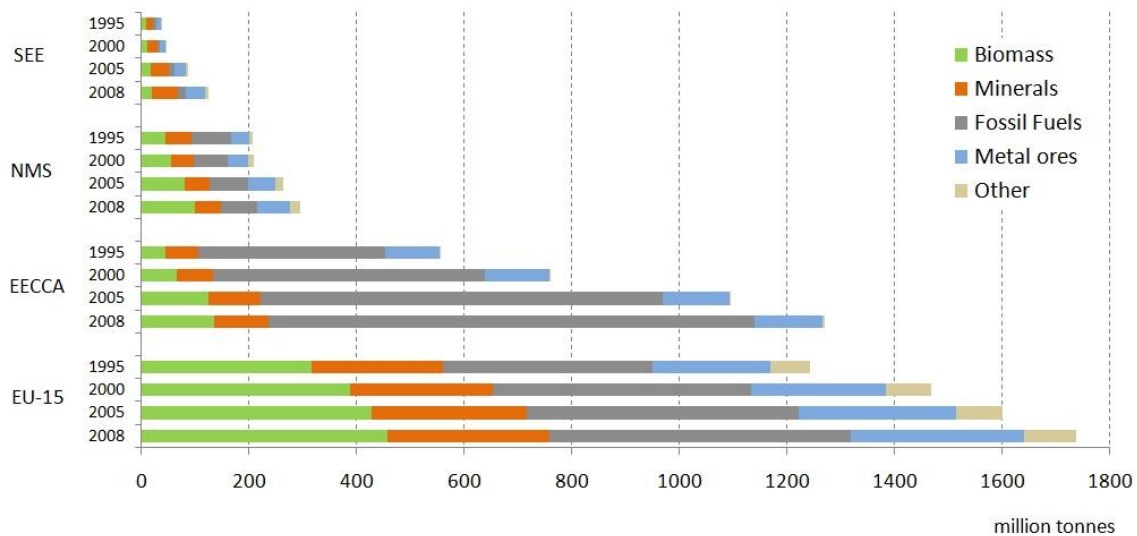
Imports of non-metallic minerals of the 30 selected countries amounted to 149 million tonnes in 2008 compared to 55 million tonnes in 1995 (+173 per cent). In each country groups, minerals constituted the lowest share of total imports in 2008, with 12 per cent in South East Europe, 15 per cent in the NES and 17 per cent in the EECCA. Minerals are usually traded less as they are considered to be widely available. In 2008, the main importers were the Russian Federation, Poland and Turkey. The Russian Federation imported mainly gravel and sand, Poland and Turkey imported mainly fertiliser minerals.

In contrast to imports, the export structure of the three groups differs significantly (Figure 5). Fossil fuels were the dominant type of exports in the Group of 30 with around 986 million tonnes in 2008 (1995: around 427 million tonnes; +131 per cent). Fossil fuels were predominantly exported by the EECCA-countries (together 903 million tonnes); this group is clearly dominated by the Russian Federation which is the largest supplier of fossil fuels (oil, gas and coal and products made by fossil energy carriers, total exports: 638 million tonnes in 2008), followed by Kazakhstan, the tenth largest supplier of fossil fuels globally (115 million tonnes in 2008). By contrast, the New EU Member States decreased their exports of fossil fuels during the investigated period by 8 per cent (from 73 million tonnes to 67 million tonnes).

Biomass exports of the Group of 30 increased most between 1995 and 2008 (by a factor of 2.6) and constituted the second highest export category in the 30 selected countries (2008: 253 million tonnes, 1995: 99 million tonnes). The group of EECCA countries had the highest biomass exports in absolute terms (around 134 million tonnes in 2008) due to, among others, Russian's exports of timber and Ukraine's exports of cereals. This group is followed by the NMS (99 million tonnes in 2008) whereof wood and timber from the Czech Republic and Poland are important parts.

The Group of 30 exported around 224 million tonnes of metals in 2008, compared to 145 million tonnes in 1995 (+56 per cent). Like exports in fossil fuels and biomass, the EECCA-countries export most metals (2008: 127 million tonnes, 1995: 102 million tonnes; +25 per cent), followed by the NMS (2008: 61 million tonnes, 1995: 33 million tonnes; +83 per cent). SEE has the highest increases in metal exports of around 248 per cent (from 10 million tonnes in 1995 to 35 million tonnes in 2008). The largest exporters of metals, in particular: iron and steel in different stages of processing, are actually the Ukraine, Russian Federation and Turkey.

Figure 5 Physical exports of the Group of 30



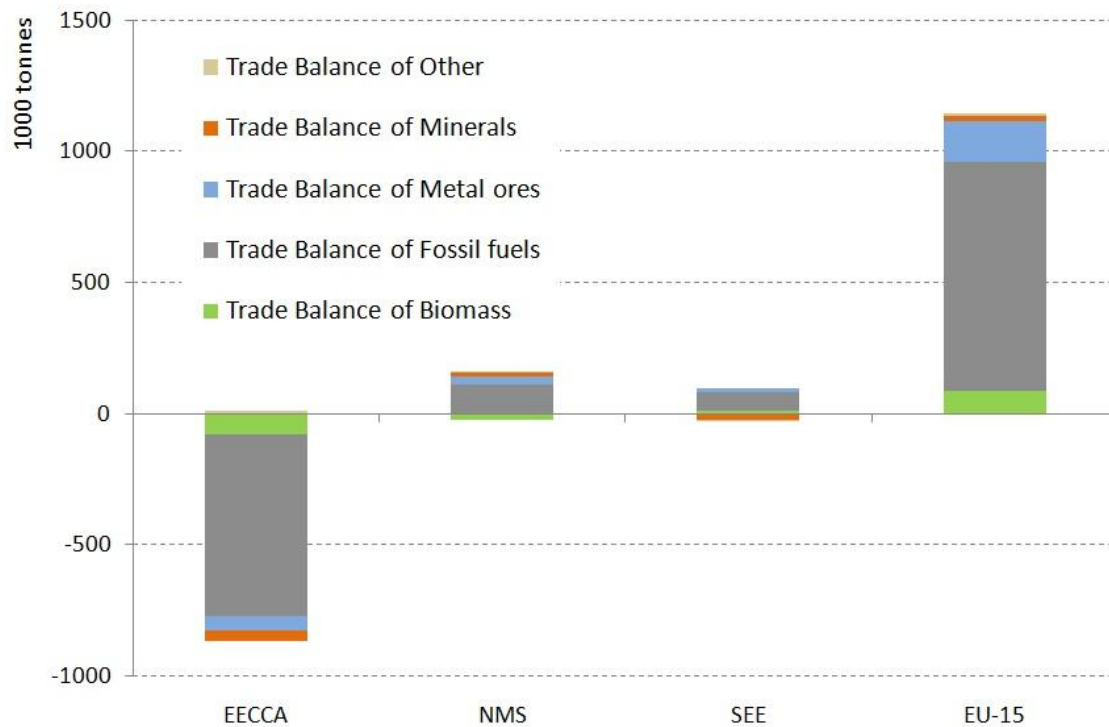
Source: Dittrich, 2011a

Minerals are of minor relevance in trade. Minerals are predominantly exported by EECCA-states (2008: 102 million tonnes; 1995: 60 million tonnes; +70 per cent) with high exports of fertilizer minerals by Russian Federation and Ukraine as well as high exports of gravel and sand by Ukraine. The South East European countries have the highest increases (of +309 per cent) in minerals export (from 12 million tonnes in 1995 to around 48 million tonnes in 2008) while the new EU-member states firstly declined their mineral exports (from 50 million tonnes in 1995, to 43 million tonnes in 2000) and increased them again up to 45 million tonnes in 2008.

In 2008, the Group of 30 was a net-exporter of around 660 million tonnes of different materials (up from 277 million tonnes in 1995). Looking at the aggregated physical trade balances of each group individually, however, only the EECCA countries are net-exporters. The new EU Member States and the South East European countries are net-importers, as is the EU-15 (see Figure 6). Physical trade balances show net-redistribution of resources and allow identifying net consumers and net suppliers of resources on the global level. Note that the physical trade balance is calculated as imports minus exports, in contrast to standard monetary trade balances. Positive values therefore mean net-imports of materials and negative values indicate net-exports. While EECCA countries together are net-exporter of all

material categories, dominated by fossil fuels, the EU-15 is a huge net-importer of all materials, also dominated by fossil fuels. The NMS as well as the South East European countries have a mixed trade structure: the NMS are net-exporters of biomass, but net-importers of fossil fuels, metals and non-metallic minerals. The South East European countries together are net-exporters of non-metallic minerals, but net-importers of fossil fuels, metals and biomass.

Figure 6 Physical trade balance of SEE, EECCA, NMS and the EU-15 (2008)

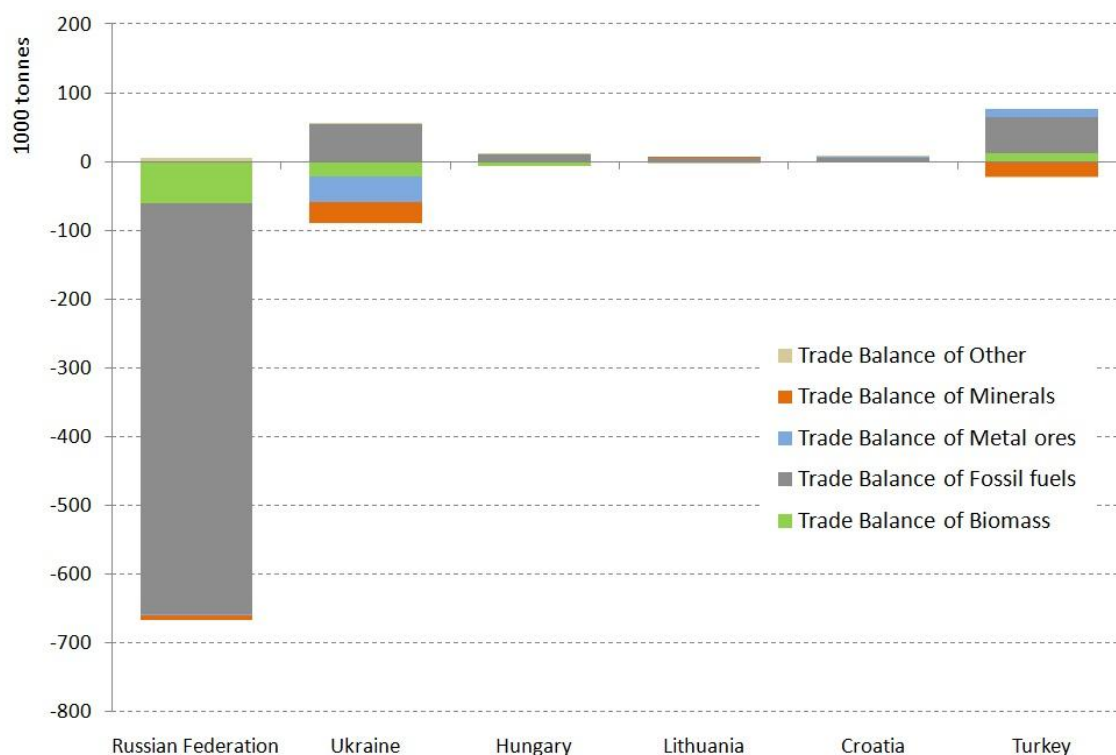


Source: Dittrich, 2011a

Exports as well as net-exports of EECCA are clearly dominated by the Russian Federation which is the largest supplier of resources in physical terms of all countries worldwide. Like Kazakhstan, Azerbaijan and Turkmenistan, fossil fuels make up the highest share of net-exports of the Russian Federation, whereas Ukraine and the other EECCA-members are net-importers of fossil fuels (see Figure 7).

Apart from the two Islands of Cyprus and Malta, all NMS are net-exporters of biomass. All NMS are net importers of fossils and almost all of them are net-importers of metals. One exception is Estonia, which was a net-exporter of metals in 2008. Estonia is an interesting case for most of the analysed years, since according to trade data Estonia is a net-exporter of metals, although it is not extracting metals at all. The same holds true for the other Baltic States in various years during the 1990s. The exported metal products of all of the three countries are mainly iron and steel waste, which could originate in dismantled infrastructure or industrial complexes or in not recorded trade, amongst other trade with cars (see e.g. Öko-Institut et al. 2011).

Figure 7 Physical trade balances of selected countries by material category (2008)



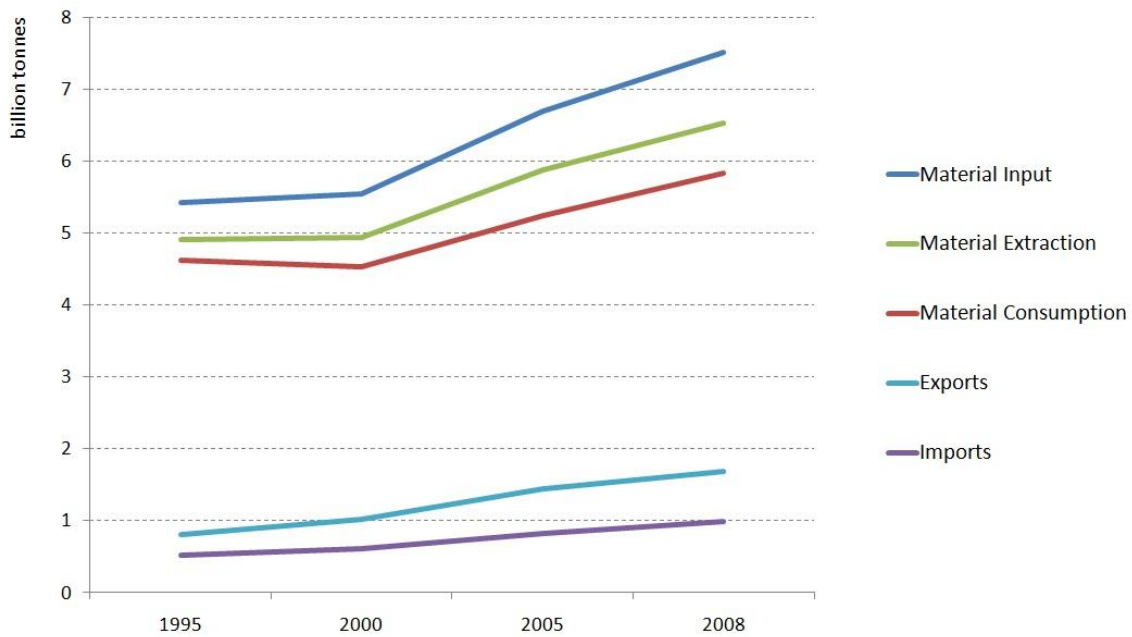
Source: Dittrich, 2011a

Material consumption

In economic terms, Domestic Material Consumption (DMC) is related to the consumption activities within a country. DMC is therefore closely related to GDP (EUROSTAT, 2001). In environmental terms, DMC is an indicator for potential environmental pressures associated with the disposal of residual materials to the domestic environment.

Figure 8 shows extractions, imports and exports at a glance as well as the material input (extraction plus imports) and material consumption (extraction plus imports minus exports) during the investigated period. While during the 1990s, extractions remained nearly constant and exports increased more than imports, absolute material consumption of the 30 countries together decreased from 4.6 billion tonnes in 1995 to 4.5 billion tonnes in 2000. Thereafter, material consumption increased, in line with above-average growth of extraction, to 5.8 billion tonnes in 2008.

Figure 8 Extraction, trade, material input and material consumption in the Group of 30 (1995-2009)



Source: own calculation based on Dittrich 2011a and SERI 2011a

Table 4 shows that the three investigated groups of countries are significantly less dependent on imports than the EU-15. Import dependency is usually measured by the share of imports in material consumption. Numbers of 100 per cent or below show to what extent material is imported for consumption, a number above 100 per cent indicates that imports are re-exported. On average, around 17 per cent of the 30 countries' material consumption was imported in 2008 (up from 11.4 per cent in 1995; see Table 4) which is nearly as much as import dependency of Asia in 2005 (Giljum et al., 2010) and higher than import dependency of emerging economies in 2005 (Dittrich et al., 2011).

In general, import dependencies of countries with large domestic resource endowments are minor or negligible while dependencies of small countries and islands are higher. Thus, EECCA and in particular the Russian Federation are nearly self sufficient; Russia's imports of biomass, minerals and fossil fuels (mainly products such as plastics and chemicals) are rather negligible. The highest dependencies can be observed in the NMS, notably with regard to metal ores and fossil fuels, a pattern that is even more pronounced for the EU-15, which has very low endowments of those two material groups within its territory. The values above 100 especially for metal ores indicate further processing in industries which are processing metals: e.g. Hungary is extracting around 841,000 tonnes of metals while it is importing 6,298 million tonnes predominantly in form of semi-processed products (e.g. parts of vehicles). Hungary is exporting 6,254 million tonnes of metals, mostly in the form of products which are mainly made of metals (such as passenger vehicles). Thus, a dependency value of 710 per cent reflects the fact that Hungary is importing, processing and exporting more than sevenfold its own consumption of metals.

Table 4 Import dependencies of three groups and EU-15 in contrast in 2008 (% share of imports in DMC)

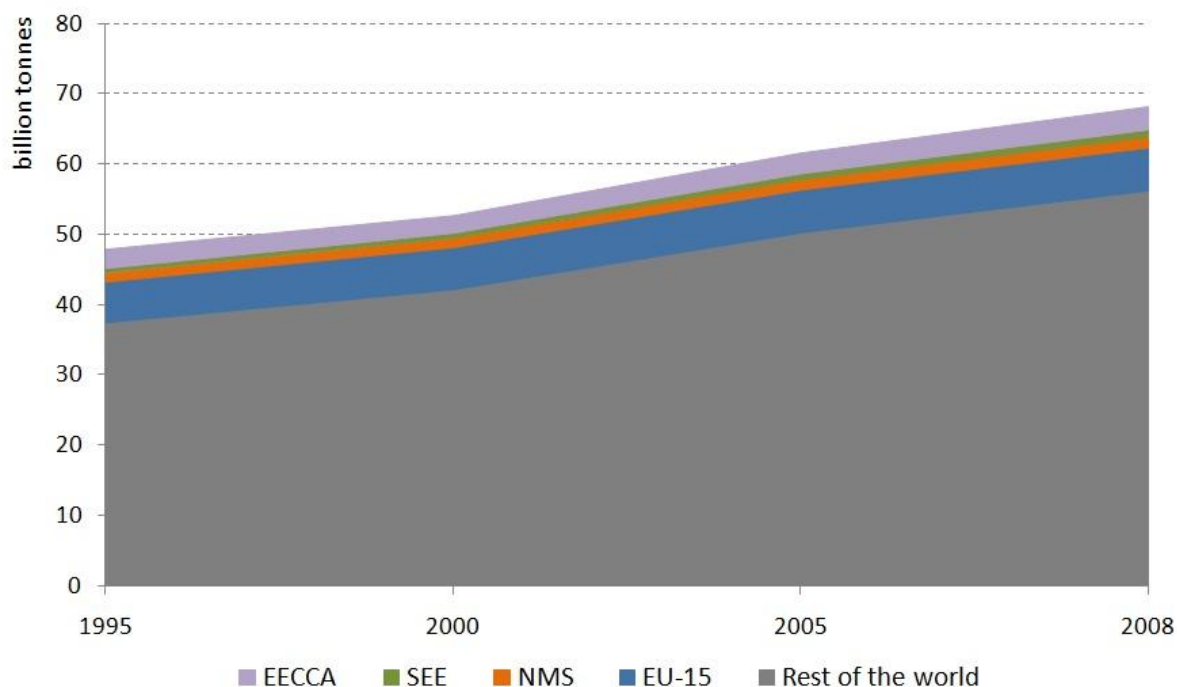
	All materials	Biomass	Minerals	Fossil fuels	Metal ores
Hungary	33.4	25.0	9.3	65.9	710.6
Lithuania	35.6	13.4	15.1	228.1	1178.0
NMS, average	27.0	25.2	8.8	41.2	65.2
Croatia	44.1	28.9	26.8	95.9	254.4
Turkey	18.3	11.3	2.4	47.4	129.2
SEE, average	19.7	12.9	4.9	39.9	96.1
Russian Federation	7.7	6.8	5.1	6.4	18.6
Ukraine	24.4	5.0	7.3	49.0	39.5
EECCA, average	11.5	6.6	6.4	17.8	15.5
Group of 30, average	17.1	11.7	6.8	27.0	32.6
EU-15, average	57.7	44.5	9.8	102.6	210.9

Source: own calculation based on Dittrich 2011a and SERI 2011a

On the global level, material consumption has grown by a factor of 1.4 between 1995 and 2008 up to around 68 billion tonnes (Figure 9). In the 30 selected countries, absolute material consumption increased by a factor of 1.26 during the 13 years which is below global average but high compared to EU-15 where absolute material consumption nearly stagnated due to a slight decrease since 2005 (+5 per cent growth between 1995 and 2008). While in 1980 around 10.6 per cent of world population lived in the 30 countries consuming 9.6 per cent of all globally consumed materials, in 2008 around 7.1 per cent of world population reside in the selected countries consuming 8.5 per cent of globally consumed materials.

In almost all countries directly affected by the collapse of Communism absolute material consumption decreased during the 1990s. Collapse of industries, (re-)organisation of the countries' economic system and partly even civil wars resulted in a decline of economic activities, which is reflected in the declining values of absolute material consumption in Table 5. The highest decreases in absolute terms are found among the EECCA countries where the amount of consumed materials shrank from 2.7 billion tonnes to 2.48 billion tonnes between 1995 and 2000 (- 8.2 per cent). The Russian Federation decreased its material consumption by around 10 per cent and Ukraine by 22 per cent while most of the other EECCA countries stagnated or increased their absolute material consumption, e.g. Kazakhstan's material consumption grew by 2.4 per cent during the second half of the 1990s. Excluding Turkey, South East European countries also decreased their material consumption from 187 to 179 million tonnes during the five years (-4.4 per cent), most notably in Albania (-31 per cent) and Serbia and Montenegro (-13 per cent).

Figure 9 Domestic Material Consumption (DMC) absolute of the three groups, EU-15 and globally (1995-2008)



Source: own calculation based on Dittrich 2011a and SERI 2011a

Most NMS already increased their absolute material consumption after 1995, but some decreases of absolute material consumption can still be observed between 1995 and 2000, in particular in Hungary and Romania (-2.6 and -25 per cent respectively). In Hungary, the consumption of all material categories declined between 1995 and 2005, most notably of construction minerals (-36 per cent), which still made up 54 per cent of total extraction in Hungary in 2008. The marked decline in Hungary's material consumption between 2005 and 2008 can largely be explained by the decline in extraction of construction minerals. It is important to note that Poland, the Czech Republic, Slovakia, Slovenia and the Baltic states also show significant decreases of absolute material consumption during the years before 1995 as far as reliable data for that time. Poland, for example, decreased its absolute amount of used materials from around 522 to 437 million tonnes between 1990 and 1995 (-16 per cent), the Czech Republic from around 185 to 162 million tonnes between 1993 and 1995 (-5 per cent) and Lithuania from 35 to 22 million tonnes between 1992 and 1995 (-36 per cent).

Table 5 Absolute amounts of domestic material consumption (1995 – 2008), million tonnes

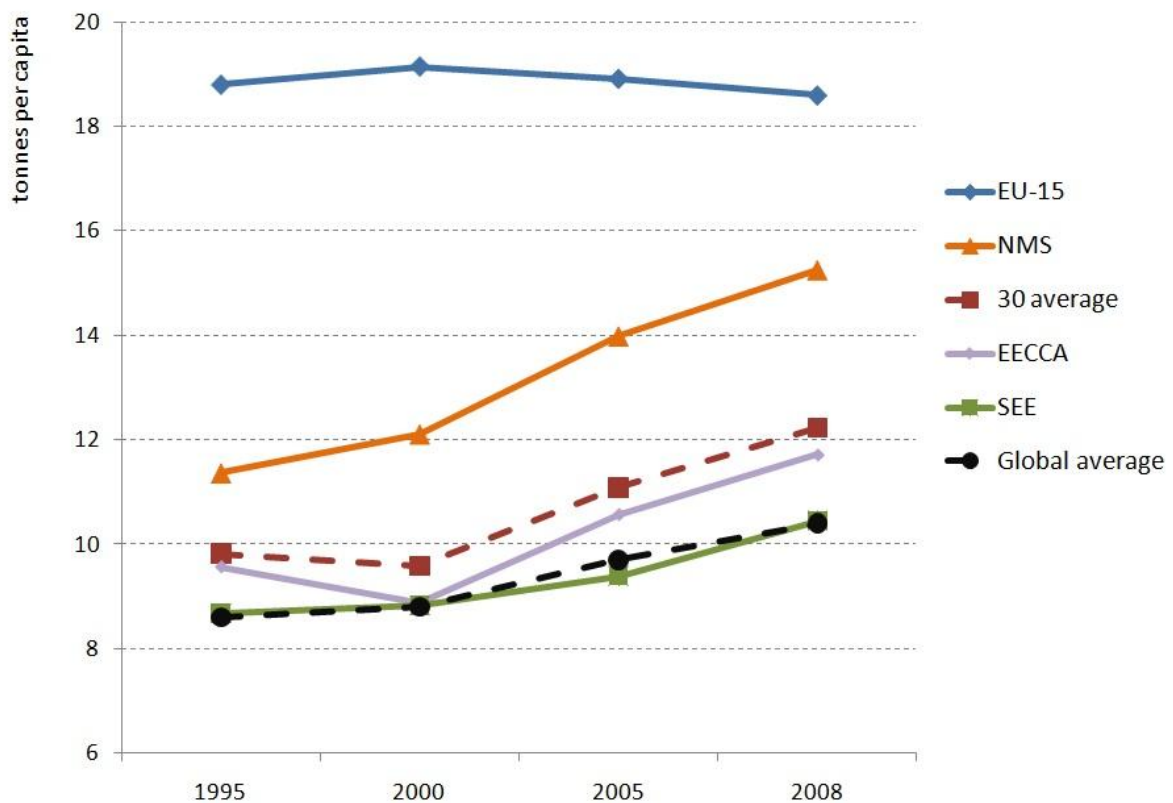
	1995	2000	2005	2008
Hungary	93	91	146	104
Lithuania	41	45	64	73
NMS, total	1208	1274	1448	1577
Croatia	28	27	49	51
Turkey	530	596	654	749
SEE, total	717	775	869	996
Russian Federation	1702	1533	1742	1976
Ukraine	389	304	383	405
EECCA, total	2702	2480	2932	3255
Group of 30, total	4627	4529	5249	5827
EU-15, total	5876	6059	6151	6144

Sources: own calculation based on Dittrich 2011a, SERI 2011a

Material consumption in the selected countries provides a different picture when the focus is on per capita numbers. The average per capita consumption of the 30 countries has increased from 9.8 tonnes per capita in 1995 to 12.2 tonnes in 2008 (+25 per cent). Thus, average per capita consumption is above global average of 10.4 tonnes but clearly below EU-15 average of 18.6 tonnes per capita in 2008 (see Figure 10).

Analysing the three groups it can be observed that material consumption of the new EU members grew most strongly, from 11.4 tonnes per capita in 1995 to 15.3 tonnes in 2008 (+34.3 per cent) which is only slightly below the EU-15 average (it is important to note that EU-15 slightly decreased their per capita material consumption from 18.8 to 18.6 tonnes during the period). The new EU members are thus clearly on a path of catching up with the EU-15 patterns of material consumption. Eastern European countries increased their per capita material consumption by 20.5 per cent up to 10.4 tonnes in 2008. In contrast, EECCA average material consumption per capita remained below global average during the whole investigated period and reached 10.4 tonnes in 2008. Due to the fact that population size decreased in the group of the EECCA countries, the increase of average material consumption per capita is partly due to population decrease. Those trends are in contrast to the developments in other developing and emerging world regions, such as in Asia or Africa, where absolute amounts of material consumption are increasing, but per capita numbers show a downward trend due to high population growth.

Figure 10 Domestic Material Consumption (DMC) per capita, three groups and global and EU-15 averages (1995-2008)



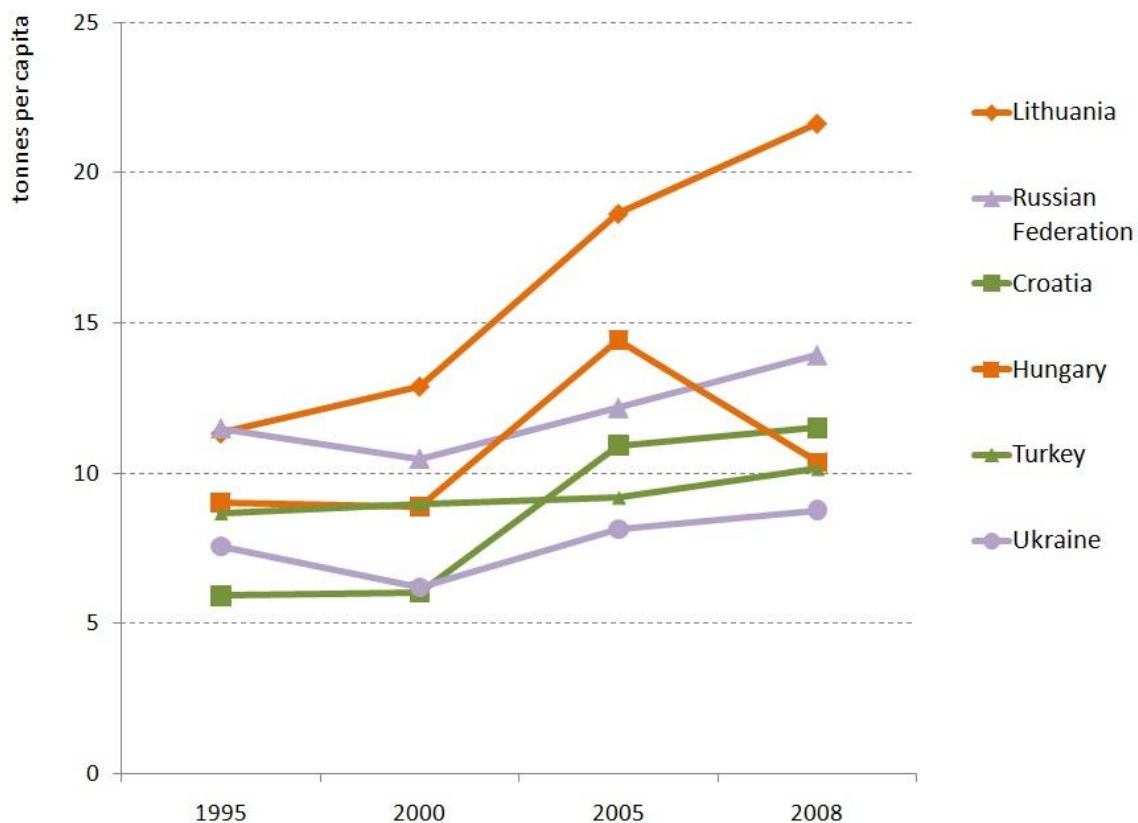
Sources: own calculation based on Dittrich 2011a, SERI 2011a

Average material consumption did not decrease in any of the 30 countries between 1995 and 2008. The highest growth rates of per capita consumption (90- 95 per cent) can be found in Croatia, Cyprus, Lithuania, Latvia and Armenia (Armenia started from a very low level; see also Annex 1). In 2008, the highest material consumption per capita could be found in Slovenia (27.0 tonnes), Cyprus (26.6 tonnes), Estonia (25.0 tonnes), Kazakhstan (22.7 tonnes) and Lithuania (21.6 tonnes). The lowest material consumption could be found among the poor Central Asian countries Tajikistan, Azerbaijan and Georgia with values below 3.5 tonnes per capita in 2008.

In general, the highest growth of per capita material consumption can be found between 2000 and 2005 compared to slower growth rates after 2005 in nearly all of the 30 countries. While most of the new EU-members increased per capita consumption constantly after 1995, nearly all of the South East European countries directly affected by the collapse of Communism as

well as the EECCA countries decreased their per capita material consumption, as absolute material consumption levels decreased even faster than population. For example, in the Russian Federation the reduction in material consumption clearly outweighs the fall in population size (-9.9 per cent versus -3.0 per cent) between 1995 and 2000; thereafter, population size kept on shrinking while absolute material consumption grew resulting in an average per capita consumption of 13.9 tonnes in 2008 (see Figure 11). After 2005, in most of the countries per capita material consumption kept on growing but slower than before. The decrease in Hungary is clearly exceptional and mainly a result of outstanding high extraction of industrial minerals in 2005.

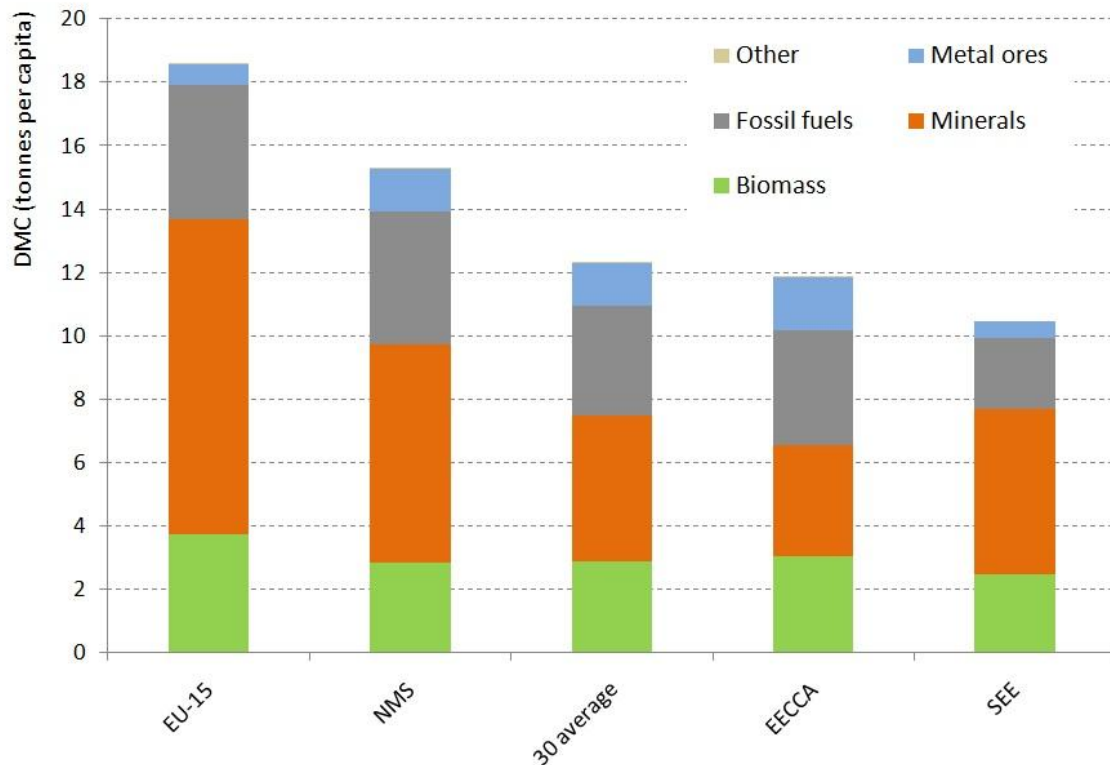
Figure 11 Domestic Material Consumption (DMC) per capita, selected countries (1995-2008)



Sources: own calculation based on Dittrich 2011a, SERI 2011a

With regard to the composition of material consumption some pattern already observed in Asian and emerging economies can be confirmed also in this study: richer countries consume higher amounts of minerals and fossil fuels resulting in low shares of biomass in DMC, while poorer countries have higher shares of biomass in material consumption (see Figures 12 and 13). The EU-15 as well as the NMS have a significantly higher per capita consumption of non-metallic minerals of 9.9 tonnes (EU-15) and 6.9 tonnes (NMS), respectively, compared to 5.2 and 3.5 tonnes in SEE and EECCA, respectively. These minerals are predominantly construction minerals, reflecting higher construction activities both for building new and for maintaining existing infrastructure in all EU countries.

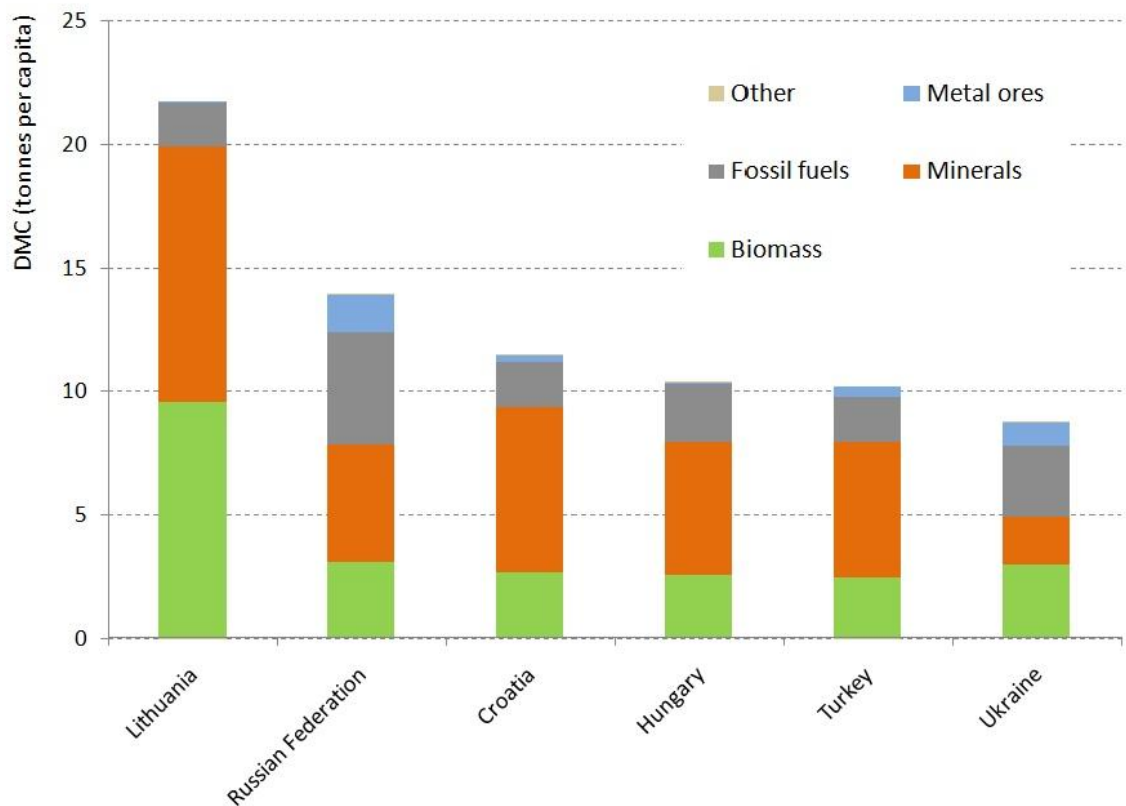
Figure 12 Material consumption (DMC) per capita of the groups according to material categories (2008)



Sources: own calculation based on Dittrich 2011a, SERI 2011a

Generally, richer countries have also a higher share of metal consumption than poorer countries reflecting demand for infrastructure, higher industrial activities (production and maintaining stock of machines) and consumption (machines and electronics in private households). However, average per capita metal consumption in EECCA countries is higher than in South East Europe and the new EU countries (1.7 tonnes in EECCA countries compared to e.g. 1.4 tonnes in new EU members), which is mainly due to high values in Russia and Kazakhstan. These high values reflect rather a deficiency of the methodology than a higher consumption of habitants of countries with high net-exports of metals: metal extraction is counted as gross metal ore with concentrations usually below 10 per cent. The remaining 90 per cent of extracted materials, which remain as excavated materials (often times even toxic) in the extracting country, are counted as domestic metal extraction. The picture would change if indirect or upstream-flows are considered.

Figure 13 Domestic Material Consumption (DMC) per capita of selected countries according to material categories (2008)



Sources: own calculation based on Dittrich 2011a, SERI 2011a

The remaining materials would be counted as so-called “upstream material flows” of exported iron or other metal, allocated and added to the consumption of the importing country and thus subtracted from domestic material consumption in the metal exporting country. These assessments are still rare and until now not available for the Russian Federation and Kazakhstan; the case of copper-exporting Chile has shown that including all indirect or upstream flows results in a reduction of material consumption of up to 50 per cent (Dittrich et al., 2011; Estrada Calvo, 2007; Giljum, 2004; Munoz et al., 2009). In the Russian Federation and Kazakhstan, metal consumption holds a share of 11 per cent and 39 per cent, respectively, of DMC; it can be assumed that a notable part of this is excavation rather than personal consumption in both countries.

In sum, the collapse of Communism and the changes of economic systems, which have gone along with a backlash of economic activities in almost all affected countries, resulted in a remarkable decrease of absolute and per capita material consumption during the 1990s. While the economies of the new EU-members recovered faster and earlier the process took longer and the decreases were even stronger in most of the other South East European and EECCA countries.

Material productivity

Combining data on GDP and Domestic Material Consumption (DMC) allows deriving a material productivity indicator (GDP/DMC), which illustrates how much economic value is being generated per unit of material consumption.

Box 2 De-coupling and its economic drivers

According to the latest report by the UNEP International Resource Panel (UNEP, 2011), de-coupling can be defined in two ways. First, de-coupling means using fewer quantities of resources per unit of economic output, i.e. less material, energy, water and land to produce one Dollar of Euro of GDP. Second, de-coupling refers to reducing the environmental impact of any resources that are used or economic activities that are undertaken. Examples for those environmental impacts are emissions (e.g. of greenhouse gases), waste production or land and ecosystem degradation.

It is important to distinguish between so-called “relative de-coupling” and “absolute de-coupling”. Relative de-coupling of resources or impacts means that the environmental indicator (e.g. material consumption) is growing slower than the economic indicator (e.g. GDP). This implies that in a situation of relative de-coupling, environmental pressures can still increase. Relative de-coupling has been a quite common phenomenon with regard to several environmental indicators (including air emissions, energy use and material consumption) and will also be described in this study. Absolute de-coupling, however, means that the environmental pressure decreases irrespective of the development of GDP. Absolute de-coupling can thus only be achieved, when resource productivity increases faster than GDP. Trends of absolute de-coupling are rare in reality, however, on the global level, absolute de-coupling clearly must be the objective, given that humanity already today is using more resources than the global ecosystems can provide in a sustainable manner (WWF et al., 2010).

De-coupling trends are determined by several economic driving factors:

- GDP growth rates: higher GDP leads to higher resource productivity numbers, thus resource productivity trends are closely linked to the affluence or income of a country (Steinberger and Krausmann, 2011).
- Sectoral economic structures: primary resource extraction activities (such as agriculture and mining) as well as basic industries (such as metal or chemical industries) are typically more resource-intensive than higher manufacturing industries (e.g. ICT) or activities in the service sectors (e.g. communication, banking, insurance). At the same time, service sectors typically produce higher value added than the basic industrial sectors. The economic structures thus determine to a large extent the resource productivity and de-coupling trends of a country.
- Energy systems: energy production is one of the most resource-intensive economic activities and the structure of the energy sector often influences the national environmental performance. Countries heavily dependent on coal for electricity production typically have lower resource productivities and lower de-coupling trends compared to countries producing larger shares with natural gas, water power or renewable energy forms.
- Integration into the global economy: outsourcing material and energy-intensive production to other world regions and substituting domestic production by imports can also lead to an apparent improvement in resource productivities and accelerating de-coupling of a country. Those developments have been particularly discussed in the context of the Kyoto protocol on GHG emissions (for example, Peters and Hertwich, 2008).

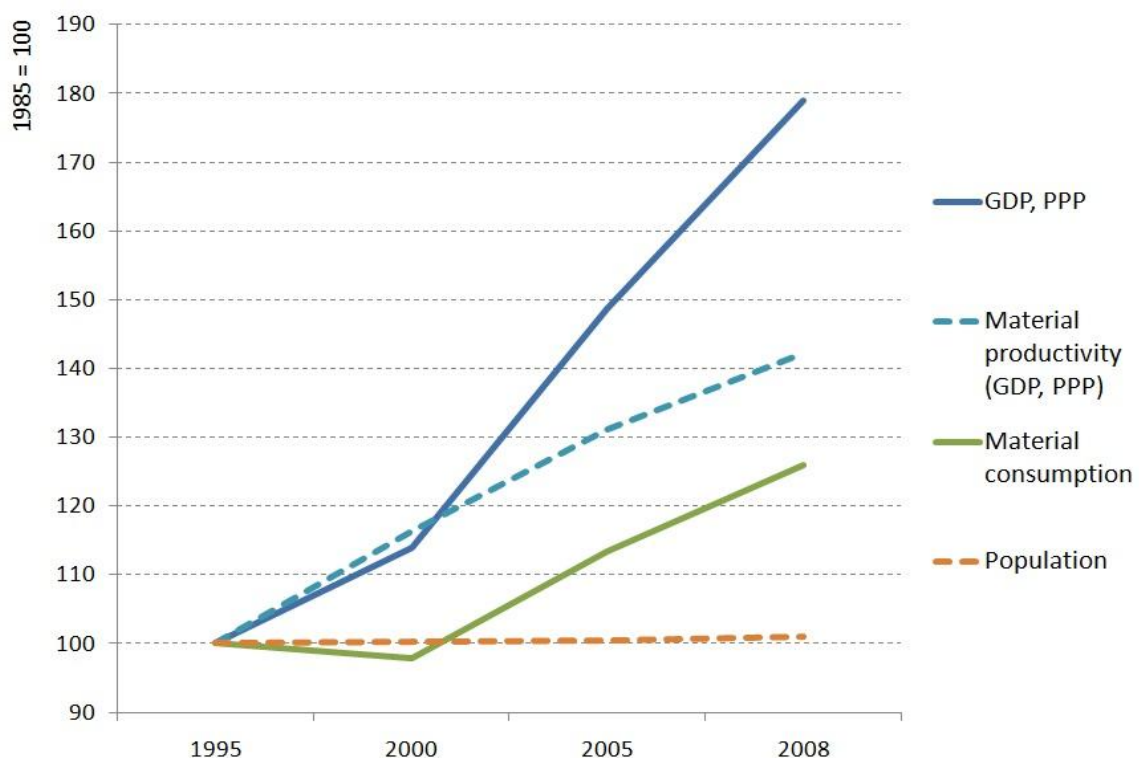
General recommendations for accelerating de-coupling trends (see e.g. UNEP, 2011):

- Support the development and transfer of resource-efficient technologies, in particular in the areas of mobility, housing and food

- Foster eco-innovation not only on the product and process levels, but also on the systemic level (e.g. switching urban transport systems from private cars to public transport)
- Integrate resource efficiency aspects in policy impact assessments
- Elaborate circular economy strategies, following the example e.g. of Japan
- Support the development of new resource-light, but high-quality lifestyles

Figure 14 illustrates the overall trends in GDP, material productivity, material consumption and population across the Group of 30. Accelerated economic development after the year 2000 in the region is clearly reflected in the graph. Between 1995 and 2000, GDP (based on purchasing power parity, PPP) rose significantly slower than after 2000 (an average of 2.6 per cent per annum between 1995 and 2000 compared to 4.8 per cent per annum between 2000 and 2008). During the same period, material consumption decreased, followed by a strong increase between 2000 and 2008 (126 per cent). As growth in GDP was continuously higher than growth in material consumption, material productivity rose constantly, altogether by 42 per cent between 1995 and 2008. Population in the Group of 30 stayed almost constant.

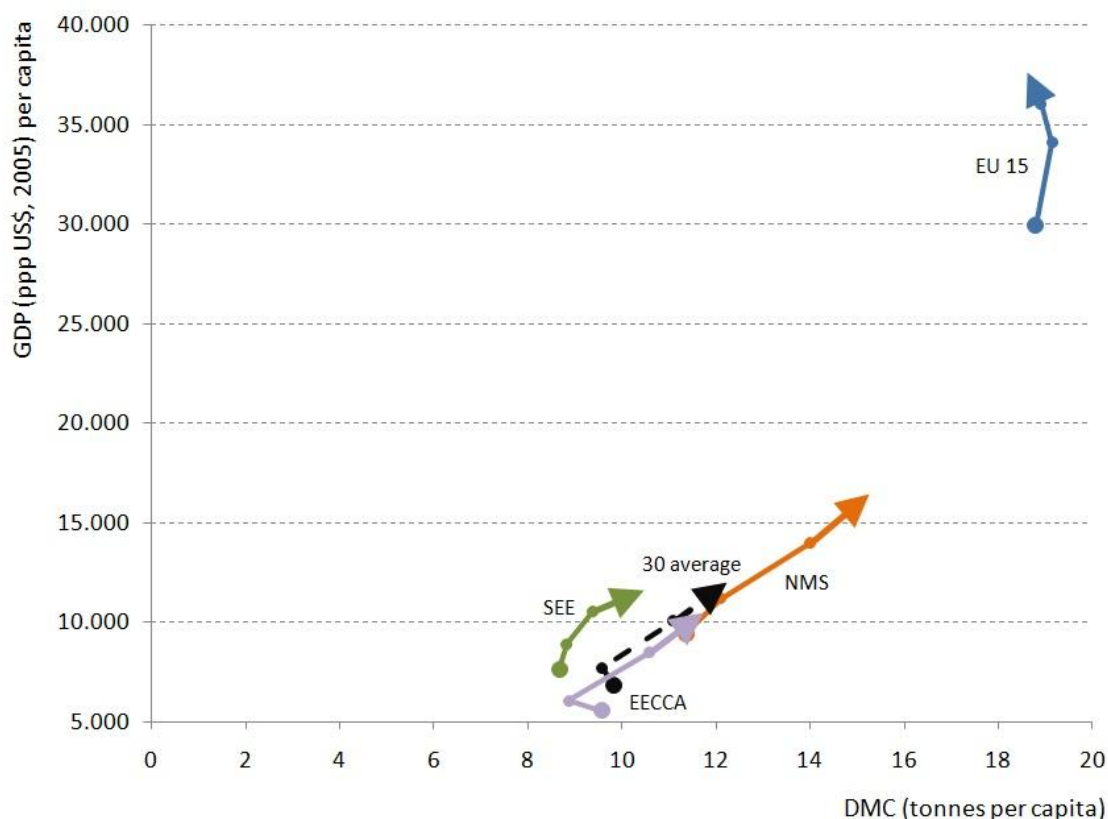
Figure 14 GDP (PPP constant 2005 US\$), population, material consumption and material productivity in 30 countries and region (1995-2008)



Sources: own calculation based on Dittrich 2011a, SERI 2011a, UN Data 2011, Worldbank 2011

Figure 15 shows this link for the averages of the three groups, the Group of 30 and the EU-15. The relationship between per capita GDP and DMC is homogenous for the Group of 30 and the three country groups. Growth and a positive relationship between GDP and DMC can be seen across the NMS, EECCA and the SEE, but with very different stages in absolute numbers. For the SEE countries an absolute decoupling effect between per capita GDP and per capita material consumption can be observed (as the former has grown whereas the latter has declined) between 1995 and 2000. For the EU-15 a small but absolute decoupling effect is observable, but at a very high level of material consumption. It is important to note, however, that a major part of this absolute de-coupling effect is due to the closing down of domestic industries and the substitution of domestic production of highly material- and energy intensive products by imports from abroad (EEA, 2010). As the three investigated groups still have large domestic heavy industry sectors, the direction of development is characterised by a closer link of GDP and DMC.

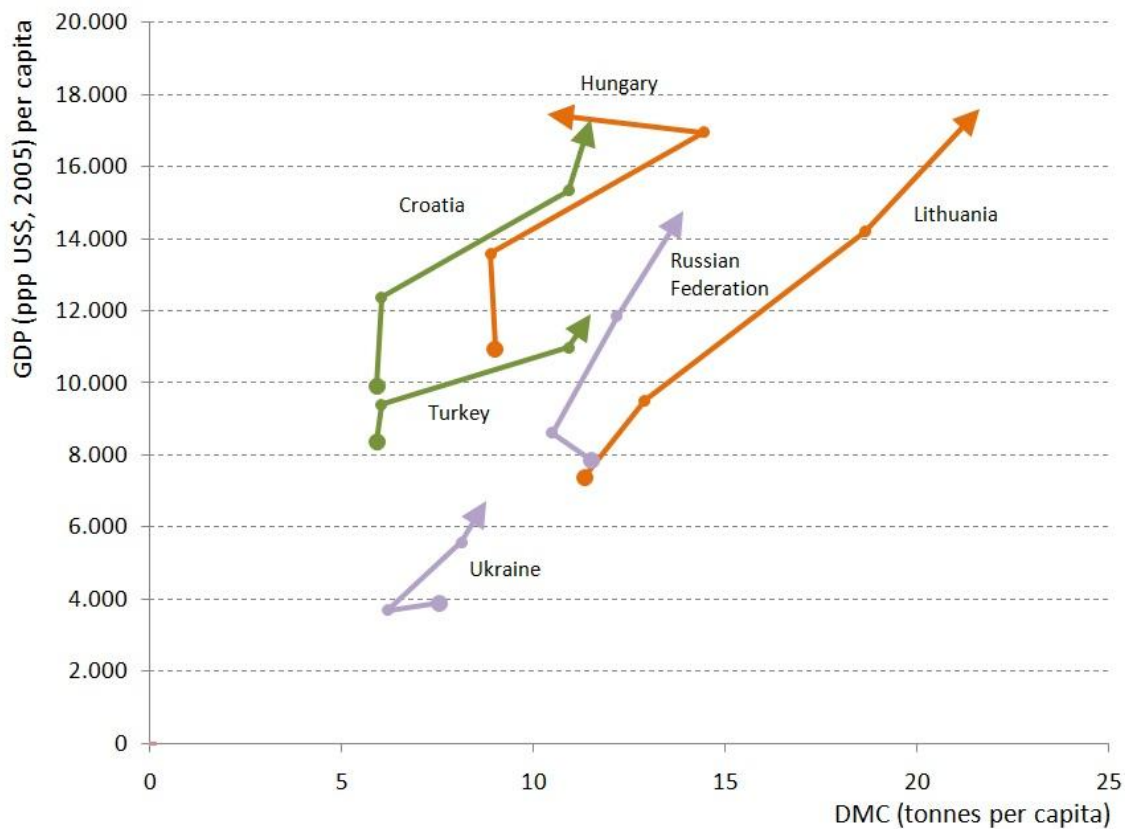
Figure 15 Per capita GDP (PPP constant 2005 US\$ Dollar) and DMC in the Group of 30, EECCA, SEE, NMS and EU-15 (1995-2008)



Sources: own calculation based on SERI 2011a, UN Data 2011, Worldbank 2011

For a further investigation Figure 16 illustrates the relationship of per capita GDP and DMC for six countries, two out of each group. The Russian Federation and Ukraine show the same relationship between GDP and DMC, with very low values for both indicators for the Ukraine and about twice the GDP values for the Russian Federation. The collapse of the USSR and the resulting economic changes can be observed in both countries between 1995 and 2000, when their material consumption levels declined. Following a very strong decline in output during the early 1990s, the Russian Federation began to experience an upswing in per capita GDP in the second half of the 1990s, which led to an overall small increase between 1995 and 2000. Lithuania and Hungary show diverging relations of per capita GDP and DMC. Interestingly, we find an absolute decoupling of GDP and DMC in Hungary between 2005 and 2008 (DMC per capita declined and GDP increased), which can be explained by the closing down of construction mineral extraction sites in Hungary between 2005 and 2008. Lithuania's per capita GDP and DMC continuously showed strong levels of growth. Hungary had about the same GDP per capita but significantly smaller DMC values, especially in 2008. Turkey achieved a relative decoupling between per capita GDP and DMC between 1995 and 2008 (higher growth in GDP than in DMC). Croatia combines high GDP values with low DMC values compared to the other five countries illustrated.

Figure 16 Per capita GDP and DMC in selected countries in the EECCA (Lithuania, Ukraine, Russian Federation), SEE (Croatia, Turkey), and NMS (Hungary, Lithuania) (1995-2008)



Sources: own calculation based on SERI 2011a, UN Data 2011, Worldbank 2011

Most countries in the Group of 30 experienced a relative decoupling between per capita GDP and per capita material consumption (as the former has grown faster than the latter). Many countries show this development for the entire period of time, for example Armenia, Estonia, Kazakhstan, Latvia and Turkmenistan. This trend is in line with the recent developments in industrialised regions (for an overview, see Bringezu and Bleischwitz, 2009). For some countries even an absolute decoupling is observable, as GDP per capita increased and DMC per capita decreased. Azerbaijan shows a remarkable absolute decoupling between 2005 and 2008 but also between 1995 and 2008. Other examples for absolute decoupling are Slovakia and Tajikistan between 2005 and 2008. Falling GDP in combination with falling material consumption is only observable for the first period between 1995 and 2008 in Moldova, Romania, Tajikistan and Ukraine. Table 6 provides an overview of DMC and GDP growth between 1995 and 2008.

On average, material productivity in the Group of 30 improved from 692 to 984 US\$/tonne between 1995 and 2008. Material productivity for the Group of 30 thus increased faster (albeit from a much lower level) than the EU-15 average, which improved from 1593 to 2027 US\$/tonne over the same period. Generally, industry- and service-oriented countries, such as those in the EU-15, have higher material productivities than resource-based countries. The average of EECCA shows a remarkable increase of 77 per cent in this period of time. A significant increase of material productivity can be observed in South East Europe between 1995 and 2005, followed by a slight decline between 2005 and 2008.

Although the three group averages show a similar picture at slightly different levels, material productivity conceals important variations at a country perspective (Figures 17 and 18).

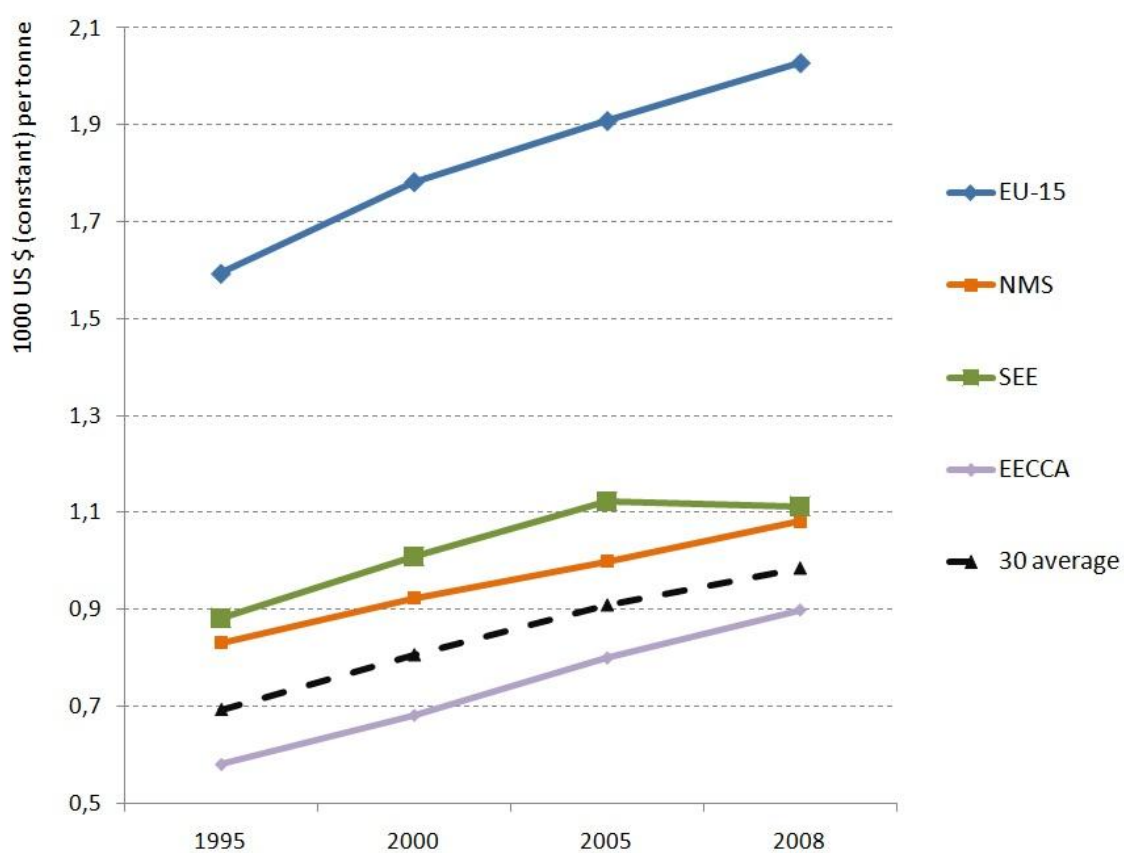
Table 6 Growth rates of per capita DMC and per capita GDP (PPP 2005)

	1995-2000		2000-2005		2005-2008		1995-2008	
	DMC growth (%)	GDP growth (%)	DMC growth (%)	GDP growth (%)	DMC growth (%)	GDP growth (%)	DMC growth (%)	GDP growth (%)
Albania	-29.48	33.26	87.94	28.23	31.30	18.51	74.02	102.50
Armenia	30.83	34.54	17.97	78.62	26.47	37.11	95.20	229.50
Azerbaijan	9.46	34.32	89.93	80.57	-60.01	80.17	-16.87	336.97
Belarus	2.61	38.37	4.79	44.82	41.61	36.42	52.26	173.36
Bosnia and Herzegovina	72.14	206.21	5.57	24.42	24.37	19.87	126.01	356.68
Bulgaria	5.69	5.41	7.78	35.96	23.22	22.27	40.36	75.23
Croatia	1.97	24.64	81.19	23.94	5.33	12.84	94.61	74.31

	1995-2000		2000-2005		2005-2008		1995-2008	
	DMC growth (%)	GDP growth (%)	DMC growth (%)	GDP growth (%)	DMC growth (%)	GDP growth (%)	DMC growth (%)	GDP growth (%)
Cyprus	23.51	12.14	33.78	10.27	15.93	9.20	91.56	35.04
Czech Republic	4.23	8.25	6.70	20.59	6.06	14.05	17.95	48.88
Estonia	11.81	40.69	37.91	50.41	3.00	12.68	58.82	138.43
Georgia	20.52	42.23	83.16	44.30	23.38	25.08	172.36	156.71
Hungary	-1.51	24.11	62.60	24.82	-28.23	2.87	14.94	59.38
Kazakhstan	8.84	20.15	23.30	60.92	5.16	20.34	41.12	132.67
Kyrgyzstan	4.76	22.68	11.67	15.05	16.34	18.22	36.11	66.87
Latvia	32.48	39.69	38.56	52.83	5.06	19.99	92.86	156.16
Lithuania	13.79	28.97	44.64	49.16	16.10	23.96	91.09	138.47
Macedonia, FYR	-12.94	13.12	3.34	5.75	38.62	14.78	24.71	37.30
Malta	28.47	22.42	7.42	2.10	0.67	7.97	38.92	34.96
Moldova	-19.65	-10.31	63.67	42.52	7.15	17.20	40.92	49.81
Poland	21.72	30.60	4.59	17.28	10.51	19.37	40.69	82.84
Romania	-24.64	-5.21	24.14	36.90	26.03	25.86	17.90	63.33
Russian Federation	-8.80	9.70	16.11	37.62	14.40	24.59	21.14	88.10
Serbia and Montenegro	-10.96	24.71	4.91	29.12	7.60	20.83	0.50	94.56
Slovakia	5.33	20.31	23.83	27.09	-1.79	26.92	28.10	94.07
Slovenia	8.66	23.83	0.01	19.14	23.99	15.74	34.74	70.77
Tajikistan	-17.79	-6.27	28.46	52.92	-5.31	17.66	0.00	68.65
Turkey	3.55	12.30	2.44	16.67	10.38	8.44	17.08	42.08
Turkmenistan	8.05	13.44	21.87	101.02	8.76	32.15	43.21	201.35
Ukraine	-18.15	-5.19	31.36	51.05	7.79	20.37	15.89	72.39
Uzbekistan	0.31	11.67	12.45	22.58	4.45	22.69	17.83	67.95
Global Average	2.33	11.79	10.23	11.85	7.22	9.42	20.93	36.81

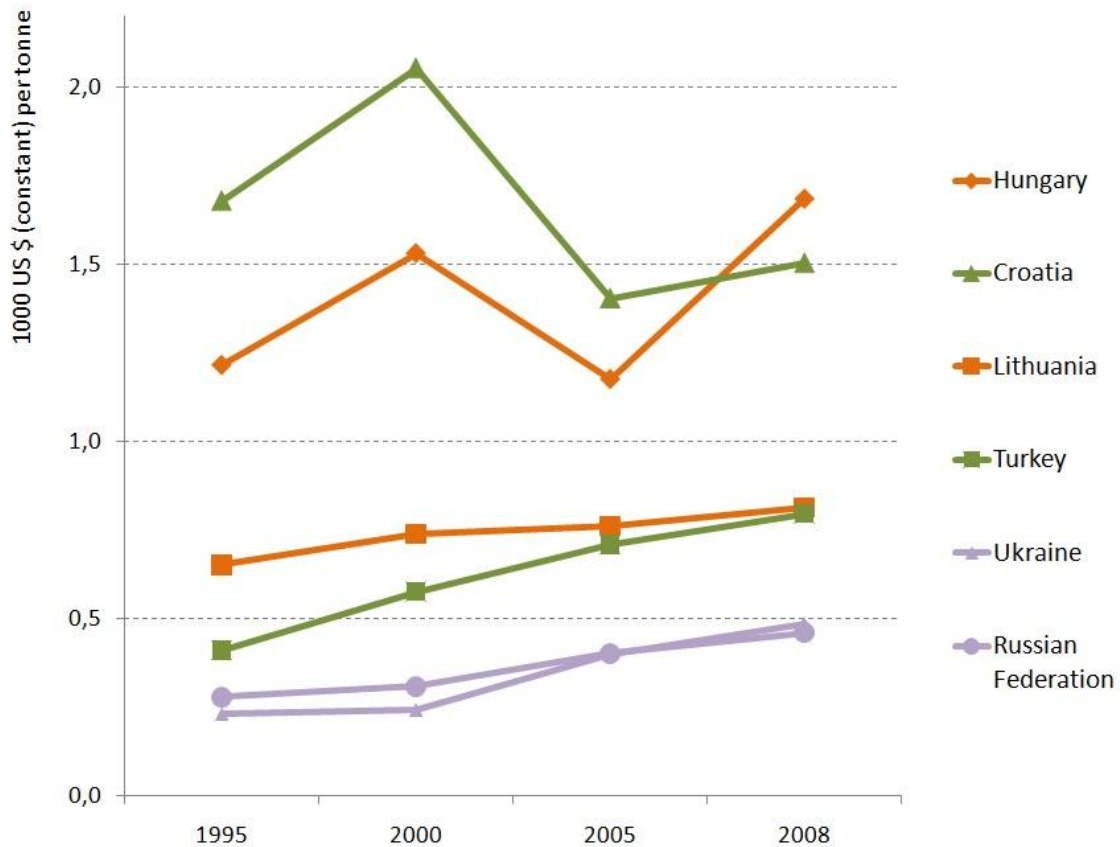
Sources: own calculation based on SERI 2011a, UN Data 2011, Worldbank 2011

Figure 17 Material productivity per capita in the Group of 30, EECCA, SEE, NMS and EU-15 (1995-2008)



Sources: own calculation based on SERI 2011a, UN Data 2011, Worldbank 2011

Figure 18 Material productivity by country and region (1995-2008)



Sources: own calculation based on SERI 2011a, UN Data 2011, Worldbank 2011

Countries with low levels show remarkable increases in material productivity, such as the Russian Federation, Ukraine and Turkey. Ukraine more than doubled its productivity starting with 230 \$/tonne in 1995 and reaching 490 \$/tonne in 2008. But also material productivity of the Russian Federation increased by 64 per cent from 280 to 460 \$/tonne in this period. Turkey almost doubled its material productivity, reaching 800 \$/tonne in 2008. Croatia and Hungary started at significantly higher levels of material productivity and show a strong increase between 1995 and 2000. Between 2000 and 2005 Croatia's material productivity declined by 32 per cent, the one for Hungary by 25 per cent. In the following three years Hungary could increase its productivity by 43 per cent up to a value of 1680 \$/tonne whereas Croatia could only stabilise its value at 1500 \$/tonne.

4. Main findings and outlook

Coming back to the questions posed in the introduction, the main findings are summarised below.

- **How has material extraction and consumption developed between 1995 and 2008?**

Between 1995 and 2008, material extraction grew significantly in all three groups under investigation with a major increase in extraction of construction minerals. The collapse of Communism, the development of market-based economies and the following economic decline that affected almost all countries, resulted in a remarkable decrease of absolute and per capita material consumption during the early and late 1990s. Absolute material consumption of the 30 countries together decreased slightly between 1995 and 2000 (from 4.6 to 4.5 billion tonnes), but thereafter increased significantly to 5.8 billion tonnes in 2008. While the economies of the new EU-members recovered faster and earlier, the process took longer and the decreases had been even stronger in most of the South East European and EECCA countries. The average per capita consumption of the 30 countries increased by 25 per cent between 1995 and 2008, from 9.8 to 12.2 tonnes. This is above the global average of 10.4 tonnes but still below EU-15 average of 18.6 tonnes per capita in 2008. Domestic Material Consumption (DMC) of the 30 states investigated in the study reflects a strong focus on extraction, which increased much stronger than imports and exports. This suggests that these countries have become more self-sufficient. An open question remains as to how much added value is thus generated, for example in Hungary (where a lot of processing takes place).

- **How much and what types of materials do different economies extract and consume, in absolute and per capita numbers?**

Apart from fossil fuels, minerals not only constitute the second largest category of extraction in the Group of 30, their extraction also experienced a very remarkable growth, especially for construction. In per capita terms, the new EU member states are clearly on a path of catching up with the EU-15 countries, while the other investigated groups show lower levels of material consumption. As in particular the EECCA region has significant exports of materials with significant up-stream material flows (in particular, metal ores), those numbers for per capita consumption would even be lower, if those up-stream materials were not allocated to the extracting country, but to the consuming country.

- **How has the physical trade volume in Central and Eastern Europe (CEE) and the Newly Independent States (NIS) developed between 1995 and 2008?**

The Group of 30 doubled its material trade volume between 1995 and 2008. Export growth was stronger than import growth. The export structure of the three groups differs significantly. Fossil fuels were the dominant type of exports in the Group of 30. Biomass

exports of the Group of 30 increased most between 1995 and 2008 (by a factor of 2.6).

- **To what extent do CEE and NIS depend on imports of different types of materials to maintain national production and consumption, and what types of materials do CEE and NIS supply to the world markets?**

In physical terms, only the EECCA countries are net-exporters of materials, especially of fossil fuels). The New EU Member States and South-East European countries are net importers. The three country groups (EECCA, NMS, SEE) are significantly less dependent on imports than the EU-15. EECCA and in particular Russia are nearly self-sufficient.

The situation in terms of resource dependencies in those three groups is therefore different from the EU-15, which is very vulnerable in particular in the areas of fossil fuels and metal ore imports. While for the EU-15, ensuring stable access to resources outside the EU territory is a major policy issue, the main issue in the investigated groups of countries is how the existing industries can be maintained and transformed into higher resource-efficient industries.

- **How has the material productivity developed between 1995 and 2008?**

GDP increased stronger than material consumption for the whole period under consideration in the 30 countries. Thus, material productivity rose constantly, altogether by 42 per cent between 1995 and 2008.

In general, the New EU Member States are the group that recovered fastest from the collapse of Communism. Due to their geographical position and political as well as economic orientation towards the West, they attracted more FDI and established stronger trade links. After relatively short declines in the 1990s they managed to recover comparatively quickly. In terms of resource use it is clear that they are generally more industry-oriented than the other groups in this study.

Compared to the other country groups, Eastern Europe, Caucasus and Central Asia have taken longer to recover since the early 1990s. Most of the countries in this region are still grappling at various degrees of intensity with the transition from centrally planned to market economies. This is reflected in their patterns of material use and material productivity, which are very different from the NMS. They are mostly resource-based economies, many of which have largely de-industrialised.

The counties of South East Europe (with the exception of Turkey) took longest to recover, largely due to conflicts and instabilities in the region and a lack of FDI. Their development in terms of material consumption and material efficiency is still much more stagnant than those of the other two regions, and it remains to be seen how they will progress in the future.

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Annex 1 DMC, DMC per Capita and Material productivity (GDP/DMC) (tonnes)

	1995			2000			2005			2008		
	DMC	DMC per Capita	Material productivity (GDP/DMC)	DMC	DMC per Capita	Material productivity (GDP/DMC)	DMC	DMC per Capita	Material productivity (GDP/DMC)	DMC	DMC per Capita	Material productivity (GDP/DMC)
Bulgaria	103,632,512	12.34	0.55	105,096,613	13.04	0.55	108,771,331	14.05	0.70	132,009,736	17.32	0.69
Cyprus	10,168,860	13.90	1.29	13,506,001	17.17	1.17	19,203,468	22.97	0.96	22,966,969	26.63	0.91
Czech Republic	162,373,176	15.72	0.99	168,303,476	16.38	1.03	178,917,665	17.48	1.16	193,246,294	18.54	1.25
Estonia	22,626,577	15.75	0.50	24,110,620	17.61	0.62	32,681,687	24.28	0.68	33,526,637	25.01	0.75
Hungary	93,051,279	9.01	1.21	90,603,269	8.87	1.53	145,535,126	14.43	1.18	103,938,333	10.35	1.68
Latvia	14,464,771	5.75	1.06	18,073,783	7.62	1.12	24,287,671	10.56	1.24	25,135,298	11.09	1.41
Lithuania	41,139,004	11.33	0.65	45,103,991	12.89	0.74	63,650,424	18.64	0.76	72,683,095	21.64	0.81
Malta	3,599,071	9.52	1.76	4,770,458	12.23	1.68	5,301,813	13.14	1.60	5,448,901	13.23	1.71
Poland	451,124,183	11.69	0.77	547,215,085	14.23	0.83	568,020,896	14.88	0.93	627,094,809	16.45	1.00
Romania	217,276,916	9.58	0.75	162,019,570	7.22	0.95	193,885,441	8.96	1.04	242,992,111	11.29	1.04
Slovakia	48,906,263	9.12	1.16	51,752,343	9.60	1.32	64,063,892	11.89	1.36	63,149,363	11.68	1.76
Slovenia	39,935,842	20.07	0.79	43,373,230	21.81	0.90	43,627,865	21.81	1.08	54,657,981	27.04	1.01
Albania	13,387,518	4.27	0.84	9,241,541	3.01	1.60	17,612,025	5.66	1.09	23,367,215	7.43	0.98
Bosnia and Herzegovina	14,713,710	4.42	0.37	28,076,153	7.60	0.66	30,342,871	8.02	0.78	37,655,447	9.98	0.75
Croatia	27,594,535	5.91	1.68	26,674,146	6.03	2.05	48,504,583	10.92	1.40	50,997,876	11.50	1.50
Macedonia. FYR	24,152,452	12.30	0.52	21,515,233	10.71	0.68	22,554,386	11.07	0.69	31,485,812	15.34	0.57
Serbia and Montenegro	107,293,885	12.83	0.41	93,409,342	11.42	0.58	96,658,169	11.98	0.71	102,802,984	12.89	0.80
Turkey	530,042,727	8.66	0.97	595,988,769	8.97	1.05	653,774,008	9.19	1.19	749,443,873	10.14	1.17
Armenia	13,764,077	4.27	0.40	17,184,351	5.59	0.41	20,201,209	6.59	0.62	25,649,382	8.34	0.67
Azerbaijan	25,882,494	3.37	0.55	29,671,469	3.69	0.68	58,757,751	7.00	0.64	24,301,423	2.80	2.89
Belarus	75,943,708	7.45	0.57	76,480,013	7.64	0.77	78,304,338	8.01	1.07	109,811,431	11.34	1.03
Georgia	5,734,208	1.21	1.45	6,450,125	1.46	1.71	11,661,415	2.67	1.35	14,461,776	3.30	1.37
Kazakhstan	254,698,474	16.10	0.28	260,873,882	17.53	0.31	327,360,897	21.61	0.40	356,222,472	22.73	0.46
Kyrgyzstan	21,933,825	4.78	0.26	24,607,276	5.01	0.30	28,754,441	5.59	0.31	34,328,183	6.50	0.31
Moldova	13,530,258	3.68	0.50	10,766,599	2.96	0.56	17,407,137	4.84	0.49	18,522,077	5.19	0.53
Russian Federation	1,702,466,462	11.49	0.68	1,533,411,522	10.48	0.82	1,742,023,076	12.17	0.97	1,976,249,645	13.92	1.06
Tajikistan	6,221,680	1.08	0.96	5,466,690	0.89	1.09	7,435,042	1.14	1.30	7,364,127	1.08	1.62
Turkmenistan	37,034,048	8.84	0.23	43,017,348	9.56	0.24	56,403,316	11.65	0.40	63,881,824	12.67	0.49
Ukraine	389,353,685	7.56	0.52	304,239,647	6.19	0.60	382,817,776	8.13	0.69	405,204,965	8.76	0.77
Uzbekistan	154,941,540	6.80	0.21	168,149,548	6.82	0.24	200,720,488	7.67	0.26	218,845,972	8.01	0.31
EU-15	5,875,546,237	18.79	1.59	6,059,270,360	19.14	1.78	6,150,658,488	18.91	1.91	6,144,122,399	18.59	2.03



UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Telephone: (+43-1) 26026-0, Fax: (+43-1) 26926-69
E-mail: unido@unido.org, Internet: <http://www.unido.org>