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MATERIAL FLOW INDICATORS FOR THE REPUBLIC OF SERBIA, 2001–2011

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PREFACE

This publication was produced in cooperation with Statistical Office of Sweden (SCB) under Swedish International Development Cooperation Agency (SIDA) projects. One of the aims of the projects is finding the appropriate data sources as well as mapping all the available data for compiling a number of material flow indicators.

In view of a growing need for statistical monitoring of the environment, SORS started developing Environmental Accounts in 2010. As a result of this work, Economy-Wide Material Flow Accounts (EW-MFA) were established as the basis for calculating material flow indicators.

This publication presents basic principles and methods for creating one of the modules of environmental accounts – Economy-Wide Material Flow Accounts (EW-MFA) as well as the results for the Republic of Serbia. The general methodological framework has been defined in the publication "The System of Environmental-Economic Accounting (SEEA) - Central Framework" published by European Commission (EC), Food and Agriculture Organization (FAO), International Monetary Fund (IMF), Organization for Economic Cooperation and Development (OECD), United Nations (UN) and World Bank (WB).

This publication consists of four chapters: the first chapter provides introduction and background information on the System of National Accounts and Satellite Accounts as well as on Environmental-Economic Accounting, the second chapter describes Economy-Wide Material Flow Accounts, the third chapter analyzes the results of material flow indicators for Serbia, while the fourth chapter describes the activities planned for the further development of environmental accounts for Serbia.

We are fully convinced that the various data presented will facilitate overall observance of environmental pressures and impacts, and offer essential information for a wide range of users. We expect that the results from this publication will also be used as a background for creating development policy for the Serbian economy.

The publication is prepared in the Department for National Accounts, Prices and Agriculture of the Statistical Office of the Republic of Serbia with the assistance of experts from the Statistics Sweden, Annica Carlsson and Louise Sörme.

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Director
Prof. Dragan Vukmirović, PhD

List of abbreviations

DEU	Domestic Extraction Used
DMC	Direct Material Consumption
DMI	Direct Material Input
EAA	Economic Accounts for Agriculture
EC	European Commission
ESA	European System of Accounts
EU	European Union
Eurostat	Statistical Office of the European Union
EW-MFA	Economy-Wide Material Flow Accounts
EXP	Exports
FAO	Food and Agriculture Organization
GDP	Gross Domestic Product
GNP	Gross National Product
IEEAF	Integrated System of Environmental and Economic Forestry Accounts
IMP	Imports
IMF	International Monetary Fund
MFA	Material Flow Accounts
NAMEA	National Accounting Matrix including Environmental Accounts
OECD	Organization for Economic Cooperation and Development
PPS	Purchasing Power Standards
PTB	Physical Trade Balance
RMC	Raw Material Consumption
RME	Raw Material Equivalents
RoW	Rest of the World
SCB	Statistical Office of Sweden
SDIs	Sustainable Development Indicators
SEEA	System of Environmental-Economic Accounting
SIDA	Swedish International Development Cooperation Agency
SORS	Statistical Office of the Republic of Serbia
SNA	System of National Accounts
UN	United Nations
WB	World Bank

CONTENTS

I INTRODUCTION

1.1. Environmental Accounts as Satellite Accounts in the System of National Accounts

National accounts present a specific domain of economy, almost identical by its form and contents in all modern economic systems. This makes national accounts unique in relation to other economic domains. System of National Accounts (SNA), as an internationally adopted standard, originated in the necessity to define single and uniform macroeconomic presentation of systems of data on economic structures and flows that are internationally comparable. It is a result of continuous and long lasting efforts taken by global economic experts.

SNA is an all-comprising, uniform and harmonized set of macroeconomic accounts, balance sheets and tables grounded on internationally adopted concepts, definitions, classifications and accounting rules. It is defined in a form that provides a systematic picture of a country's economic activity, applying at the same time economic theory in practice. In this way international economic comparisons have been standardized.

Primarily, national accounts data are intended to provide information covering various kinds of economic activities and sectors of economy. Therefore, they make it possible to monitor major economic categories such as production, gross fixed capital formation, household consumption, government consumption, exports or imports. National accounts ensure that causative mechanisms acting internally in economy are determined and explained. This analysis assumes a form of estimations for parameters of functional relations among various economic categories, applying econometric models based on the time series at current and constant prices. They are regarded as a prerequisite for creating economic policy and decision making at all government and internal levels.

Satellite accounts are an integral part of the system of national accounts. They present a related system of transactions, accounts and balance items recorded annually. Their major importance lies in the fact that they are a consistent set of indicators that provide a precise image of specific segments of economy. Many elements expressed in satellite accounts could not be visible in the system of national accounts as they are either indirectly used in calculations or represent an integral part of categories presented on the higher level.

The purpose of satellite accounts is to meet the demands for specific data on performances of particular economic activities. They focus on providing explanations and analysis, and ensure detailed calculations by regrouping certain items expressed in the SNA as well as supplementary information such as non-monetary flows, employment and gender structure. Therefore, they may diverge from the SNA concepts, while simultaneously being related to the concepts of economic theory and practice (financial statements, business plans, taxation and monetary policy, and the like).

Satellite accounts are reliable to the extent allowed by the data used for their compilation.

The sources of the data are heterogeneous and cover a variety of economic and financial indicators, directly or indirectly related to the aggregates of the accounts. Direct data sources are the surveys specially designed for requirements of satellite accounts on the basis of which it is possible to derive the values of certain aggregates. Indirect data sources are the surveys within the statistical system scheduled to follow specific economic areas or features (production output, prices, salaries and wages, employment, and the like). Apart from statistical system, indirect data sources are administrative data which normally offer a lot of statistical information. These data are particularly useful for the areas that are not covered by regular surveys.

The main characteristics of satellite accounts are the following:

- They are based on clearly stated SNA definitions, which ensures comparability and creation in compliance with international standards;
- Certain concepts of the SNA could be applied in modified forms;
- They are provided on high level details;
- Apart from monetary indicators, satellite accounts contain physical (quantities, pieces and the like) and other non-monetary indicators (sex, age, occupation, and the like);
- Application of statistical and mathematical models is possible.

Environmental issues, such as ever arising problems of preservation of natural environment, climate changes, availability of natural resources, water quality, land degradation, air quality, biodiversity, waste management and the like, are the subject of interest for policy makers. An ever increasing pressure exerted on natural environment and upgraded environmental awareness made it necessary for the countries to value them more precisely and measure their natural resources. Therefore, environmental accounts gradually gain their importance.

Environmental accounts are those satellite accounts that establish a link between the data on natural environment and the SNA. They are regarded as supplementary to environmental and other economic statistics, in a way that environmental variables are presented in compliance with the concepts and definitions of national accounts. The data can be used for integrated environmental and economic modeling, analysis of correlation of economic trends and environmental issues, estimating economic instruments related to natural environment, and so forth. Environmental accounts are intended to ensure a conceptual framework for integrating environmental statistics and its economic implications, which means economic impact on environment as well as environmental influence on economic movements. From these accounts it is possible to derive a coherent set of indicators and descriptive statistics that are useful for informing policy makers, especially in the areas of green economy/green growth, management of natural resources and sustainable development. Environmental accounts provide information on the impact of economic activities of a country on natural environment and the importance of natural resources for the national economy. Their significance is evident for modeling the impact of fiscal and monetary measures, as well as for estimating environmental performances by industries.

1.2. History of Environmental - Economic Accounting

Early work on national accounting in the 20th century placed focus on monitoring the economic growth. This required measuring the production, consumption and accumulation of produced assets. These activities instigated growth in income which could provide a higher living standard. The significance of non-produced assets was largely ignored. Monetary transactions related to resource extraction and the use of environment were not presented. This led to the fact that the depletion and degradation of natural resources did not represent a cost of production.

While the System of National Accounts did not recognize these costs, environmental accounting at national economy level became an active consideration for many researchers. At the same time, it was recognized that natural resources themselves will not last forever. For this reason, increasing attention was paid to the measurement of natural resources in both physical and monetary terms during the 1970s. Great efforts were made to include the cost of depletion as an adjustment to the main national accounts aggregates such as Gross Domestic Product. All these and many other efforts provided the theoretical background for the System of Environmental - Economic Accounting (SEEA) framework. The United Nations Statistical Office established the first SEEA environmental accounting system in 1993.

1.3. The concept of the System of Environmental - Economic Accounting

The System of Environmental - Economic Accounting (SEEA) provides information on interactions between economy and environment as well as stocks and changes in stocks of environmental assets. This system includes the internationally accepted standards, definitions, accounting rules and tables for creating internationally comparable statistical data on the environment and its relation to the economy. These are consistent with the SNA in order to facilitate the integration of environmental and economic statistics. It is a multipurpose system that provides a wide range of statistics and indicators with different analytical potential. At the same time, the system is flexible as it can be adapted to the needs of different countries and different policies.

In this international guideline on environmental accounts, the elaborated accounting framework focusing on describing and analyzing environment and its interactions with economy was presented.

This system can serve as a tool for strategic planning and policy analysis in order to identify directions of sustainable development. Policy makers who set environmental standards should pay attention to the potential impact on the economy (which of the industries would be adversely affected and the consequences for employment and purchasing power). At the same time, industrial development policy makers should be aware of the long-term consequences of using natural resources on the environment.

The starting point of environmental accounting is SEEA but, because of its specificity, certain categories of the accounts need to be broken down further or reclassified. Other elements have to be added for the specific purpose of environmental accounting. For example, the classification of non-produced assets shows separate items for subsoil assets like oil reserves, mineral reserves, non-cultivated biological resources and water resources.

From the environmental point of view, the SNA and its key aggregates like GDP, gross fixed capital formation and savings have two main disadvantages:

1. The depletion and scarcity of natural resources is neglected, which threatens the sustained productivity of economy;
2. The degradation of environmental quality and its consequences to human health and welfare are ignored.

In the national accounts aggregates, only produced assets are explicitly taken into account. Non-produced natural assets – such as land, mineral reserves and forests – are included in the asset boundary insofar that they are under the effective control of institutional units. However, the cost of their use is not explicitly accounted for in production cost. This may either imply that the price of the product does not include such a cost or – in case of some depletion cost – that such a cost is lumped together with other unidentified elements in the residual derivation of operating surplus.

SEEA allows these costs to be explicitly recognized and estimated. Environmental accounts are a systematical presentation of relevant statistical data on natural resources, quality of ecosystem and human impact on the environment. Information on natural resources and material flows are reported in monetary terms and through indicators. At the same time, they illustrate the state of the natural environment and allow the calculation of gross national product of corrected environmental factors - so called green GNP ("green Gross National Product").

The objective of integrated environmental and economic accounting system is to provide detailed description of links between environment and economy as well as availability of environmental and economic data based on similar accounting standards and concepts. Correct interpretation and analysis of the data required is expressed in physical units, because they are more convenient than the data expressed in monetary units. For this reason, to create material flows from environment to economy and back, the data should be expressed in tonnes, as material flows change their shape and composition during the production and consumption process.

1.4. Relationship between the System of Environmental-Economic Accounting and the System of National Accounts

Understanding this relation is of a great importance, as the environmental accounts are satellite accounts of national accounts. The accounting approach of the SEEA is based on the System of National Accounts (SNA) which implies that, fundamentally, the same classifications and concepts are used. Only for the specific purpose of environmental accounts, modifications have been made. Environmental accounts are such a satellite which connects environmental data to national accounts. The SEEA is a global conceptual basis for environmental accounts. Moreover, the conceptual and practical guidelines are available for different modules of environmental accounts by Statistical Office of the European Union (Eurostat). The environmental accounts are designed to be internationally comparable through these common frameworks, concepts and methods.

The SNA is a measurement framework that has been developed since the 1950s as a pre-eminent approach to measurement of economic activity, economic wealth and the general structure of the economy. The SEEA applies accounting concepts, structures, rules and principles of the SNA to environmental information. Therefore, the SEEA allows integration of environmental information (often measured in physical terms) with economic information (often measured in monetary terms) in a single framework. Its strength comes from the capacity to present information in both physical and monetary terms in a coherent manner. As it uses the same accounting conventions, it is, in general, consistent with the SNA. However, given the specific analytical focus of the SEEA on the environment and its connections with economy, as well as its focus on measuring the stocks and flows in physical and monetary terms, there are some differences between the SEEA and SNA.

II MATERIAL FLOW ACCOUNTS

2.1. Historical development of Material Flow Accounts

The Material Flow Accounts (MFA) are based on former concepts of material and energy balance, introduced in the 1970s. The MFA concept was developed in 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) were determined by the overall scale of industrial metabolism rather than toxicities in specific substances.

Since the beginning of the 1990s when the first material flow accounts on the national level were presented (Austria, Japan and Germany), MFA has been a rapidly growing field of scientific and policy interest and major efforts have been undertaken to harmonize methodological approaches developed by different research teams. The World Resources Institute pioneered the comparative empirical analysis of national economies in material terms and the development of internationally comparable material flow indicators. Also, material inputs of some industrial countries have been assessed and guidelines for the resource input indicators have been defined. Today, the MFA methodology is internationally standardized, and a number of methodological handbooks are available.[1]

2.2. Methodological background of Material Flow Accounts

The use of statistics expressed in physical terms in environmental accounting is aimed at connecting the data on material flows to other data in economy or product groups reflecting economic activities involved and thus improve and expand the information produced by material flow statistics for policy and decision-making in both environmental and economic spheres. For these purposes the data on material flows are also applied in the SEEA and National Accounts Matrix including Environmental Accounts (NAMEA) frameworks. The use of material flow statistics in modeling including physical and economic components, input-output approaches and linking material flows to information on environmental quality and land use, are expected to further expand their usefulness.

[1] For details see M. Fischer-Kowalski, F. Krausmann, S. Giljum, S. Lutter, A. Mayer, S. Bringezu, Y. Moriguchi, H. Sch¨utz, H. Schandl and H. Weisz (2011): Methodology and Indicators of Economy-Wide Material Flow Accounting, In *Journal of Industrial Ecology, page* 857

The SEEA encompasses measurement in three main areas:

1. Physical flows of materials and energy within economy and between the economy and environment;
2. Stocks of environmental assets and changes in these stocks, and
3. Economic activities and transactions related to the environment.

Measurement in these areas is turned into a series of accounts and tables.

In the area of environmental accounts, Eurostat has developed a number of modules focused on a specific area of importance to the environment, which can be divided into three groups:

1. Physical flows accounts;
2. Monetary flows accounts;
3. Assets accounts.

Conceptually, Economy-Wide Material Flow Accounts (EW-MFA) belong, according to SEEA, to the first area (Physical flows of materials and energy within economy and between the economy and environment) and to the first group (Physical Flow Accounts).

Physical Flow Accounts explain in detail the recording of physical flows. The different physical flows - natural inputs, products and residuals - are placed in the structure of a physical supply and use table; from this starting point, the measurement of the physical flows can be expanded on a range of different materials or reduced to focus on specific flows. Natural inputs are all physical inputs that are moved from their location in the environment as a part of economic production process, or are directly used in production. Products are goods and services that result from a process of production in economy. Residuals are flows of solid, liquid and gaseous materials and energy that are discarded, discharged or emitted by establishments and households through processes of production, consumption or accumulation.

Flows from environment to economy are recorded as natural inputs (such as flows of minerals, timber, fish, water). Flows within economy are recorded as product flows and flows from economy to environment are recorded as residuals (such as solid waste, air emissions, return flows of water).

2.3. The basic categories of material flows

There are different aspects of observing the material flows. Within input flows, important distinctions are made:

Used vs. unused

The category of used materials is defined as the amount of extracted resources which enters the economic system for further processing or direct consumption. All used materials are transformed within the economic system. Used materials acquire the status of commodity and have the economic value. Unused extraction includes materials that had to be moved during the extraction activities and do not enter the economic system for further processing (such as cover materials or overburden from mining as well as residuals from harvest in agriculture). Therefore they do not have economic value.

Direct vs. indirect

Direct flows refer to the actual weight of the products and therefore do not take into account the life-cycle dimension of the production chain. Indirect flows, however, indicate all materials that have been required for manufacturing (up-stream resource requirements) and comprise both used and unused materials.

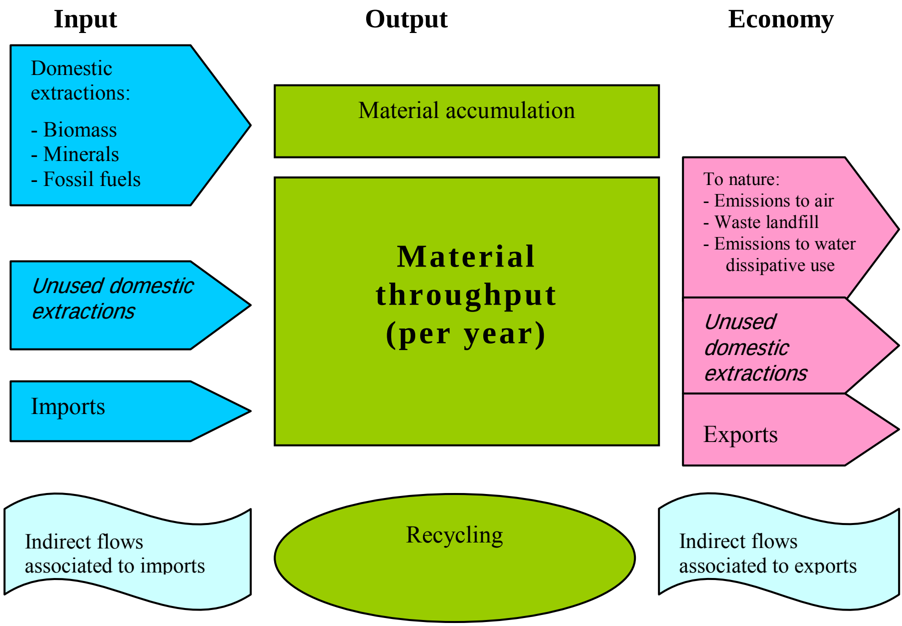
Domestic vs. Rest of the World (RoW)

This category refers to the origin and/or destination of the flows.

A standard material flow account focuses on flows of solid materials. This group is further classified into 3 main subgroups of material inputs:

- Biomass (from agriculture, forestry and fishery);
- Minerals (metal ores and non-metallic minerals like stones or clays);
- Fossil energy carriers (coal, oil, gas).

Economy-wide material scheme, without water and air[2]



Material inputs to the economic system include used domestic extraction of various material groups (fossil fuels, minerals and ores, and biomass) and unused domestic extraction. Finally, material inputs include physical imports as well as indirect flows associated with them.

Material inputs can be:

1. Accumulated within the economy (net addition to stocks, such as infrastructure and durable consumer goods);
2. Consumed domestically within the accounting period (in most cases one year) and thus crossing the system boundary as the waste and emissions back to nature, and/or;
3. Exported to other economies.[3]

[2] Serbian results for EW-MFA presented later in Chapter three are related to the following categories only: Domestic Extractions, Imports and Exports.

[3] See link: http://seri.at/wp-content/uploads/2009/09/Material-Flow-Accounting-and-Analysis-MFA. Encyclopaedia-of-the-International-Society-for-Ecological-Economics-ISEE.pdf.

2.4. Economy-Wide Material Flow Accounts

2.4.1. The basic characteristics

Economy-wide material flow accounts (EW-MFA) are the framework for compiling statistics involving flows of materials from natural resources to national economy. EW-MFA are descriptive statistics, in physical units (tonnes). They are consistent with the principles and system boundaries of SNA and follow the residence principle. This means that EW-MFA are also a part of SEEA.

EW-MFA are consistent compilations of the overall material inputs into national economies, the changes of material stocks within the economic system and the material outputs to other economies or to the environment.

In EW-MFA, two types of material flows across system boundaries are relevant:

- Material flows between the national economy and the natural environment - these consist of the extraction of primary (i.e. raw, crude or virgin) materials from and the discharge of materials into the natural environment;
- Material flows between the national economy and RoW - these encompass imports and exports. Namely, only flows that cross the system boundaries on the input-side or on the output-side are counted.

Material flows within the economy are not represented in EW-MFA.

Eurostat compiles and analyzes physical data in the framework of its EW-MFA by portraying economies in physical terms using the national accounting principles and adequate questionnaire. The EW-MFA Questionnaire includes mainly the direct material flow accounts with the components: Domestic Extraction Used (DEU), Imports (IMP), and Exports (EXP).

EW-MFA are meta-compilations of the data from various official statistics, most of which are regularly provided and updated by national statistical offices. It is mainly based on the data by the statistics of agriculture, forestry, fishery, mining, and energy. Imports and exports data are typically taken from foreign trade statistics although some countries use national accounts as the primary data source for the data about external trade.

The classification of materials used in EW-MFA is a Eurostat based system. Domestically extracted materials are grouped into 4 main categories:

- Biomass;
- Metal ores;
- Non metallic minerals, and
- Fossil energy materials/carriers.

For imports and exports, the products are grouped into 6 main categories:

- Biomass and biomass products;
- Metal ores and concentrates, primary and processed;
- Non metallic minerals, primary and processed;
- Fossil energy materials/carriers, primary and processed;
- Other products, and
- Waste imported for final treatment and disposal.

2.4.2. Relationship between Economy-Wide Material Flow Accounts and other accounting systems

The Eurostat EW-MFA is an integral part of SEEA which is closely related to SNA and European System of Accounts (ESA). In addition to EW-MFA, SEEA includes other environmental accounts.

The EW-MFA is also closely related to the Economic Accounts for Agriculture (EAA) as well as the Integrated System of Environmental and Economic Forestry Accounts (IEEAF), which are the elaborations of ESA for the agricultural and forestry activities. Furthermore, EW-MFA is related to other physical flow modules of the European environmental accounting system, like Air Emission Accounts. The advantage of harmonizing EW-MFA with ESA and other accounting systems lies in the fact that those data – apart from being used for establishing general environmental indicators like Domestic Extraction Used (DEU), Direct Material Input (DMI) and Domestic Material Consumption (DMC) – can be applied in hybrid environmental-economic analyses which combine physical data on environmental pressures with monetary data on economic driving forces.

2.4.3. Purpose of Economy-Wide Material Flow Accounts

The general purpose of EW-MFA is to describe the interaction of domestic economy with natural environment and the RoW in terms of material flows. Material inputs to economy are extractions of materials from the natural environment and imports of material products (goods) from the RoW. Outputs are disposals of materials to natural environment and exports of material products and waste to the RoW.

EW-MFA provide aggregated background information on composition and changes of the physical structure of socio-economic systems. They represent a very useful methodological framework for analyzing economy-environment relations and deriving environmental and integrated environmental/economic indicators. Material flow based indicators can be aggregated from micro to macro level. The aggregated indicators based on material flows allow comparisons with other aggregated economic indicators (GDP, unemployment rate, and the like), hence providing policy makers with information. Therefore, they can help shift the policy focus from dealing with the purely monetary analysis to integrating biophysical aspects.

The basic purposes of their implementation are to:

- Provide the information on the structure and changes of physical metabolism of economy over time;
- Derive a set of aggregated indicators for the use of natural resources;
- Derive resources productivity and eco-efficiency indicators, like the relation between resource use indicators and GDP, and other economic indicators;
- Provide indicators for the material intensity of lifestyles by connecting these indicators to population size and other demographic indicators;
- Integrate information into the National Accounts;
- React flexibly and quickly to new policy demands;
- Permit analytical uses including estimation of material flows and land use induced by imports and exports as well as decomposition analyses separating technological, structural and final demand changes.

2.5. Economy-Wide Material Flow based indicators

2.5.1. Policy relevance and utility

Material flow indicators should:

- Provide a representative picture of material flows and their interactions with the environment and economy;
- Be simple, easy to interpret and able to present trends over time;
- Reflect changes in economic activities, resource productivity, technology development and environment;
- Have a reference value to be compared with, so the users can assess significance of the indicator;
- Provide basis for international comparisons.

MFA and its indicators are to provide the basis for political measures and the evaluation of their effectiveness. In that sense some particular aspects need to be considered:

- Environmental and economic significance of material flow indicators;
- Relation to environmental pressures or impacts;
- Relation to economics and economic related issues;
- Level of reference values that indicators can be compared with;
- Level of aggregation;
- Using a set of individual indicators as opposed to the use of highly aggregated indicators;
- Country-specific indicators.

In accordance with the international recommendations, a number of MFA indicators can be calculated.

2.5.2. Definitions of the basic categories and indicators

The main categories of EW-MFA are:

- **Biomass**

Biomass includes organic non-fossil material of biological origin. According to MFA conventions, domestic extraction (DE) of biomass includes all biomass of vegetable origin extracted by humans and their livestock, fish capture, and the biomass of hunted animals. Biomass of livestock and livestock products (such as milk, meat, eggs) are not included in the domestic extraction.

- **Metal ores and non metallic minerals**

Metal ores and non metallic minerals are two major groups of minerals as seen from the top level of the MFA classification, consisting of mining, construction and industrial minerals.

- **Fossil energy carriers (materials)**

Petroleum resources and other fossil energy carriers are materials formed in the geological past from the biomass. They include solid, liquid and gaseous materials.

- **Imports and exports**

As opposed to domestically extracted materials, goods traded with the RoW are the commodities and products in various stages of processing: basic commodities (unmilled cereals, ore concentrate and the like), semi-manufactured goods (worked wood or steel ingots) and finished goods (technical equipment, furniture and the like).

Indicators based on EW-MFA:

Domestic Extraction Used (DEU) is the input from the natural environment to be used in economy. DEU is the annual amount of raw materials (with the exception of water and air) extracted from the natural environment.

Physical Trade Balance (PTB) equals physical imports minus physical exports. The physical trade balance is thus defined reverse to the monetary trade balance (which is exports minus imports). The physical trade surplus (positive value) is the net import of materials, and physical trade deficit (negative value) indicates the net export of materials.

Direct Material Input (DMI) measures the direct input of materials for use in economy, that is all materials that have economic value and are used in production and consumption activities. DMI equals DEU plus imports. DMI includes materials that are either accumulated in infrastructure, buildings, and durable goods according to their lifetime, or exported. Recycled materials are not included in DMI.

Domestic Material Consumption (DMC) measures the annual amount of raw materials extracted and used in national economy, plus all physical imports minus all physical exports. DMC represents the part of all material inputs into economic system. DMC equals DMI minus exports. It measures domestic extraction of material resources in tonnes, whereas the imports are measured in the weight of goods crossing the boundary, regardless of the extent to what the imported products have been processed. This indicator is a basis for calculating one of the Sustainable Development Indicators (Resource Productivity).

Domestic Extraction Used (DEU)
+
Imports
=
Direct Material Input (DMI)
-
Exports
=
Domestic Material Consumption (DMC)

Raw Material Consumption (RMC) indicator includes imports expressed or converted into their raw material equivalents (RME), that is into equivalents of domestic extractions that have been induced in the rest of the world to produce the respective goods. RMC can serve as an alternative analytical measure for material consumption, and it may be more precise than DMC for analyzing countries' material needs for maintaining a specific standard of living.[4] It is currently being developed in Eurostat.

[4] For details see the document: "Consultation Paper: Options for Resource Efficiency Indicators", European Commission, page 51.

Domestic Resource Dependency is used to indicate dependence of physical economy on domestic raw material supply. It presents domestic extraction to domestic material consumption ratio.

Trade intensity indicators are used to indicate the imports or exports intensity of physical economies. They present the ratio of imports and exports to DMC respectively.

For the international comparisons some of the material flow indicators are used. To compare the levels of economy-wide material use in the overall economy, the indicator **Domestic Material Consumption per capita** is used**.**

To indicate overall material efficiency of the economy, two indicators that relate DMC to GDP are used: Material Intensity and Resource Productivity.

Material intensity is defined as DMC to GDP ratio.

Resource productivity is the inverse of material intensity, thus GDP to DMC ratio.

Gross domestic product (GDP) is an aggregated measure of production equal to the sum of the gross value added of all resident institutional units engaged in production (plus any taxes, and minus any subsidies on products) or to the sum of the final uses of goods and services (all uses except intermediate consumption), plus value of exports of goods and services, less the value of imports of goods and services, or the sum of primary incomes distributed by resident producer units.

Gross domestic product at constant prices refers to the volume level of GDP. Constant price estimates of GDP are obtained by expressing values in terms of the base period.

Purchasing Power Standards (PPS) are defined by equating the total real final expenditure of the EU 27 on a specific basic heading, aggregate or analytical category to the total nominal final expenditure of the EU 27 on the same basic heading, aggregate or analytical category.

When using GDP, the following should be kept in mind:

- For resource productivity trends, if looking at one geographic area during one time period, GDP in current prices (Euros) should be used;
- If comparing one geographic area over two or more time periods, GDP in chain-linked volumes to reference year should be used;
- If comparing several geographic areas during one time period, GDP in PPS should be used.

2.6. EW-MFA indicators as sustainable development indicators

Sustainable development indicators (SDIs) are the indicators that measure progress made in sustainable growth and development. They indicate the sustainability of social, environmental and economic development.

Resource productivity is the main indicator of sustainable consumption and production, which is one of eleven topics of SDIs. Resource productivity is the ratio between GDP and DMC**.** It shows how productively economy consumes resources in the production of products and services for market needs. If GDP increases more than DMC, the resource productivity increases and vice versa. Typically, as the economy grows, more materials such as energy, construction materials and metals are needed. Extraction and use of these materials is in many cases associated with environmental pressures, and economic growth is often linked with increasing environmental degradation. By using materials more efficiently and getting more economic value out of each unit used, it is possible to break this link; this means that the economy can continue to grow while the associated environmental pressures remain stable or even decline, which is described as **absolute decoupling**. **Relative decoupling**, however, means that resource use may increase at a lower rate than economic growth or the resource use remains constant while the economic output increases. In general, decoupling is the key objective of EU Sustainable Development Strategy and Europe 2020 Strategy. These strategies are oriented towards improving resource efficiency, in order to reduce overall use of non-renewable natural resources and related environmental impacts of raw materials use. They are thereby oriented towards using renewable natural resources at a rate that does not exceed their regeneration capacity.

Domestic Material Consumption per capita measures the total amount of materials directly used by economy per capita (inhabitant).

In addition to these two mentioned indicators, EW-MFA provides a basis for calculating two more SDIs: Components of Domestic Material Consumption and Domestic Material Consumption by Materials.

III ECONOMY-WIDE MATERIAL FLOW INDICATORS FOR THE REPUBLIC OF SERBIA

3.1. Introductory notes

Economy-wide material flow accounts provide a more comprehensive picture of the industrial metabolism than single indicators. They are an important basis for derivation of environmental indicators and indicators of sustainability. In order to monitor and assess the environmental performance of national and regional economies, a variety of indicators has been proposed.

In view of the growing need for statistical monitoring of environmental protection, SORS has started developing Environmental Accounts in 2010. As a result of this work, EW-MFA has been established which is the basis for calculation of Material Flow Indicators.

3.2. Data sources and methods

For compilation of basic MFA categories, SORS has used the data available in statistical system. Where necessary, estimations have been done by using coefficient factors or procedures described in Eurostat’s compilation guidelines.

The data from the agricultural, forestry, and fishery statistics are used for calculation of all the items for the Biomass category, except for the items Grazed biomass and Crop residuals where internationally recommended procedures are used.

The industry statistics data are used for calculating all the items for category Metal ores and Non metallic minerals, except for the items Clay and Limestone where internationally recommended procedures are used.

Industry and energy (energy balance) statistics data are used for calculating the category Fossil energy materials.

EW-MFA estimates of physical flows of Imports and Exports are based on the external trade statistics.

National accounts are data source for GDP.

3.3. Quantitative overview of the results of calculation of indicators

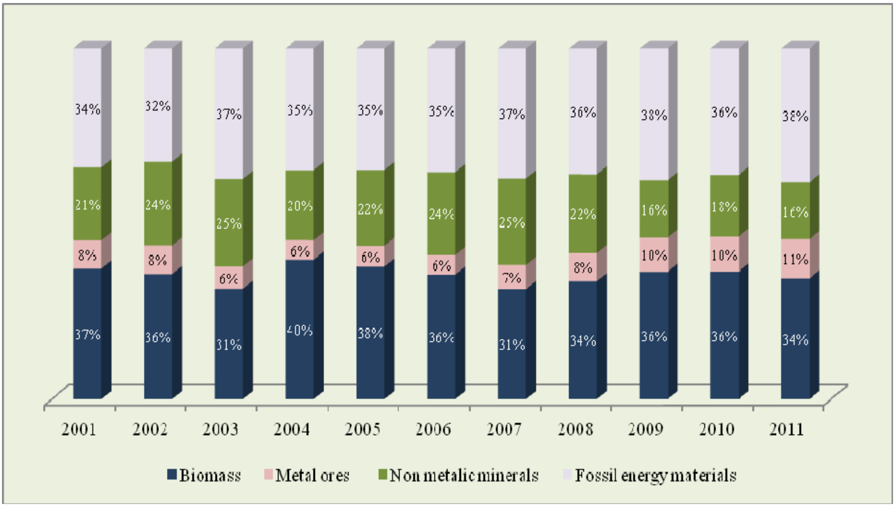
Domestic Extraction Used

Domestic Extraction Used per category of materials is presented in Table 1 and Figures 1 and 2. For the period 2001-2011, biomass and fossil energy materials had the greatest share in the structure of DEU. Average annual growth rate of DEU was 1.6% between 2001 and 2011. The category Metal ores, that had the smallest share in the structure of DEU, recorded the largest increase between 2001 and 2011, growing at 5.0% in average per year.

Table 1. Domestic Extraction Used (DEU) per category of materials, 2001–2011

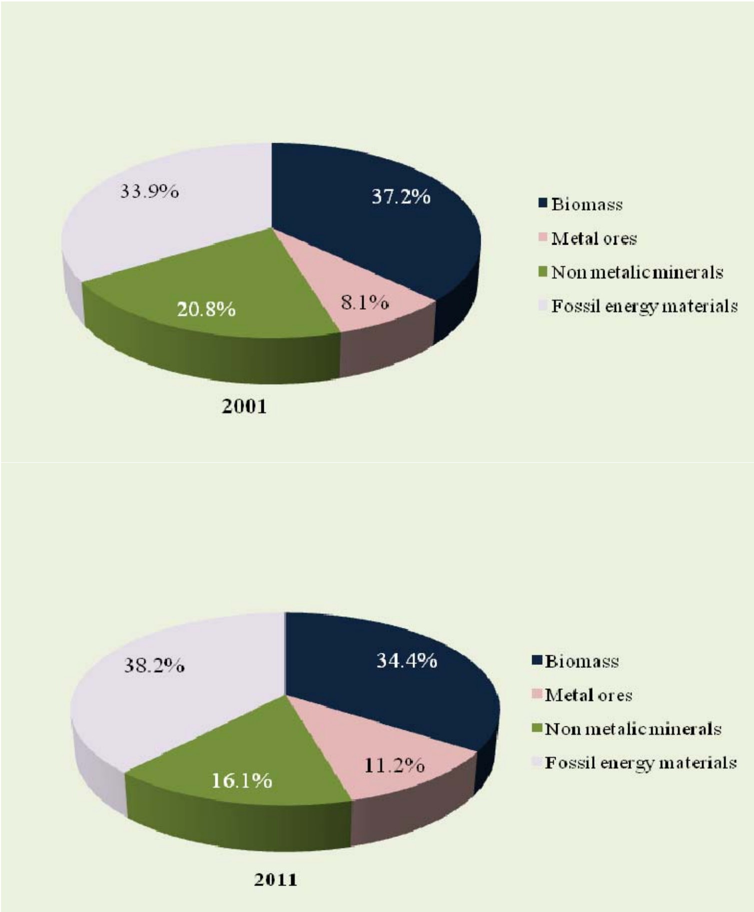
	Domestic Extraction Used (DEU), in '000 tonnes											Average annual growth, in %
	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	
Total	**95016**	**101175**	**92167**	**101160**	**103888**	**106793**	**102442**	**110263**	**104689**	**108534**	**111330**	**1.6**
Biomass	35377	36117	29024	40239	39298	37929	32149	37058	38030	39479	38348	0.8
Metal ores	7653	8252	5894	5606	6167	5946	7065	8882	10239	10884	12474	5.0
Non metallic minerals	19773	24172	22921	20225	22443	25254	25236	24740	17040	19006	17945	-1.0
Fossil energy materials	32213	32635	34328	35090	35980	37663	37992	39583	39380	39165	42564	2.8

Figure 1. Structure of Domestic extraction used (DEU) per category of materials, 2001-2011



Fossil energy materials present the bulk of materials extracted in Serbia in 2011, with the share of 38.2%; this is a significant increase in share as compared to 2001 (33.9%). The category with the largest share in 2001 was biomass with 37.2%, while its share decreased to 34.4% in 2011.

Figure 2. Structure of Domestic Extraction Used (DEU) per category of materials, 2001 and 2011



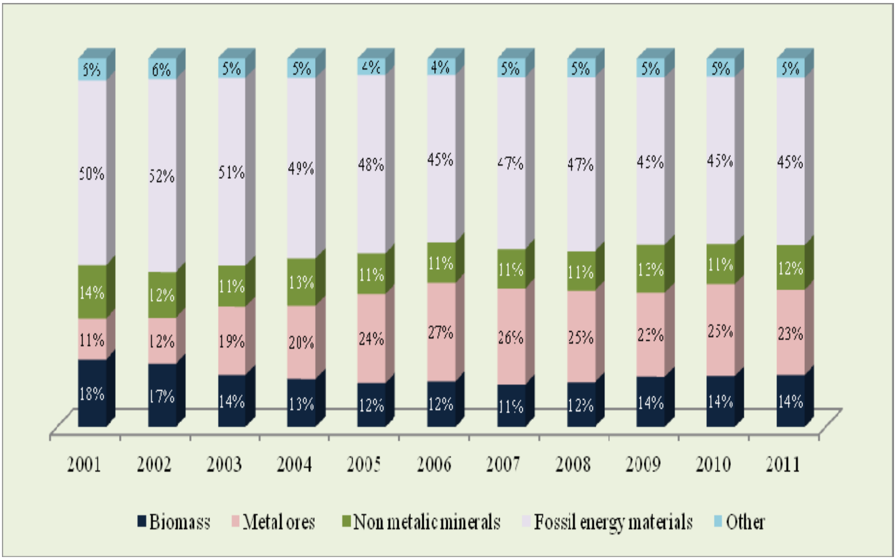
Imports and exports in physical terms

The imports per category of materials are presented in Table 2 and Figure 3. Fossil energy materials had the greatest share in the observed period. Their share in total imports was 47.9% in average, while other categories had the following average shares: biomass 13.8%, metal ores 21.3%, non metallic minerals 11.8% and other 5.1%.

Table 2. Imports per category of materials, 2001-2011

	Imports, in '000 tonnes											Average share 2001-2011, in %
	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	
Total	**7737**	**9064**	**10372**	**13346**	**13070**	**15246**	**15020**	**15180**	**12011**	**13807**	**13752**	**100**
Biomass	1415	1551	1464	1735	1554	1886	1721	1839	1635	1905	1938	13.8
Metal ores	860	1131	1921	2652	3163	4073	3921	3771	2737	3442	3178	21.3
Non metallic minerals	1118	1127	1157	1716	1439	1669	1606	1623	1568	1504	1670	11.8
Fossil energy materials	3879	4743	5286	6536	6326	6935	7012	7178	5459	6269	6250	47.9
Other	465	512	544	707	588	683	761	769	612	687	716	5.1

Figure 3. Structure of imports per category of materials, 2001- 2011

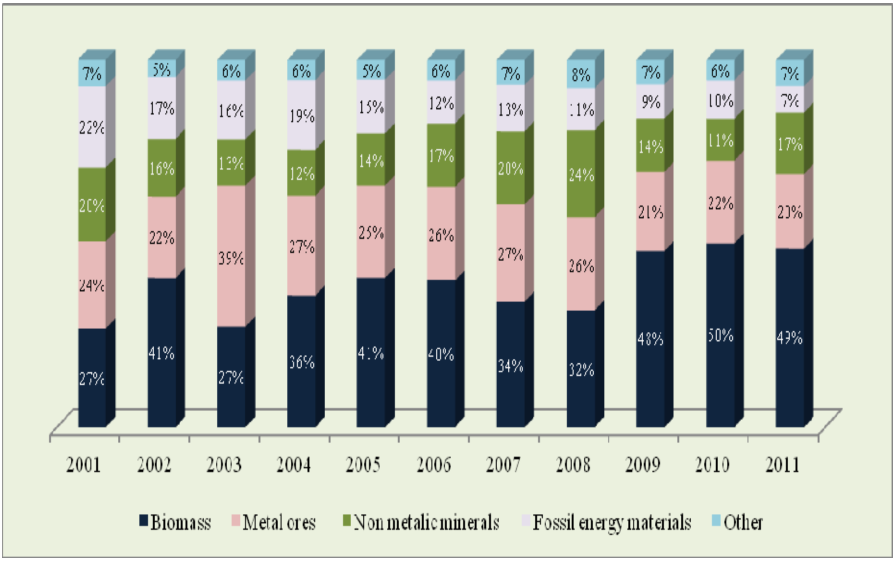


The exports per category of materials are presented in Table 3 and Figure 4. Biomass had the greatest share in the observed period. Its share in total export was 38.6% in average, while other categories had the following average shares: metal ores 25.4%, non metallic minerals 16.2%, fossil energy materials 13.7% and other 6.2%.

Table 3. Exports per category of materials 2001-2011

	Exports, in '000 tonnes											Average share 2001-2011, in %
	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	
Total	**3076**	**4940**	**4815**	**4720**	**6104**	**8342**	**9461**	**9533**	**8703**	**10313**	**10693**	**100**
Biomass	823	2016	1314	1684	2493	3335	3223	3017	4189	5173	5219	38.6
Metal ores	738	1090	1859	1295	1530	2129	2530	2445	1867	2314	2164	25.4
Non metallic minerals	615	773	603	588	863	1431	1874	2251	1260	1169	1784	16.2
Fossil energy materials	679	832	770	893	890	982	1194	1088	808	1081	766	13.7
Other	220	229	270	260	328	465	641	733	579	576	761	6.2

Figure 4. Structure of exports per category of materials, 2001-2011



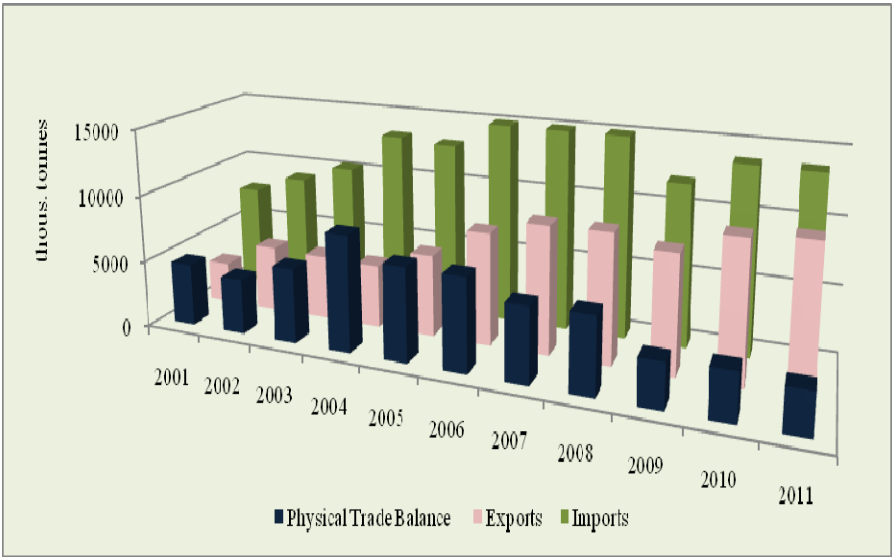
Physical Trade Balance

The physical trade balance is presented in Table 4 and Figure 5. During the observed period, PTB recorded a surplus. The value of imports was 1.78 times higher in the 2011 as compared to 2001, while the value of exports increased by 3.48 times in physical terms. Therefore, the value of the PTB reached its minimum value in 2011 (3059 thousand tonnes).

Table 4. Physical trade balance (PTB), 2001–2011

	Physical trade balance (PTB), in '000 tonnes											Cumulative growth 2011, 2001=100
	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	
Physical trade balance	**4661**	**4124**	**5556**	**8627**	**6966**	**6903**	**5560**	**5647**	**3309**	**3494**	**3059**	**65.6**
Imports	7737	9064	10372	13346	13070	15246	15020	15180	12011	13807	13752	177.7
Exports (-)	3076	4940	4815	4720	6104	8342	9461	9533	8703	10313	10693	347.7

Figure 5. Components of Physical Trade Balance (PTB), 2001–2011



Direct Material Input

Direct Material Input is presented in Tables 5 and 6 and Figure 6. The value of DMI in 2011 increased by 21.7%, as compared to 2001. Its highest value, 125444 thousand tonnes, was reached in 2008. In 2011, the value of DMI consisted of 89% of DEU and 11% of total material imports, unlike 2001 when the value of DMI consisted of 92.5% of DEU and 7.5% of total material imports.

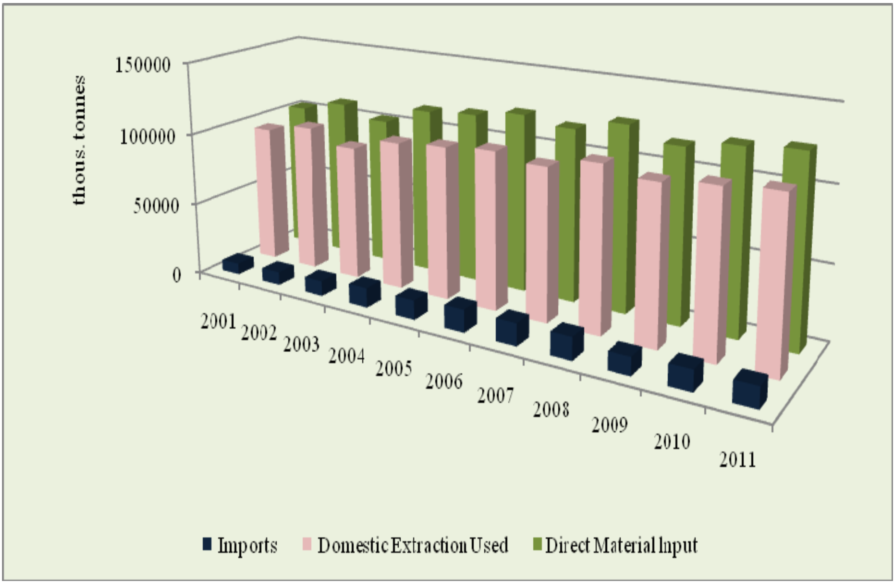
Table 5. Direct Material Input (DMI), 2001–2011

	Direct Material Input (DMI), in '000 tonnes											Cumulative growth 2011, 2001=100
	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	
Direct material input	**102753**	**110239**	**102539**	**114507**	**116958**	**122039**	**117462**	**125444**	**116701**	**122341**	**125082**	**121.7**
Domestic extraction used	95016	101175	92167	101160	103888	106793	102442	110263	104689	108534	111330	117.2
Imports	7737	9064	10372	13346	13070	15246	15020	15180	12011	13807	13752	177.7

Table 6. Structure of Direct Material Input (DMI), 2001–2011, in %

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Direct material input	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
Domestic extraction used	92.5	91.8	89.9	88.3	88.8	87.5	87.2	87.9	89.7	88.7	89.0
Imports	7.5	8.2	10.1	11.7	11.2	12.5	12.8	12.1	10.3	11.3	11.0

Figure 6. Components of Direct Material Input (DMI), 2001–2011



Domestic Material Consumption

Domestic Material Consumption is presented in Tables 7 and 8 and Figure 7. The value of DMC in 2011 increased by 14.8%, as compared to 2001. Its highest value, 115910 thousand tonnes, was recorded in 2008. In 2011, the value of DMC consisted of 97.3% of DEU and 2.7% of PTB, unlike 2001 when the value of DMC consisted of 95.3% of DEU and 4.7% of PTB.

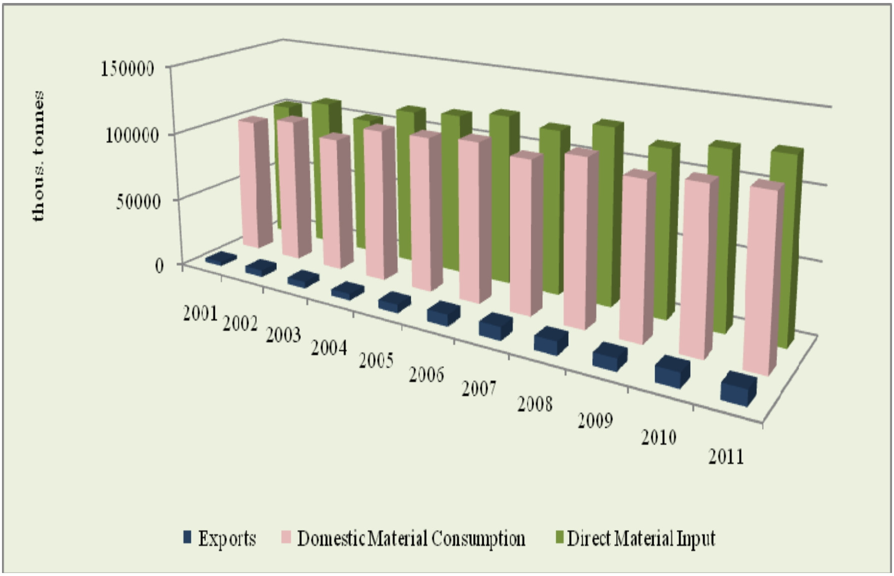
Table 7. Domestic Material Consumption (DMC), 2001–2011

	Domestic Material Consumption (DMC), in '000 tonnes											Cumulative growth 2011, 2001=100
	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	
Domestic material consu-ption	**99677**	**105300**	**97724**	**109787**	**110854**	**113697**	**108002**	**115910**	**107998**	**112028**	**114389**	**114.8**
Direct material input	102753	110239	102539	114507	116958	122039	117462	125444	116701	122341	125082	121.7
Exports	3076	4940	4815	4720	6104	8342	9461	9533	8703	10313	10693	347.7

Table 8. Structure of Domestic Material Consumption (DMC), 2001–2011, in %

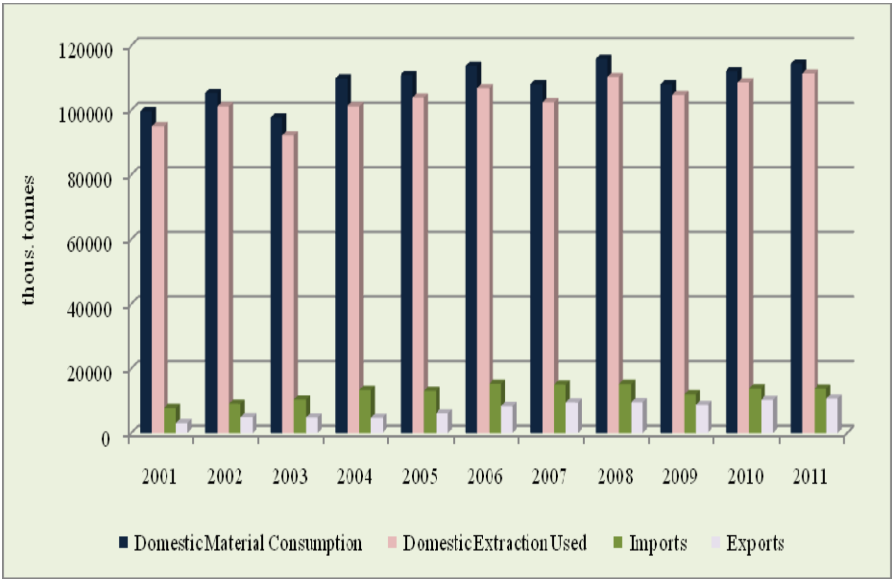
	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Domestic terial consumption	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
Domestic extraction used	95.3	96.1	94.3	92.1	93.7	93.9	94.9	95.1	96.9	96.9	97.3
Physical trade balance	4.7	3.9	5.7	7.9	6.3	6.1	5.1	4.9	3.1	3.1	2.7

Figure 7. Components of Domestic Material Consumption (DMC), 2001-2011



Detailed structure of Domestic Material Consumption (DMC) is presented in the Figure 8.

Figure 8: Components of Domestic Material Consumption, 2001-2011



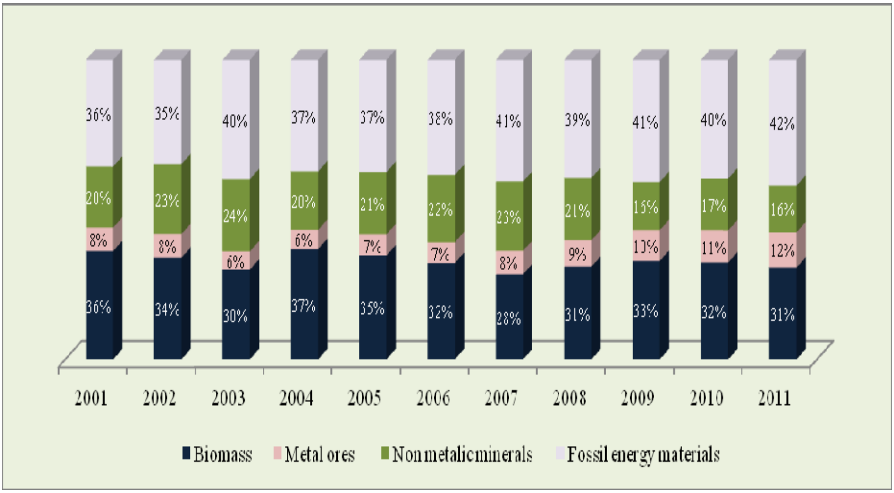
DMC divided per category of materials provides information on the composition of materials used in economy and is presented in the Table 9 and Figure 9.

Table 9. Domestic Material Consumption (DMC) by materials, 2001–2011, in '000 tonnes

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Biomass	35968	35652	29175	40290	38360	36480	30648	35880	35476	36211	35067
Metal ores	7775	8293	5956	6963	7800	7891	8456	10208	11108	12012	13488
Non-metallic minerals	20276	24526	23475	21354	23019	25493	24968	24113	17348	19341	17831
Fossil energy materials	35413	36546	38844	40732	41416	43616	43809	45673	44032	44353	48048

Fossil energy materials represent the bulk of materials consumed in Serbia in 2011, with the share of 42.0% which is a significant increase in share as compared to 2001 (35.6%). The category with the largest share in 2001 was biomass (36.2%), while its share dropped to 30.6% in 2011.

Figure 9. Domestic Material Consumption (DMC) by materials, 2001–2011



Material Intensity and Resource Productivity

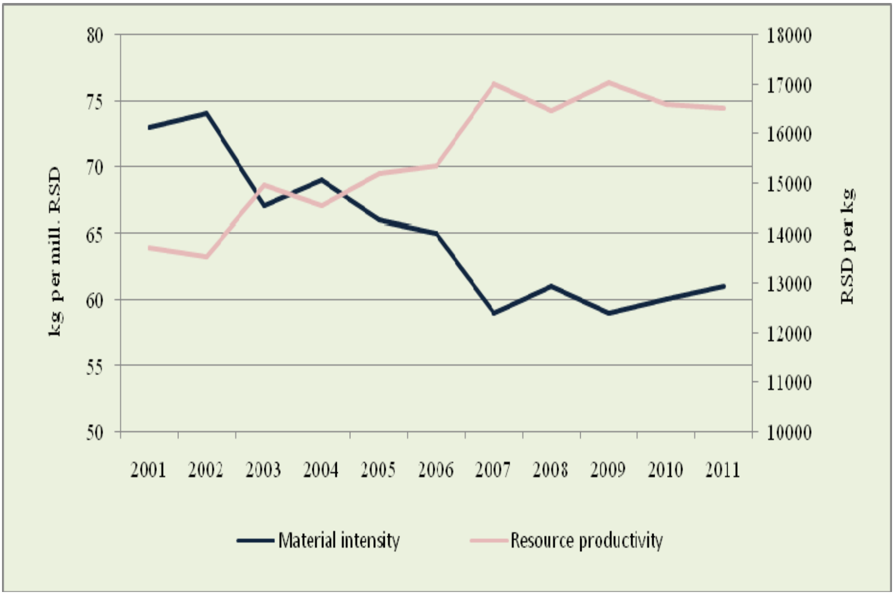
The values of these indicators for the period 2001-2011 are presented in the Table 10 and Figure 10.

Table 10. Material intensity and Resource productivity, 2001-2011

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Material intensity (kg per mill. RSD)	73	74	67	69	66	65	59	61	59	60	61
Resource productivity (RSD per kg)	13703	13534	14949	14548	15186	15333	17011	16455	17042	16594	16506

Material intensity decreased during the period, while resource productivity increased; this means that less materials in kg was needed to produce one million dinars of GDP, i.e. the economy generated higher amount of GDP by using one unit of material.

Figure 10. Material intensity and Resource productivity, 2001-2011



Indicators: DEU/DMC, Import to DMC and Export to DMC

Comparative review of indicators DEU/DMC, Import to DMC and Export to DMC is presented in Table 11.

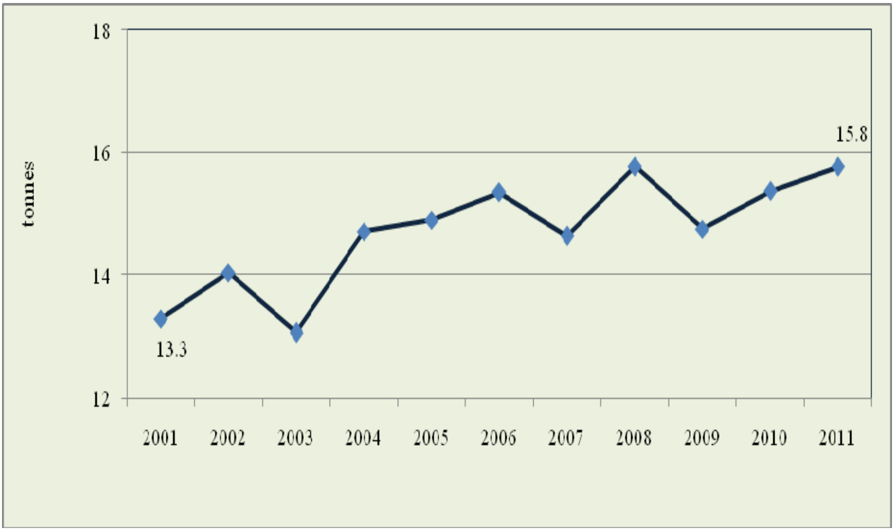
Table 11. DEU/DMC, Import to DMC and Export to DMC, 2001-2011, in %

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
DEU/DMC	95.3	96.1	94.3	92.1	93.7	93.9	94.9	95.1	96.9	96.9	97.3
Import to DMC	8.1	9.0	11.3	13.2	12.6	14.3	14.7	13.8	11.5	12.7	12.4
Export to DMC	3.1	4.7	4.9	4.3	5.5	7.3	8.8	8.2	8.1	9.2	9.3

Domestic material consumption per capita as Sustainable Development Indicator

Domestic material consumption per capita in Serbia is presented in the Figure 11. The value of DMC per capita in 2011 was 15.8 tonnes, presenting an increase as compared to 2001 when its value was 13.3 tones. Over the observed period, DMC per capita increased by 1.7 % per year in average.

Figure 11: Domestic material consumption per capita, 2001-2011



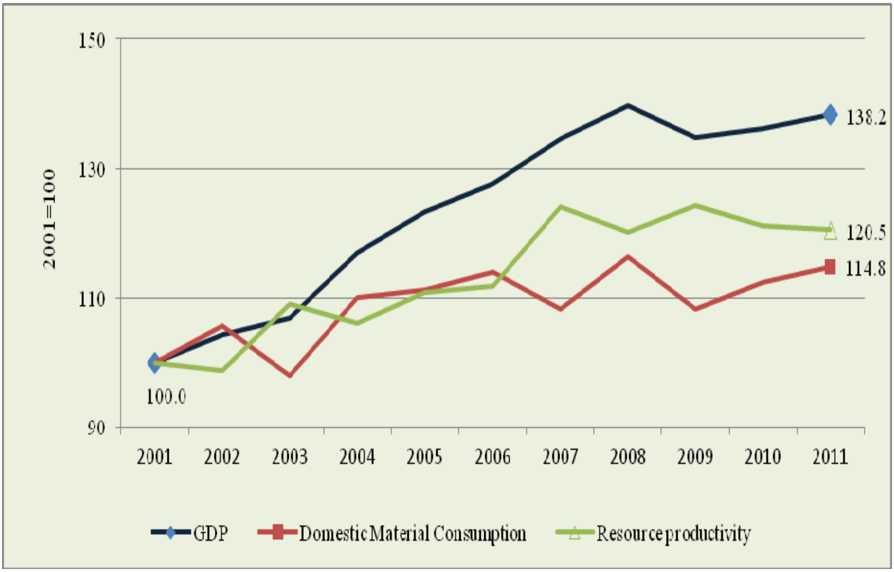
Resource productivity as Sustainable Development Indicator

Resource productivity, Domestic Material Consumption and GDP are presented in Table 12 and Figure 12. Despite the growth of recourse usage, resource productivity (measured as GDP divided by DMC) had an increasing trend of about 1.9% per year in average, in the period 2001-2011. This is due to the fact that GDP increased significantly faster than DMC. During the period 2001-2011, the average DMC growth rate was 1.4% which is less than half of the average GDP growth rate (3.3%). This result indicates that a relative decoupling, as the key objective of Sustainable Development Strategy and Europe 2020 Strategy, has been achieved.

Table 12. Resource productivity, Domestic Material Consumption and GDP, 2001–2011

	Resource productivity, Domestic Material Consumption and GDP (2001= 100)											Average annual growth
	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	
Resource productivity	100	98.8	109.1	106.2	110.8	111.9	124.1	120.1	124.4	121.1	120.5	101.9
Domestic Material Consu-mption	100	105.6	98.0	110.1	111.2	114.1	108.4	116.3	108.3	112.4	114.8	101.4
GDP	100	104.3	107.0	116.9	123.3	127.6	134.5	139.6	134.7	136.1	138.2	103.3

Figure 12: Comparison of Resource productivity, Domestic Material Consumption and GDP



3.4. International comparisons

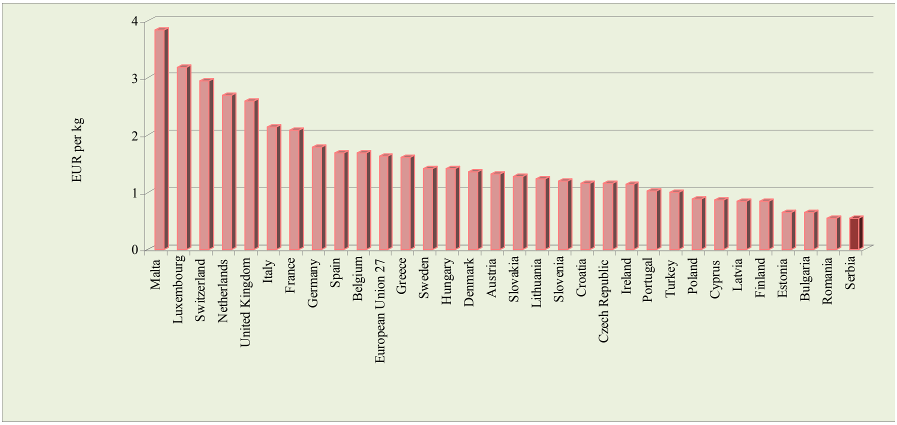
The process of European integrations of the Republic of Serbia and the development activities in the field of environmental accounts aim to reach full harmonization with European legislation.

All EU member states, Norway, Switzerland and the candidate countries transmit EW-MFA to Eurostat. The data sources used by the national statistical institutes for the compilation of these accounts may differ in scope and quality. After the Regulation (EU) 691/2011 on European Environmental Economic Accounts entered into force, the EW-MFA Questionnaire has been sent out every year requiring the data up to T-24 months.

Material flow accounts have been developed in many countries and the indicators are being used for monitoring material efficiency. The information provided by material flow statistics is essential for achieving the goal of eco-efficiency like reducing the use of materials in the economy and the impact of the economy on the environment. The most frequently used indicators for this purpose are Resource productivity and Domestic material consumption per capita.

Resource productivity by countries for 2009 is presented in Figure 13. Apparently, this indicator varied across the countries. The differences are determined by several factors, such as the structure of economy (basic industry or raw material processing versus hi-tech manufacturing), share of service sector, scale and patterns of consumption, level of construction activities, and the main sources of energy. Resource productivity is particularly strong in service oriented countries like Malta, Luxembourg and Switzerland, while countries like Romania, Estonia and Serbia demonstrated an exceptionally low level of resource productivity.

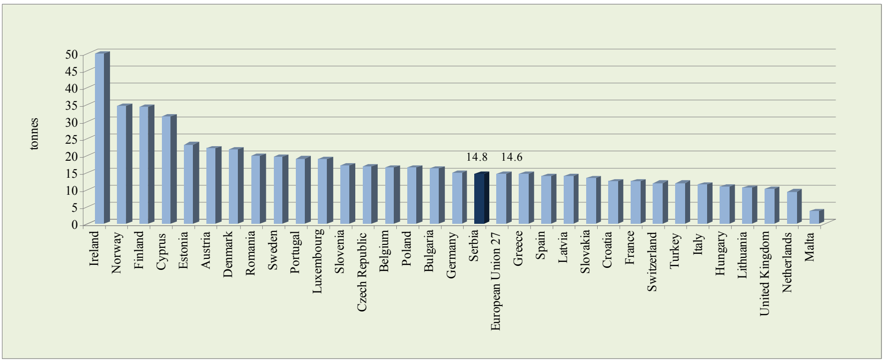
Figure 13: Resource productivity by countries, 2009



Source: Eurostat

DMC per capita by countries for 2009 is presented in the Figure 14. With DMC amounting to 14.8 tonnes per capita, Serbia is positioned 18th among 33 observed countries, slightly above the average for EU27 (14.6 tonnes per capita). When analyzing the neighboring countries, DMC per capita in Serbia is lower than in Romania, Slovenia and Bulgaria and higher than in Croatia and Hungary.

Figure 14: Domestic material consumption per capita, by countries, 2009



Sources: Eurostat and SORS

IV ACTIVITIES PLANNED FOR FURTHER DEVELOPMENT OF ENVIRONMENTAL ACCOUNTS

The development of material flows over time and proportions between them are interesting from policy perspective. The analyzed indicators measuring progress of the overall use of natural resources, productivity, resource dependency and similar, are significant not only in view of effective management of natural resources but also for the purpose of international comparisons.

Through SIDA projects in the forthcoming years, SORS will continue the work on other modules of environmental accounts which will provide good inputs for calculating variety of indicators, Environmental and Sustainable development indicators being among the most important.

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