



Analysis

Patterns of change in material use and material efficiency in the successor states of the former Soviet Union



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ABSTRACT

The successor states of the former Soviet Union present a unique opportunity to study the changes in the socio-metabolic profile of a cohort of nations which underwent a radical and contemporaneous shift in economic system. That change was from being regions within an economically integrated, centrally planned whole, to being independent nations left to find their own place in the global economic system. The situation of these nations since the dissolution of the Soviet Union provides a rare experiment, in which we might observe the influence of the different starting conditions of each nation on the development path it subsequently followed, and the attendant socio-metabolic profiles which resulted. Here we take the opportunity to examine patterns for the region as a whole, and for three individual countries. We also examine the relative importance of three different drivers of material consumption using a version of the IPAT framework. Finally, an area for follow-on investigation was suggested by a significant positive correlation observed between the economic growth of individual successor states, and the degree to which they improved their material productivity. This latter is of potential importance in assessing whether dematerialization acts primarily to accelerate or retard economic growth.

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1. Introduction

This study examines trends in material use and material efficiency for a region, Eastern Europe, the Caucasus and Central Asia (EECCA) which is composed of 12 countries which together accounted for the bulk of the former Soviet Union (the Baltic states are not included). A newly established database is used for this purpose, covering the period 1992 to 2008. The database has been constructed applying the economy wide material flows accounting (EW-MFA) methodology in a manner identical or very similar to that used for studies on a number of individual nations and global regions e.g. Gierlinger and Krausmann (2012), Kovanda and Hak (2008), Krausmann et al. (2009), Krausmann et al. (2011), Schandl and West (2010), and West and Schandl (2013). This greatly facilitates valid comparisons between this region and those dealt with previously, and the data presented here makes a valuable

contribution to extending consistent EW-MFA coverage of world regions¹.

Inter-regional comparisons however are not the main purpose of this study. The focus here is instead on the opportunity to examine the socio-metabolic paths taken by the EECCA region as a whole, and three of its constituent nations, subsequent to the economic shock delivered by the dissolution of the former Soviet Union. This is the first time that material flow accounts for this region have been made available. They demonstrate the impact on natural resource use of the economic transition from centrally planned to market based economies. Earlier research has looked at Eastern European economies e.g. Kovanda and Hak (2008) which compared the Czech Republic, Hungary and Poland, however this study goes beyond previous findings

¹ Historically the MFA approach used for this study was one of two systems employed to organize environmental accounts at the national and international scale and in accordance with economic accounts. MFA was largely promoted by the Organisation for Economic Co-operation and Development (Haberl et al., 2004) and is essentially a flow account of natural resources. The complement is the System of Economic and Environmental Accounts (SEEA) of the United Nations (Bartelmus, 2007) which focuses on stock changes in natural resources and built assets. For MFA the science and policy community has reached broad agreement on the methodologies to be employed (Fischer-Kowalski et al., 2011) and more recently MFA has become an integrated part of the SEEA c.f. European Commission et al. (2012).

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and examines economies that were initially part of the same national economy i.e. the former Soviet Union. In addition to the dissolution of the Soviet Union and the integrated, centrally planned economy it had provided, the period 1992–2008 also encompassed external change of great importance to the successor states. Perhaps the most important external change was the reinvigoration of global economic growth which attended the increasing industrialization of Asia's population giants from the beginning of the 21st Century. This led to massive increases in demand for primary materials (Schandl and West, 2010), so extractive industries generally became much more profitable in the latter half of the period studied. This presumably made the path of developing a primary resource exports sector more attractive to those countries which had that option, while simultaneously eroding the competitiveness of any existing industries which used these resources inefficiently.

For this study, the overarching framework through which the evolving patterns of material flows and material productivity are viewed is that of socio-metabolic transitions, described in work such as Krausmann et al. (2008) and Schandl et al. (2009), and social-ecological regime change (Fischer-Kowalski and Haberl, 2007; Krausmann et al., 2008). A social-ecological regime denotes the relationship of economic and social systems to the natural relations that determine resource availability in society. Metabolism has become a genuinely interdisciplinary concept used in sociology and biology alike, with socio-economic metabolism applying to the labor processes, technical systems, and infrastructure which maintain the material and energy requirements of a social system (Schandl and Schulz, 2002), and the metabolic processes of the "anthroposphere" as dealt with by Baccini and Brunner (1991). Metabolic transitions are large scale reconfigurations of the socio-economic system, and including changes in its relationship to the natural environment, relationships which are often highly interdependent and perhaps co-evolutionary (Weisz and Clark, 2011). Using these concepts as an analytical framework allows us to establish information systems that cover all aspects of economic activity including the resource use and emissions that fuel and result from economic activity.

Economic development in the EECCA countries prior to 1992 was as regions² of the USSR, interacting mainly with each other as members of the same centrally planned economy. The USSR also had preferential economic links to a number of other centrally planned economies through the Council for Mutual Economic Assistance (Comecon), but otherwise was not well integrated into the broader global trading system. From 1991 on, the successor states to the USSR had to function as independent nations, competing in a global economy. It is important to note however that while the USSR was only officially dissolved in 1991, a contraction of economy, reflected in decreasing material flows, was underway by the late 1980s (Schaffartzik et al., 2014). Similar contractions in material flows for other countries in the years prior to their turning away from central planning have been recorded in other research e.g. in Kovanda and Hak (2011). While this contraction had been in train well before 1992, commencing during the period of perestroika, 1992 forms an appropriate beginning to the time series for this study as it is the first year for which most successor states have separate statistics for most materials.

This paper is structured as follows: A brief description of the methodology used to construct the underlying database is provided in Section 2, with a much more detailed technical annex provided as supporting information. Section 3 describes and illustrates salient points about material flows and aspects of resource efficiency for the region as a whole, then for three individual focus countries. The drivers of material flows are then discussed within the context of an IPAT framework. Section 4 provides a general discussion and conclusions, and also

suggests further research to follow up on an apparent link between growth and material intensity found for this region.

2. Methods and Data Sources

The methods used for compiling national material flow datasets for EECCA economies are largely consistent with the current methodological guidelines set out in Eurostat (2011), but include a number of methodological refinements for biomass and metal or accounts that have been developed by the authors and applied for regional studies of Asia and the Pacific (Schandl and West, 2010) and Latin America and the Caribbean (West and Schandl, 2013).

As described in detail in those studies, we base accounts for grazing of livestock on a detailed analysis of meat and dairy products and the energy demand required for their production and an analysis of the feed gap whereas most other studies base their grazing accounts on livestock numbers (Fischer-Kowalski et al., 2011). The main data sources we used for biomass were FAO (2011a) for crop biomass and FAO (2011b) for wood. Coefficients to determine crop residues were sourced from Haberl et al (2007), while all coefficients relating animal product output to feed inputs were derived from Wirsenius (2000).

For metal ores, the deciding methodological issue is about the decision you take on ore grades and we have chosen to apply historically variable grades reflecting changes in deposit quality and extraction technology but have not been able to employ ore grades specific to regions and countries as done, for example, in individual country specific studies such as Mudd (2007a,b). The base data sources used for metal ores and industrial were Matos (2009), UN Statistical Division (2011a), and USGS (2011). Ore grade factors are based on the extensive published and unpublished research of Gavin Mudd (Mudd, 2007a,b), except for copper ore grades, which are based on Gerst (2008).

Construction materials are based on applying a time varying multiplier to apparent consumption of cement, determined from Matos (2009), and UN Statistics Division (2011b). Fossil fuel data has been sourced from IEA (2011), with minimal transformation. Modification to the source data required to apply the MFA method guidelines is explained in Schandl and West (2010) and West and Schandl (2013). The fact that methods used for this study are similar to the previous regional studies allows direct comparison of the results from the three regional datasets. A more detailed account of the procedures used is contained in the supporting information to this article.

Based on the accounting framework used we derive a set of indicators which represent direct material flows including Domestic Material Extraction (DE), the Physical Trade Balance (PTB) and domestic material consumption (DMC), i.e. a set of standard indicators. Direct indicators do not reflect the amount of resources that have been mobilized outside of a country's territory to satisfy domestic consumption nor do they report on such flows that have been mobilized but not entered the economy such as large earth movements in mining or by-catch in fishing, i.e. hidden flows. The focus on direct flows makes the analysis highly compatible with the system boundaries of national accounts but ignores the global impact of consumption on material utilization and important environmental impacts especially in primary industries. Despite the limitations the accounts and indicators presented here allow us, for the first time, to analyse the material use dynamics of the EECCA region and also provide the data needed for the analysis of the material footprint of consumption (Wiedmann et al., 2013). A good treatment of where and why DMC has been used in recent work, and of its relationship to other material flow indicators, is contained in Giljum et al. (2014).

To analyse the broad drivers of material use, a variant of the Impact = Population × Affluence × Technology (IPAT) framework is used in this research. The method used was employed in West and Schandl (2013) and is described there but essentially is based on earlier work by Herendeen (1998). In our study DMC is used as a proxy for environmental impact (I), a per capita exchange rate

² Regions in the same nation probably best describe the functional role of individual Soviet Socialist Republics, even though they were nominally independent republics.

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