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Improving the knowledge base on material flow analysis for Asian developing countries: A case study of Lao PDR

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ABSTRACT

National material flow accounts have reached maturity over the past decade. Many countries, including the European Community and Japan, now report material flows as part of their national statistical reporting. Global and country by country data has been prepared by the International Resource Panel of United Nations Environment, filling a reporting gap for many countries of the global South. In this research we establish, for the first time, a national material flow account for a low-income country – Lao People's Democratic Republic – which is solely based on national statistical data from the Lao PDR and in-depth information on the specifics of a low-income, Southeast Asian economy. We develop accounts for domestic extraction and trade for the period 1988–2015. In contrast to existing accounts based on international data sources, our calculation of material flows in Lao PDR includes detailed information about the mining sector, agriculture (including livestock fodder and subsistence economy), forestry and timber harvest which are not available from the international data. The results indicate that domestic material extraction increased ten-fold from 11.3 million tonnes to 120.1 million tonnes, driven by the extraction of natural resources for infrastructure development and primary resource export-oriented sectors. We also engaged with the Lao PDR National Statistical Office to improve trade accounts and have added sensitivity analysis to our accounts. This allows us to test the robustness and credibility of the international datasets that are filling the gap in the absence of national accounts in many developing countries in Asia and beyond.

1. Introduction

Material flow analysis (MFA) is an analytical framework used to assess domestic extraction and trade of materials and the disposal of waste and emissions by a national economy in a way that is compatible with economic accounting and the System of Integrated Environmental and Economic Accounting (SEEA) (Ayres and Simonis, 1994). The accounting framework has reached maturity in the past couple of decades (Fischer-Kowalski et al., 2011) and has become part of official statistical accounting in many countries, most notably in the European Union (EU) and Japan. In these countries MFA has become a core component of environmental accounting and serves as a basis for evidence-based policy making. The Japanese government's Sound Material Cycle Society high level policy objective, for instance, uses three indicators derived from material flow accounts (Takiguchi and Takemoto, 2008) to support the implementation of a 3R policy agenda. Similarly, in the EU, resource productivity is used as the lead indicator, along with other MFA indicators, in the EU Resource Efficiency Scoreboard to measure progress toward increased resource efficiency of individual Member States and the European Union as a whole (European Commission, 2017).

Resource efficiency has become an important objective of the G7 major economies, which launched a new initiative in Germany in 2016 that requires the integration of resource management and economic policy in one coherent framework (Bringezu et al., 2016). In the G7 Toyama Environment Ministers' Meeting held at Toyama, Japan in May 2016, the Toyama Framework on Material Cycles reaffirmed the G7's active leadership in environmental policies with the common vision of enhancing resource efficiency and promoting the 3Rs (Ministry of the Environment Government of Japan, 2016). Implementation of the new Sustainable Development Goals (SDGs) and the monitoring of progress toward goals and targets that address resource productivity, sustainable resource management and resource efficiency at industry level are especially important for low-income countries that have large development needs and require timely and affordable natural resources. Despite this essential need for the materials that will underpin human

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development and prosperity, many low-income countries use their domestic natural resources to generate export revenues, i.e. their resources benefit people in other parts of the world, mostly in high income countries (Wiedmann et al., 2015).

Information needs for low-income countries are substantial but the institutional capacity, financial resources and human capital for statistical reporting are often lacking (UNEP, 2013). Nevertheless, there are a number of examples of material flow accounts for developing countries and regions that have been prepared by academics, often with support from the United Nations (UNEP, 2011).

Several studies have employed standard Eurostat methodology for national material flow accounting and hence provide datasets and indicators that are comparable across countries. MFA datasets now exist for the Philippines (Martinico-Perez et al., 2016), India (Singh et al., 2012), China (Wang et al., 2012), and Asia and the Pacific (Schandl and West, 2010), as well as for the global level (UNEP, 2016). However, many of these studies sourced their data from international databases and utilized international parameters, not giving due justice to special characteristics of low-income economies, such as their considerable share of subsistence economic activities, underreporting and grey economic activities, and particular features of their agricultural and livestock systems.

In this study for the Lao People's Democratic Republic (Lao PDR) we chose a different strategy for establishing material flow accounts, relying as much as possible on nationally available data. Lao PDR is a land-locked country located in the center of the Indochinese peninsula, with a small population of 6.4 million and a very low population density of 27 persons per km^2 (Lao Statistics Bureau, 2015b). Over the past decade the Lao economy has grown strongly, with the annual Gross Domestic Product (GDP) growth rate consistently over 7%. Per-capita GDP increased from 324 US$ to 1818 US$ between 2000 and 2015 (World Bank, 2017a) but Lao PDR is still considered to be one of the least developed countries in Asia. Lao PDR is rich in natural resources including metal ores, fossil fuels, timber, non-timber forest products and hydroelectricity. The structural composition of the Lao economy has shifted from agriculture to industry and services since the economic liberalization of 1986. The proportion of GDP generated by the agriculture sector shrank from 52.1% to 23.8% over the period 2000–2015 (Lao Statistics Bureau, 2015a).

The United Nations Environment Programme has invested in material flow accounts since 2011 (Schandl et al., 2010; UNEP, 2011). This has underpinned a number of reports which provide MFA datasets for all countries in Southeast Asia, including Lao PDR (UNEP, 2015). We use the international dataset as a benchmark for the current study and aim to show how the use of national data and expertise leads to different results in MFA accounts. To put it another way, we consider how accurate material flow accounting based on international data sources is for low-income countries. The latest methods guide from Eurostat (2013) suggests that using domestic statistical data and country-based parameters to compile a national MFA account could deliver more realistic results.

Due to steady development in Lao PDR over the past decade, we believe that the structure and level of resource use will have changed. This is a good opportunity for Lao PDR to update its industrial ecology knowledge, and could provide information for policy makers to integrate results of our study into the national development strategy. Lao PDR has only just started to build up significant infrastructure to support economic development. The need to catch up with its neighbors in urbanization and industrialization and to improve the material standard of living of its people will require a massive amount of materials. Appropriate policies to support sustainable resource use and resource efficiency are necessary to guide Lao PDR's development planning. Historical trends on material extraction and consumption patterns are key information for policy makers. Integrating sustainable resource use into economic development could enable Lao PDR to identify strategies to increase the country's competitiveness, and achieve the aspired economic benefits at lower environmental cost. With this study we wish to build an evidence base for resource policy in Lao PDR. The objectives of this study are:

- to provide insight into resource use in relation to economic development in Lao PDR by establishing robust data and indicators for material extraction and trade
- to compare national MFA data for Lao PDR with previous studies and selected countries in the region
- to improve the methodology for material flow accounting in low-income countries
- to discuss the results with respect to their importance for resource management policy and the Sustainable Development Goals.

2. Methodology and data sources

Economy-wide material flow analysis (EW-MFA) is an analytical framework to provide information on natural resource use for a national economy. The European Statistical Office (Eurostat) played an important role in the development of the EW-MFA methodological guidelines. Eurostat's EW-MFA compilation guidelines have been widely used to compile EW-MFA at global, regional and national scales. In this study, the latest Eurostat EW-MFA guidelines (Eurostat, 2013) will be used as the main framework to discover the resource use patterns of Lao PDR for the years 1988–2015. To estimate some materials that are missing in the official statistical reports, the standard approaches suggested by Eurostat will be used along with adaption to appropriate country-based coefficients. The materials were distinguished into 33 types and aggregated into four main material categories including biomass, metal ores, non-metallic minerals, and fossil energy materials. We accounted for the main EW-MFA indicators such as Domestic Extraction: DE, Imports: IMP, Exports: EXP, Physical Trade Balance: PTB and Domestic Material Consumption: DMC.

2.1. Domestic extraction

2.1.1. Biomass

Data for the dataset on domestic extraction of biomass was obtained from the Center for Agricultural Statistics of the Department of Planning and Cooperation, Ministry of Agriculture and Forestry of Lao government through an official data request letter; it covers the majority of crops in Lao PDR (Ministry of Agriculture and Forestry of Lao PDR, 2015a). The sub-category of crops has been aggregated from 34 different crops recorded in national agricultural statistics. Crop residues are not reported in agricultural statistics and were estimated for key crops including rice, maize, soybeans, and sugar cane. The estimates were based on harvest factors and recovery rates provided by Eurostat (2013) and were adjusted for local conditions. In Lao PDR, fodder crops are mainly used to feed pigs and poultry and were calculated using a demand-side approach. Total demand for fodder crops was estimated based on the number of pigs and poultry, and feeding factors provided by the Lao government (Ministry of Agriculture and Forestry of Lao PDR, 2015b).

Animal feed recorded in the industrial products statistics was deducted from total fodder demand to estimate fodder crops. Grazed biomass was estimated in a similar fashion. Feed demand for livestock was separately estimated for four different livestock categories including buffalo, cattle, goats and sheep based on the number of livestock in the agriculture dataset and feeding factors provided by the Department of Livestock and Fisheries, MAF (Ministry of Agriculture and Forestry of Lao PDR, 2015b,c). Following Eurostat (2013), estimated fodder crops and grazed biomass were converted to air dry weight, i.e. 15% moisture content.

Due to the lack of data on wood production in Lao official statistics, the Food and Agriculture Organization (FAO, 2017) database was used to fill the gaps. Based on the FAO wood and timber production figures,