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主 論 文 の 要 旨

論文題目 **Socio-economic Material Metabolism of the Philippines /**
 フィリピンにおける社会経済に関わる物質代謝

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論 文 内 容 の 要 旨

Technological advancements enable to transform materials and energy from natural environment into usable forms, to improve and develop society and economy. Such advancement, together with demographic change and economic growth resulted in fast growing global material consumption. Growing material requirements of socio-economic processes, however, are responsible for the degradation of natural environment through intensified resource extraction, and increasing waste disposal and emissions.

Countries are now confronted with growing challenges of improving the economy while protecting the environment. The very economically dynamic Asia-Pacific region has become crucially important for global material use that is reflected in the increased volume of scholarly studies of socio-economic metabolism and material flows for the region and for specific countries. However to date, many countries have only been examined as constituents of global regions, obscuring country-specific details which may be key to understanding patterns of material needs and economic development. This PhD research project aimed to fill this gap and contribute to the body of knowledge in the field of industrial ecology through an in-depth examination of the material flows and stocks mobilized by economic development and policy in the Philippines. This served as a case study for the socio-metabolic transition of a medium-sized emerging economy in the Asia-Pacific region and perhaps beyond. This research developed a full material flow account for the Philippines to establish the trends, identify driving forces, monitors progress in decoupling of economic growth and environmental pressure, and material efficiency in the country.

The first chapter of the thesis that resulted from the research project introduced the background, motivation, research objectives and presented the main research question “What are the trends of socio-economic metabolism in the Philippines?” Furthermore, the scope and limitations and structure of the dissertation were provided in this chapter. In essence, the aim has been to develop a knowledgebase that

helps policy makers to address the dual objective of human development and environmental and resource conservation through resource efficiency and natural resource management policies. The timeliness of this approach has been reinforced by the recently agreed Sustainable Development Goals which address similar issues and require data and indicators that this study has produced.

The second chapter compiled the principles and theories, framework and refers to seminal studies employing economy wide material flow accounting and analysis. It discussed the system boundaries, and the relationship of the physical economy and the natural environment. It also introduced the Philippines, its socio-economic profile, and national environmental and developmental policies.

The third chapter presented the methodology to develop the material flow database of the Philippines which covered the period from 1980 to 2014. It highlighted methodological improvements of the accounting tailored to the economic and metabolic characteristics of an Asian developing country. It thereby extended the Eurostat methods guidelines. Data sources, estimations, and indicators derived from the database were also discussed in this chapter.

The fourth chapter showed the trends of material flows and stock of the Philippines. It showed that during two decades the input, production and consumption of resources has doubled in the Philippines, and the country shifted from net resource dependence in 1980 to a net resource provider in 2014. The domestic extraction was further elucidated at the provincial level. Furthermore, this chapter provided the output indicator by showing the trends of material outflows to three environmental gateways – atmosphere, water and land. The waste and emissions released to the environment had tripled from 1980 to 2014. Net addition to stock grew slower than waste and emissions that is testament of a lack of infrastructure investment in the Philippines.

The fifth chapter presented the analysis of socio-economic metabolism of the Philippines. It showed that the country has transitioned from a biomass or renewable based to nonrenewable-based socio-economic system that has become dependent on large amounts of non-renewable materials creating new environmental problems. The research found that population growth was the primary driver of material consumption but has been overtaken by affluence since the year 2000. Relative changes in resource use expressed as production indicator, Domestic Material Consumption (DMC) and consumption indicator, Material Footprint (MF) grew in unison but at a lower rate than GDP. This meant that a relative decoupling of material consumption and economic growth in the Philippines had been achieved. The Philippine economy grew while reducing the material intensity of the economy because of the increasing share of GDP occurring in the relatively less material intensive services sector. In the same vein, the output to the environment, indicated by Domestic Processed Output (DPO) grew at a lower rate than GDP from the year 2005. This relative decoupling does not mean an overall reduction of DPO since the environmental Kuznets curve shows growing pressure on the environment as the economy grows.

The sixth chapter presented the policy implications of the research project. It showed how this study

responds to the information requirements of a modern environmental policy stance that looks at economy and environment simultaneously. This knowledge base has not previously been available in the Philippines. The study findings called for strengthened policies on resource efficiency, waste minimization and greenhouse gas abatement. The dataset also showed slow progress in achieving Sustainable Development Goal (SDG) targets 8.4, 12.2 and 12.5.

The seventh chapter concluded this study. It provided details of achievements based on the objectives. The limitations and the areas for future studies were also presented in this chapter.

The core of this research has been published in three peer-reviewed journal publications in high-level journals including *Journal of Industrial Ecology*, *Ecological Economics* and *Resource Conservation and Recycling*. Beyond the contribution to the scholarly literature and knowledgebase for the science of industrial ecology the study has also presented a data set and indicators that is relevant to public policy in the Philippines and in other ASEAN economies.