# Measuring sustainability: an elaboration and application of the system of environmental-economic accounting for Indonesia

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## Summary

Indonesia is experiencing various environmental challenges related to its fast economic growth. Therefore, it is necessary to have measurable and applicable indicators to obtain accurate data and information regarding the costs of adverse environmental impacts arising from economic activities to support more effective and targeted decision-making. Therefore, this thesis aims to answer how we can set up environmental-economic accounts in developing countries such as Indonesia and how such accounts can support both development as environmental policies. So, the overall objective of this PhD thesis can be formulated as follows: *how can we set up environmental-economic accounts in developing countries such as Indonesia, and how can such accounts support both development as environmental policies?*

This overall aim will be supported by answering the following research questions:

1. Focusing on developing countries in general: what is the potential of the SEEA in supporting the monitoring of SDGs indicators, what is the current state of the SEEA implementation, and what are the barriers for a comprehensive SEEA implementation? (Chapter 2)

2. How can we enrich the Indonesian SNA with environmental costs accounts and what are the sectors and types of environmental interventions for which such accounts have to be developed with the highest priority? (Chapter 3)

3. Using the SNA enriched with environmental cost accounts, what final demand components drive most external costs and hence would be priorities for consumption-based policies? How much are the environmental costs for each final demand component in Indonesia, what are the economic sectors which perform best when both economic and environmental performance are considered simultaneously? (Chapter 4)

4. How can we use the SNA enriched with environmental cost accounts to assess the economic and environmental implications of investment in new economic activities, illustrated by the potential use of Indonesian natural resources to produce electric vehicle batteries and electric vehicles? (Chapter 5)

The starting point of this thesis illustrates how the System of National Accounts (SNA) as expanded in the System of Environmental and Economic

Accounts (SEEA) can be used to analyze the economic and environmental pillars of sustainable development and those related to the Sustainable Development Goals (SDGs) (question 1). Afterward, an exploration is carried out to assess the priorities for improving and expanding environmental accounts in Indonesia, utilizing environmental costs related to emissions and resource extraction in Indonesia to measure priority (question 2). We then combine such environmental cost accounts with the Indonesian input-output table of 2010 to explore Indonesia's environmental costs related to emissions and the use of forest resources from a consumption perspective, and identify priority sectors in terms of economic and environmental performance using linkages analysis (question 3). Finally, a simulation is conducted to analyze the economic and environmental impacts of electric vehicle (EV) production in Indonesia (question 4).

Chapter 2 assesses the potential of the SEEA to contribute to monitoring SDG-related indicators. This chapter also analyzes the current level of the SEEA implementation and barriers to implementation of the SEEA, with a special focus on developing countries. The findings confirmed that the SEEA is a very useful accounting system to cover SDGs. As a standard international statistical framework, the SEEA has a great potential to support the monitoring of SDG indicators and asses priorities with regard to development and environment in each country. Indicators and analytical methods based on SEEA exist already that can support the national SDG processes. Indicators relevant for monitoring progress to the SDGs in general are conceptually clear, can be based on an internationally established calculation methodology, and can be calculated by information that is can be derived from the SEEA. However, the success of the SEEA in supporting the SDGs will largely depend on the ability of countries to develop their SEEA-based accounts in an internationally comparable manner.

The SEEA aims to cover environmental and economic aspects in general. Due to a difference in economic structure however, emphasis of what is relevant for developing and developed countries may differ. In most developing countries, natural resources management and energy security are important issues to be covered in such accounting programs. But in most developed countries, the focus is more on expenditure flows, economic instruments, resource efficiency, and environmental degradation related to economic production and consumption activities. Barriers to the SEEA implementation, particularly in developing countries, are related to several issues. An inquiry among practitioners and a literature survey showed that data availability, data quality, and lack of human resources are the three main obstacles at the compilation stage and further development of the environmental-economic

accounts. There are strong indications that financial and technical assistance from international institutions plays an essential role in supporting the successful development and implementation of the SEEA, especially for developing countries. Countries without regular government funding experience greater obstacles in developing their SEEA accounts.

Chapter 3 focuses on research question 2. The chapter describes an initial effort to assess environmental costs related to emissions and resource extraction by economic sector in Indonesia. This exercise had as goal to identify priority sectors, emissions and resource extractions for which more precise data are desirable. According to the calculation results, the total environmental costs in Indonesia were around 13% of GDP in 2010. Indonesia's total environmental costs are mainly due to the depletion of energy and mineral resources, which account for about 55% of the total environmental costs. The remaining 38% came from environmental costs due to environmental degradation from air pollution, and almost 7% due to environmental costs caused by the destruction of the ecosystem. We can conclude that the Indonesian Central Bureau of Statistics (BPS) is on the right track by prioritizing mineral and forest accounts in its compilation and publication of the environmental-economic accounts. However, BPS has not yet been able to include environmental accounts related to environmental degradation caused by air emissions, while chapter 3 shows air emissions contribute significantly to external costs in Indonesia. If BPS would invest in setting up emission accounts, it highly recommended to include data on air pollution emissions from electricity sector; manufacture of basic iron and steel and of ferro-alloys and first products thereof & re-processing of secondary steel into new steel; mining of coal, lignite, and extraction of peat, and 7 other sectors that contribute the most to Indonesia's environmental costs. These top ten sectors cover 73% of the environmental degradation due to air pollution. The top ten air pollutants are responsible for 93.70% of the external costs related to air emissions, with SOx, NOx, and $CO_2$ being most important.

Chapter 4 examines Indonesia's environmental costs from emissions and forest resources from a consumption perspective and identifies the priority sectors in terms of economic and environmental performance. Environmentally Extended Input-Output (EEIO) analysis is used for this purpose. For this purpose, the environmental extensions and external costs by sector as identified in Chapter 3 were linked to the Indonesian Input-Output table. Based on the calculation results, it is estimated that the environmental cost of emissions driven by final demand are about 7% of the Indonesian GDP. The environmental costs of these emissions arise primarily from domestically produced final consumption, with household consumption becoming the most

significant contributor to total environmental costs of emissions, followed by environmental cost from the gross fixed capital formation, and export. On the other hand, the environmental cost of forest resources is only about 7.5% of the total environmental cost, with gross fixed capital formation and household consumption being the main final demand components that contribute to environmental costs from forest resources. Finally, a forward and backward linkage analysis was done to assess how growth in economic activity in a specific sector would influence overall value added and external cost generation in Indonesia. This analysis pointed out that stimulating economic activity in the following sectors would maximize economic growth with minimal additional external costs: manufacture of textile; publishing, printing, and reproduction of recorded media; chemicals n.e.c.; manufacture of other non-metallic mineral products n.e.c.; construction; and other land transport. Stimulation of economic activity in these sectors will hence have a more than proportional positive impact on Indonesia's economic development, with a relatively limited increase in external costs.

Chapter 5 answers question 4. A simulation is conducted to analyze the economic and environmental impact of electric vehicle (EV) production in Indonesia. The impacts are analyzed by a simulation scenario that assumes that all the nickel ore currently exported by Indonesia will be absorbed for further processing in new domestic economic activities. These new activities are assumed to consist the production of electric vehicle batteries (EVB) and electric vehicles (EVs), assuming that all EVs produced are destined for export. The simulation results indicate that the production of electric vehicles positively increases output, value-added growth, and job creation of the Indonesian economy with respectively 1.87%, 1.5%, and 0.5%. This finding forms the defensible justification for the Indonesian government's ambition to use its large nickel reserves to stimulate fast-growing upstream user industries, such as battery and EV production. The simulation also found that EVB and EV production create additional external costs of emissions. The amounts are, however, insignificant. The extra external costs as a percentage of the extra GDP generated by these two sectors is only around 2.2%. It should be stressed that the simulation assumes that all produced EVs will be exported. Using EVs domestically can reduce the production of traditional vehicles and, therefore, lower job gains and value-added. EVs do not have direct emissions, which, if they replace traditional vehicles domestically, have the potential to lead to reduced external costs, depending on the carbon intensity of the electricity used.

Chapter 6 concludes that the SEEA plays an essential role in supporting sustainable development and a green policy agenda, also for countries with

abundant natural resources like Indonesia. This thesis shows that many economic and environmental indicators relevant for measuring progress to the SDGs at the national or global level can be measured via integrated environmental-economic accounting systems. Therefore, data that are included in comprehensive accounting databases combining the SNA and environmental satellite systems (SEEA) are very relevant for analyses in the context of scientific policy advising. Information from SEEA can primarily be used as a basis for policy approaches to integrate environmental concerns into sector policies or - more broadly - for policies towards sustainable development. The SEEA covers both environmental and economic SDGs well. In chapters 3-5, we demonstrated how the SEEA is a powerful tool for setting priorities, analyzing environmental priorities, and assessing the impacts of economic development on SDGs. That suggests the SEEA is vital. As we saw in chapter 2, implementation can be complex, but it can be overcome with financial resources and technical assistance. Finally, this thesis gives several recommendations to overcome obstacles in the implementation of the SEEA, both at the preparatory stage and in the further development of the environmental-economic account. The first one is to build linkages between sustainability measurement and policy implication. The sustainability measurement results best include an analysis component in their routine report and built-in feedback to the relevant stakeholders. In Indonesia, its statistics office (BPS) is recommended to strengthen the current system of environmental-economic accounts by establishing priority accounts based on policy needs to address national policy priorities, including green economy, and monitoring SDGs. In addition to the mineral and the forest accounts that BPS has carried out, the account that should be prioritized is the air emissions accounts, which in this study is the second contributor to the total environmental costs in Indonesia. Next to this, it is recommended to enhance integration/coordination between different institutions that have environmental and economic data available. The coordination mechanism must be regulated in the provisions and regulations related to data so that the coordination procedure is clearly described. Third, it is recommended to enhance training and capacity building with regard to environmental-economic accounting. Such capacity building provides a better understanding of the concepts and engages experts in professional development through collaborative activities, staff exchanges, and training on data compilation, analysis, and evaluation. Fourth, partnerships and coordination should be enhanced with International and donor agencies. Lastly, a data quality assurance mechanism should be developed.