MinFuture

Fostering Resource Security and Sustainable Development through improved monitoring of the Physical Economy

MinFuture Policy Brief (D6.4.1)

Summary

Many of today's large societal challenges, such as climate change mitigation, resource security, urbanisation and migration require a fundamental transformation of the way we use natural resources. However, our understanding of the stocks and flows of materials and energy (the physical economy) is highly fragmented and involves significant knowledge gaps. The current practice of monitoring selective flows at reference points that are not clearly defined is inefficient and expensive and hinders robust quantitative systems analysis needed for effective policymaking. The MinFuture project has developed of a framework aimed at providing guidance on how to perform a more systematic monitoring of the physical economy, as well as steps helping to implement such a system.

Key recommendations

1. Develop a data infrastructure for material and energy stocks and flows that integrates stocks and flows data from governmental statistics and individual projects into a systems context.

2. Establish legal and institutional conditions, at relevant governance levels, to support the development and maintenance of this data infrastructure.

3. Address main knowledge gaps on the accounting of (i) geological stocks, (ii) anthropogenic (in-use) stocks, and (iii) supply chains.

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1 What is the need for monitoring raw material stocks and flows?

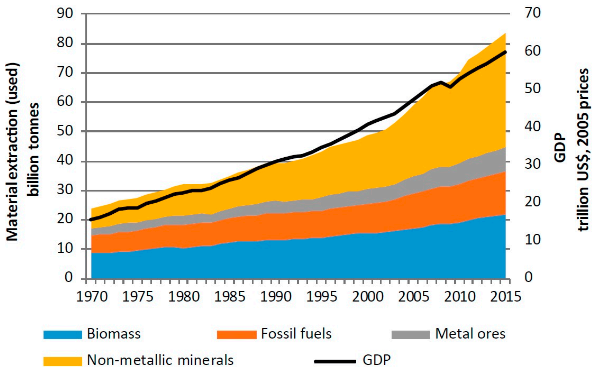
Raw materials are the backbone of modern societies and all industrial supply chains. They play a prominent role in global socio-economic development, particularly in countries with emerging industries or industries already in place. Advancing effective raw material policies that address materials flows along supply chains, hence, is of vital importance for sustainable economic growth, competitiveness and prosperity.

Global use of raw materials has steeply increased in recent decades as consequence of global trends such as population growth, urbanisation, proliferation of westernised consumption patterns, and technological development. The associated increase in magnitude and complexity of global material flows raises concerns about future raw material availability and security of supply, particularly regarding critical raw materials. Furthermore, the above-mentioned global trends go hand in hand with social and environmental impacts related to increasing energy use, waste generation and CO_2 emissions. This poses a challenge to sustainable development and achieving environmental policy objectives regarding climate change, resource efficiency, and circular economy.

Developing effective strategies for addressing these challenges requires a robust understanding of the complex system of material and energy flows in the economy – the physical economy. Monitoring the physical economy is essential for informing robust strategic policy-making, e.g. for

- Identifying priority areas for strategic policy-making;
- Forecasting potential challenges, risks, and opportunities related to raw materials management;
- Evaluating the effectiveness of alternative policy strategies and identifying potential synergies and trade-offs (e.g. problem shifts).

Figure 1: Global material extraction in billion tons, and global GDP in trillion US dollars [1]

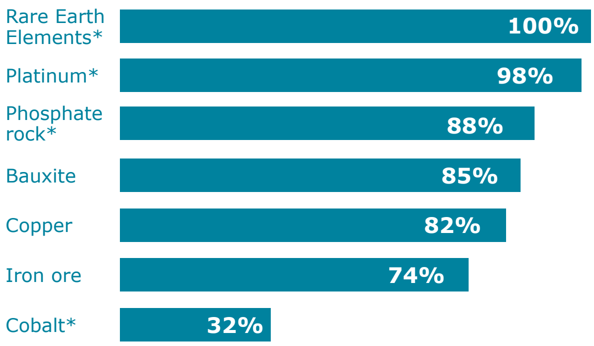


Source: Material extraction data from ((2016a), GDP from UNSD (2015).

Industrialised and emerging economies with high demand for and low domestic production of important raw materials can benefit particularly from a systematic monitoring of the global physical economy. That is the case for the EU, which is highly reliant on imports for several strategically and economically important materials (see Figure 2).

The availability of robust information about anthropogenic material cycles allows for developing realistic scenarios of future raw materials management. When communicated adequately to decision-makers, these scenarios can serve as a solid basis for developing new policies or monitoring the impact of already existing

Figure 2: Import reliance of EU member states for selected raw materials in percent [3]



* Critical raw materials (CRM) according to the 2017 list of CRMs for the EU

policies. Examples of policies that would benefit from a robust physical monitoring at the EU level are, for instance, the Strategic Implementation Plan of the Raw Materials Initiative (RMI), the Circular Economy Action Plan, or the Battery Action Plan.

Furthermore, a systematic monitoring of the physical economy is also crucial for simultaneously achieving various goals set through existing international policy regimes. For instance, it allows for a more effective monitoring and forecasting of greenhouse gas (GHG) emissions and, thus, of compliance with the Paris Agreement. Moreover, a system understanding of the physical economy is important to address several SDGs under the 2030 Agenda (see Figure 3).

Figure 3: Examples of SDGs benefitting from a systematic monitoring of the physical economy (www.globalgoals.org)

2 What is the challenge of monitoring the physical economy?

At present, systematic programmes for monitoring the physical economy appear widely lacking. There have been several attempts to monitor various stocks and flows of materials and energy (also known as physical accounting) from different sources in order to provide a more systematic overview of the physical economy. At EU level, for example, EUROSTAT has established a monitoring programme on economy-wide material flow accounts (EW-MFA), and DG-GROW commissioned a study on Raw Material System Analysis (RMSA).

Nevertheless, despite such initiatives, current methods and models for monitoring global cycles of materials still face numerous limitations. In particular, they have a limited system perspective and predominantly focus on monetary transactions. Furthermore, their underlying data basis is often [4]:

- Highly fragmented, as government agencies in different countries and regions often use different reference points for their measurements, resulting in inconsistent data that require harmonisation; or
- Measured but not available due to confidentiality reasons; or
- Not measured at all and, hence, needs to be estimated often on weak grounds resulting in large uncertainties.

A further challenge that monitoring institutions face, for instance the national statistical institutions in the EU member states, is the reliance on data from other organisations, for instance the United States Geological Service (USGS).

Existing models are thus heterogeneous and incompatible and the data they produce are often unreliable and difficult to interpret for scientists and policy-makers alike. Thus, they are insufficient to address the resource security and sustainability challenges described above. This highlights the need for further development of a systematic monitoring of the physical economy that can effectively contribute to informed policy-making.

3 What could be done to solve it?

MinFuture Framework – A possible improvement for monitoring the physical economy

The systematic monitoring of the physical economy faces several structural and methodological limitations, which hamper its effective use in policy-making. In this context, the EU financed Horizon2020 project MinFuture has developed a framework, which intends to help identifying and overcoming these limitations

The framework roots in the methodology of Material Flow Analysis (MFA). It consists of seven components, organised in a hierarchical structure. Thus, a fundamental principle of the framework is that the robustness of upper levels depends on the robustness of lower level components (see Figure 4):

- **Data** on stocks and flows are only meaningful if the reference points of the measurements in the **system** are clearly defined and communicated. A well-defined system thus enhances the robustness of the monitoring.

- These are the preconditions for developing **models and scenarios** and for analysing the **uncertainty** associated with the MFA.

- Once the complex system of a material cycle is understood, it is possible to develop appropriate quantitative measures or **indicators**. These serve as a basis for analysing and comparing the performance of different sectors or countries and for determining policy priorities. Elaborating easy-to-understand **visualisations** helps to communicate the outcomes of models and their uncertainty.

- At the top of the pyramid stands the ultimate goal of MFA, namely to **support the decision making** process and to facilitate the development of **strategies** from governments and industries.

Further information:
https://minfuture.eu/framework

Figure 4: The MinFuture Framework pyramid [5]

4 How could this be achieved?

In order to move away from monitoring individual and isolated flows towards a systematic monitoring of the physical economy, we recommend:

- Developing a data infrastructure for material and energy stocks and flows that integrates stocks and flows data from governmental statistics and individual projects into a systems context. This is a large task requiring coordinated efforts between different government, businesses, and research institutions as well as facilitation through legal and institutional means.

    - There is a need for **institutions** that have a mandate and the necessary resources to coordinate the data integration at the national, EU, and global levels. For this purpose, MinFuture calls for the establishment of a high-level working group, which will evaluate institutional options to coordinate the monitoring of the physical economy. Organisations such as the IRP, IEA, OECD, UNSD IGF, and UNECE could play an important role in establishing such a group.

    - **Legal interventions** have a great potential to facilitate the development of a data infrastructure for physical accounting. At the EU level, legal options include the possibility of either amending the existing INSPIRE Directive or preparing a new Directive for monitoring the physical economy. Setting out clear legal conditions is important as they provide the right motivation to national governments to move in this direction. Moreover, they help ensure that data infrastructure on physical material stocks and flows is compatible and usable across national boundaries. For this purpose, common implementing rules are needed, for example in data specifications, metadata, data services and data interoperability.

- Addressing the main knowledge gaps that exist regarding the physical accounting of:

    - **Geological stocks**. A mass-balance consistent accounting of geological stocks does not yet exist. Securing access to future minerals supply requires in-depth knowledge of the quantities and qualities of materials stored in the earth crust. For this purpose, a framework for reporting mass-balance-consistent figures of geological stocks over time and space is required. Additionally, further developments and improvements in 3D geological models are necessary in order to provide important underpinning knowledge about geological stocks.

    - **Anthropogenic (in-use) stocks**. Here, we recommend the development of a standardised methodology and framework for physical accounting of anthropogenic stocks, which will provide consistent terminology, calculation methods and enable the integration of existing accounting approaches. In addition, data need to be produced using techniques and tools, such as remote sensing, GIS, 3D city models and others describing the built environment.

    - **Production and trade**. Statistics of production and trade are inconsistent, which greatly hampers the possibility to track materials through the supply chain. We recommend the establishment of an international expert group working on a long-term goal to harmonise production and trade statistics from a global supply chain and material cycle perspective.

References

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3 European Commission (2017). Study on the review of the list of Critical Raw Materials – Critical Ray Materials Factsheets. Luxembourg: Publications Office of the European Union

4 Petavratzi, E.; Allesch, A.; Müller, D.; Liu, G.; Rechberger, H.; Cullen, J.; Lundhaug, M.; Simoni, M.; Heldal, T.; Cao, Z. (2018). A systems approach for the monitoring of the physical economy - MinFuture framework. MinFuture Deliverable D5.1, British Geological Survey.

5 MinFuture project (2018) A Framework to improve monitoring of the physical economy. https://minfuture.eu/framework

Further reading:

Fact-Sheet of MinFuture project: https://minfuture.eu/monitoring-physical-economy

A systems approach for the monitoring of the physical economy - MinFuture framework: https://minfuture.eu/systems-approach-monitoring-physical-economy

A roadmap towards monitoring the physical economy: https://minfuture.eu/results

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