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EU methodology for critical raw materials assessment: Policy needs and proposed solutions for incremental improvements

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ABSTRACT

Raw materials form the basis of Europe's economy to ensure jobs and competitiveness, and they are essential for maintaining and improving quality of life. Although all raw materials are important, some of them are of more concern than others, thus the list of critical raw materials (CRMs) for the EU, and the underlying European Commission (EC) criticality assessment methodology, are key instruments in the context of the EU raw materials policy.

For the next update of the CRMs list in 2017, the EC is considering to apply the overall methodology already used in 2011 and 2014, but with some modifications. Keeping the same methodological approach is a deliberate choice in order to prioritise the comparability with the previous two exercises, effectively monitor trends, and maintain the highest possible policy relevance. As the EC's in-house science service, the Directorate General Joint Research Centre (DG JRC) identified aspects of the EU criticality methodology that could be adapted to better address the needs and expectations of the resulting CRMs list to identify and monitor critical raw materials in the EU.

The goal of this paper is to discuss the specific elements of the EC criticality methodology that were adapted by DG JRC, highlight their novelty and/or potential outcomes, and discuss them in the context of criticality assessment methodologies available internationally.

1. Introduction

Raw materials form the basis of Europe's economy to ensure jobs and competitiveness, and they are essential for maintaining and improving our quality of life. Securing reliable, sustainable, and undistorted access of raw materials and their circular use in the economy is, therefore, of growing concern within the EU (EC, 2014, 2011; Vidal-Legaz et al., 2016) and globally (Coulomb et al., 2015). Recent years have seen a tremendous increase in the amount of materials extracted and used (Krausmann et al., 2009) together with a significant growth in the number of materials used in single products (product complexity) (Greenfield and Graedel, 2013). Global economic growth coupled with technological change (e.g., low-carbon energy and transportation systems, modern defence and communication systems) will increase the demand for many raw materials in the future (Blagoeva et al., 2016; Pavel and Tzimas, 2016).

"Criticality" combines a comparatively high economic importance with a comparatively high risk of supply disruption (Buijs et al., 2012). In 2008 the U.S. National Research Council proposed a framework for evaluating material "criticality" based on a metal's supply risk and the impact of a supply restriction (NRC, 2008). Since that time, a number of organizations worldwide have built upon that framework in various

Abbreviations: CPA, Statistical classification of products by activity; CRM, Critical Raw Materials; EI, Economic Importance; EOL-RIR, End of Life Recycling Input Rate; GVA, Gross Added Value; HHI, Herfindahl Hirschman Index; IR, Import Reliance; JRC, Joint Research Centre; MSA, Material System Analysis; NACE, Statistical Classification of Economic Activities in the European Community; PPI, Policy Potential Index; RGI, Resource Governance Index; RM, Raw Material; RMI, Raw Materials Initiative; ROW, Rest of the World; SR, Supply Risk; WGI, World Governance Index; WTO, World Trade Organization

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ways (BGS, 2012; DOD, 2013; EC, 2014; Graedel et al., 2015; IW Consult, 2011; Morley and Eatherley, 2008; NSTC, 2016; Skirrow et al., 2013).

Even though all raw materials are important (EC, 2010, 2012, 2015), some resources are obviously of more concern than others. The list of CRMs for the EU (EC, 2014, 2011) and the underlying criticality methodology (Chapman et al., 2013; EC, 2010) are therefore key instruments in the context of the EU raw materials policy. Such a list is a precise commitment of the Raw Material Initiative (RMI) (COM, 2008; EC, 2008) and subsequent updates.

The EU criticality methodology was developed between April 2009 and June 2010 with the support of the European Commission's (EC) Ad-Hoc Working Group on Defining Critical Raw Materials (AHWG-CRM) within the RMI in close cooperation with EU Member States (MS) and stakeholders (EC, 2010). The EC criticality methodology has already been used twice; to create a list of 14 CRMs for the EU in 2011 (EC, 2011) and an updated list of 20 CRMs in 2014 (EC, 2014).

Given the intense and active dialogue with multiple stakeholders, the use of best available data reflecting the current situation and recent past (non-speculative and non-forward looking approach), and considering that fully transparent datasets and calculations were made available to a large group of experts, the EC criticality methodology is generally well accepted in the EU, as well as considered reliable and robust. After the two releases of the list and considering several policy documents that make explicit reference to CRMs (EC, 2015, 2012, 2008), it can certainly be stated that the EC criticality methodology is a well consolidated and reliable tool, which represents a cornerstone of the raw materials policy in the EU.

In view of the next update of the CRMs list (every three years according to the RMI), the EC is considering to apply again the same methodology. This choice of continuity is synonymous with giving priority to comparability with the previous two exercises, which is in turn correlated to the need of effectively monitoring trends and maintaining the highest possible policy relevance.

Nevertheless, some targeted and incremental improvements of the existing EU criticality methodology are required, taking into account the most recent methodological developments in the international arena (BGS, 2015; Graedel et al., 2015; NSTC, 2016; Roelich et al., 2014), evolving raw materials markets at international scale, and considering explicit requests from the European industry and changing policy priorities and needs, e.g., on trade (OECD, 2014). A valuable support also came from recent projects funded by the EU under different schemes, which tackled specific aspects of criticality (e.g., CRM_InnoNet, 2015; ERECON, 2014; EURARE, 2017) and/or contributed to generate European data on flows and stocks of CRMs (BIO by Deloitte, 2015).

As the EC in-house science service, the Directorate General (DG) Joint Research Centre (JRC) provided scientific advice to DG GROWTH in order to assess the current methodology and identify parameters that could be adjusted to better address the needs and expectations toward the methodology of capturing issues of raw materials criticality in the EU. This work was conducted in close consultation with the ad hoc working group on CRMs, who participated in regular discussions with DG GROWTH and other EC services and provided informed expert feedback. The analysis and subsequent revisions started from the assumption that the methodology used for the 2011 and 2014 CRMs lists proved to be reliable and robust and, therefore, the JRC mandate was focused on fine-tuning and/or targeted incremental methodological improvements.

The goal of this paper is to present key new or modified elements of the EU criticality methodology, to highlight their novelties and/or potential outcomes, and to discuss them in the context of criticality assessment methodologies available internationally. A comprehensive presentation of the revised EC methodology is not a goal of the present paper, but will be presented in a future EC publication or communication in view of the third revised list expected in 2017.

2. Materials and methods

2.1. Current EC criticality methodology

CRMs are both of high economic importance to the EU and vulnerable to supply disruption. Vulnerable to supply disruption means that their supply is associated with a high risk of not being adequate to meet EU industry demand. High economic importance means that the raw material is of fundamental importance to industry sectors that create added value and jobs, which could be lost in case of inadequate supply and if adequate substitutes cannot be found.

Bearing the above concepts in mind, criticality has two dimensions in the EC methodology: (1) Supply Risk (SR) and (2) Economic Importance (EI). A raw material is defined as being critical if both dimensions overcome a given threshold (EC, 2014).

The SR indicator in the EU criticality assessment (EC, 2014, 2011) is based on the concentration of primary supply from countries and their level of governance. Production of secondary raw materials (recycling) and substitution are considered as risk-reducing filters.

The supply risk is calculated with the following equation:

$$SR = HHI_{WGI} \bullet (1 - EoL_{RIR}) \bullet SI \quad (1)$$

In this formula, *SR* stands for supply risk; *HHI* is the Herfindahl Hirschman Index (used as a proxy for country concentration); *WGI* is the scaled World Governance Index (used as a proxy for country governance); EOL_{RIR} is the End-of-Life Recycling Input Rate; and *SI* is the Substitution Index (EC, 2014).

The importance of a raw material to the economy of the Union is assessed by the indicator “Economic Importance (EI)”. This indicator relates to the potential consequences in the event of an inadequate supply of the raw material. In previous criticality assessments (EC, 2014, 2011), EI was evaluated by accounting for the fraction of each material associated with industrial megasectors at EU level and their gross value added (GVA).

The economic importance is calculated with the following equation:

$$EI = \sum_s (A_s * Q_s) \quad (2)$$

In the above formula A_s is the share of demand of a raw material in a megasector and *Qs* is the megasector's Gross Value Added (EC, 2014).

The EC criticality methodology considers both abiotic and biotic raw materials. The 2011 assessment considered 41 non-energy, non-agricultural raw materials (EC, 2011), while the 2014 assessment considered 54 candidate materials (EC, 2014).

As a precise policy mandate, in order to maximise comparability with the 2011 and 2014 CRMs lists, the current methodology is to be retained, except for specific aspects for which there were policy and/or stakeholder needs on the one hand to introduce alterations, or strong scientific reasons for refinement of the methodology on the other. These will be discussed in the next sections.

2.2. Policy needs for improvements

The EC criticality methodology, since the publication of the first list of CRMs in 2011, has responded to the needs of governments and industry to better monitor the raw materials situation and inform decision makers about how the security of supply of raw materials can be achieved through diversification of supply, i.e., from different geographical sources but also from primary sources, recycling and substitution and to prioritise needs and actions. For example, at the EU level the list serves as a supporting element in negotiating trade agreements and challenging trade distortion measures, and in programming the research and innovation funding for technological solutions for sustainable production of CRMs or their substitution under the Horizon 2020.