Establishing an environmental sustainability threshold on non-renewable resource use

Concept of environmental sustainability thresholds

Human activities continue to put pressure on the world's natural resources and ecosystems. Many of these natural systems can withstand this pressure only up to a certain threshold – a so-called tipping point – beyond which serious negative and possibly irreversible consequences occur. As the exact thresholds are often unknown, prudence requires identifying danger zones before the threshold is reached, or safety zones in which humanity can safely operate. It is therefore important to find out where environmental thresholds exist, what values they have and to measure the distance to this threshold. This should help to alert policy makers in due time before a danger zone is reached and enable them to respond effectively to avoid unsustainable consequences. One objective of the study to which this factsheet is linked was to propose indicators for environmental thresholds relevant in the EU policy-making context.

Relevance of the topic

On the global level, there is a clear trend of steadily increasing extraction and use of both renewable and non-renewable natural resources for the production of goods and services. The larger fraction are non-renewable resources, i.e. resources which cannot be produced, re-grown or regenerated on a time scale which can sustain their consumption rate (e.g. strategic resources such as fossil fuels, phosphorus, uranium, lithium, neodymium, platinum, rare earths). Non-renewable resources currently account for almost 80% of overall resource consumption in the EU (in terms of mass). The rapidly growing consumption of these resources is causing severe environmental damage, including land use changes and the production of toxic waste and emissions to air and water. For example, air emissions such as sulphur dioxide (SO_2) and nitrogen oxides (NO_x) resulting from the combustion of fossil fuels and the processing of metal ores are associated with harm to human health, the acidification and eutrophication of water and soils, and consequently damage to natural ecosystems, cultural heritage and agricultural crops. Often these effects cross national boundaries, as pollutants in the air can travel a considerable distance away from their source.

Readily available and potential future threshold indicators

For renewable resources, several threshold-related concepts and indicators have been developed. The most prominent example is the Ecological Footprint, which compares human demand for biological capacity with the available biocapacity of the national and global ecosystems.

Establishing thresholds for the use of non-renewable resources is a challenging task. It requires linking current amounts of resource use with negative environmental impacts which show threshold phenomena. This would allow quantifying a maximum level of non-renewable resource use based on the maximum levels of the related environmental impacts that can be sustained by the ecosystem. So far, very few studies on non-renewable resource use have explicitly analysed the correlation or causal relationships between indicators of resource use and indicators of environmental impact. A prominent exception is the link between the burning of fossil fuels and the emission of CO_2 and the related effect

of global warming. Along the same lines, the concept of Environmental Impact Load (EVIL)[1] relates certain environmental pressures from non-renewable resource use (such as greenhouse gas emissions) to critical loads politically defined at national level.

Following the EVIL concept, a new proxy indicator, not linked to climate change, is proposed below, relating the consumption of non-renewable resources of a country to a set of critical loads of air emissions. The non-renewable resources of a country are measured by its "Domestic (non-renewable) Material Consumption ($DMC_{non\text{-}renewable}$)", which is an established indicator on the European level and is used here in per capita terms. The new proxy indicator shows if a country's current level of non-renewable resource use causes national air emissions which are below or beyond an environmental threshold, represented by the national emission ceilings for four types of air emissions: sulphur dioxide (SO_2), nitrogen oxides (NO_x), ammonia (NH_3), and non-methane volatile organic compounds (NMVOC). As EVIL has so far only been tested for Germany, this is the first attempt to provide a cross-country analysis of non-renewable resource use from a threshold perspective across the EU.

Advantages and disadvantages of suggested proxy threshold indicator

The following table summarises the key advantages and disadvantages of the suggested proxy threshold indicator for non-renewable resource use.

$DMC_{non\text{-}renewable}$ per capita in relation to SO_2, NO_x, NH_3, and NMVOC emissions

Advantages	• Domestic Material Consumption (DMC) currently is the most commonly used indicator on resource use in Europe. DMC is included in several core European indicator sets (sustainable development indicators, structural indicators). • As the resource use data is collected on a level which disaggregates a number of materials, the biotic versus abiotic part of DMC can easily be separated. • Emissions data for the four air pollutants is readily available for recent years by the EEA. • The proxy threshold indicator should allow evaluating current levels of non-renewable resource use on the country level (in absolute and per capita terms) from an environmental threshold perspective. It illustrates whether a certain quantity of non-renewable resource use causes air emissions, which are above or below a national air emission ceiling.
Disadvantages	• Difficult to derive resource-specific causal relations between amounts of resource use on the national level and emissions on the national level; thus difficult to derive specific policy suggestions in case non-renewable resource use is above a critical load, as emissions can be reduced by a large number of different actions (substitution of the quantity and quality of different non-renewable resources; applying pollution abatement technologies, etc.). • Both the underlying resource use indicator (DMC) as well as the emissions data do not cover life-cycle wide resource use and life-cycle wide emissions. The suggested proxy threshold indicator is therefore unable to capture burden shifting to other regions due to the outsourcing of resource- and pollution-intensive production. In order to change this, other resource use indicators would need to be applied, which include the non-renewable resources embodied in internationally traded products. Also the emission indicators would need to be based not on a territorial principle, i.e. emissions on the territory of a country, but on a consumption principle, i.e. total global emissions related to the consumption of a country. However, such comprehensive environmental indicators are currently unavailable for both the categories of resource use and emissions. • The emission ceilings provided by the EEA for the 4 air pollutants represent political thresholds rather than scientific thresholds. The underlying scientific data are not published.

[1] developed by the IFEU research institute in Heidelberg, Germany

Data availability in the EU

Data availability for both parts of the suggested proxy indicator ($DMC_{non\text{-}renewable}$ data from EUROSTAT and air emission data from the EEA) is generally good.

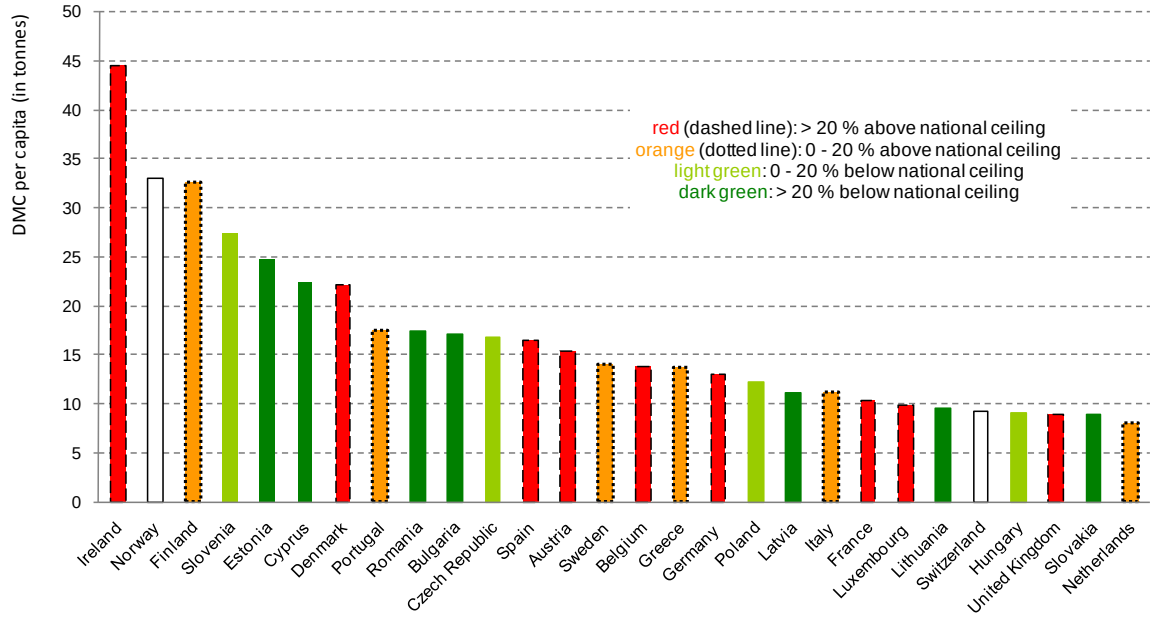
$DMC_{non\text{-}renewable}$ per capita in relation to SO_2, NO_x, NH_3, and NMVOC emissions

	$DMC_{non\text{-}renewable}$ per capita	Critical loads of SO_2, NO_x, NH_3, and NMVOC emissions
Unit of measurement	1000 tonnes	National emission ceilings for SO_2, NO_x, NH_3, and NMVOC. Emission trends of Member States 1990-2007 for SO_2, NO_x, NH_3, and NMVOC.
Data sources	EUROSTAT	European Environment Agency (EEA)
Temporal coverage	1996-2008	For the EU27, total SO_2, NO_x, NH_3, and NMVOC emissions are available for 2005 - 2008
Geographical coverage	EU-27 countries plus Norway and Switzerland	EU-27
Update of data	Biannually	Every year
Access to data (free/fee)	Free	Free
Links / references	http://nui.epp.eurostat.ec.europa.eu/nui/show.do?dataset=env_ac_mfa&lang=en	European Environment Agency (2010): Air pollutant emissions data viewer (NEC Directive): http://dataservice.eea.europa.eu/PivotApp/pivot.aspx?pivotid=468

Exemplary illustration

The suggested threshold indicator has been tested for four types of air emissions: SO_2, NO_x, NH_3 and NMVOC. The following figure provides an example for the case of NO_x.

Figure 1: $DMC_{non\text{-}renewable}$ per capita in relation to national NO_x emissions (2007)



Source: own calculations based on EUROSTAT MFA data and EEA emission data

Figure 1 illustrates that the different EU Member States have very different NO_x emissions resulting from non-renewable resource use. Countries with very different levels of per capita DMC (non-renewable) are both emitting above and below national ceiling levels. This suggests that a large number of factors influence the process by which non-renewable resource use is transformed into specific air emissions. For the case of NO_x, these factors are the detailed composition of the non-renewable DMC, in particular the types and amounts of fossil fuels used for combustion and the applied production and abatement technologies. In order to derive specific policy recommendations about what part of the non-renewable DMC causes NO_x emissions, a detailed analysis of the non-renewable DMC as well as of the main national sources of NO_x emissions would be needed. The same kind of inconclusive results are obtained for the three other types of air emissions (SO_2, NH_3 and NMVOC).

Conclusion

The analysis of the proxy indicator $DMC_{non\text{-}renewable}$ per capita in relation to a set of air emissions shows that there is no clear conclusion on the relation between the consumption of non-renewable resources and the surpassing of certain air emission ceilings. Countries with very different levels of non-renewable resource consumption have emissions which are below or above their national emission ceiling.

At its current stage of development, the proxy indicator is therefore of limited use for policy making in a cross-country perspective. To derive specific policy actions, a more detailed analysis of the links between non-renewable resource use and environmental impacts with threshold phenomena is needed, as a large number of factors influence the process in which non-renewable resource use is transformed into specific air emissions. Moreover, the threshold indicator needs to be tested with other threshold relevant data, as the national emission ceilings adopted by the EEA have not been derived from a purely scientific calculation, but are rather the results of a process of political negotiations based on scientific thresholds. The underlying scientific data have neither been published by the EEA nor by the developers of the underlying emissions calculation model and were therefore not freely available. Only when more data on thresholds become available and the correlations with the non-renewable DMC have been tested, a final conclusion on the policy usefulness of this approach and proxy threshold indicator can be drawn.

Further reading

Ecologic Institute and SERI (2010) Establishing an environmental sustainability threshold on soil erosion, Fact Sheet, September 2010.

Ecologic Institute and SERI (2010) Establishing an environmental sustainability threshold on water quality, Fact Sheet, September 2010.

Ecologic Institute and SERI (2010) Establishing an environmental sustainability threshold on water quantity, Fact Sheet, September 2010.

Rockström, J., Steffen, W., Noone, K., Persson, A., Chapin, F. S., Lambin, E. F., et al. (2009). A safe operating space for humanity. *Nature*, *461*(7263), 472-475.

SERI, GLOBAL 2000, Friends of the Earth Europe. 2009. Overconsumption? Our use of the world's natural resources. Vienna/Brussels.