Executive summary

Is Belgium living within its safe operating space?

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CLIMACT

Based on independent risk assessments, the **Climate and Environment Risk Assessment Center (CERAC)** aims to provide the National Security Council and other policymakers with r**ecommendations** to enable Belgium to **avoid, minimize and adapt** to climate and environment risks, and those generated by measures to transition to a sustainable society.

CERAC will use, among other methodologies, the **nine planetary boundaries** to guide its work program. CERAC has tasked a consortium (CLIMACT, RAMBOLL, ULB-CEESE) to execute research into translating the Planetary Boundary Framework for Belgium. A better understanding of the safe operating space for Belgium within these boundaries is important element for the **complex risk assessment approach** of the Center.

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Planetary boundaries

Sticking to planetary boundaries is essential for humanity's lasting prosperity. In 2009, researchers established boundaries for **nine biophysical processes** whose crossing could **destabilize the Earth's system**. These nine thresholds collectively define a **"safe operating space"**. In 2023, six of the nine boundaries had been transgressed on a global scale: climate change, biosphere integrity, land-system change, freshwater change, biogeochemical flows, and novel entities.

The planetary boundaries framework provides **a systemic view of environmental pressure.** Translating this framework at Belgian level can help provide insights in Belgium's environment and climate risks.

Translating planetary boundaries for Belgium

In Belgium, six out of the nine planetary boundaries were the most relevant to assess (see Figure 1). These include climate change, biosphere integrity, land-system change, blue water, biogeochemical flows, and air quality (aerosols). Boundaries not assessed are novel entities, ocean acidification, and ozone depletion.

To establish Belgian thresholds for each, a proportionate allocation of the global threshold has been made, creating the 'Belgian safe operating space" (depicted by the green circle in Figure 1). Since there's no consensus on what constitutes a 'fair share", three allocation methods have been employed. Figure 1 illustrates the most common method, 'per capita", which assigns the global threshold based on a country's population in comparison to the global population.

Belgium's impact on planetary boundaries has been evaluated in three ways: production-based, consumption-based, and territorial. The production-based approach measures the environmental pressure generated by activities within Belgium, regardless of whether these goods and services are then consumed in Belgium or elsewhere in the world. Conversely, the consumption-based approach estimates the environmental pressure, in Belgium or elsewhere in the world, resulting from the Belgian consumption.

The territorial approach captures the environmental impact observed on Belgian territory, although its origins may lie elsewhere. While drawing inspiration from existing literature, these concepts are tailored to suit the requirements of this study and may diverge from those found in other sources.
The territorial approach is used for biosphere integrity and air quality. For the former, biodiversity loss is observed in Belgium. However, the causes of this loss of biodiversity may originate beyond Belgium's borders, for example, through the introduction of invasive species from other countries. Similarly for air quality, it is measured in Belgium but can come from sources outside the territory.

Several countries have translated planetary boundaries to their national scale. This study uses methods from existing research, validated by scientists who specialize in the planetary boundaries. Belgian climate and environment experts provided input to develop the methodology and results.

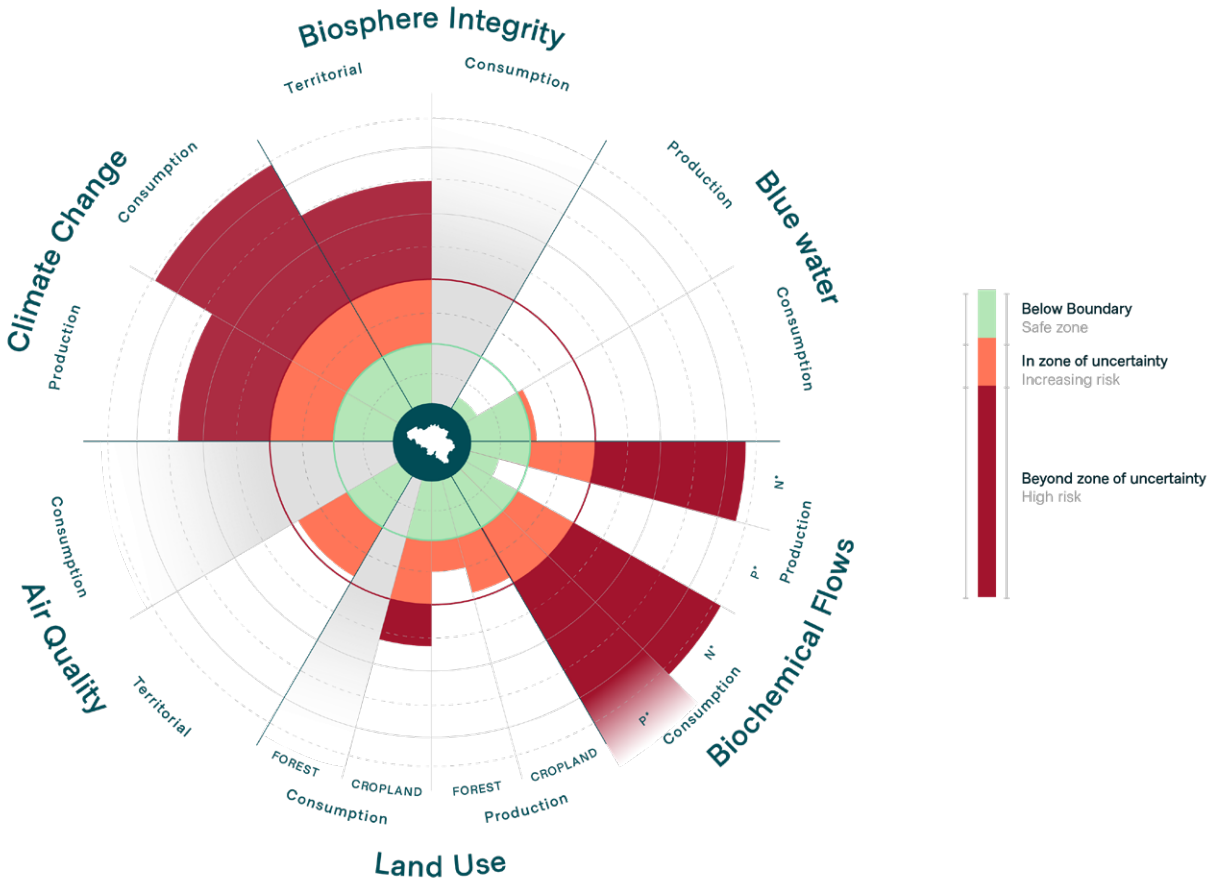

Figure 1: Six planetary boundaries translated to Belgium. The radial plot illustrates the national overshoot of six planetary boundaries on a standardized scale. Belgium surpasses its "fair share" of the global safe operating space for most production-based, territorial, and consumption-based boundaries. The safe zone is represented at the centre, where the outer edge of the green circle signifies the normalized boundary (= 1). Following the boundary transgression is a region of escalating but uncertain risks (= 1 - 2). Beyond this lies a zone of high risk, indicated by the red line (= 2), indicating a boundary transgression by a factor of 2. Moving outward from the red line, transgression factors follow approximately along the grey lines.

Results

Based on production or territorial footprints, and a per capita allocation method, five out of the six planetary boundaries at the Belgian level have been surpassed (Figure 1). Different allocation methods may produce different results, which will be available in the full report published in May 2024.

From a consumption perspective, all six boundaries have been exceeded. For the six planetary boundaries assessed, Belgium's consumption-based footprint exceeds the production-based footprint, as detailed below. Belgium can further decrease its Earth system disruption through consumption adjustments, surpassing production-based efforts. Both approaches are complementary. They should be implemented concurrently.

To stay within a Belgium's safe operating space, the Belgian production-based footprint should be reduced by a factor of three for biosphere integrity and nitrogen cycle, and a factor of two for land use and air quality. In addition, Belgium should reduce the negative impact of its consumption on the global blue water cycle and the phosphorus cycle. For climate change, Belgium should reach net-zero emissions as quickly as possible to minimise the overshoot of the Belgian 'fair share".

Downscaling the planetary boundaries to the national level has limitations. Firstly, the results are a recent snapshot and do not account for planned policies or past effort. However, even if a country exceeds its threshold, its policies could lead to long-term improvement; on the other hand, a country may be below the threshold but with a negative trend due to a lack of policies. Secondly, the consumption-based footprint depends on trade data, which is less reliable for Belgium due to its high volume of trade. Consumption is estimated based on imports and exports, the uncertainty of which is greater for countries with extensive trade as Belgium.

The Planetary Boundaries framework at the global level also has limitations. A first attention point of the framework is that it could lead to an unfair transition, by limiting the right to resources of developing countries, preventing their development. To mitigate this criticism in the Belgian study, the 'right to development" method has been employed . This allocates the right to resources based on a country's development index, thus giving more right to resources to developing countries (more details in the full report). A second attention point is that most control variables focus on global cycles. Although regional thresholds have been favoured as much as possible for downscaling at Belgian level, this limitation remains important for blue water where the indicator used does not allow to assess regional risks, such as water scarcity.

Biosphere integrity

Belgium exceeds its territorial share of the global biosphere integrity boundary by a factor of 3.5. The boundary transgression is evaluated by estimating the current species and abundance relative to a historical baseline with minimum human impacts. The planetary boundary is set at 90% maintained intactness, with Belgium's value being at 65% in 2014. While there exist other indicators with more up-to-date data, the intactness indicator was selected, albeit slightly dated, because it was the only one that allowed a prospective analysis (see details in the full report). The biodiversity threshold is significantly exceeded due to intense land use, resource exploitation, and climate change. This study does not evaluate the production-based footprint due to the significant data processing it would require. Further research may enable the estimation of Belgium's impact on biodiversity globally.

Climate change

Belgium exceeds its 'fair share" of the climate boundary by more than 3.5 times for production-based emissions and over 4 times for consumption-based emissions. This assessment is based on Belgium's cumulative CO_2 emissions since 1850. The global boundary is set at 350 parts per million (ppm) of CO_2 concentration, which was translated into a carbon budget downscaled for Belgium. Belgium's CO_2 emissions since 1850 significantly surpass this threshold. Due to its early industrialization, Belgium holds a greater historical responsibility compared to the global average, necessitating faster and greater emission reductions.

Blue water

The Planetary Boundary framework overlooks local and seasonal risks associated with water scarcity, which is a critical issue in Belgium and requires additional research. Based on the current knowledge in the context of the approach for this PB, Belgium's production-based footprint falls within the uncertainty range, suggesting that its production practices do not significantly disrupt the global freshwater cycle. However, consumption-based water use slightly exceeded its fair share. This indicates that decisions on imports of goods and services should consider water risks elsewhere in the world. Boundary transgression is evaluated based on annual average blue water consumption from rivers, lakes, and groundwater. This study does not downscale the planetary boundary of green water due to the significant data processing it would require. In addition, it is crucial to incorporate seasonal and regional variations for further risk assessment.

Air quality

When considering aerosols, the health perspective takes precedence over the biophysical process perspective in the assessment of air quality in Belgium. The PM 2.5 concentration has been considered in a territorial approach based on existing regional and national data. The World Health Organization (WHO) recommends that the annual mean concentration of PM 2.5 should not exceed 5 g/m^3. Despite the recent policies and progress, Belgium still exceeds the WHO boundary by a factor two, creating a risk on health. Improving air quality could lead to positive externalities, such as lowering the health costs and simultaneously reducing emissions.

Biogeochemical cycles

Belgium exceeds its 'fair share" of the nitrogen regional boundary by more than 4 times for production-based emissions and over 4.5 times for consumption-based emissions. Nitrogen pollution and the associated risk of eutrophication are crucial issues in Belgium. The analysis considers the amount of nitrogen that ends up in croplands, including manure. As fertilizer pollution is a local issue, it is crucial to consider soil properties and concentration, rather than the total amount, for further risk assessment. The fact that the consumption-based footprint is higher than the production-based footprint can be explained by the fact that Belgium is a small country whose agriculture and export policy does not allow it to feed its large population. Belgium therefore must import agricultural products that require fertilizers.

Regarding phosphorus, Belgium's consumption-based footprint transgresses the boundary by more than 12 times. From a production perspective, Belgium is a small user of phosphorus fertilizers, and current local issues stem from past intensive use. On the other hand, adopting a consumption-based perspective reveals a notable increase in Belgium's phosphorus footprint. This escalation is primarily attributable to agricultural imports from regions characterized by phosphorus-intensive farming practices, particularly South American imports for food and feed.

Land use

Belgium surpasses its 'fair share" of the land use boundary by 1.5 times for forests and nearly 2 times for cropland. For forests, the boundary is based on what remains of the theoretical forest cover during the Holocene. With only 22% forest cover, Belgium exceeds the threshold of 50% of the potential forest cover during the Holocene. The latter is assumed 100% for Belgium, in accordance with judgement of experts on the subject. Belgium's low forest cover is mainly due to pressures for land from agriculture and urbanisation. From a consumption perspective, Belgium contributes to deforestation through imports. However, the Planetary Boundaries framework is applicable to temperate forests and holds greater relevance at the EU level than at the national level since Belgium only represents a small part of temperate forests.

Concerning cropland, Belgium exceeds its 'fair share" in both production and consumption. Locally, extensive cropland leads to various environmental issues that should be mitigated through sustainable practices. In terms of consumption, measures to reduce cropland demand are essential to lessen Belgium's negative global impact.

National perspective on planetary boundaries

The study underscores the need for further examination of environmental risks, with particular emphasis on biodiversity and climate change. These are core planetary boundaries through which the other boundaries operate. These areas should be prioritized for risk assessment by CERAC.
The exceeded nitrogen threshold highlights the risk of eutrophication, both regionally and globally. Additionally, the extensive use of cropland in Belgium suggests significant agricultural-related externalities, impacting biodiversity and water resources. Exceeding WHO air quality guidelines poses a health risk in Belgium. The planetary boundary framework for water has notable limitations as it does not account for local and seasonal water scarcity risks. Nevertheless, Belgium ranks 18th among the world's most water-stressed countries according to the World Resources Institute. Lastly, the application of the planetary boundary framework to temperate forests appears more relevant at the EU level.
Finally, the study generates research questions for further studies at Belgian level, the main ones being as follows. First, it suggests evaluating the impacts of Belgium's consumption on biosphere integrity. For blue water, it advocates for augmenting temporal and regional granularity to effectively identify water stress patterns. The study emphasizes reviewing the methodology for biogeochemical cycles, recommending a focus on soil properties and concentration rather than total annual amounts. Concerning land uses, it advocates for the evaluation of artificialization.

The full report will include detailed methodology, results, including footprints from alternative downscaling methods, and listing primary physical hazards.
The study will be continued and will focus on identifying main social impacts related to boundary approaches and transitions. This part will be ready by the summer 24. For any question, please contact CERAC at info@cerac.be

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