Triple Planetary Crisis of climate change, biodiversity loss and pollution: Baseline anlaysis toward 2050

Overview

“Triple planetary crisis”, which collectively refers to climate change, biodiversity loss and pollution, poses a growing and significant threat to human health, well-being and the environment. These three planetary challenges are closely interlinked. Beyond their direct biophysical connections (e.g., the negative impact of a warmer climate and pollution on biodiversity), they share many common socioeconomic drivers and trends, including land use change, increased fossil fuel demand, and population and economic growth. Additionally, they are interconnected through policy responses. Environmental policies targeting one planetary challenge can have positive and/or negative spillovers on the other two challenges.

While each planetary crisis has been discussed and studied in recent years, few studies examine these three planetary challenges simultaneously. With this background, the contribution of this paper is to analyse the triple planetary crisis by (i) providing projections of its evolution toward mid-century under current policies (i.e., baseline analysis) and (ii) unpacking the main drivers behind the three planetary crises.

Methods

The projections are based on the OECD’s ENV-Linkages model linked with PBL’s IMAGE modelling framework. The ENV-Linkages model is a recursive dynamic computable general equilibrium (CGE) model. One important strength of the ENV-Linkages model is that, in addition to the common features of CGE models in climate polices (such as different types of fossil fuels, various types of electricity generations and GHG emissions, which are based on GTAP data), it also covers air pollutant emissions, material use, plastic use, and land use change. The IMAGE framework is an integrated assessment modelling framework that simulates the environmental consequences of human activities worldwide. It covers detailed environmental measures (which are beyond the scope of CGE models), in particular various biodiversity measures and water demand.

Results

The paper covers various aspects of the triple planetary crisis. In this abstract, we focus on two illustrative figures from the paper. Figure 1 shows the annual income growth rate between 2020 and 2050 and the contribution of various drivers. The economic variables simulated in the ENV-Linkages model (some of which are captured in Figure 1) are fed into the IMAGE framework to simulate detailed environmental measures. Figure 2 shows the projected evolution of the main environmental measures of the triple planetary crisis, along with the decomposition of the drivers.

Figure 1 shows that global income growth is driven in roughly equal parts by labour, capital and technology. At the regional level, faster income growth in emerging and developing economies aligns with the concept of conditional convergence: countries that are further from their technology frontier will grow faster as they catch up with more developed economies (Dellink et al., 2017). Population growth influences income in two distinct ways: per capita income decreases with larger population (as resources are shared among more people), but a larger working-age population leads to higher labour supply, which is a component of GDP. This is most evident in Sub-Saharan Africa: the currently young population implies a rapid increase in the working age population in the coming decades, leading to fast growth in labour supply. However, total population growth almost matches this pace, dampening income growth (GDP per capita). Investments, capital growth and technological developments positively affect income growth. Emerging economies, such as the South Asia region, can sustain fast growth with significant contributions from technological progress as they catch up. In the higher-income region, the contribution of the demographic factors is rather small, with capital and technology mainly driving overall income growth.

Figure 1. Average annual income growth between 2020 and 2050 and contribution of the various drivers

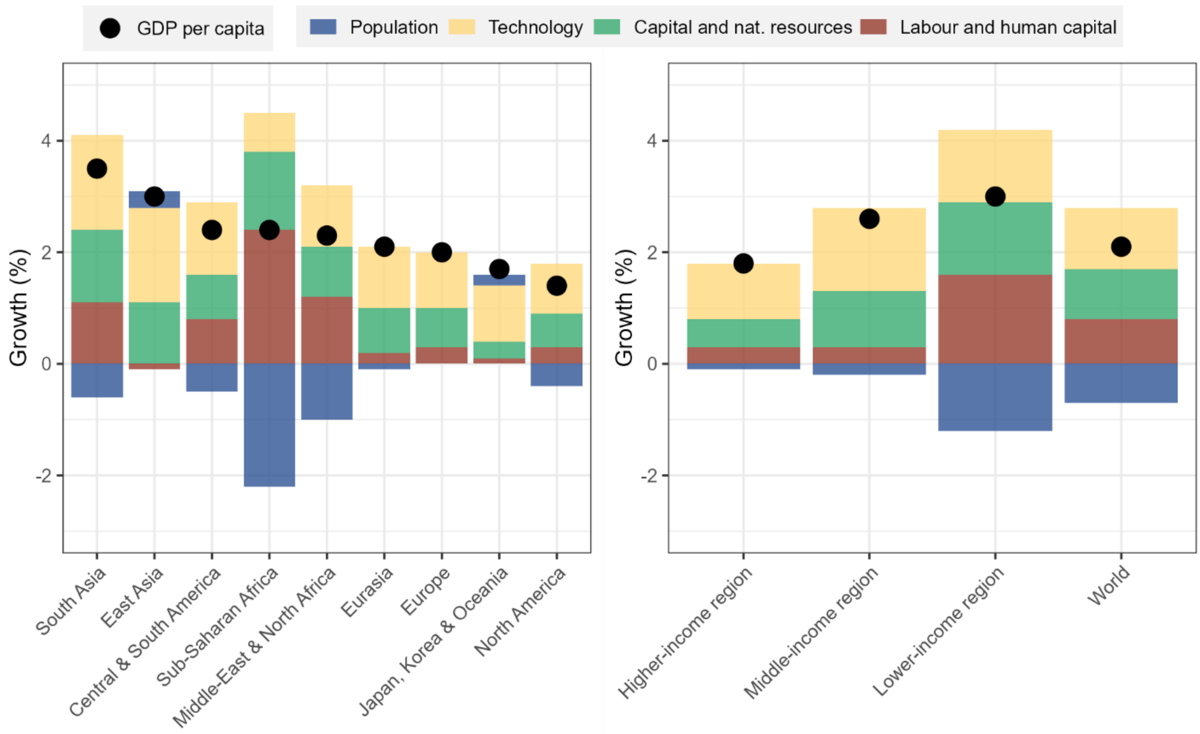
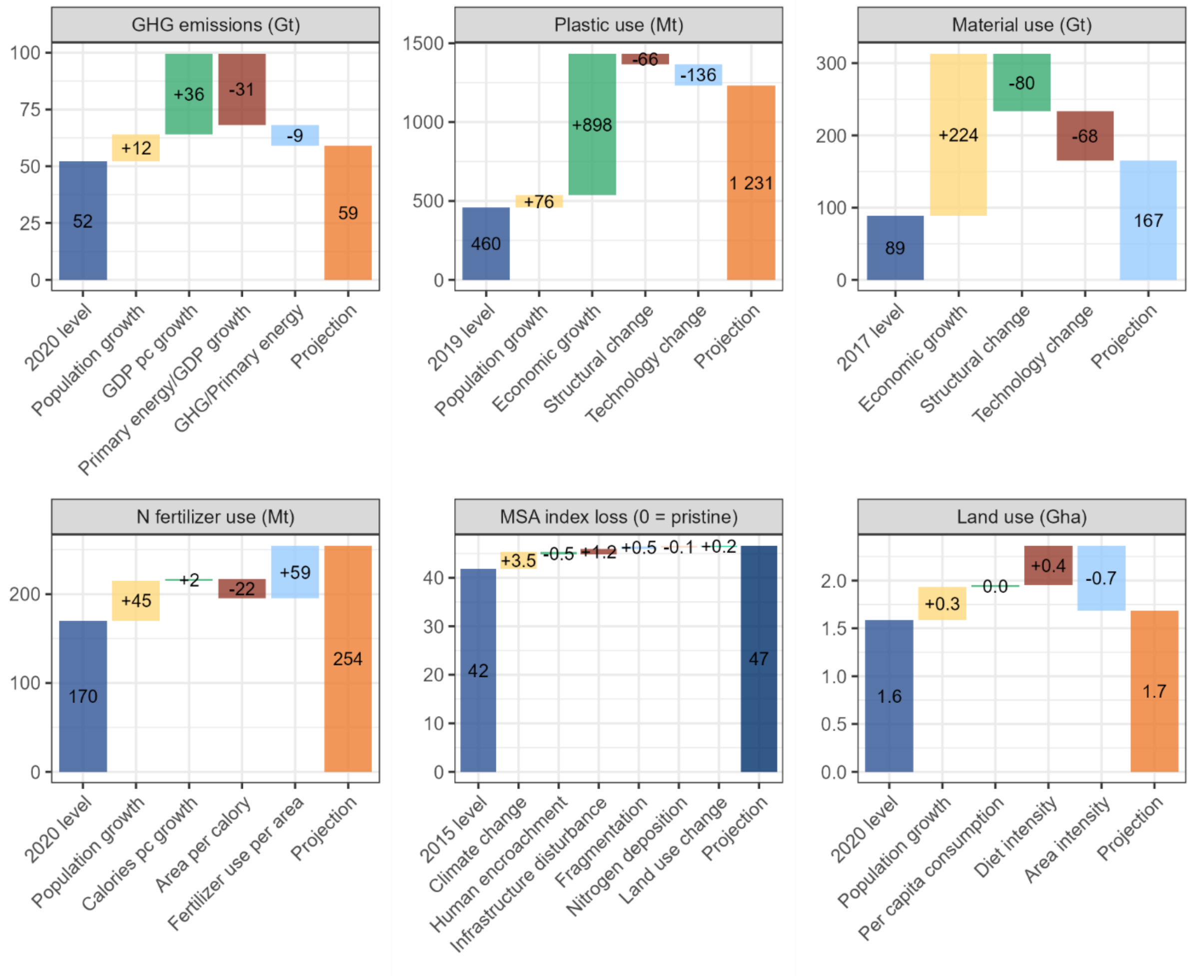


Figure 2 shows the contribution of various drivers to the main environmental indicators under the triple planetary crisis. The upper part of Figure 2 examines GHG emissions, plastics, and materials use. In these three cases, a similar pattern emerges: population and GDP per capita growth increase the pressures, while structural and technology changes alleviate environmental pressures. In the case of GHG emissions, structural and technology changes translate into a smaller primary energy-to-GDP ratio (i.e., lower energy intensity) and a smaller GHG-to-primary energy ratio (i.e., lower emission intensity). While the relative decoupling of economic growth and GHG emissions is achieved under current policies, more stringent policies are needed for absolute decoupling. These storylines for the drivers of environmental pressures are consistent with the literature (e.g., Popp, 2012).

The lower part of Figure 2 illustrates the dynamics surrounding biodiversity loss. The drivers of fertilizer use, biodiversity loss (measured as the loss in Mean Species Abundance, MSA), and land use show different dynamics, where specific drivers are more important than economic growth and structural change. Population growth remains a positive driver in all these charts (shown indirectly for MSA loss through climate change, infrastructure disturbance, fragmentation and land use change). The main projected driver of increased biodiversity loss to 2050, however, is climate change (and not anymore land use change, as it has been the case in the past decades). The decomposition of drivers behind biodiversity loss clearly shows the links between the climate crisis and the biodiversity crisis.

The largest driver of both fertilizer use and land use illustrates (in opposite directions) the current trend of agricultural intensification, where land-saving efficiency is increased through greater fertilizer use. However, this dynamic does not constitute a free arbitration, as land expansion is quite constrained by its availability. For land use, the largest driver corresponds to diet intensity, revealing the efficiency of the food transformation industry as well as the evolution of diets towards more meat.

Figure 2. Decomposing the key factors of environmental pressures and drivers: Projected evolution between 2020 and 2050



Conclusions

Quantitative projections offer a consistent analytical view for understanding how the triple planetary crisis may unfold in the coming decades under current policies. Although these projections indicate a bleak future, the follow-up paper explores what are the most efficient policies to address these crises, taking advantage of synergies and limiting trade-offs across policy instruments.

References

Dellink, R. et al. (2017), "Long-term economic growth projections in the Shared Socioeconomic Pathways", Global Environmental Change, Vol. 42, pp. 200-214.

Popp D. (2012), "The Role of Technological Change in Green Growth", World Bank Policy Res Work Pap.