

Figure 1. Importance of bio-based primary sectors worldwide

Four bioeconomic transformation pathways

Global commodity trade and innovation transfer are key mediators of sustainability outcomes in the global bioeconomy (Fig. 2). We distinguish four distinct transformation pathways:

- A) Substitution of fossil by bio-based resources**
- B) Increases in primary sector productivity**
- C) Enhanced biomass use efficiency**
- D) New bio-based applications**

National and local context factors will determine which pathways dominate and can interact with mediators to produce desired and undesired outcomes.

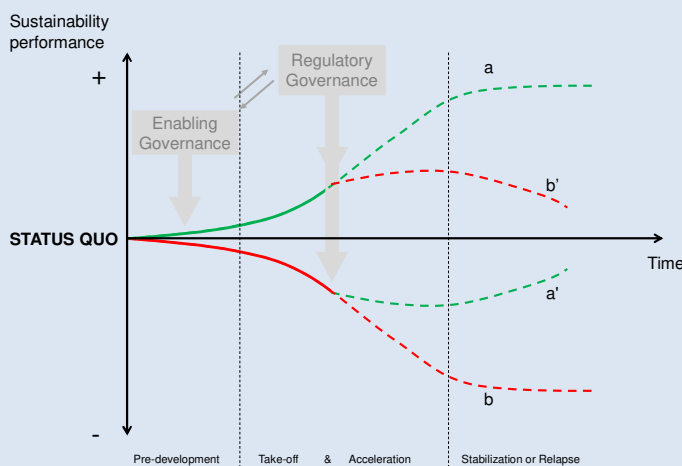


Fig. 3: Possible bio-based transformation trajectories and entry points for governance

Background

Visions of bioeconomic transformation imply an increasing reliance on bio-based resources, products, and principles at global scale. But, the global bioeconomy landscape (Fig.1) is heterogeneous in terms of countries' comparative advantages and governance capacity. Transformation outcomes may thus not be sustainable by definition.

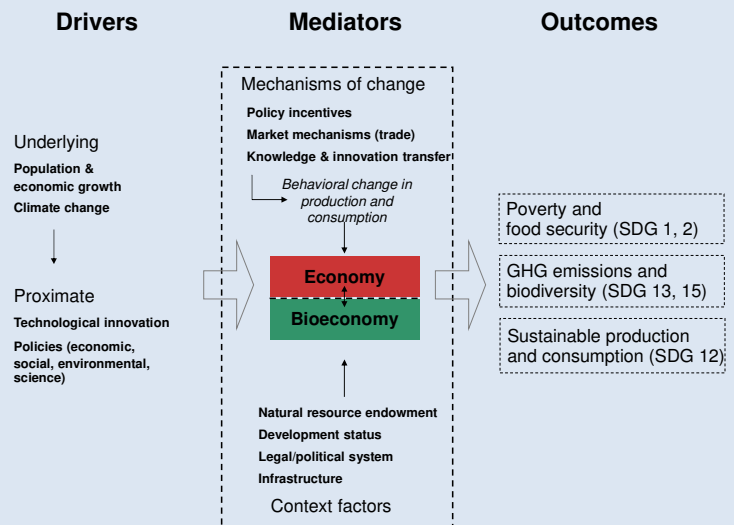


Fig. 2: Conceptual framework of bio-based transformation

Interdisciplinary research needs

- Develop indicators that cover key outcome dimensions (Fig. 2) at relevant temporal and spatial scales
- Enhance impact assessment tools to explicitly account for pathway-specific interactions between mediators and context factors (Fig. 2)
- Design multi-level governance models with pathway-specific integrated enabling (e.g., German EEG) and regulatory components (e.g., EU iLUC Directive 2015/1513) (Fig. 3).