

Bend the trend

Pathways to a liveable planet as
resource use spikes

Annex: Case Studies (Part I)

Brazil

Germany

Ghana

Japan

Lithuania

Nigeria

Poland

South Africa



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Production: Mai Ngô

Suggested citation: United Nations Environment Programme (2024): Global Resources Outlook 2024: Bend the Trend – Pathways to a liveable planet as resource use spikes. International Resource Panel. Nairobi.

resourcepanel.org/reports/global-resources-outlook-2024

**Global Resources Outlook
2024**

Bend the trend

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resource use spikes

Annex: Case Studies (Part I)



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Introduction and rationale

While the Global Resources Outlook 2024 (GRO 2024) discusses material resource use and its environmental impacts on the global and regional scale, data at country level underpins the analyses in Chapters 2 and 3. This Annex presents country profiles based on this country-level data, covering data on material flows (Chapter 2) and environmental impacts (Chapter 3) of resource use for a set of eight countries. The objective of these country profiles is to illustrate that the data and assessments presented in the report can also be applied at national level.

To develop the case studies, country experts were asked to use the underlying country-level data as a basis to describe and interpret the trends and patterns observed, reproducing some of the figures of the report at the national level. The countries covered is based on the set of country experts who, during the IRP meetings which took place while the GRO24 report was being developed, volunteered to create illustrative examples for the national realities they are familiar with. The authors of the report hope that this stimulates additional countries to use the GRO 2024 data.

Data presented here at consistent with the aggregated results published in this report. For material flows (linked to Chapter 2), they are based on the International Resource Panel's (IRP) material flow database, which in some cases may differ from national-level statistics.

Environmental impact data (linked to Chapter 3) comes from the dataset generated ad hoc for this edition of the GRO, [available at this data viewer: https://public.tableau.com/app/profile/livia.cabernard](https://public.tableau.com/app/profile/livia.cabernard). The viewer provides data on the environmental impacts of the extraction and processing of material resources as well as their downstream use (>160 sectors and several provisioning services). In addition, the tool provides data on the international trade relations to discuss the role of displacing impacts through trade of material resources.

To support country experts, two workshops to explain how to use the tools that made available the data used in chapters 2 and 3 of the 2024 GRO report were organized. The patterns and trends are described, as well as the type of additional information and remarks provided by experts, differ across the different country examples. The case studies have not been peer reviewed and represent the views of the Case Study Authors alone.

Disclaimers:

This Annex was not reviewed nor input and recommendation provided through a formal process by IRP membership. The views and analysis expressed are those of the specific case study authors alone, and serve as illustrative examples of the types of analysis possible using IRP data.

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Country Profiles



International
Resource
Panel

Global Resources Outlook 2024

Country Profile: Brazil

Cássia Ugaya, Federal University of Technology, Parana



01

Country Profile: Brazil

1.1. Domestic extraction, domestic material consumption and material footprint

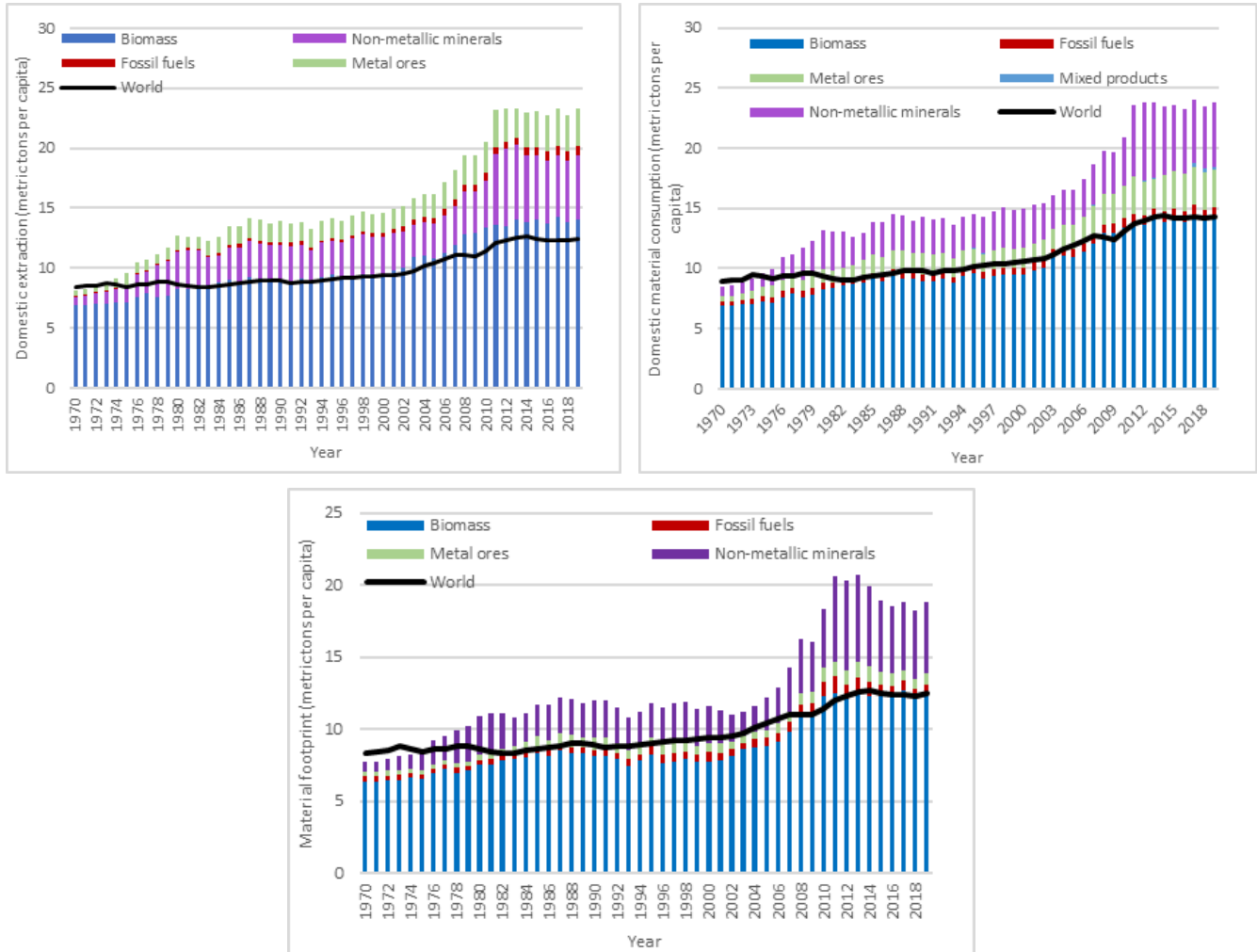


Figure 1.1: Domestic extraction, domestic material consumption, and material footprint per capita. Source: UNEP IRP Global Material Flows Database. Data for Brazil.

- Material resources form the backbone of Brazil's economy. In 2019, extraction in Brazil accounted for approximately 14 billion tons, exhibiting an average annual growth rate of 3.8% since 1970. Although biomass is the highest contributor, it reduced from 84.0% to 60.6% during the period.
- Brazil's domestic extraction increased from 8.2 to 23.3 metric tons per capita from 1970 to 2019 (left figure). A similar tendency was observed in Brazil's material footprint, which rose from 7.7 to 18.8 metric tons per capita, placing the country above the world average (black line) since 1976.
- From the domestic extraction, among all material resources, non-metallic minerals, fossil fuels and metal ores saw the most substantial increases, respectively an average annual growth of 4.2%, 4.1%, and 3.8% during the period. Although biomass increased at a yearly rate of 1.5% during the same period, it remained the most extracted resource in 2019, accounting for 60.6% of total extraction.

1.2. Environmental impacts

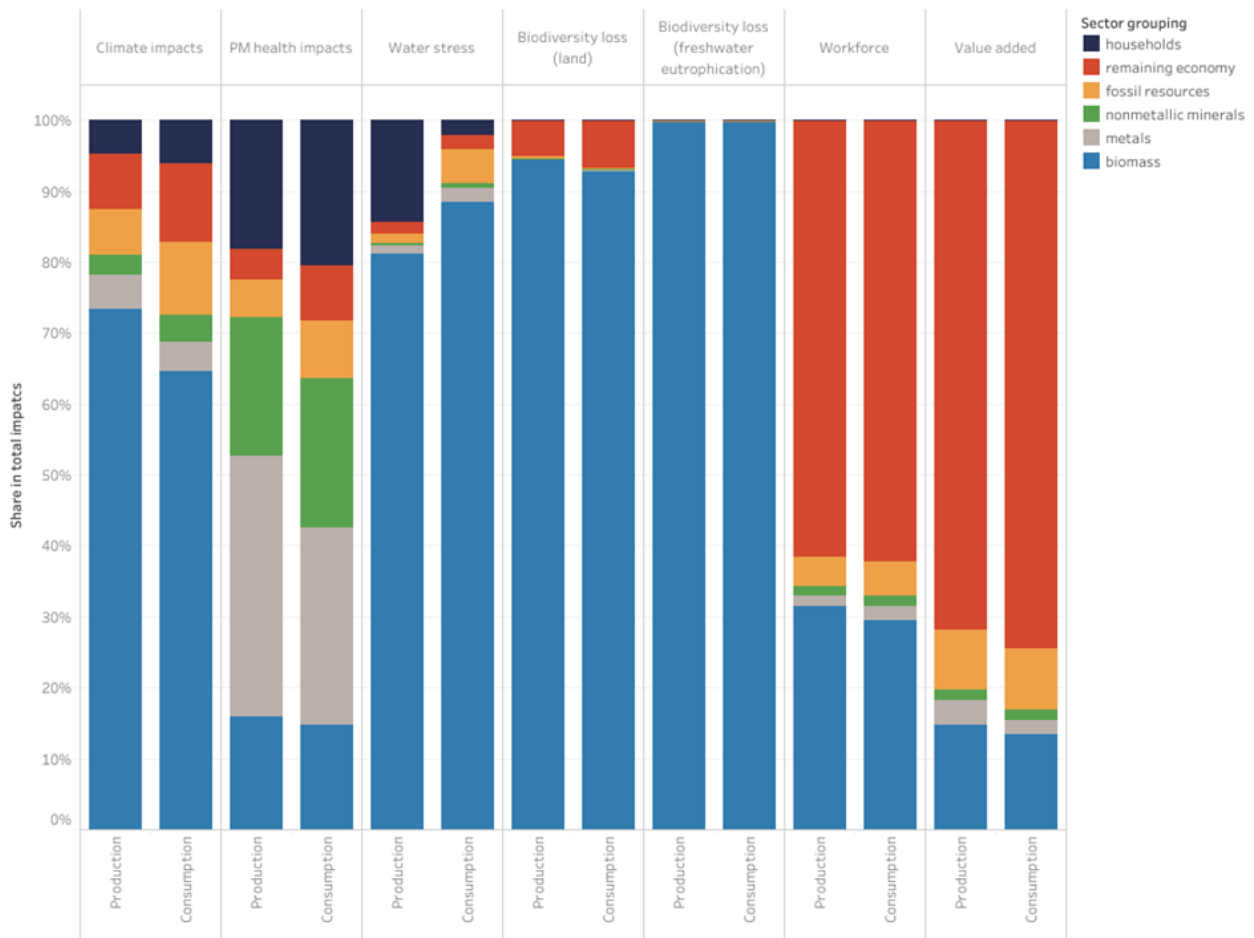


Figure 1.2: Relative contribution of different types of material resources (extraction and processing), the remaining economy (downstream chain of resource extraction and resource processing) and households to global environmental and socioeconomic impacts for the year 2022. Left columns: production-related perspective, right columns: consumption-related perspective. Data for Brazil.

- There is a minor discrepancy between the proportions of environmental impacts caused by production and consumption across different sectors. In both cases, it's noteworthy that while material resource extraction accounts for most of the environmental impacts, it contributes less to value added and workforce than the rest of the economy.
- The extraction and processing accounted for most of Brazil's environmental impact related to consumption:
 - 71.6% of the health impacts related to outdoor particulate matter (HI-PM);
 - 82.8% of climate impacts;
 - 93.2% of biodiversity loss related to land;
 - 95.3% of water stress;
 - 99.8% of biodiversity loss related to freshwater eutrophication,
- From these impacts, biomass is responsible for most of the impacts on climate (64.6%), water stress (88.4%), and biodiversity loss related to land (92.8%) and freshwater eutrophication (99.8%).

- The HI-PM are generated by various sectors, with metals, households, and non-metallic minerals being the highest contributors.
- In terms of environmental impacts, material resources (biomass, metals, non-metallic minerals, and fossil resources) have a higher contribution for climate, PM health impacts, and biodiversity loss in the production perspective than in the consumption perspective. Conversely, when it comes to water stress, the material resources have a greater impact from a consumption perspective than from a production perspective.
- The majority of jobs and economic value are generated in the “remaining economy”, which includes the production of high-value semi-finished and finished products such as automobiles (and parts), machinery, electronics, etc., from raw material inputs.

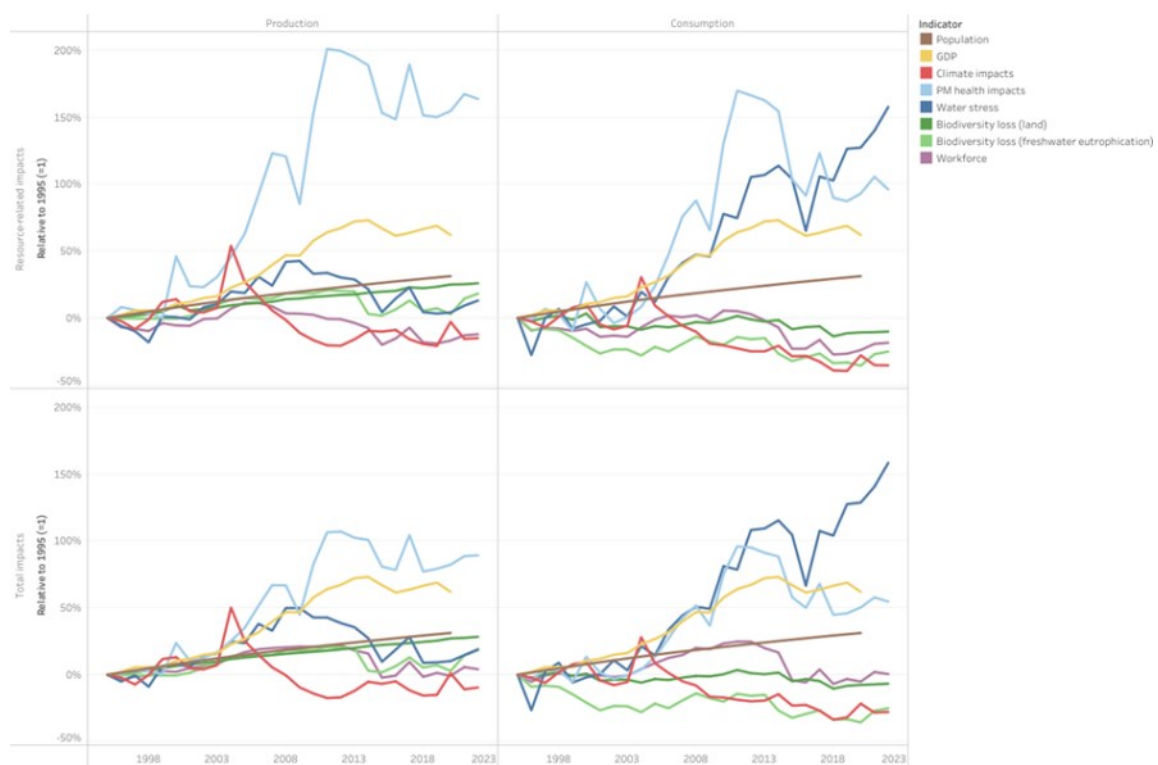


Figure 1.3: Temporal development of environmental impacts and socio-economic indicators from 1995 to 2022, from a production (left) and consumption (right) perspective. Data refers to resource use (top figures) as compared to the total economy (bottom figures). Data for Brazil.

- From 1995 to 2020, Brazil’s Gross Domestic Product (GDP) related to material resources experienced a growth of 61.9%, while the population saw an increase of 31.2%.
- During the same period, the climate impacts from the production perspective decreased by approximately 2.9%. However, the climate impact from consumption saw a more significant reduction of about 27.9%, indicating a decoupling of climate impacts from GDP growth.
- Biodiversity loss related to land use saw an increase of 25.0% from a production perspective. Interestingly, this trend was reversed from a consumption perspective, where biodiversity loss decreased 10.7%, showing that the resources extraction was mainly caused by the increase of biomass exports.
- While biodiversity loss from freshwater eutrophication decreased by about 35.5%, the water stress increased by 127.2%.



Figure 1.4: Time series of absolute (above panel) and per capita (below panel) values of climate change and land-related biodiversity loss split by resource group (cultivation, extraction, and processing) and downstream use (remaining economy and households). Moving averages over five years used for land occupation and change. Left: production perspective. Middle: consumption perspective (footprints). Right: net trade impacts (positive values indicate that impacts occur in these locations for producing exported goods, negative values indicate that goods are imported to these regions causing impacts and value added elsewhere). The red lines show the global per-capita average values. Data for Brazil.

- While climate impacts increased from a production perspective (a 1.1% increase from 2.5 billion t CO₂ eq), they reduced from a consumption perspective (21.5% reduction from 2.5 billion t CO₂ eq). A similar trend was observed for biodiversity loss due to land use, which increased in the production perspective from 5.3 thousandth global PDF to 6.8 thousandth global PDF, but decreased from a consumption perspective from 5.4 thousandth global PDF to 5.0 thousandth global PDF. Consumption impacts (middle figures) were higher than production impacts for fossil resources, the remaining economy, and non-metallic minerals. This indicates that goods imported into Brazil are causing impacts elsewhere (as shown by negative values in the right-hand figures).
- Biomass impacts on climate change reduced from 2.2 billion t CO₂ eq to 2.0 billion t CO₂ eq from a production perspective, decreasing its contribution from 86% in 1995 to 77% in 2020. A similar result occurred from a consumption perspective, with biomass decreasing from 2.0 billion t CO₂ eq to 1.3 billion t CO₂ eq during the same period, reducing its contribution to climate change in the country from 82% to around 68%.
- This increase was mainly at the expense of non-metallic minerals, which rose from 4.2 billion t CO₂ eq to 6.5 billion t CO₂ eq and the rest of the economy, which increased from 1.1 billion t CO₂ eq to 1.9 billion t CO₂ eq during the period.

- Similar trends are also verified while analysing the impacts per capita. In both perspectives and for both impacts, the Brazilian impacts are higher than the global average. From a production perspective, the climate impacts increased from 15.5 t CO₂ eq/capita in 1995 to 12.0 t CO₂ eq/capita in 2020, whereas from a consumption perspective, it reduced from 15.2 t CO₂ eq/capita to 9.1 t CO₂ eq/capita. The impact of biomass on climate change decreased from 13.4 t CO₂ eq/capita to 9.3 t CO₂ eq/capita from a production perspective. A similar trend was observed from a consumption perspective, with biomass decreasing from 12.4 t CO₂ eq/capita to 6,3 t CO₂ eq/capita during the same period. This reduction in biomass impact led to a decrease in its contribution to climate change in the country, from 82% to approximately 68%.
- The contribution of material resources processing and extraction to biodiversity loss was primarily attributed to biomass. However, the biomass contribution decreased in both perspectives, from 97% in 1995 to 93% in 2020 in the consumption perspective and from 97% to 94% in the production perspective during the same period.
- The per capita biodiversity loss caused related to land decreased from both, production and consumption perspectives. In 1995, it was 323 billionth global PDF and 331 billionth global PDF, and by 2020, it had reduced to 252 billionth global PDF and 252 billionth global PDF.

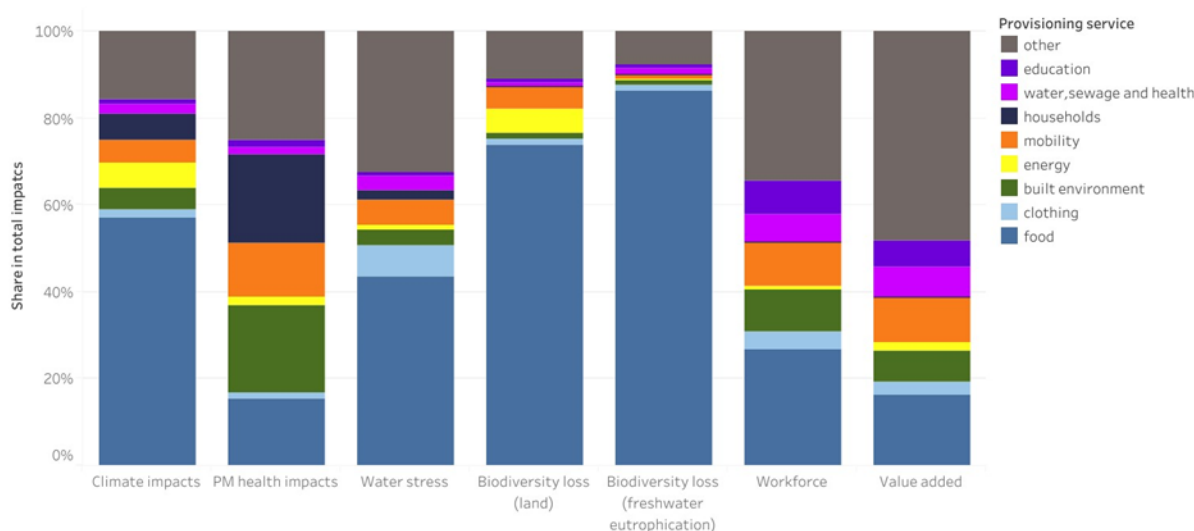


Figure 1.5: Relative contribution of different types of provisioning systems to global environmental and socioeconomic impacts for the year 2022. Household consumption includes emissions from mobility & energy (adding to the separately shown impacts of these provisioning systems). Data for Brazil.

- The provisioning systems of food is the main contributor of most of the impacts, except PM health impacts: biodiversity loss (86.2% for freshwater eutrophication and 74.0% for land-use), climate impacts (57%), water stress (43.4%), workforce (26.6%) and value added (16.3%).
- As for climate impacts, after food, the major contributors, yet with remarkable difference, were households (6.1%), energy (5.7%), and mobility (5.4%). In the case of water stress, the other main contributors were clothing (7.4%) and mobility (5.8%).
- Household and built environment each account for about 20% of particulate matter-related health impacts, followed by food (15.4%), and mobility (12.3%). Traffic avoidance and modal shifts, such as increasing public transport use and electrification of the vehicle fleet, can help to lower these impacts.

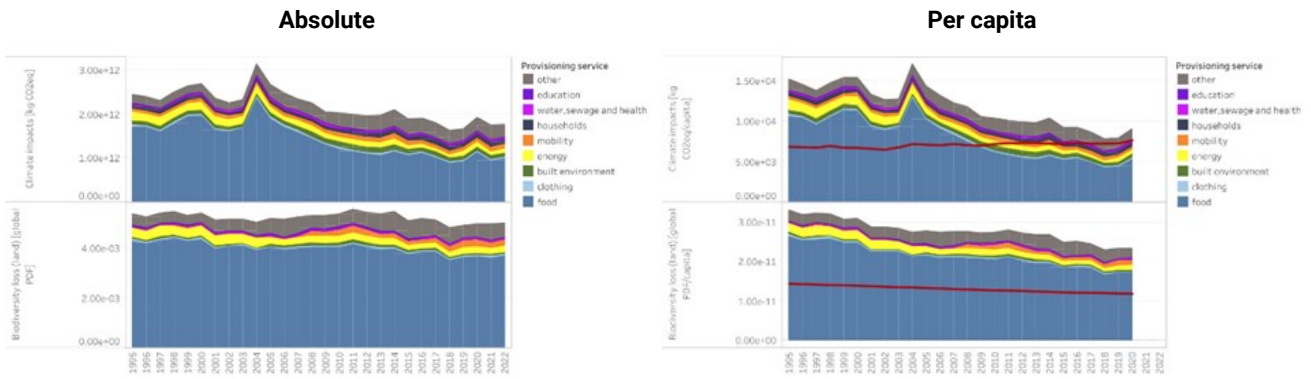
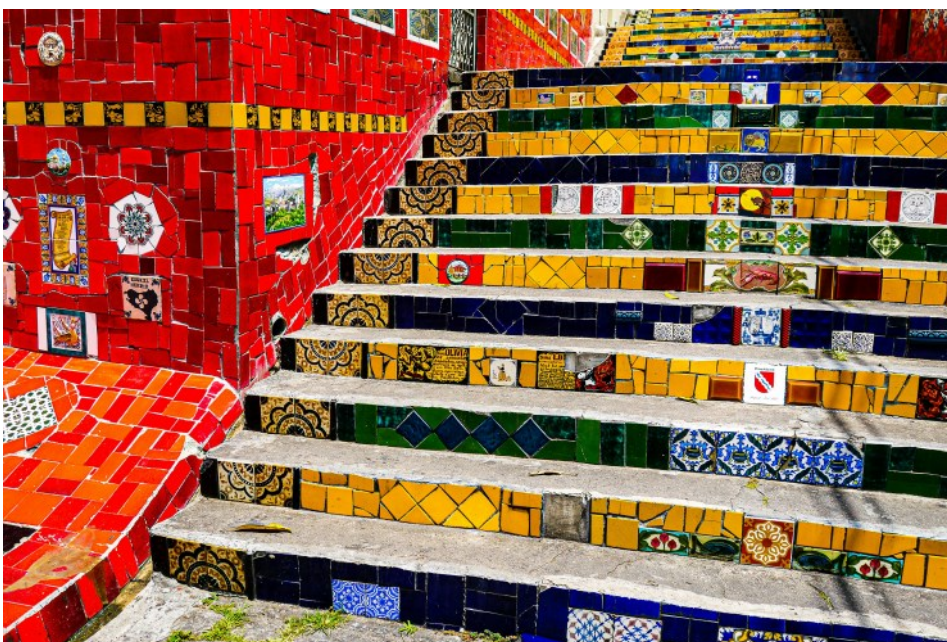


Figure 1.6: Time series of climate change (top) and land-related biodiversity loss (bottom) split by provisioning system. Household consumption includes emissions from mobility and energy (adding to the separately shown impacts of these provisioning systems). Left figures: absolute impacts. Right figures: per capita impacts, compared to global per-capita average, indicated by the red lines. Data for Brazil.

- The climate impacts caused by the energy, food and clothing sectors decreased (from 0.2 billion t CO₂ eq, 1.7 billion t CO₂ eq, and 49.9 million t CO₂ eq in 1995 to 0.1 billion t CO₂ eq, 1.0 billion t CO₂ eq, and 36.4 million t CO₂ eq in 2022).
- On the other hand, the remaining services saw an increase in their contributions on climate impacts, particularly in the mobility (1.4% yearly rate), water, sewage and health services (1.3% per annum), households (1.1% per annum), and education (0.9% per annum).
- Overall, per capita impacts to climate change and land-related biodiversity loss have generally decreased between 1995 and 2020, respectively at a yearly rate of -2.0% and -1.4%. The most significant decrease in climate impacts occurred in the energy sector (61.1%), followed by food (49.1%) and clothing (41.5%). For instance, the climate impact caused by energy decreased yearly by about 3.7% over this period.
- In the case of biodiversity loss, the highest decrease per capita occurred in the clothing sector (-51.9%), followed by energy (-41.7%) and food (-34.7%). On the other hand, there was an increase for mobility (7.4% per year) and households (4.5% per year). All in all, mobility and household increased respectively more than 500% and 200% during the period.



AXP Photography
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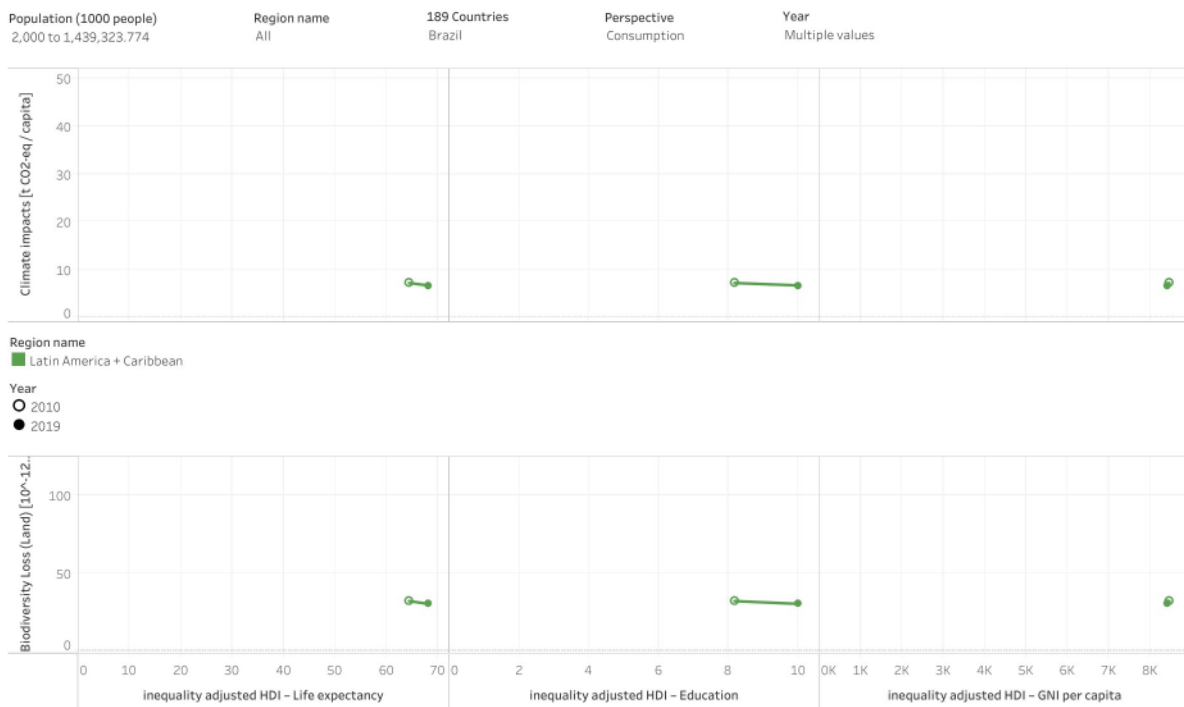


Figure 1.7: Per-capita impacts (consumption perspective) against wellbeing trajectory from 2010 to 2019. Data for Brazil.

- Although there was a slight decrease in Gross National Income (GNI) per capita between 2010 and 2019, Brazil has improved regarding the Inequality adjusted Human Development Index (HDI): Life expectancy and Education and there was a slight decrease in consumption climate impacts and land-related biodiversity impacts.
- Brazil is in the medium human development group according to HDI. The life expectancy at birth and education (respectively 72.8 years and 15.6) are slightly higher than the world average (71.4 and 12.8) in 2021.

1.3. Additional remarks on material flows and environmental impacts

Additional information on natural resource use in Brazil can be found in the 2004 publication by the Brazilian Institute of Geography and Statistics (IBGE). However, it's worth noting that this source is not regularly updated and this information was then included in the sustainable development indicators published by IBGE in 2015. Other information is typically disaggregated, with no single publication encompassing all statistics regarding material flows

and environmental impacts. Examples of these dispersed publications include energy-related data (EPE, 2023¹), water usage (IBGE, 2020²), and for industry, agriculture and cattle (IBGE, 2023³).

There are some publications related to environmental impacts in Brazil, including one on threatened species (last updated in 2009) and the sustainable development indicators (IBGE, 2015⁴). However, these are not regularly updated.

¹ EPE, 2023. Balanço Energético Nacional. <https://www.epe.gov.br/pt/publicacoes-dados-abertos/publicacoes/balanco-energetico-nacional-2023>
² Instituto Brasileiro de Geografia e Estatística (2020), Tabela de recursos e usos física. <https://www.ibge.gov.br/estatisticas/multidominio/meio-ambiente/20207-contas-economicas-ambientais-da-agua-brasil.html?edicao=37027&t=resultados>
³ Instituto Brasileiro de Geografia e Estatística (2023), <https://www.ibge.gov.br/#> for industry (Pesquisa Industrial Anual), agricultura (Produção Pecuária) and cattle (Produção Pecuária).
⁴ IB Instituto Brasileiro de Geografia e Estatística (2015). Indicadores de desenvolvimento sustentável: Brasil : 2015. 352p. ISBN: 9788524043475

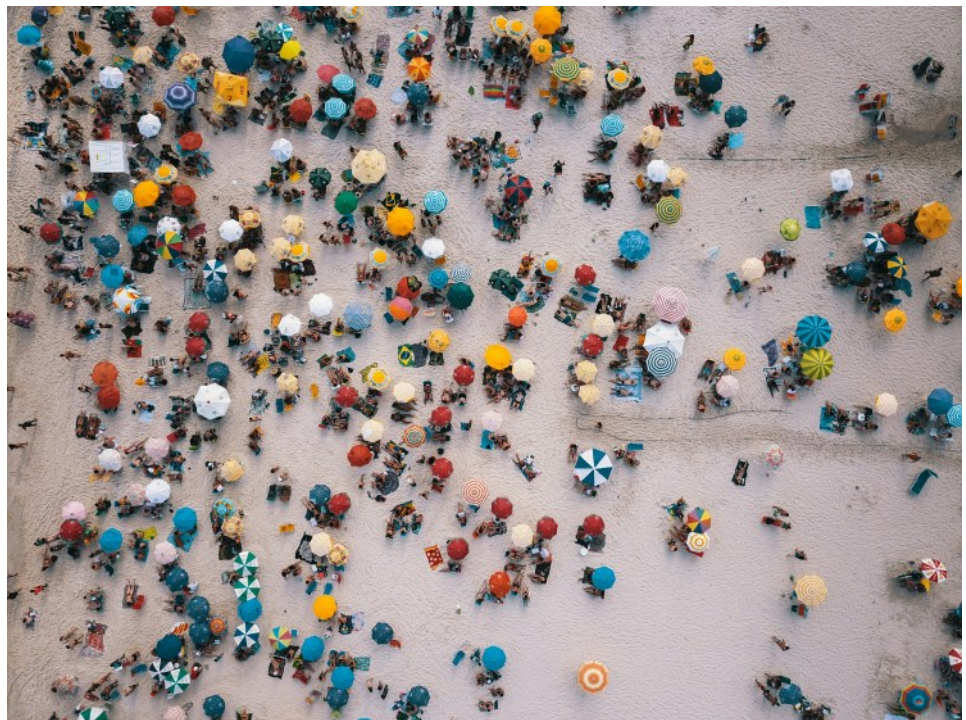
1.4. Examples of related policies

In National Policy on Climate Change (PNMC), Brazil has committed in 2009 to reducing around 37% of its greenhouse gas (GHG) emissions until 2020⁵. Recently, the aim is to change the target to reduce GHG emissions of 48% by 2025 and 53% by 2030⁶. In 2016, a plan⁷ was published including strategies in the following areas: agriculture, biodiversity and ecosystems, cities, risk management, infrastructure, mining and industry, people and vulnerable populations, water resources, health, nutritional and food safety, and coastal zones.

Brazil is a signatory to the Convention on Biological Diversity, encouraging the commercial use of native Brazilian flora species, recovery plans for threatened fish species, aiming the conservation and sustainable use of biodiversity⁸.

The country set up instruments for the management of federal water resources⁹ and created the National Water Resources Management System to define guidelines and public policies aimed at improving water supply¹⁰.

The Ministry of Health's publication¹¹ presents evidence to assist in proposing health policies through regulations on particulate matter emissions, industrial incentives, and encouragement to increase green areas in urban environments. A National Air Quality Control Program proposed the National Air Monitoring System for monitoring and evaluating air quality¹².



Luis Diego Aguilar
Unsplash

⁵ LEI Nº 12.187, DE 29 DE DEZEMBRO DE 2009. Institui a Política Nacional sobre Mudança do Clima - PNMC e dá outras providências.

⁶ Ministério do Meio Ambiente e Mudança do Clima (2023). Marina anuncia na ONU correção da meta climática brasileira <https://www.gov.br/mma/pt-br/marina-anuncia-na-onu-correcao-da-meta-climatica-brasileira>

⁷ Ministério do Meio Ambiente. Plano Nacional de Adaptação à Mudança do Clima : volume 2 : estratégias setoriais e temáticas : portaria MMA nº 150 de 10 de maio de 2016 / Ministério do Meio Ambiente. – Brasília : MMA, 2016. 2 v. 295p. ISBN: 978-85-7738-272-9.

⁸ Ministério do Meio Ambiente e Mudança do Clima (2022) Manejo e uso sustentável. Available at: <https://www.gov.br/mma/pt-br/assuntos/biodiversidade/manejo-e-uso-sustentavel>

⁹ Lei Nº 9.433, DE 8 DE JANEIRO DE 1997. Institui a Política Nacional de Recursos Hídricos, cria o Sistema Nacional de Gerenciamento de Recursos Hídricos, regulamenta o inciso XIX do art. 21 da Constituição Federal, e altera o art. 1º da Lei nº 8.001, de 13 de março de 1990, que modificou a Lei nº 7.990, de 28 de dezembro de 1989

¹⁰ Agência Nacional de Águas e Saneamento Básico (2023). Política Nacional de Recursos Hídricos. <https://www.gov.br/ana/pt-br/assuntos/gestao-das-aguas/politica-nacional-de-recursos-hidricos>

¹¹ Síntese de Evidências para Políticas de Saúde: Reduzindo a emissão do poluente atmosférico - material particulado - em benefício da saúde no ambiente urbano. 62P

¹² Guia técnico para o monitoramento e avaliação da qualidade do ar / Ministério do Meio Ambiente. Secretaria de Qualidade Ambiental. Departamento de Qualidade Ambiental e Gestão de Resíduos. – Brasília, DF: MMA, 2020. 136 p. : <https://www.gov.br/mma/pt-br/aceso-a-informacao/acoes-programas/agendaambientalurbana/ar-puro/GuiaTecnicoParaQualidadedoAr.pdf>





International
Resource
Panel

Global Resources Outlook 2024

Country Profile: Germany

Philip Nuss, German Environment Agency



02 Country Profile: Germany

2.1. Domestic extraction, domestic material consumption and material footprint

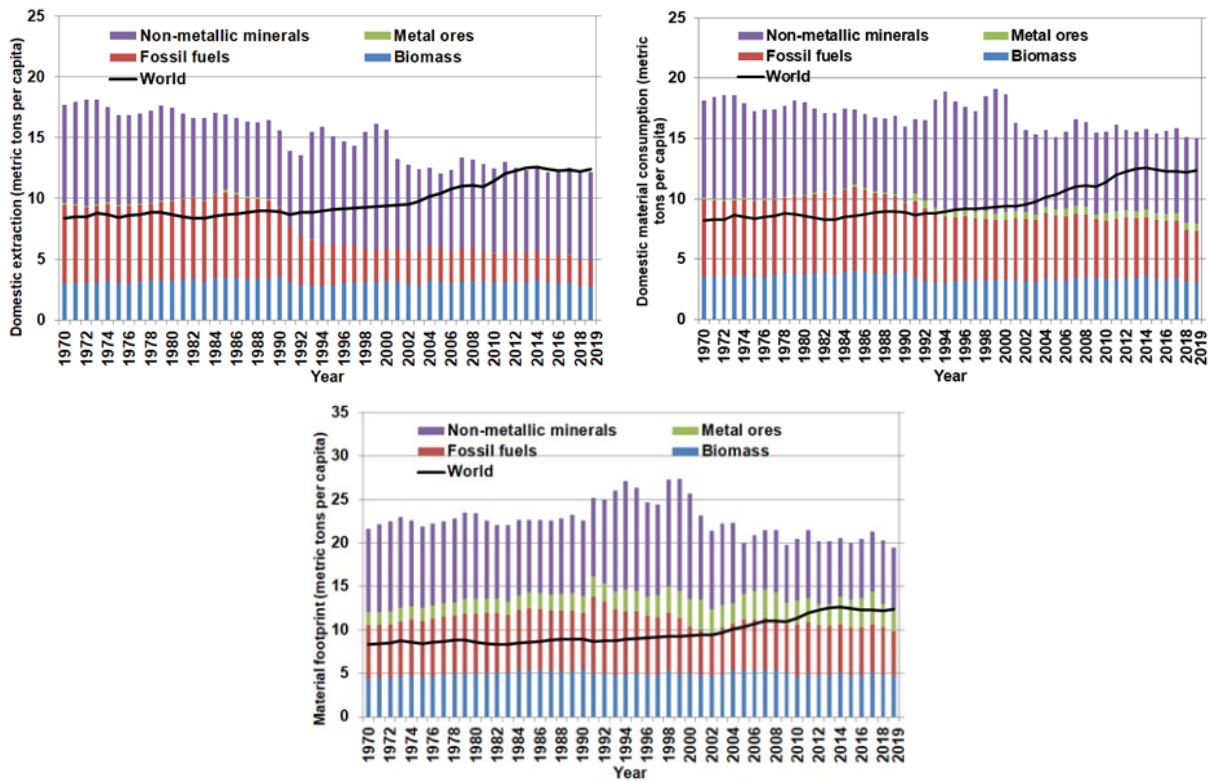


Figure 2.1: Domestic extraction, domestic material consumption, and material footprint per capita. Source: UNEP IRP Global Material Flows Database. Data for Germany.

- Material resources are the basis of Germany’s economy. In Germany, extraction accounts for almost a billion tons per year made up largely of non-renewable raw materials, especially non-metallic minerals (e.g., for construction).
- Germany’s domestic extraction decreased from 17.6 to 12.1 metric tons per capita from 1970 to 2019 (left figure). On the other hand, Germany’s material footprint remained almost constant and is with 19.4 metric tons per capita about 7 tons above the global average (black line).
- Domestic extraction of fossil fuels decreased by around two-thirds since 1970. It is expected to decrease further, e.g., due to Germany’s planned coal phase out¹³ and wider energy transition¹⁴. In 2019, non-metallic minerals contributed the bulk to extraction in Germany.
- Metal ores are essential for Germany’s transition toward a low-carbon society, but are almost exclusively imported from other countries to date (see the figures on domestic material consumption and material footprint).

¹³ <https://www.bmwk.de/Redaktion/DE/Artikel/Service/kohleausstiegsgesetz.html>

¹⁴ <https://www.bundesregierung.de/breg-de/schwerpunkte/klimaschutz/faq-energiewende-2067498>

2.2. Environmental impacts

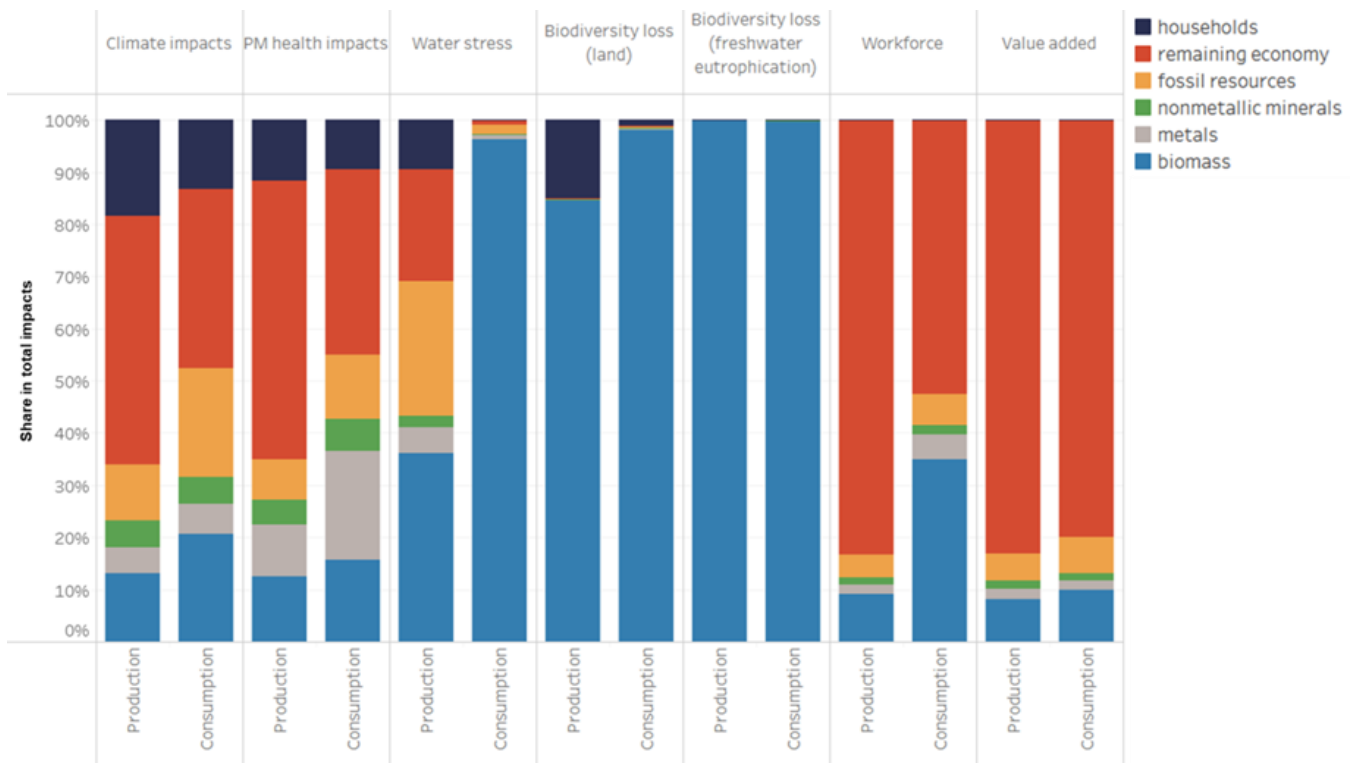


Figure 2.2: Relative contribution of different types of material resources (extraction and processing), the remaining economy (downstream chain of resource extraction and resource processing) and households to global environmental and socioeconomic impacts for the year 2022. Left columns: production-related perspective, right columns: consumption-related perspective. Data for Germany.

- The extraction and processing of materials resources accounted for about 34% of Germany's production climate change impacts.
- The extraction and processing accounted for around 52% of Germany's total climate change impacts from a consumption (footprint) perspective (the global average was approximately 55%). Therefore, policies aiming to reduce material resources demand (see section 3 below) are important levers also to achieve climate and other environmental goals.
- Outdoor particulate matter (PM) health impacts came to a large share from the remaining economy (e.g., electricity from coal power and transport).
- Water stress and biodiversity loss were caused mainly by biomass harvest and processing.
- In general, the impacts from material resources extraction and processing were higher from a consumption perspective than from a production angle.
- The majority of jobs and economic value added were generated in the "remaining economy", e.g., when high value semi-finished and finished products (automobiles (parts), machinery, electronics, etc.) were produced from raw material inputs.

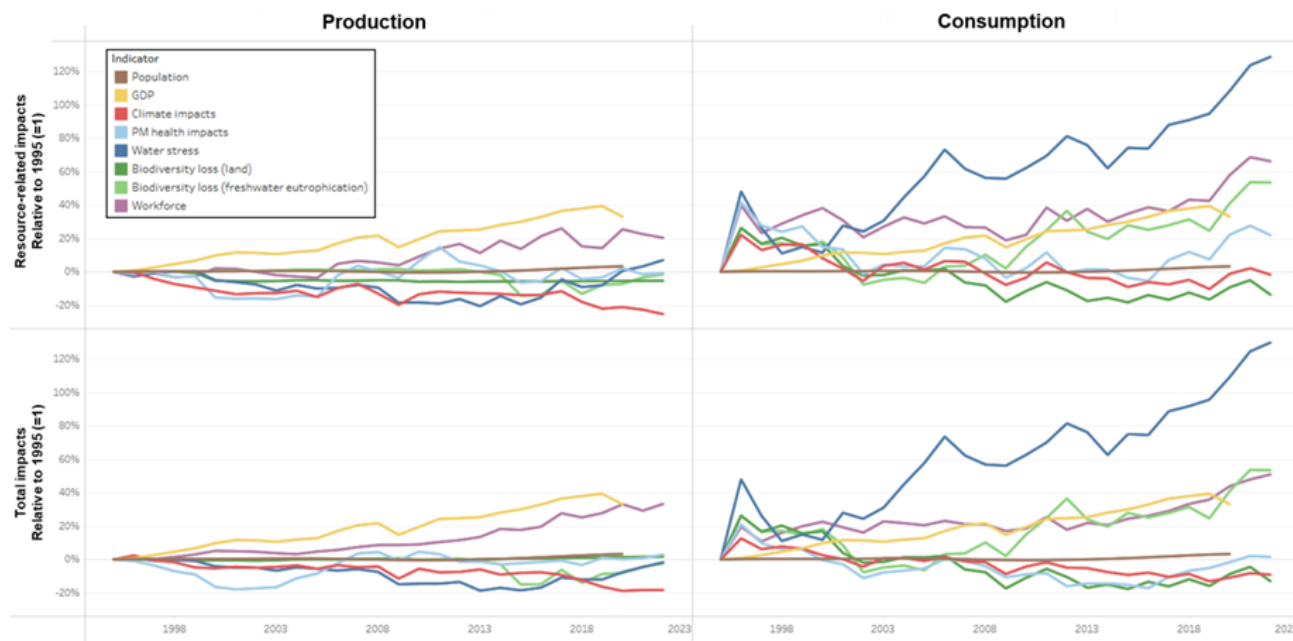


Figure 2.3: Temporal development of environmental impacts and socio-economic indicators from 1995 to 2022, from a production (left) and consumption (right) perspective. Data refers to resource use (top figures) as compared to the total economy (bottom figures). Data for Germany.

- Germany's Gross Domestic Product (GDP) has grown by 33% from 1995 to 2020, while the population has remained almost stable over the same period.
- While production climate impacts decreased by about 18%, the consumption impact was only reduced by about 9%, e.g., as a result of outsourcing carbon-intensive production abroad. Overall, this indicates absolute decoupling of climate impacts from GDP growth.
- However, in order to achieve Germany's climate targets, greenhouse gas emissions reductions have to take place at a much faster rate¹⁵.
- Land-related biodiversity loss (e.g., due to forestry and cattle farming) decreased slightly over time because of domestic land restoration measures and reduced wood imports from Indonesia.
- On the other hand, since 1995 biodiversity loss from freshwater eutrophication and water stress increased by about 50% and 130%, respectively due to enhanced imports of food and agricultural products from Asia, Africa and Latin America.

¹⁵ <https://www.umweltbundesamt.de/en/press/pressinformation/uba-forecast-2022-greenhouse-gas-emissions-down-19>

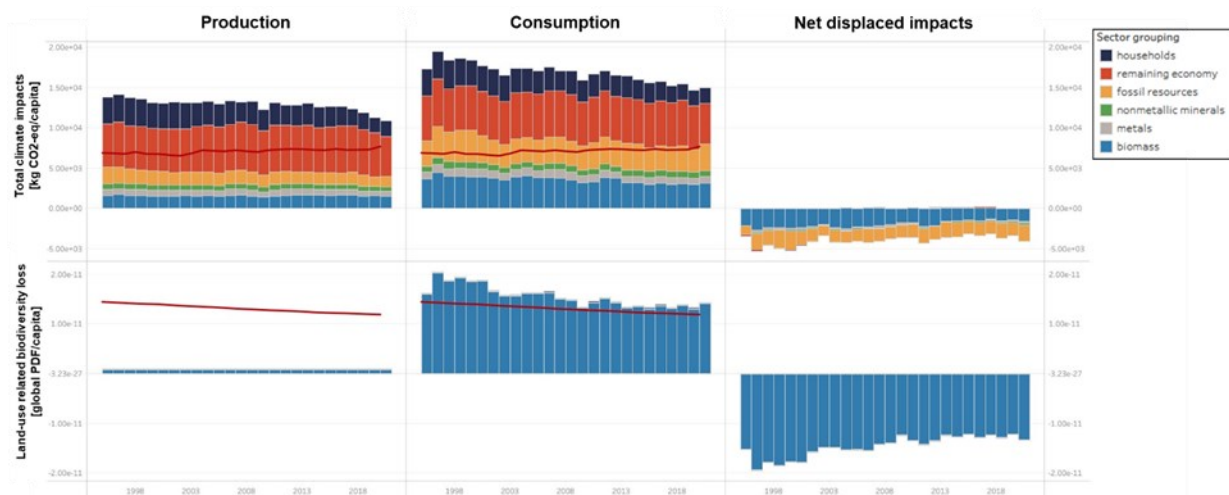


Figure 2.4: Time series of climate change (top) and land-related biodiversity loss (bottom) split by material resource group (cultivation, extraction and processing) and downstream use (remaining economy and households). Moving averages over five years used for land occupation and change. Left: Production perspective. Middle: Consumption perspective (footprints). Right: net trade impacts (positive values indicate that impacts occur in these locations for producing exported goods, negative values indicate that goods are imported to these regions causing impacts and value added elsewhere). The red lines show the global per-capita average values. Data for Germany.

- The contribution, on a per capita basis, of material resources processing and extraction to climate change impacts was dominated by fossil energy carriers and biomass (e.g., due to coal use to produce these materials but also emissions from land-use change).
- Downstream combustion of fossil fuels in the remaining economy and by households also leads to a large share of climate impacts, especially in the production perspective.
- The share of material resources to Germany's carbon footprint (top middle figure) increased slightly between 1995 and 2022.
- Land-use related biodiversity loss was dominated almost exclusively by the extraction and processing of biomass (e.g., for food products and textiles).
- Consumption impacts (footprint perspective, middle figures) are higher than production impacts (left figures) indicating that goods are imported to Germany causing impacts elsewhere (negative values in the right-hand figures).



Claudio Testa
Unsplash

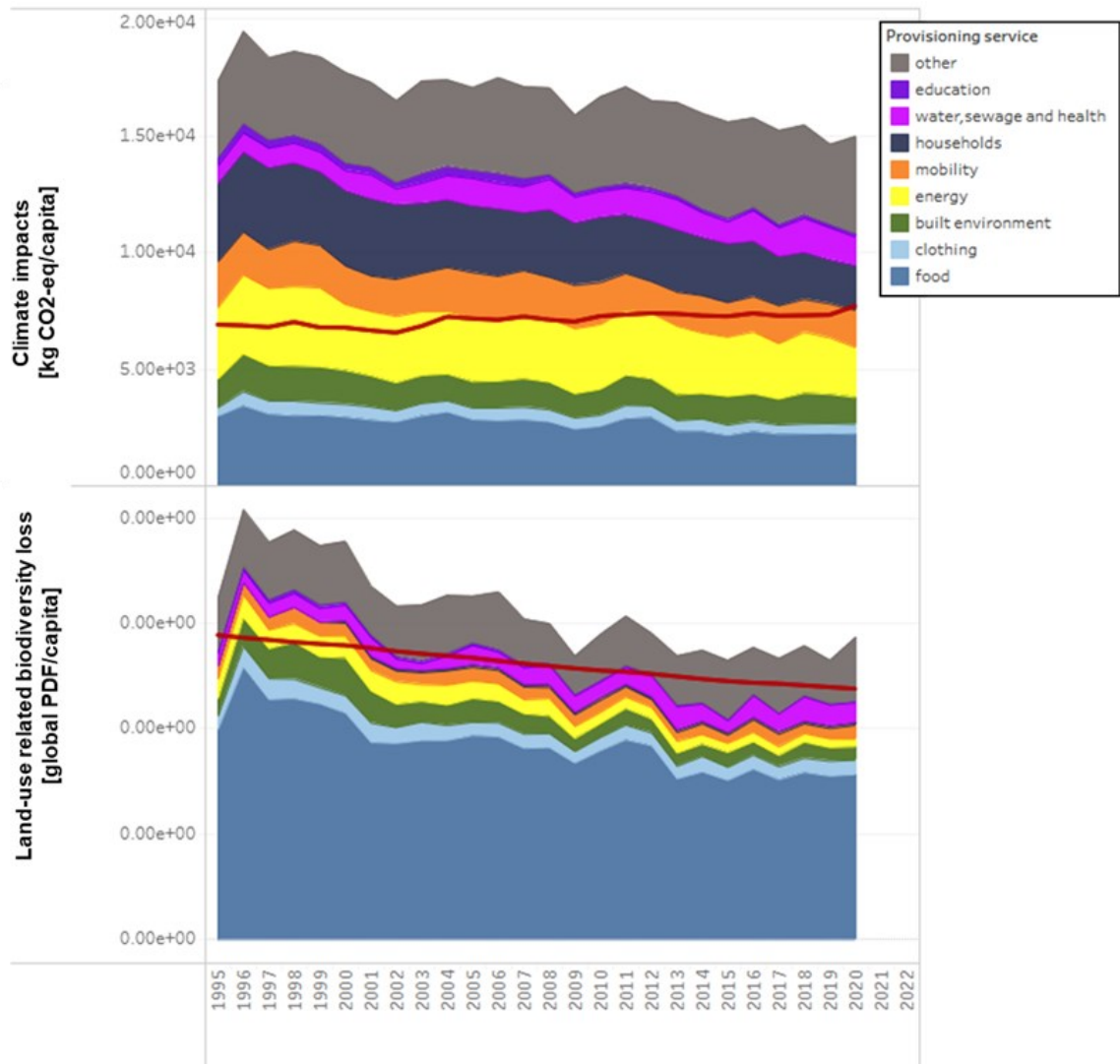


Figure 2.5: Time series of climate change (top) and land-related biodiversity loss (bottom) split by provisioning system. Household consumption includes emissions from mobility & energy (adding to the separately shown impacts of these provisioning systems). The red lines show the global per-capita average values. Data for Germany.

- Overall, per capita impacts to climate change and land-related biodiversity loss have generally decreased between 1994 and 2022.
- For example, climate impacts associated with household consumption decreased by about 40% over this time window due to energy efficiency measures (e.g., enhanced insulation and heating systems) and renewable energy transition (e.g., solar and wood pellets for hot water and heating).
- However, per-capita climate and biodiversity impacts are clearly above the global average and further significant reductions are required to stay within a safe operating space.

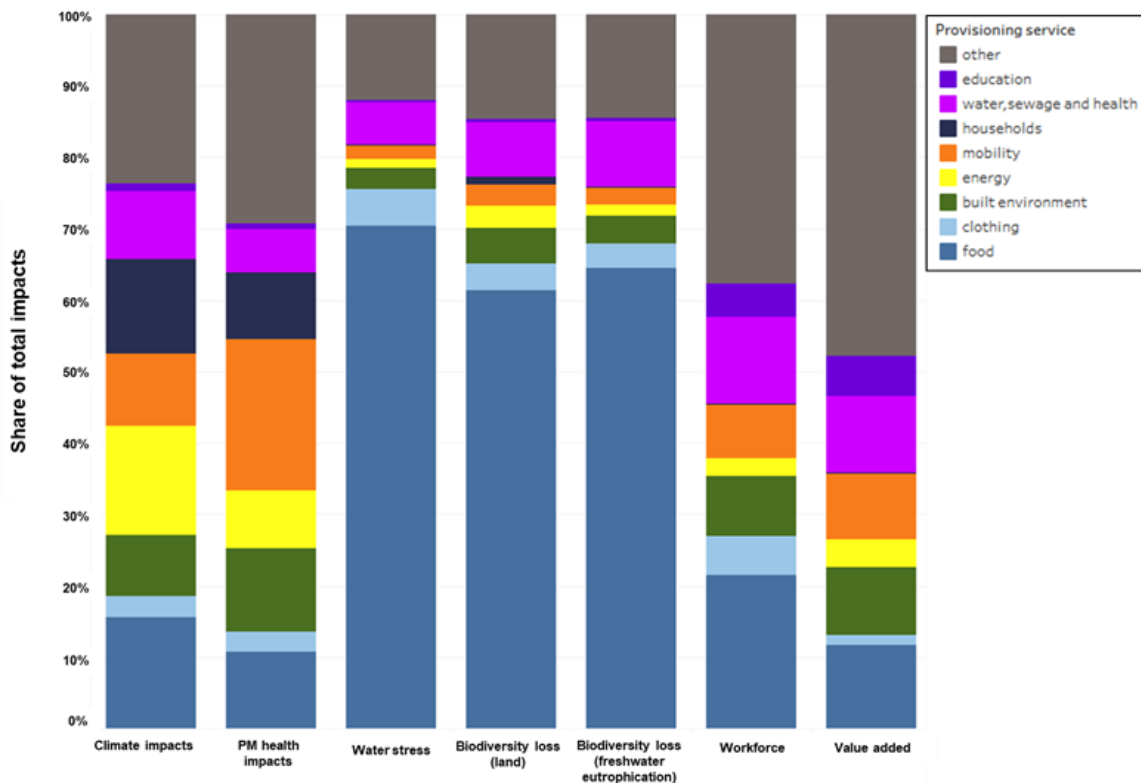


Figure 2.6: Relative contribution of different types of provisioning systems to global environmental and socioeconomic impacts for the year 2022. Household consumption includes emissions from mobility & energy (adding to the separately shown impacts of these provisioning systems). Data for Germany.

- Provisioning systems of food, energy, household consumption, mobility, and water/sewage/health together contributed to 64% to climate change impacts.
- Energy and food contributed around 15% each to total climate impacts. Policies focusing on the energy transition and climate protection¹⁶ and a more sustainable food system (e.g., switching to healthier diets and reducing food losses)¹⁷ aim at lowering such impacts.
- About 21% of all particulate matter health impacts are due to mobility (e.g., burning of fossil fuels in combustion engines). Traffic avoidance and modal shifts (e.g., more public transport and electrification of the vehicle fleet) can help to lower such impacts.
- The built environment contributes 9-12% to climate change and PM health impacts. Increasing renovation rates and electrifying heating systems (e.g., use of heat pumps) are possible options to reduce respective environmental impacts.
- Food provisioning is one of the main contributors to water stress (71%), land-related biodiversity loss (61%), and eutrophication (64%).

¹⁶ <https://www.bundesregierung.de/breg-en/issues/climate-action>

¹⁷ See, for example, the white paper by the German Federal Government on a food strategy: <https://www.bmel.de/DE/themen/ernaehrung/ernaehrungsstrategie.html> or strategies addressing food losses: <https://www.bmel.de/DE/themen/ernaehrung/lebensmittelverschwendung/strategie-lebensmittelverschwendung.html>.

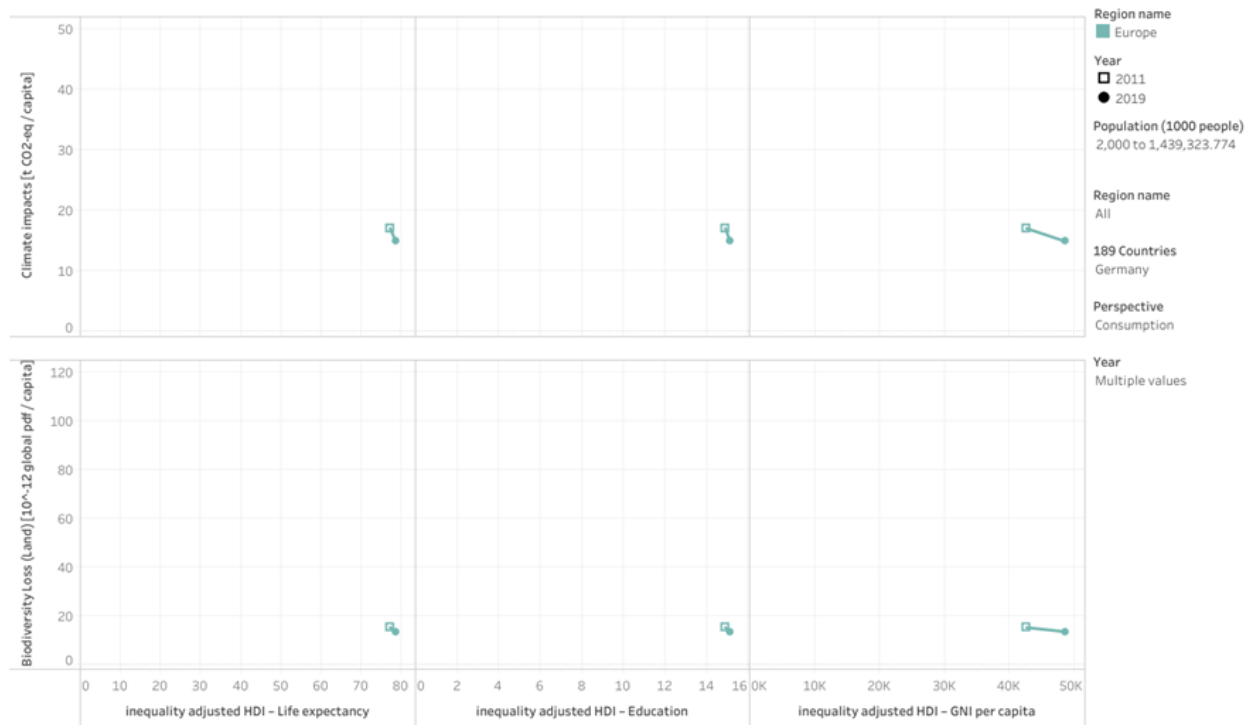


Figure 2.7: Per-capita impacts (consumption perspective) against wellbeing trajectory from 2011 to 2019. Data for Germany.

- Germany has improved regarding all three wellbeing dimensions (i.e., inequality-adjusted life expectancy, education, and income) between 2011 and 2020.
- At the same time, consumption climate impacts and land-related biodiversity impacts decreased slightly.
- However, in order to achieve Germany’s climate targets, emissions reduction have to take place at a much faster rate.
- Life expectancy and education are comparable to other European countries and income is found within the range of countries such as, e.g., Belgium, the Netherlands, Sweden, or Austria.



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2.3. Additional remarks on material flows and environmental impacts

Additional information on natural resource use in Germany can be found, e.g., in the regular report “The Use of Natural Resources. Resources Report for Germany”¹⁸ by the German Environment Agency (UBA).

The German Federal Statistical Office (Destatis) publishes data on material flow accounts¹⁹ as part of the system of environmental economic accounting. This includes estimates in raw material equivalents (RME) to derive material footprints for Germany.

The UBA study “Resource-Efficient Pathways towards Greenhouse-Gas- Neutrality (RESCUE)”²⁰ highlighted examples of economy-wide changes required in order to reduce material resources demands in Germany and the synergies this has with climate protection.

2.4. Examples of related policies

The overarching goal of German Resource Efficiency Programme (ProgRes)²¹ by the German Federal Government is to make the extraction and use of natural resources more sustainable and meet our responsibility to future generations by helping to secure the natural foundations of life for the long term. The specific objective are:

- to decouple economic growth as far as possible from resource consumption and reduce the associated environmental burdens
- to make the German economy more future-proof and competitive, thus promoting stable employment and social cohesion.

ProgRes describes a wide range of policy measures for increasing resource efficiency along the entire value chain – from raw material extraction and product design to production, use and circular economy.

The German Federal Government is currently in the process of developing a circular economy strategy (Nationale Kreislaufwirtschaftsstrategie (NKWS))²².

A variety of additional and complementary policies exist such as, e.g., the German Raw Materials Strategy²³, German Program for Sustainable Consumption²⁴, or the Waste Prevention Program. The German Sustainable Development Strategy²⁵ tracks national progress against the 17 UN Sustainable Development Goals (SDGs).

¹⁸ <https://www.umweltbundesamt.de/en/publikationen/the-use-of-natural-resources-resources-report-for>

¹⁹ https://www.destatis.de/EN/Themes/Society-Environment/Environment/Environmental-Economic-Accounting/_node.html

²⁰ C:\E\06_Auswertungen\20221212_GRO Regionalisierung and Chapter 5\Resource-Efficient Pathways towards Greenhouse-Gas- Neutrality

²¹ <https://www.bmuv.de/en/topics/water-management/overview-resource-efficiency/overview-of-german-resource-efficiency-programme-progress>

²² <https://www.bmuv.de/themen/wasser-ressourcen-abfall/kreislaufwirtschaft/nationale-kreislaufwirtschaftsstrategie-nkws> (only available in German)

²³ <https://www.bmwk.de/Redaktion/DE/Publikationen/Industrie/rohstoffstrategie-der-bundesregierung.html> (only available in German)

²⁴ <https://www.bmel.de/DE/themen/ernaehrung/nachhaltiger-konsum/nationales-programm-nachhaltiger-konsum.html> (only available in German)

²⁵ <https://www.bundesregierung.de/breg-en/issues/sustainability/germany-s-sustainable-development-strategy-354566>



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International
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Global Resources Outlook 2024

Country Profile: Ghana

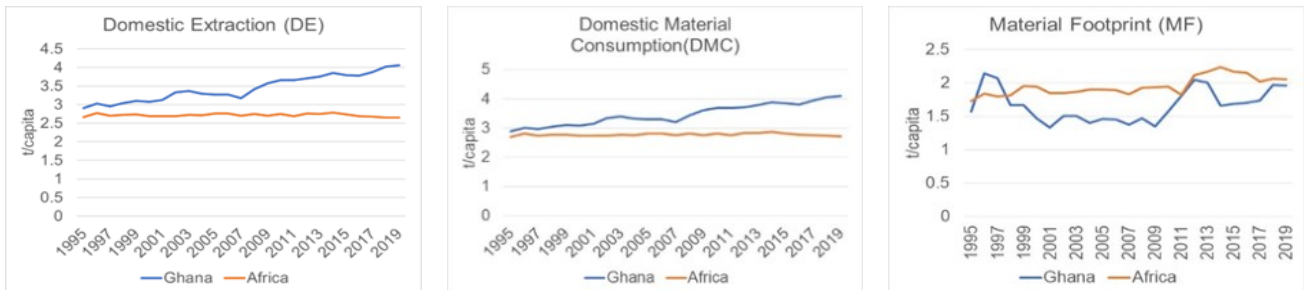
Elias T. Ayuk (IRP member) and Kwabena O. Asubonteng,
University for Development Studies, Tamale, Ghana



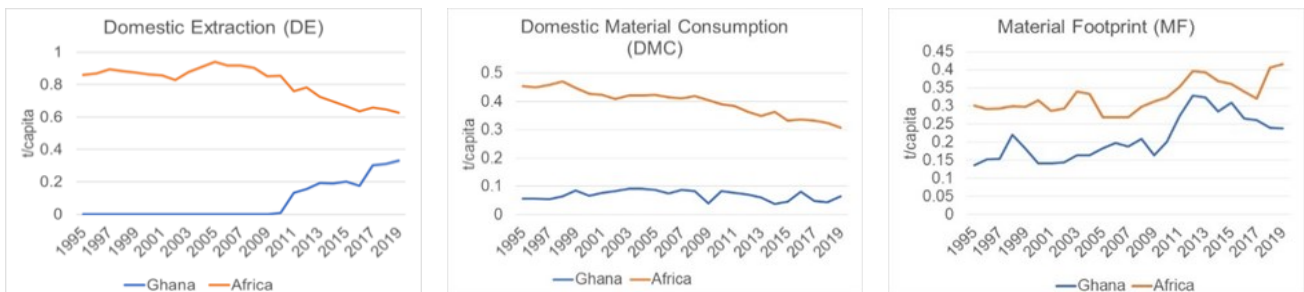
03 Country Profile: Ghana

3.1. Domestic extraction, domestic material consumption and material footprint

Biomass



Fossil fuel



Metal ore

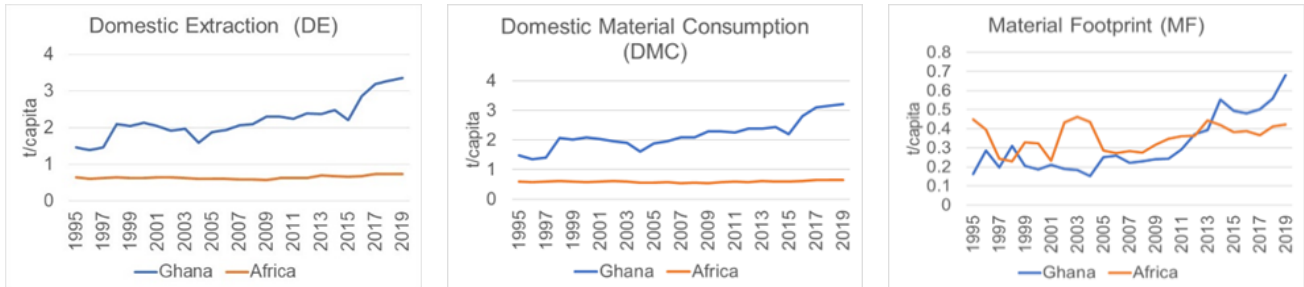


Figure 3.1: Per capita domestic extraction, domestic material consumption, and material footprint for biomass, fossil fuel, and metal ore. Source: UNEP IRP Global Material Flows Database. Data for Ghana.

- Biomass, fossil fuel, and metal ore extraction all witnessed significant increases from 1995 to 2019 in Ghana.
- Fossil fuel extraction increased by more than 300% from 2010 to 2019. This coincides with the beginning of oil extraction in 2010 in the country. This did not impact domestic consumption trends, indicating high material exports.
- The biomass material footprint increased by about 166%; the fossil fuel material footprint increased from 2009 by close to 400% up to 2016 and started falling for the following three years; and the metal ore material footprint increased more than 800% over the study period. The rising cost of domestic gas that turned households to the use of fuelwood for domestic energy and the increase in rosewood exports could have driven the increase in the material footprint of biomass.
- Ghana's biomass domestic extraction, biomass domestic material consumption, metal ore domestic extraction, and metal ore domestic material consumption exceeded the African average for these indicators.

3.2. Environmental impacts

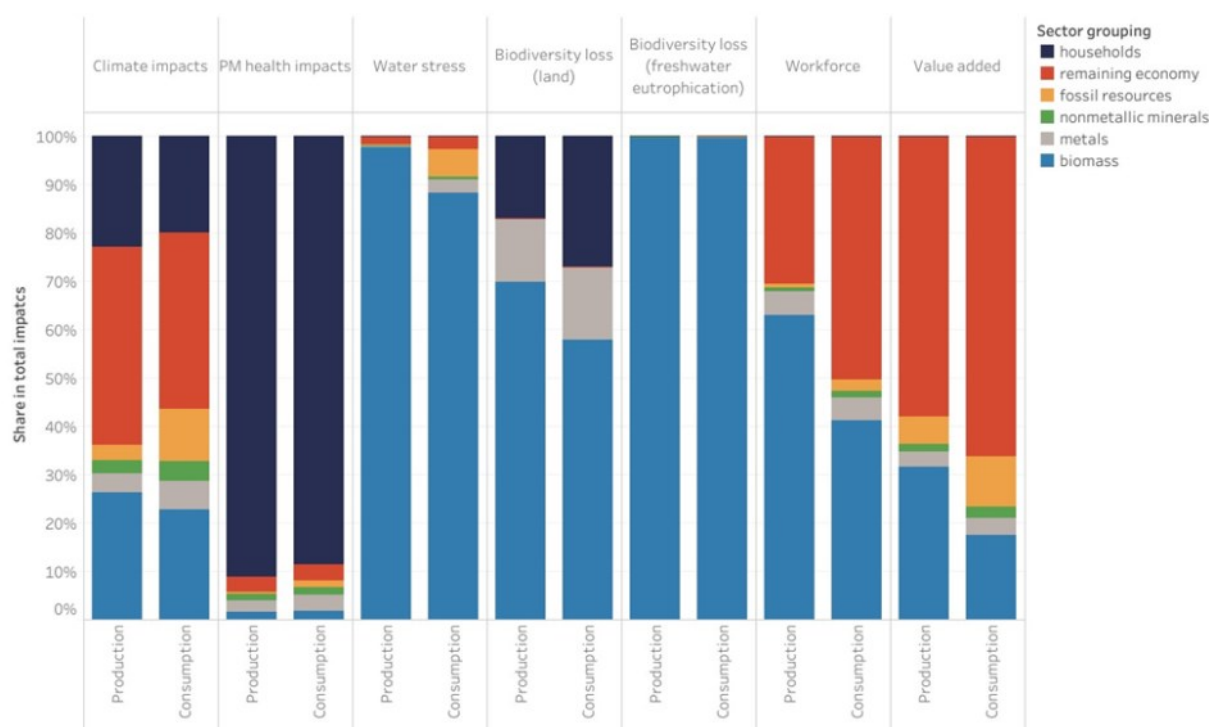


Figure 3.2: Relative contribution of different types of material resources (extraction and processing), the remaining economy (downstream chain of resource extraction and resource processing), and households to global environmental and socioeconomic impacts for the year 2022. Left columns: production-related perspective, right columns: consumption-related perspective. Data for Ghana.

- Biomass extraction was the main driver of the impacts on water stress, biodiversity loss (land), biodiversity loss (freshwater eutrophication), and workforce. This was valid for both the production and consumption perspectives.
- The contribution of biomass is higher in the production than consumption perspective. This is most likely related to the export of cocoa.
- Households, almost single-handedly, contributed significantly (90%) to PM health impacts. This is probably related to cooking fuel used in the country. In addition, transport is a significant emitter of greenhouse gas (GHG) emissions and air pollutants in most cities in Ghana. Road transport alone contributes 45.4% to total fuel combustion emissions and accounts for 13% of the overall national GHG emissions in 2016, showing a rising trend of 42% in the last ten years. Of the total road transport GHG emissions of 6,051.4 metric tonnes in 2016, buses account for 21%. Also, buses account for 17% of the total PM2.5 emissions in the country²⁶.
- The remaining economy was significant for both workforce and value-added impacts. From the production perspective, the remaining economy contributed 55% of the share of total impacts for value-added. The comparable figure for the consumption perspective was about 64%. For the workforce, the production perspective contributed 30% while the consumption perspective contributed 50%. The remaining economy, households, and fossil resources were also important actors for climate impacts.
- The highest impact on climate was related to the remaining economy both in the production and consumption perspective, which can be explained by the large share of hard and brown coal in the electricity mix.

²⁶ <https://unepccc.org/publications/market-feasibility-study-of-e-bus-deployment-in-accra-and-kumasi/#:~:text=Transport%20is%20a%20significant%20emitter,in%20the%20last%20ten%20years.>

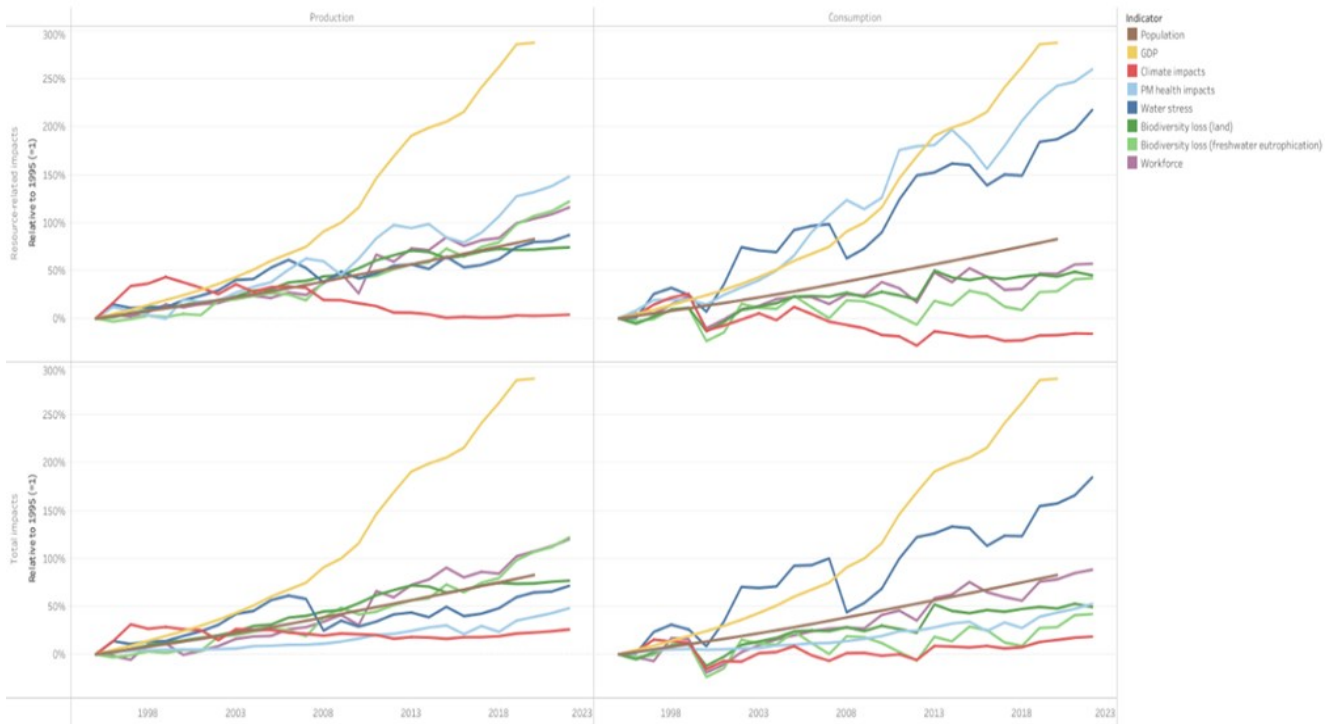


Figure 3.3: Temporal development of environmental impacts and socio-economic indicators from 1995 to 2022, from a production (left) and consumption (right) perspective. Data refers to resource use (top figures) as compared to the total economy (bottom figures). Data for Ghana.

- From a production perspective, Ghana achieved absolute decoupling with climate impacts in terms of both resource-related impacts and total impacts. GDP increased by over 75 % over the 1995-2022 period. Climate impacts decreased slightly by 5 % or remained the same over the period. Other key indicators increased slightly but grew much less than GDP, hence the country achieved relative decoupling.
- From the consumption perspective, GDP grew more than the other sectors, which also grew, but less so than the GDP growth. Concerning resource-related impacts, all sectors except climate impacts, experienced growth. Hence, Ghana achieved relative decoupling concerning these indicators.
- Still on the consumption side and concerning the total impacts, the country achieved relative decoupling with all the other sectors as GDP increased significantly more than growth in the other indicators.

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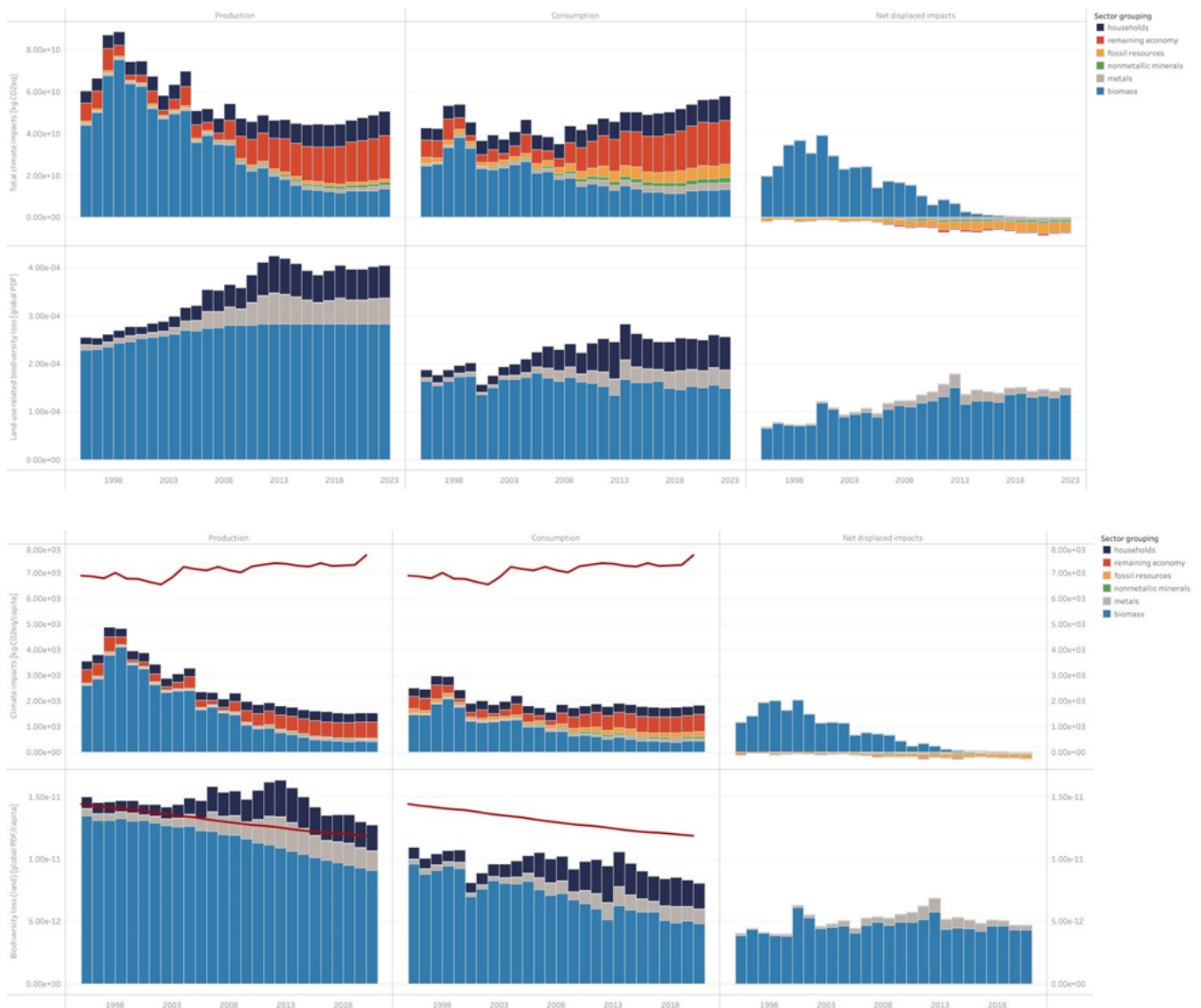


Figure 3.4: Time series of absolute (above panel) and per capita (below panel) values of climate change and land-related biodiversity loss split by resource group (cultivation, extraction, and processing) and downstream use (remaining economy and households). Moving averages over five years used for land occupation and change. Left: Production perspective. Middle: Consumption perspective (footprints). Right: net trade impacts (positive values indicate that impacts occur in these locations for producing exported goods, negative values indicate that goods are imported to these regions causing impacts and value added elsewhere). The red lines show the global per-capita average values. Data for Ghana.

- Ghana's per capita contribution to climate impact was substantially below the global average from both the production (about 55% below) and consumption (almost 60 % below) perspectives.
- In the case of biodiversity loss (land), Ghana exceeded the global average by about 25 % from a production perspective, most likely driven by the biodiversity-intensive production of cocoa and exploitation of timber and the diversification of exports such as rubber, cashew, and yam, but Ghana was below the global average by about 30 % for the consumption perspective. The growth of non-traditional exports was a result of a national strategy. See <https://www.fao.org/faolex/results/details/en/c/LEX-FAOC174377/>
- Net displacement impacts were generally positive and benefit the rest of the world.

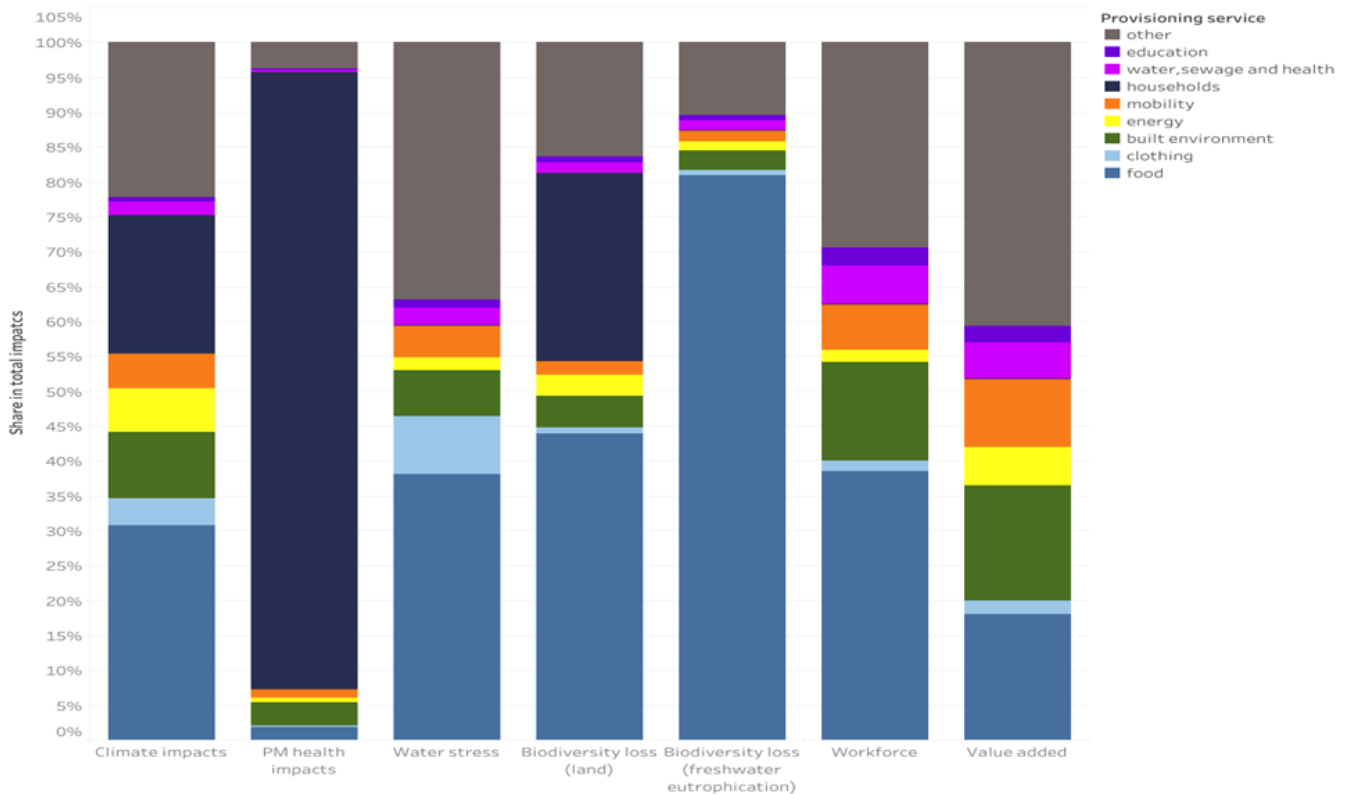


Figure 3.5: Relative contribution of different types of provisioning systems to global environmental and socioeconomic impacts for the year 2022. Household consumption includes emissions from mobility & energy (adding to the separately shown impacts of these provisioning systems). Data for Ghana.

- Food provisioning systems had significant environmental and socio-economic impacts. About 80% of the biodiversity loss (freshwater eutrophication) impacts were due to food provisioning systems. Food provisioning systems contributed about 30% of total climate impacts; 36% of water stress; more than 40% of land biodiversity loss; 36% of workforce impact; and about 17% of value-added impact.
- Cooking with solid fuels, heating, and mobility of households were the single most important contributor to PM health impacts (almost 90%). In the case of Ghana, this is mainly due to cooking and mobility²⁷. The sector also contributed about 25% to land biodiversity loss and 15% to climate impacts.
- Built environment and mobility (excluding private mobility by cars, which is included in “households”) provisioning systems had impacts across all environmental and socio-economic dimensions. The share of impact by the built environment was highest in value-added (17%), followed by workforce (15%), and climate impacts (10%). The highest contribution of the mobility sector to share of total impact was on value-added (about 7%).

²⁷ <https://unepccc.org/publications/market-feasibility-study-of-e-bus-deployment-in-accra-and-kumasi/#:~:text=Transport%20is%20a%20significant%20emitter,in%20the%20last%20ten%20years>

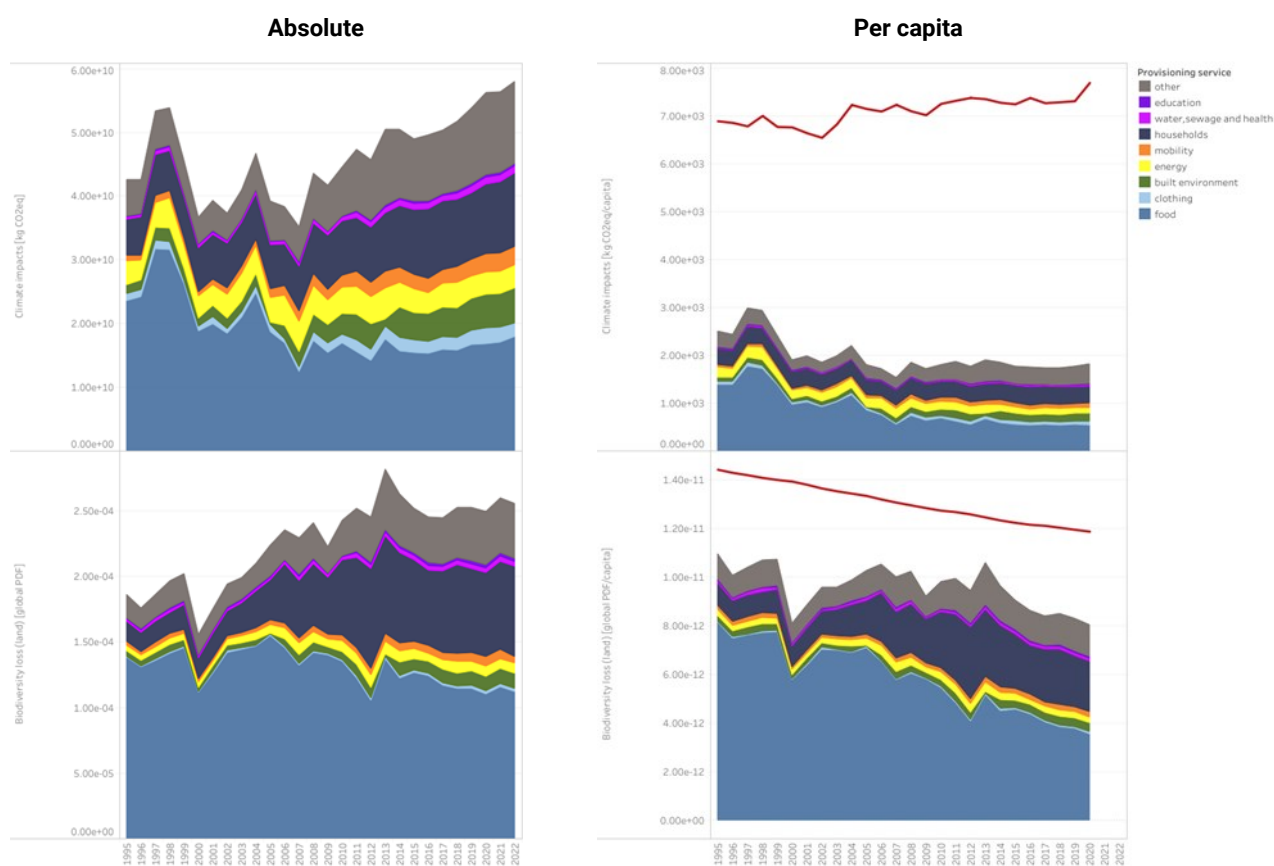


Figure 3.6: Time series of climate change (top) and land-related biodiversity loss (bottom) split by provisioning system. Household consumption includes emissions from mobility and energy (adding to the separately shown impacts of these provisioning systems). Left figures: absolute impacts. Right figures: per capita impacts, compared to global per-capita average, indicated by the red lines. Data for Ghana.

- Total climate impacts have increased over time with the top-five provisioning systems being food, other, households (cooking, private mobility, and heating), built environment, and energy.
- Broadly, per capita climate impacts have decreased and have remained constant during the recent years.
- Total biodiversity loss (land) increased by about 30% between 1995 and 2022. The increase is largely attributable to population growth.
- Per capita biodiversity loss (land) had decreased by about 20% over the period, consistent with the global trend that has been declining. In Ghana, the food and household sectors have driven this reduction.
- Ghana’s per capita climate impacts and biodiversity loss were all well below the global average.
- Between 2010 and 2019, Ghana achieved significant growth in inequality-adjusted life expectancy, education, and GNI per capita with a modest increase in per-capita climate impact and biodiversity loss. The data shows a stable effect on climate impacts and biodiversity loss.

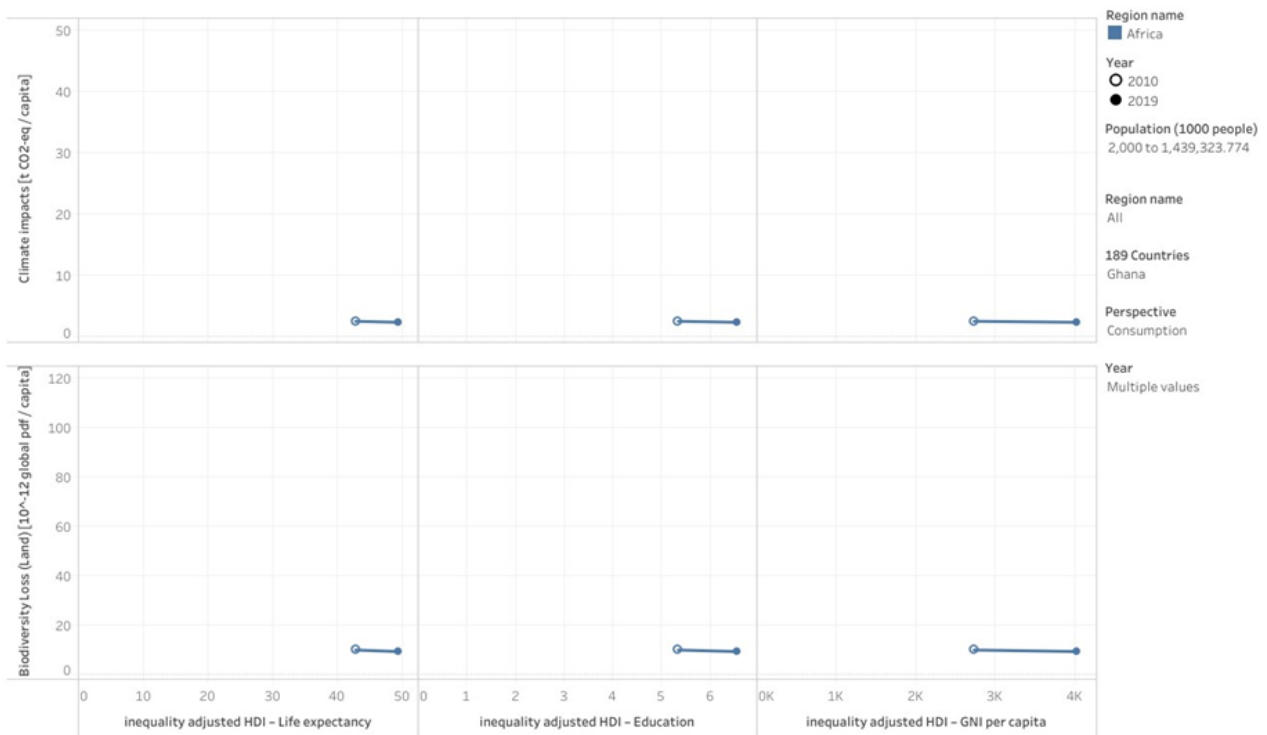


Figure 3.7: Per-capita impacts (consumption perspective) against wellbeing trajectory from 2010 to 2019. Data for Ghana.

3.3. Additional remarks on material flows and environmental impacts

Ghana has experienced impressive economic growth over the past two decades. However, there have been concerns about deforestation and environmental degradation. Although environmental impacts have increased during the 1995 – 2022 period, GDP has increased more and is consistent with relative decoupling.

Food provisioning made the greatest contribution to the total share of impact. Ghana’s per capita contribution to climate impact is significantly below the global average. Net displacement impacts were positive suggesting that impacts occur in these locations for producing exported goods.

Ghana is a party to many global conventions and has ratified several conventions including the Convention on Biological Diversity, the UN Convention to Combat Desertification, and the Paris Agreement. It has also developed policies, laws, and regulations related to the conservation and use of biodiversity. The Forest and Wildlife Policy and the Water Resources Policy are examples of these.

In summary, the current development paradigm puts a lot of pressure on the environment. Considering this, efforts to address these challenges are commendable. There is a need, however, to ensure that the implementation of the policies put in place is given the highest priority.

3.4. Examples of related policies

The Forestry and Wildlife Policy (2012). Ghana is endowed with enormous natural resources. The country has also experienced over the years rapid deforestation, land degradation, and biodiversity loss. The effects of climate change and climate variability are also evident. The Government of Ghana has developed many natural resource policies like the national environmental policy that address environmental concerns related to the triple planetary crises. One of these policies is the Forestry and Wildlife Policy, which was developed in 2012. The overall aim is the conservation and sustainable development of forest and wildlife resources. Specific objectives include a) managing and enhancing the ecological integrity of Ghana's forest; promoting the rehabilitation and restoration of degraded landscapes; c) promoting the

development of viable forest and wildlife-based industries and livelihoods, particularly in the value-added processing of forest and wildlife resources; promoting and developing mechanisms for transparent governance, equity sharing, and citizens' participation; and promoting training, research, and technology development that supports sustainable forest management²⁸.

Under this policy, the Government of Ghana has drawn from its financial resources and partnered with other stakeholders under initiatives such as the REDD+ and the Ghana Landscape Restoration and Small-Scale Mining Project (GLRSSMP) to address deforestation, biodiversity loss, and land degradation²⁹. The available evidence suggests that there is an uptake of forest enrichment and a slowing down in the increase in biodiversity loss.



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²⁸ Ghana Forestry Commission (2012). Ghana Forestry and Wildlife Policy, Accra
Forestry Commission and Ghana Cocoa Board (2016) Ghana Cocoa Forest REDD+ Programme: The Development of Ghana's Emission Reductions Programme Implementation Plan (GCFRP) https://redd.unfccc.int/files/gcfrp_final_implementation_plan.pdf. Accessed 10/07/2023.
²⁹ The World Bank (2021). Ghana Landscape Restoration And Small-Scale Mining Project: Project Appraisal Document: <https://glrssmp.epa.gov.gh/wp-content/uploads/2022/11/GH-GLRSSMP-PAD-public.pdf>. Accessed 10/07/2023



Julian Morenz

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International
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Global Resources Outlook 2024

Country Profile: Japan

Chika Aoki-Suzuki and Ran Yagasa, Institute for
Global Environmental Strategies, Japan



04 Country Profile: Japan

4.1. Domestic extraction, domestic material consumption and material footprint

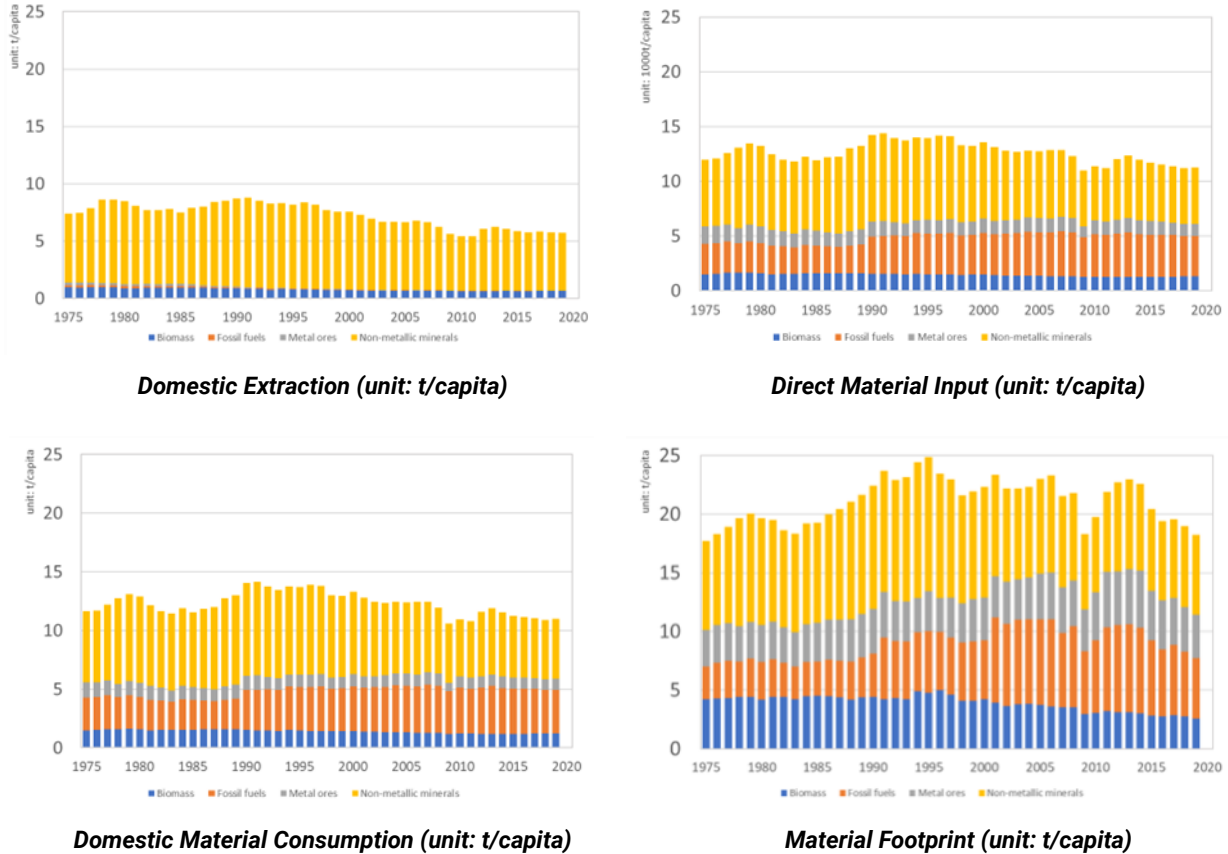


Figure 4.1: Per capita domestic extraction, domestic material consumption and material footprint for biomass, fossil fuel and metal ore. Source: UNEP IRP Global Material Flows Database. Data for Japan.

- Domestic extraction (DE) of Japan shows a decreasing trend especially after 1995, mainly because of decreasing non-metallic minerals.
- In 2019, about 90% of domestic extraction is non-metallic minerals and Japan has little domestic extraction of metal and fossil fuels.
- The reduction of non-metallic minerals is applicable for Direct Material Input (DMI), Domestic material consumption (DMC) and Material Footprint (MF). This is the main reason of the decreasing trend of these data after 1995.
- DMI and DMC show similar trend in all four resources while DMI is larger than DMC. MF is much larger than the other three indicators. This implies a resource-import product-export based economy in Japan whereas the difference between MF and DMC/DMI has been getting smaller after 2012.
- DMC of Japan shows a decreasing trend especially after 1990. But fossil resource shows an increasing trend from 1990 to 2005, then turns to slightly show a decreasing trend.
- While DMC of metals show a decreasing trend, MF of metal shows, in general, increasing trend until 2014. MF of Fossil resources show increasing trend and growth after 2000.

4.2. Environmental impacts

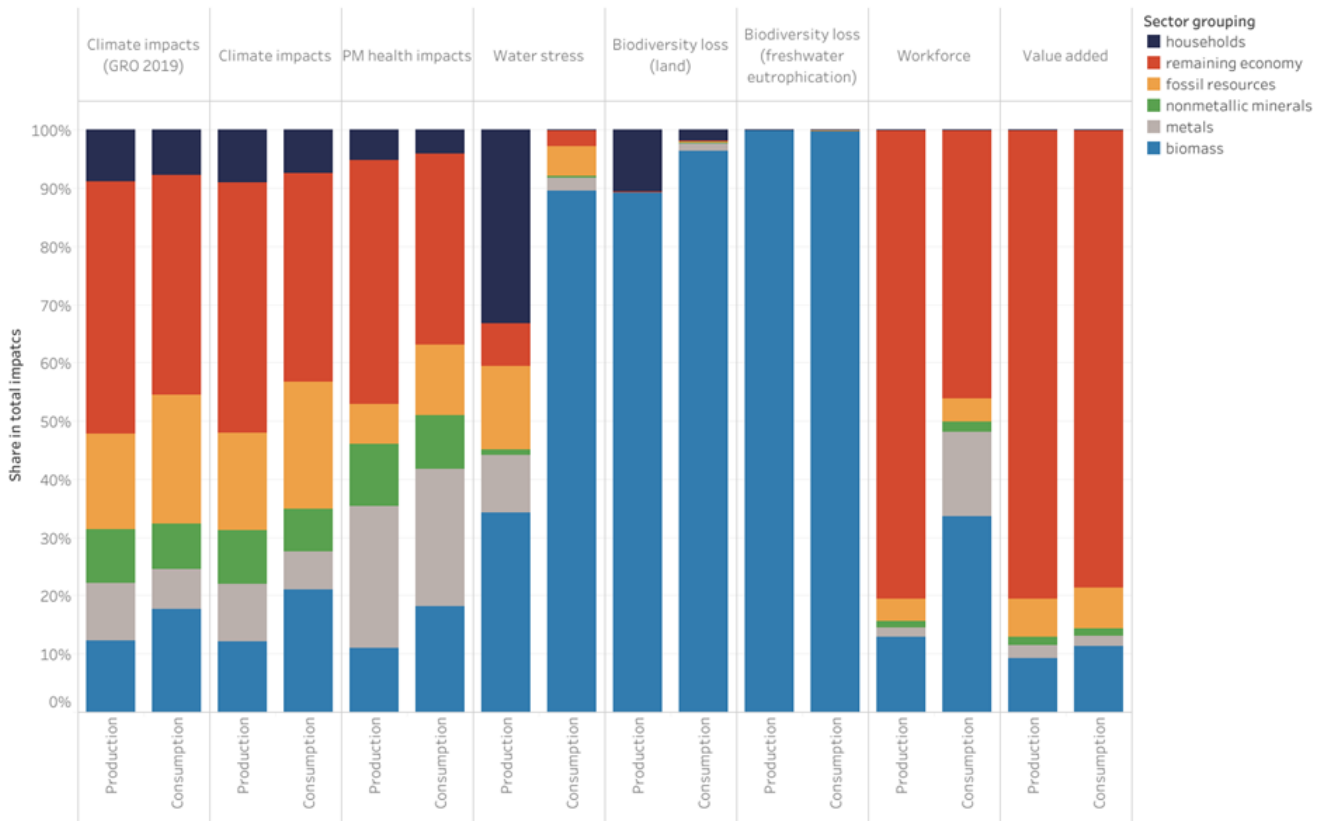


Figure 4.2: Relative contribution of different types of material resources (extraction and processing), the remaining economy (downstream chain of resource extraction and resource processing) and households to global environmental and socioeconomic impacts for the year 2022. Left columns: production-related perspective, right columns: consumption-related perspective. Data for Japan.

- Resource extraction and processing accounts for (production- and consumption- based, respectively):
 - About 48% and 57% of contribution to total climate impacts (consumption perspectives) with biomass and fossil resources being the main resource of the impact. However, remaining economy is the biggest contributor of the impact.
 - About 53% and 63% of contribution to the total air pollution impact, with metals being the main resource group contributing to the impact. However, remaining economy is the biggest contributor of the impact.
 - About 59% and 97% of contribution to total water stress with biomass resources being the main cause of the impact.
 - About 89% and 98% of contribution to total biodiversity loss (land) impacts, mostly due to biomass resources.
 - About 100% and 99% of contribution to total biodiversity loss (freshwater eutrophication) impacts, mostly due to biomass resources.



Figure 4.3: Temporal development of environmental impacts and socio-economic indicators from 1995 to 2022, from a production (left) and consumption (right) perspective. Data refers to resource use (top figures) as compared to the total economy (bottom figures). Data for Japan.

- Climate impacts from production perspective has shown coupling trend with GDP except for sudden decrease in 2009 due to economic crisis and turned to clear increasing trend since then. On the other hand, consumption perspective climate impacts show decoupling trend while being stagnant after 2009.
- Consumption based water related impacts (water stress and biodiversity loss (freshwater eutrophication)) shows strong increasing trend especially after 2010, coupling with GDP. This could imply that Japan depends on overseas production of sectors such as textile and food with large water stress.
- Air pollution impact has shown decoupling trend until 2014, however, the trend has turned out to be stagnant (production-based), to increasing trend (consumption-based)
- Biodiversity loss (land) has shown no significant change in production-based and decoupling/ decreasing trend in consumption-based. One possible background is the stagnant of domestic forest industry in Japan and the reduction of wood import, which peaked in 1996 and show decreasing trend until now³⁰.
- In both production and consumption-based results, the trends have been changed around 2014. In general, trends of production-based impacts have been stagnant after 2014, but trends of consumption-based have turned to increasing results.



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³⁰ Ministry of Agriculture, Forestry and Fisheries timber supply and demand table https://www.maff.go.jp/j/tokei/kouhyou/mokuzai_zyukyu/

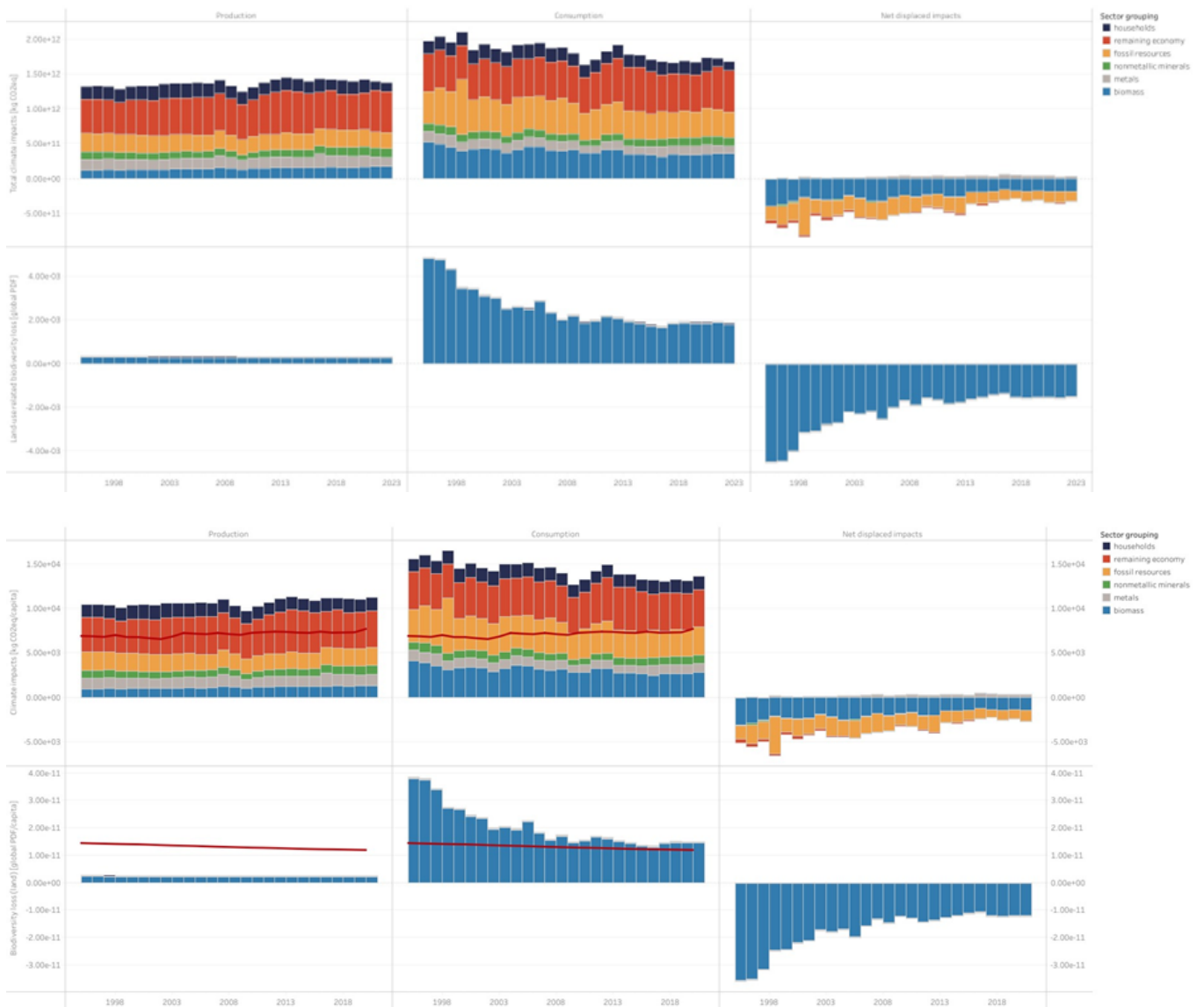


Figure 4.4: Time series of absolute (above panel) and per capita (below panel) values of climate change and land-related biodiversity loss split by resource group (cultivation, extraction, and processing) and downstream use (remaining economy and households). Moving averages over five years used for land occupation and change. Left: Production perspective. Middle: Consumption perspective (footprints). Right: net trade impacts (positive values indicate that impacts occur in these locations for producing exported goods, negative values indicate that goods are imported to these regions causing impacts and value added elsewhere). The red lines show the global per-capita average values. Data for Japan.

- No big differences are observed in trend between absolute and per capita data as well as between production and consumption perspectives.
- Climate impacts (both production- and consumption-based) and consumption-based biodiversity impact (per capita) are larger than global average.
- Consumption-based climate impact is, in general, larger than the production-based one, especially for biomass and fossil resources.
- Production-based climate impact of metal resources is larger than the consumption-based one. This is considered mainly due to metal production and exports (i.e. steel³¹, copper³²) in Japan.

³¹ Japan Iron and Steel Federation <https://www.jisf.or.jp/data/boeki/index.html>

³² Japan Copper and Brass Association <http://copper-brass.gr.jp/copper-and-brass/copper/domestic-metal>

- Climate impacts (both production and consumption-based) and production-based biodiversity loss impact has been stagnant and consumption-based biodiversity loss impact has decreased.
- Biomass³³ is a major contributing resource to biodiversity loss (land). As self-sufficiency rate of food and wood in Japan are low (38% in 2022³⁴, 41.1% in 2021³⁵, respectively), consumption impact is much larger than global average and production impact by biomass resource, resulting in negative net displaced impact of biomass for biodiversity loss (land). Some impacts from metal could be found in the negative net displaced impact, due to resource import manufacturing-based economy in Japan.

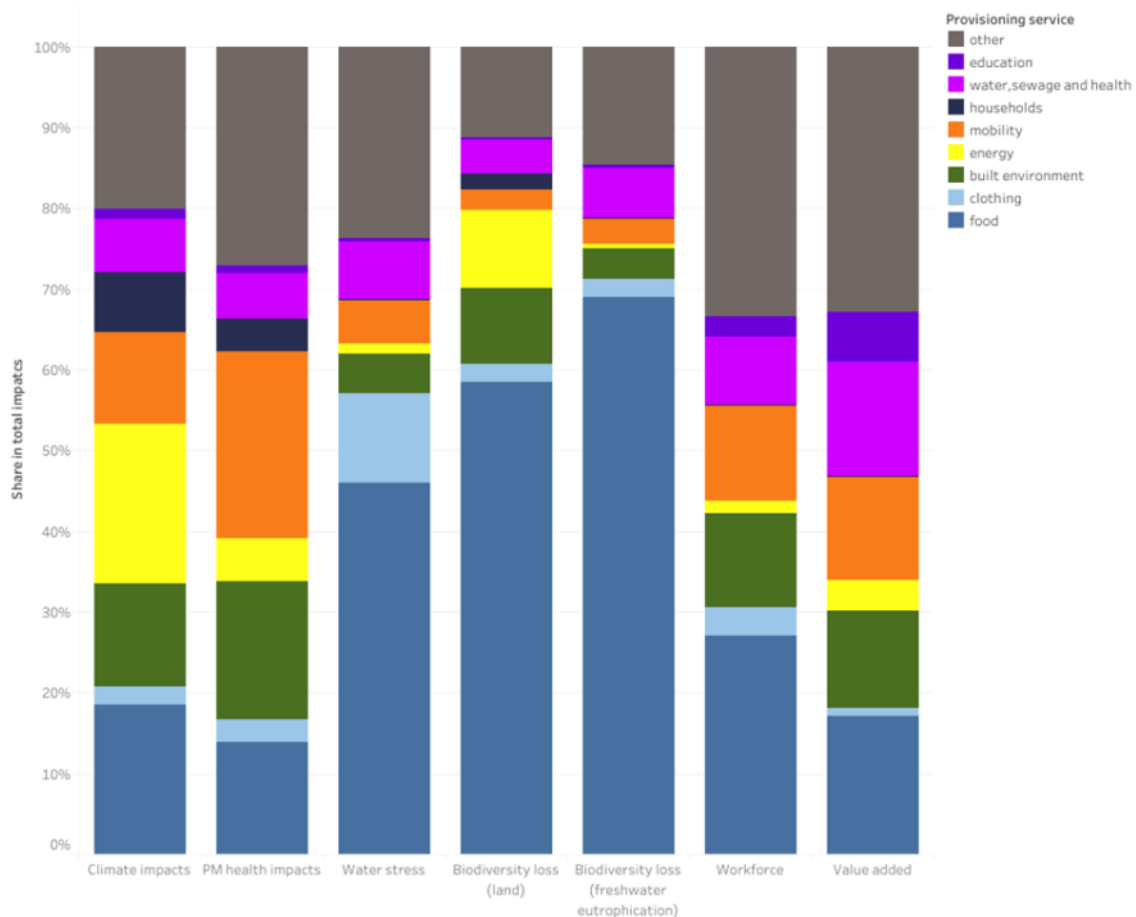


Figure 4.5: Relative contribution of different types of provisioning systems to global environmental and socioeconomic impacts for the year 2022. Household consumption includes emissions from mobility & energy (adding to the separately shown impacts of these provisioning systems). Data for Japan.

- Food and energy system are major contributors to climate impact followed by built environment and mobility systems.
- Mobility system is the major provisioning system for air pollution.
- For water stress, while food is a major contributing system, clothing sector is also a large contributor.
- Food is the biggest contributing system to biodiversity loss (both land and freshwater/ eutrophication). Built environment and energy also contribute to biodiversity loss (land).

³³ Land-related biodiversity loss is almost entirely due to biomass imports.

³⁴ https://www.maff.go.jp/j/zyukyu/zikyu_ritu/012.html

³⁵ <https://www.rinya.maff.go.jp/j/press/kikaku/220930.html>

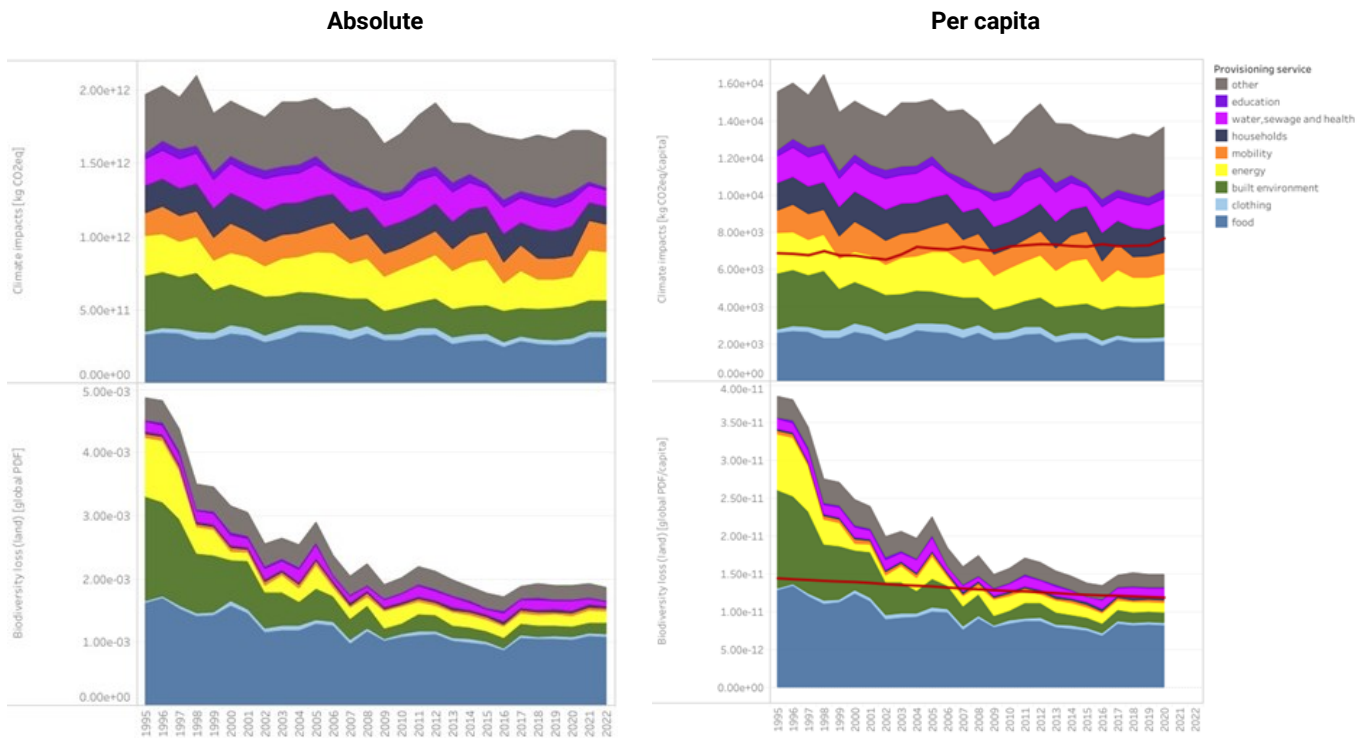


Figure 4.6: Time series of climate change (top) and land-related biodiversity loss (bottom) split by provisioning system. Household consumption includes emissions from mobility and energy (adding to the separately shown impacts of these provisioning systems). Left figures: absolute impacts. Right figures: per capita impacts, compared to global per-capita average, indicated by the red lines. Data for Japan.

- Both climate and biodiversity loss (land) of Japan show larger impact than global averages.
- Climate impact has been stagnant, showing slight decreasing trend mostly due to the impact reduction from built environment.
- Biodiversity loss impact has decreased, showing step decrease in late 1990's mostly due to the impact reduction from built environment and energy, followed by food system.
- Regarding the energy sector, wood related products including pulp steeply decreased in 1990's leading to decreasing energy use for the sector³⁶. This is likely due to Asian financial crisis in 1997.
- Regarding the built environment, the peak of construction investment is 1992 in Japan³⁷ and has steeply decreased from 1996 until 2010³⁸. This could related to the decrease of wood import for construction, leading to the reduction of land use.
- On Food, Japanese gross agricultural output has been on a long-term downward trend since its peak in 1984³⁹.

³⁶ Ministry of Agriculture, Forestry and Fisheries Timber/wood products Supply and Demand Chart https://www.maff.go.jp/tokei/kouhyou/mokuzai_zyukyu/

³⁷ Ministry of Land, Infrastructure, Transport and Tourism https://www.mlit.go.jp/tochi_fudousan_kensetsugyo/const/content/001493958.pdf

³⁸ Ministry of Land, Infrastructure, Transport and Tourism https://www.mlit.go.jp/report/press/joho04_hh_001106.html

³⁹ Ministry of Agriculture, Forestry and Fisheries https://www.maff.go.jp/j/wpaper/w_maff/r2/r2_h/trend/part1/chap3/c3_1_00.html

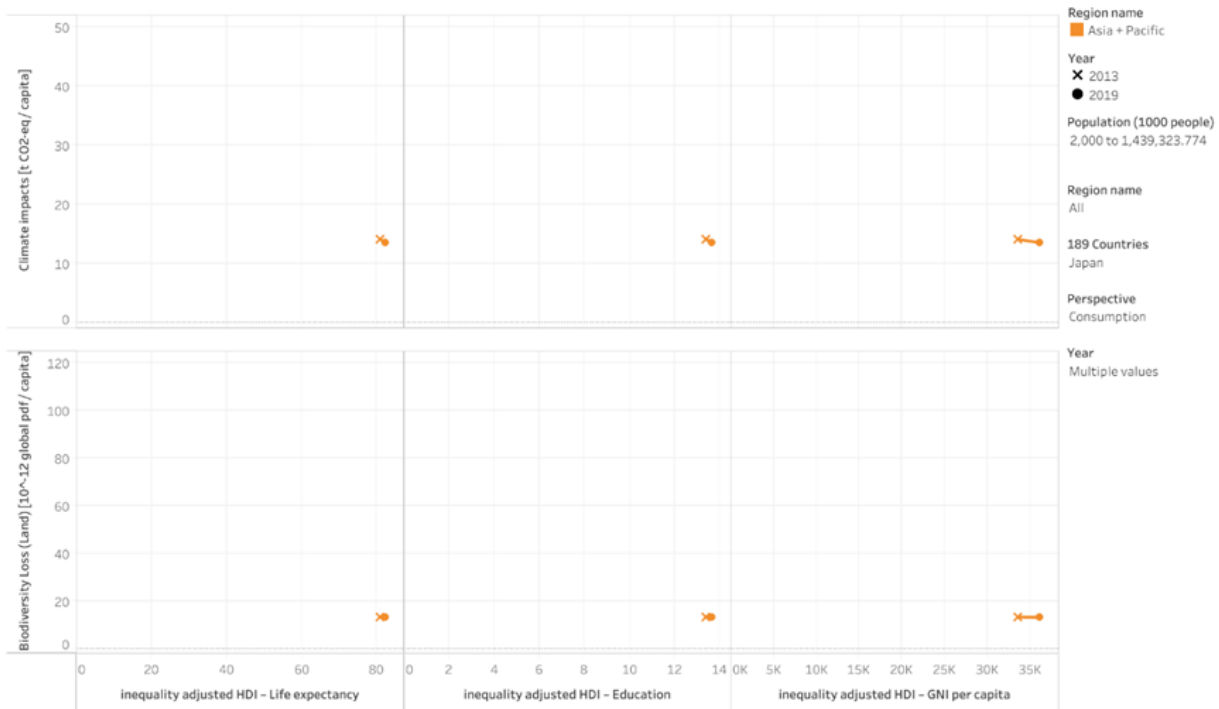


Figure 4.7: Per-capita impacts (consumption perspective) against wellbeing trajectory from 2013 to 2019. Data for Japan.

- No significant changes in the relationship between environmental impacts (climate and biodiversity loss (land)) and wellbeing (inequality-adjusted life expectancy, education and GNI) has been observed from 2013 to 2019 in Japan.

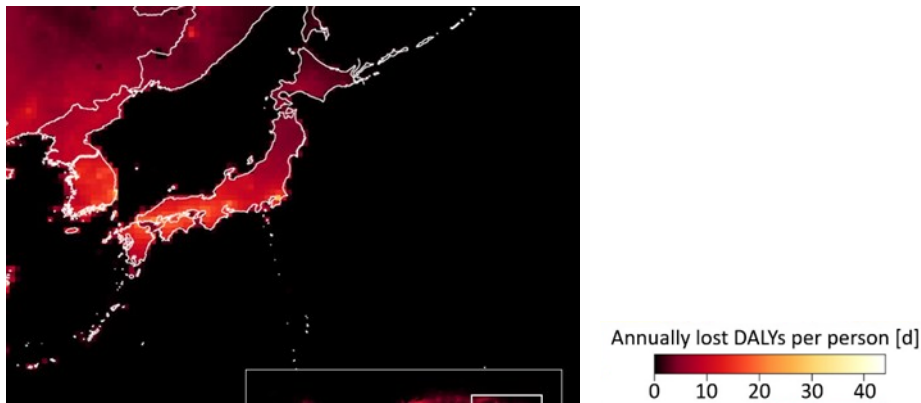


Figure 4.8: Per capita human health impacts in Disability Adjusted Life Years (DALYs) from primary and secondary particulate matter in 2019 caused by six main types of industrial activities (coal power, gas power, oil power, cement production, steel production, petroleum refining). The colors indicate the days that are lost per year and person.

- Impact to Disability Adjusted Life Years (DALYs) from particulate matter in 2019 caused by six main types of industrial activities (coal power, gas power, oil power, steel, cement, petroleum refining) are found along with major industrial area in Japan, where above manufacturing activities including oil refinery process are active, mainly in western Japan. This implies that the health impact strongly correlates to the industrialization in case of Japan.

4.3. Additional remarks on material flows and environmental impacts

Japan's MFA data in general shows that resource use in Japan has turned to decreasing trends after around 1995, implying resource decoupling in Japan. However, there are no changes in the status of resource dependence outside of the countries.

Resource extraction and processing accounts for a half of contribution to total climate impact and air pollution impact as well as most of contribution to total biodiversity loss.

The trend of environmental impacts shows different results from material flow data.

Climate impacts (production-based) has shown increasing trend and coupled with GDP.

Consumption-based climate impact and land related biodiversity loss have shown decreasing trend. Other environmental impact area has firstly shown decreasing trend and decoupling with GDP but most of environmental impact area has turned to increasing trend since late 2010's.

The per-capita impact has exceeded global average and consumption impact is higher than production impact in general.

Material efficient approach including application of domestically procured recycled resource as well as non-resource consuming business model such as Repair, remanufacturing, Product as a service model is anticipated as a possible approach to reduce consumption impact.

4.4. Examples of related policies⁴⁰

Japan has made efforts to formulate resource efficiency policy, namely for sound material cycle society (SMCS), aiming to establish a society which could reduce natural resource consumption and environmental impact through waste prevention, cyclical use of resources and appropriate disposal. SMCS policy has been developed since around the year 2000, addressing all lifecycle of resource use with policy packages including:

- Basic Act for Establishing a Sound Material Cycle Society (2000) and its Fundamental Plan for Establishing a Sound Material Cycle Society⁴¹, of which 5th plan will be formulated in 2024.
- Act on the Promotion of Effective Utilization of Resources (2000), mainly applied to producers, including design and production as well as 3R activities and engagement of producers for recycling
- Green Purchasing Act (2000) for consumption phase, especially public procurement phase
- Specific recycling acts on Containers and Packaging (1995), Home Appliances (1998), Food (2000), Construction (2000), End-of-Life Vehicles (2002) and small home appliances (2012)
- Waste management and public cleaning act for waste treatment (1970)

⁴⁰ Years refer to the year of promulgation/enactment.

⁴¹ Ministry of the Environment, Japan (2018) the 4th Fundamental Plan for Establishing a Sound Material Cycle Society <https://www.env.go.jp/content/900453386.pdf>

The results of these policies can be seen in the headline indicators of the above plan. Resource productivity (GDP/DMI), cyclical use rate and final disposal have improved:

- Resource productivity: 253 (thousand JPY/t) in 2000 to 493 (thousand JPY/t) in 2019
- Cyclical use rate (inlet): 10% in 2000 to 15.7% in 2019
- Final disposal: 56 mil t in 2000 to 13 mil t in 2016

This improvement could be mainly caused by the decrease of non-metallic minerals due to stagnant construction investment in Japan. Further efforts to address the use of other resources are necessary to reduce associated environmental impact.

In this regard, Japan has developed recently circular economy roadmap⁴² and strategy for Growth-oriented resource-autonomous economy⁴³ to further scale up and promote the transition to circular economy in Japan. These strategies are also aiming to contribute to climate mitigation and nature positive.



Jaison Lin
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⁴² Circular economy roadmap (2022) (Junkan Keizai kouteihyo) <https://www.env.go.jp/content/000071596.pdf>

⁴³ Ministry of the Economy Trade and Industry (2023) Strategy for Growth-Oriented, Resource-Autonomous Economy Strategy <https://www.meti.go.jp/press/2022/03/20230331010/20230331010.html>





International
Resource
Panel

Global Resources Outlook 2024

Country Profile: Lithuania

Viktoras Kulionis, Lund University



05 Country Profile: Lithuania

5.1. Domestic extraction, domestic material consumption and material footprint

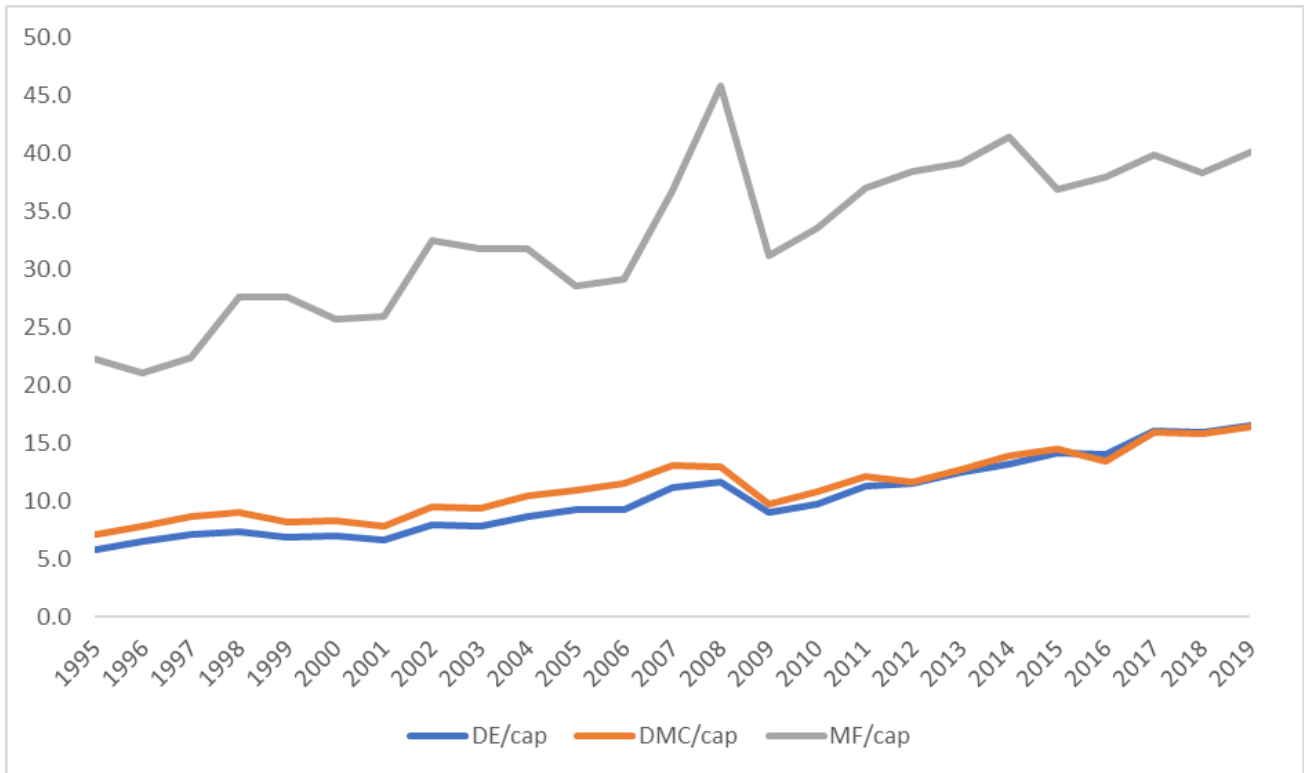


Figure 5.1: Per capita domestic extraction, domestic material consumption and material footprint for biomass, fossil fuel and metal ore. Source: UNEP IRP Global Material Flows Database. Data for Lithuania.

- There has been a significant increase in domestic extraction in Lithuania from 1995 to 2019. The per capita extraction rose from 5.8 tonnes in 1995 to 16.6 tonnes in 2019. This represents nearly a threefold increase over a 24-year period, indicating a substantial growth in the country's resource extraction activities.
- The material footprint per capita also grew from 22.2 tonnes in 1995 to 40.1 tonnes in 2019. This reflects an 80% increase, suggesting that Lithuania's consumption of raw materials (including both domestically extracted and imported goods) has grown substantially.
- While both domestic extraction and material footprint have increased, the rate of growth for domestic extraction (approximately 186%) has been more than twice the growth rate for material footprint (80%). This might suggest a shift towards greater reliance on domestically sourced materials over this period.

5.2. Environmental impacts

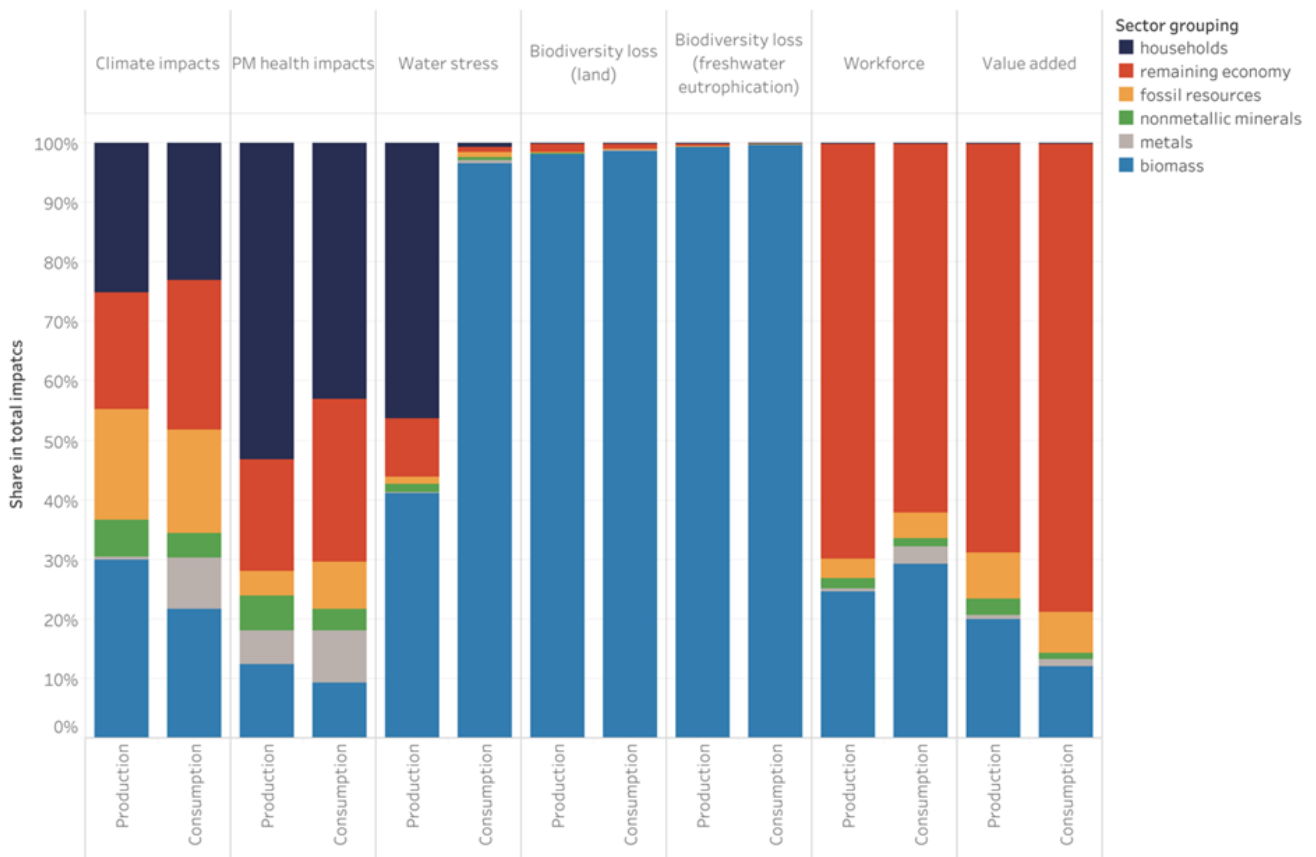


Figure 5.2: Relative contribution of different types of material resources (extraction and processing), the remaining economy (downstream chain of resource extraction and resource processing) and households to global environmental and socioeconomic impacts for the year 2022. Left columns: production-related perspective, right columns: consumption-related perspective. Data for Lithuania.

- The biomass sector has the greatest impact on biodiversity loss (land) and freshwater eutrophication compared to other sectors. This may result from extensive land use and water resources involved in biomass production, potentially leading to habitat destruction and water pollution. The sector also significantly contributes to water stress.
- Households significantly affect climate change and PM health impacts. These effects could stem from emissions and particulate matter produced by household energy use and transport activities.
- The remaining economy sector employs the largest workforce and adds the most added value compared to other sectors. This highlights the economic importance of the remaining economy in providing employment and contributing to economic output.
- Impacts on climate, PM emissions, workforce, and value added are distributed across multiple sectors, illustrating shared responsibility for impact. In contrast, biodiversity loss and water stress impacts are predominantly driven by the biomass sector. This suggests that while various sectors contribute to economic and environmental impacts, the biomass sector is a critical area for interventions related to biodiversity and water.

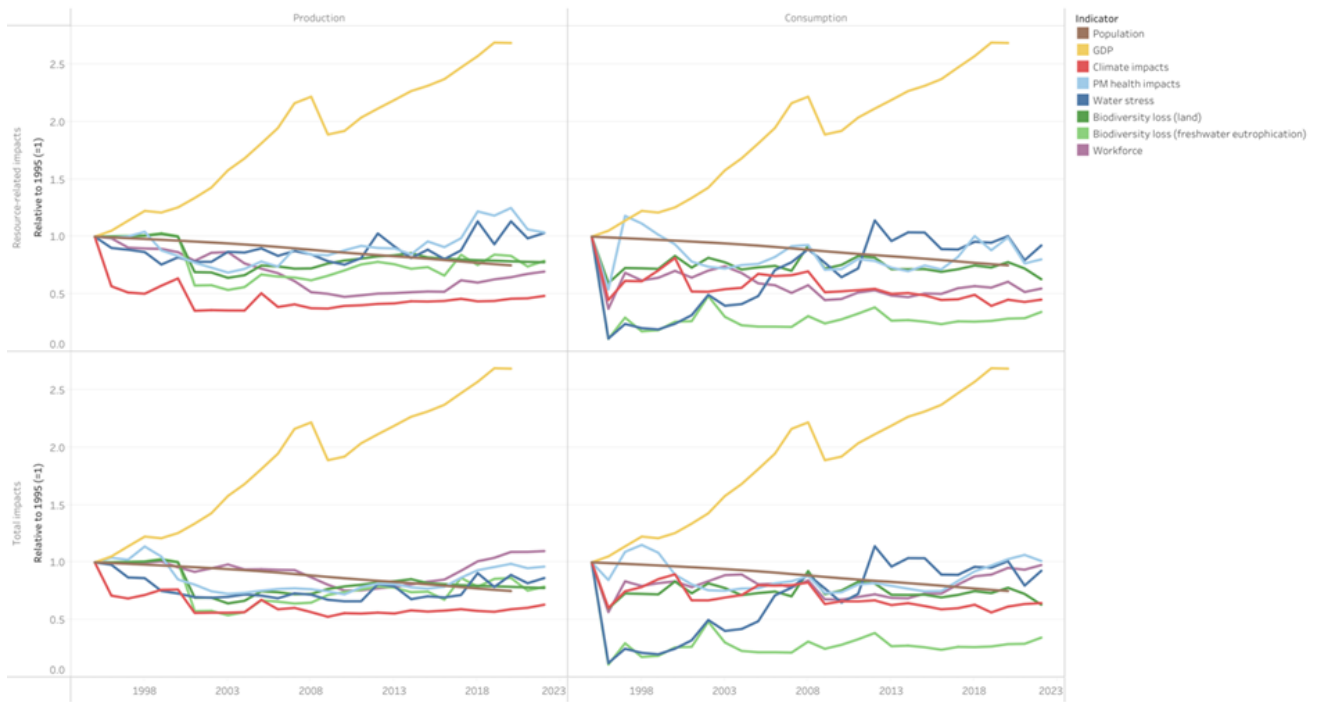


Figure 5.3: Temporal development of environmental impacts and socio-economic indicators from 1995 to 2022, from a production (left) and consumption (right) perspective. Data refers to resource use (top figures) as compared to the total economy (bottom figures). Data for Lithuania.

- Economic growth was steady over the observed period, demonstrating that the economy has grown while most environmental impacts have either declined or remained unchanged. This indicates an absolute decoupling of economic and environmental impacts, albeit very slow.
- Climate impacts decreased over the period from both a production and consumption perspective. This suggests that strategies to mitigate emissions - such as implementing cleaner technologies and adopting sustainable practices - have been effective.
- The PM health impacts remained mostly unchanged during the period which points to stable air quality. Additionally, there has been no major changes in water stress and land biodiversity loss impacts while the economy grew.
- While these points highlight promising trends, it's important to emphasize that efforts should be maintained and enhanced to further reduce the environmental impact of economic activities.



Igor Gubaidulin
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Figure 5.4: Time series of absolute (above panel) and per capita (below panel) values of climate change and land-related biodiversity loss split by resource group (cultivation, extraction, and processing) and downstream use (remaining economy and households). Moving averages over five years used for land occupation and change. Left: Production perspective. Middle: Consumption perspective (footprints). Right: net trade impacts (positive values indicate that impacts occur in these locations for producing exported goods, negative values indicate that goods are imported to these regions causing impacts and value added elsewhere). The red lines show the global per-capita average values. Data for Lithuania.

- The patterns of emissions across sectors are similar when comparing production and consumption perspectives. Despite the similarity in sector patterns, the impact of emissions is higher when viewed from the consumption perspective.
- Biomass sector is largely responsible for nearly all of the impacts on biodiversity, this applies to both the production and consumption perspectives. This could be due to the extensive use of land, water, and other resources associated with biomass production and consumption, resulting in significant habitat loss and fragmentation.
- Results show that impacts embodied in imported goods and services are higher than those embodied in exported ones. This can happen because of differences in the composition of imports and exports, differences in technology between trading partners, and due to differences in the volume of trade.

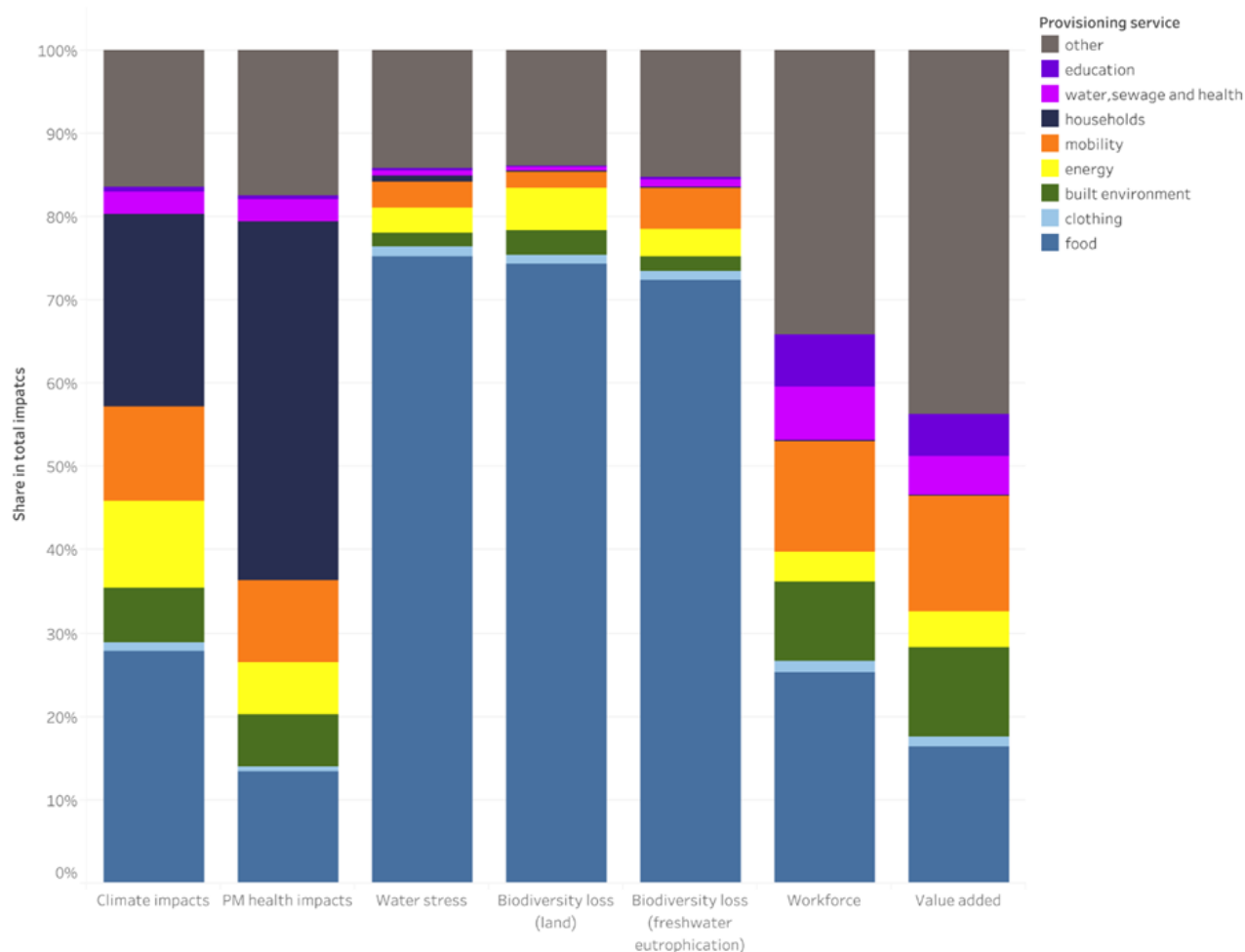


Figure 5.5: Relative contribution of different types of provisioning systems to global environmental and socioeconomic impacts for the year 2022. Household consumption includes emissions from mobility & energy (adding to the separately shown impacts of these provisioning systems). Data for Lithuania.

- The food sector has the highest impact in nearly all categories, most notably in water stress and both types of biodiversity loss. This emphasizes the environmental footprint of food production and the importance of shifting towards more sustainable practices.
- The education sector contributes to value added and workforce but shows minimal environmental impact across all categories. This highlights the potential of certain sectors to add economic value while maintaining a low environmental footprint.
- Built environment, energy and water, sewage and health sectors appear to have relatively low environmental impacts across the categories when compared to other sectors. Despite their contribution to the workforce and value added to the economy, they manage to maintain lower impacts across the categories of climate, PM health, water stress, and biodiversity loss.

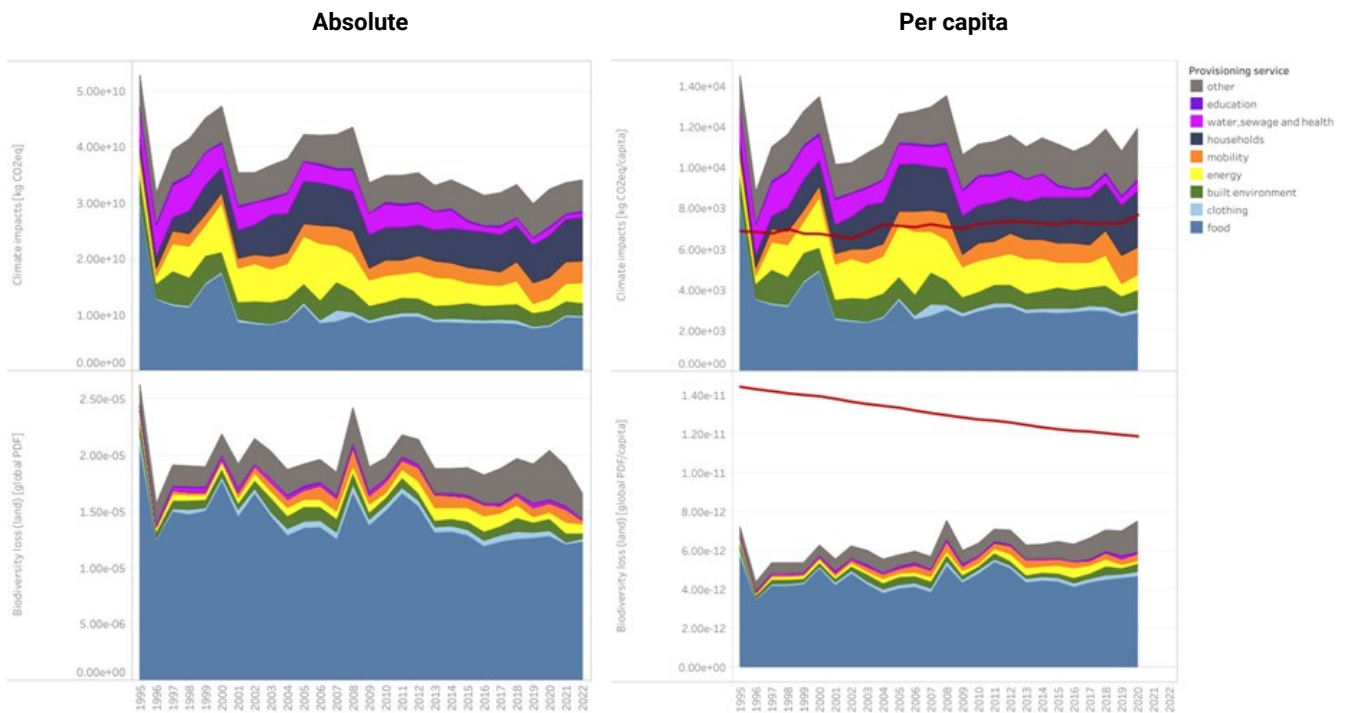
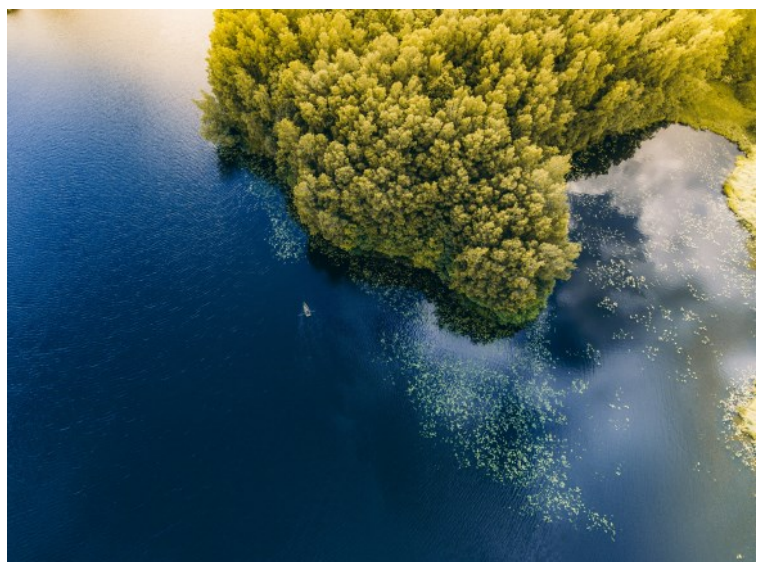


Figure 5.6: Time series of climate change (top) and land-related biodiversity loss (bottom) split by provisioning system. Household consumption includes emissions from mobility and energy (adding to the separately shown impacts of these provisioning systems). Left figures: absolute impacts. Right figures: per capita impacts, compared to global per-capita average, indicated by the red lines. Data for Lithuania.

- Food provisioning systems had the highest impact in terms of both climate impact and biodiversity loss throughout the entire period.
- The impact of energy, and water, sewage and health provisioning systems on climate change and land biodiversity loss has been steadily decreasing, highlighting the declining environmental footprint of these sectors. However, the impacts from households and mobility have increased over the period, pointing towards the growing environmental challenges associated with these sectors.
- The increasing contribution of the "other" provisioning systems to land biodiversity loss suggests that there are some activities (e.g. production of biochemicals) not falling under the traditional sector categories that are exerting growing pressure on terrestrial ecosystem and these activities should not be overlooked.



Humphrey Muleba
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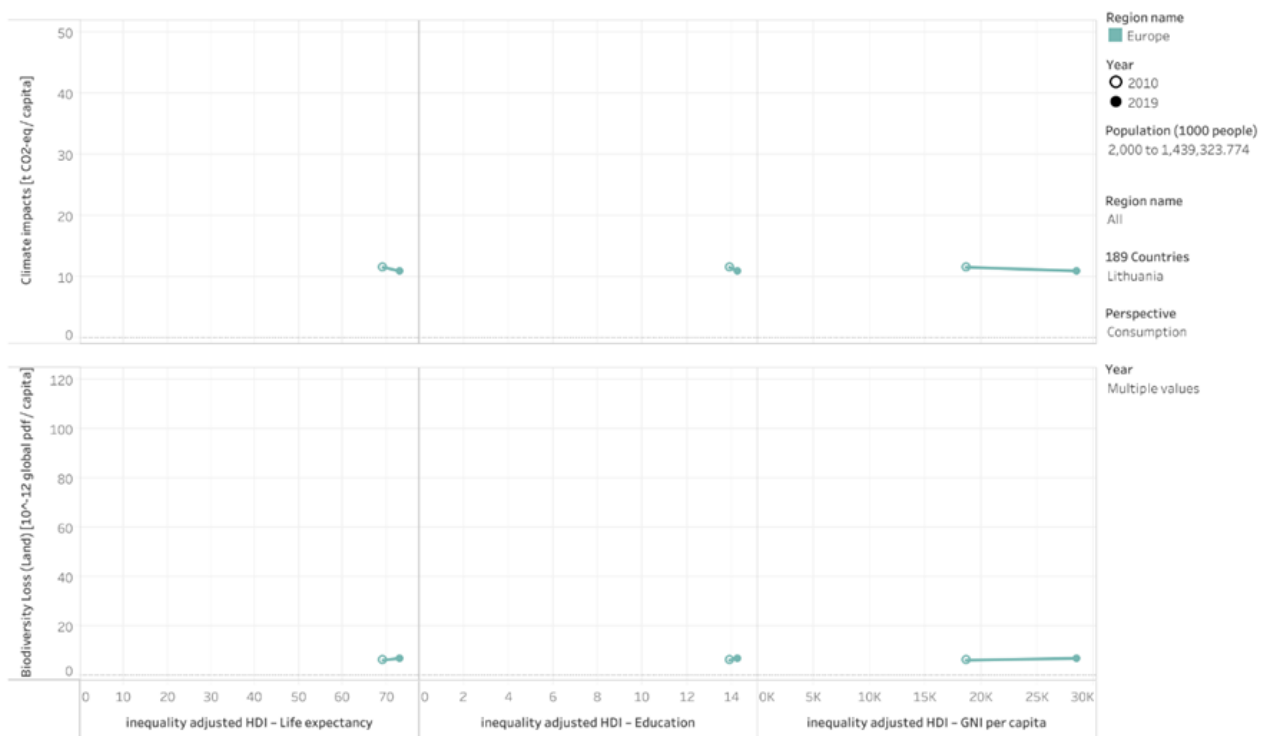


Figure 5.7: Per-capita impacts (consumption perspective) against wellbeing trajectory from 2010 to 2019. Data for Lithuania.

- All parameters exhibit a positive development between 2010 and 2019. There has been a small improvement in the inequality-adjusted life expectancy, a small increase in the inequality-adjusted education duration and a relatively large increase in the inequality-adjusted gross national income. This happens on background of a decrease in climate impact and a small increase in biodiversity impact.

5.3. Additional remarks on material flows and environmental impacts

The results show that the food sector has the highest impact on climate change, water stress, and biodiversity loss, both in terms of land and freshwater ecosystems. Meanwhile, the sectors related to built environment, energy, and water, sewage and health have relatively lower environmental impacts. Interestingly, the education sector holds significant value-added but has little environmental impact, indicating an area where growth could be sustainable.

The increasing contribution of the "other" sector to land biodiversity loss suggests that there are a range of activities not falling under the traditional sector categories that are exerting growing pressure on terrestrial ecosystems. This underscores the importance of identifying and managing these activities to curb their rising impacts on biodiversity.

As Lithuania's economy continues to develop, the country can leverage this progress to invest more heavily in green technology, renewable energy, and efficient resource management.

5.4. Examples of related policies

Lithuania is committed to the EU's climate and energy goals, which include reducing greenhouse gas emissions, increasing the share of renewable energy, and improving energy efficiency.

Lithuania has implemented various measures to promote energy efficiency, particularly in buildings. These measures include financial schemes to support the renovation of multi-apartment and public buildings⁴⁴.

Lithuania has also focused on improving waste management. The country introduced various initiatives in the waste management domain for

example, deposit refund scheme (see *The Economist*, 2020)⁴⁵. By 2019, the recycling rate of plastics had already reached 70%, according to Eurostat⁴⁶ making it the leading country in the EU in terms of plastic recycling.

Lithuania has encouraged sustainable farming practices, for example, through the promotion of organic farming. In Lithuania, 8.1% of the farming land is organically certified, matching the prevailing 8% average of the European Union. By 2030, the country anticipates that the organic agricultural land will constitute 25% in line with the EU goal⁴⁷.



Justinas Teselis
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⁴⁴ APVA, 2023 Aplinkos projektų valdymo agentūra | Aplinkos projektų valdymo agentūra (apva.lt), <https://www.apva.lt/>

⁴⁵ <https://www.economist.com/europe/2020/01/11/why-lithuanians-cash-in-on-their-trash>

⁴⁶ [https://ec.europa.eu/eurostat/web/products-eurostat-news/-/ddn-20211027-2#:~:text=Nine%20EU%20Member%20States%20recycled,%25\)%20and%20Slovenia%20\(50%25\)](https://ec.europa.eu/eurostat/web/products-eurostat-news/-/ddn-20211027-2#:~:text=Nine%20EU%20Member%20States%20recycled,%25)%20and%20Slovenia%20(50%25))

⁴⁷ <https://orgprints.org/id/eprint/46074/1/Country-Report-Organic-LITHUANIA-EkoConnect-2021.pdf>



Vesta Rugilė Nausėdaitė

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International
Resource
Panel

Global Resources Outlook 2024

Country Profile: Nigeria

Elias T. Ayuk, IRP, and Kwabena O. Asubonteng,
University for Development Studies, Tamale, Ghana

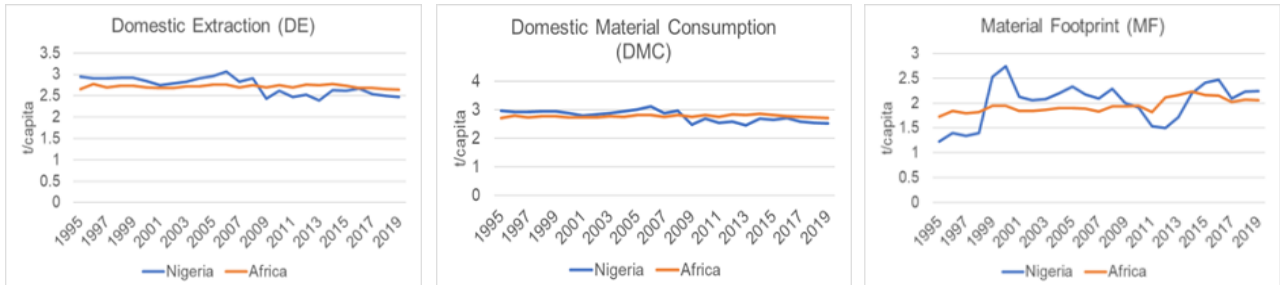


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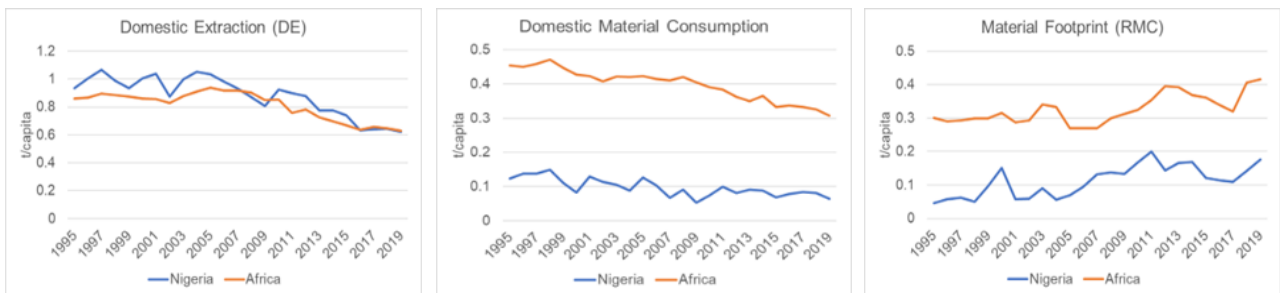
06 Country Profile: Nigeria

6.1. Domestic extraction, domestic material consumption and material footprint

Biomass



Fossil fuel



Metal ore

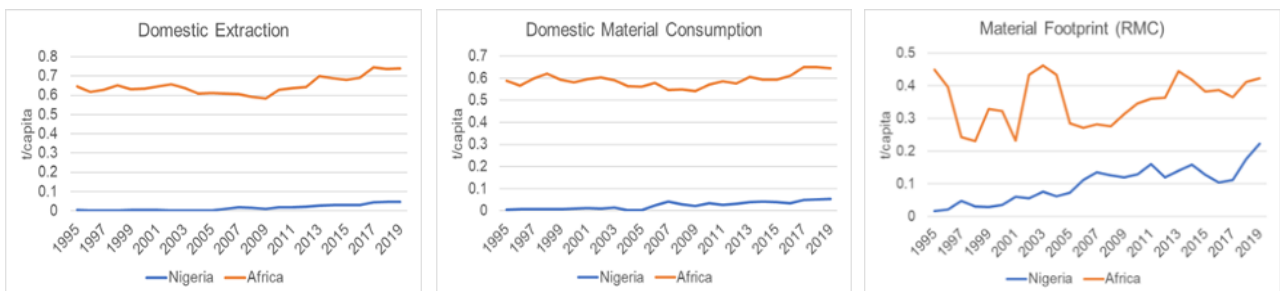


Figure 6.1: Per capita domestic extraction, domestic material consumption, and material footprint for biomass, fossil fuel, and metal ore. Source: UNEP IRP Global Material Flows Database. Data for Nigeria.

- Biomass extraction oscillated between 2.5 tonnes and 3 tonnes per capita during the period.
- Biomass extraction and consumption show similar trends suggesting that most biomass is consumed in the country.
- Nigeria's biomass material footprint, domestic extraction (1995-2008), and fossil fuel domestic extraction per capita exceeded the average for the African continent.
- Domestic fossil fuel extraction per capita declined from 1995 to 2019. It peaked in 2004, reaching about 1.05 tonnes per capita. In 2019, it was about 0.6 tonnes per capita. This could be attributed to sporadic supply disruptions and conflicts observed in the country⁴⁸.
- The per capita material footprint for fossil fuel increased from .05 tonnes in 1995 to about 0.175 in 2019, representing a 250 % increase. The highest level was observed in 2011 with a per capita footprint of 0.2 tonnes.

⁴⁸ US Energy Information Administration (2023). Country Analysis Brief: Nigeria

- Nigeria's metal ore per capita extraction and consumption were quite low. They were more than six-fold lower than the African average. The rates remained stable over the period. This is probably because Nigeria has challenges, notably concerning mining and processing, with its metal ore sector⁴⁹.
- Metal ore per capita material footprint increased by around a factor of 10 from 0.02 tonnes per capita to about 0.2 tonnes. This was probably driven by increased imports and transitions in the value chain. These levels were significantly lower than the African average.

6.2. Environmental impacts

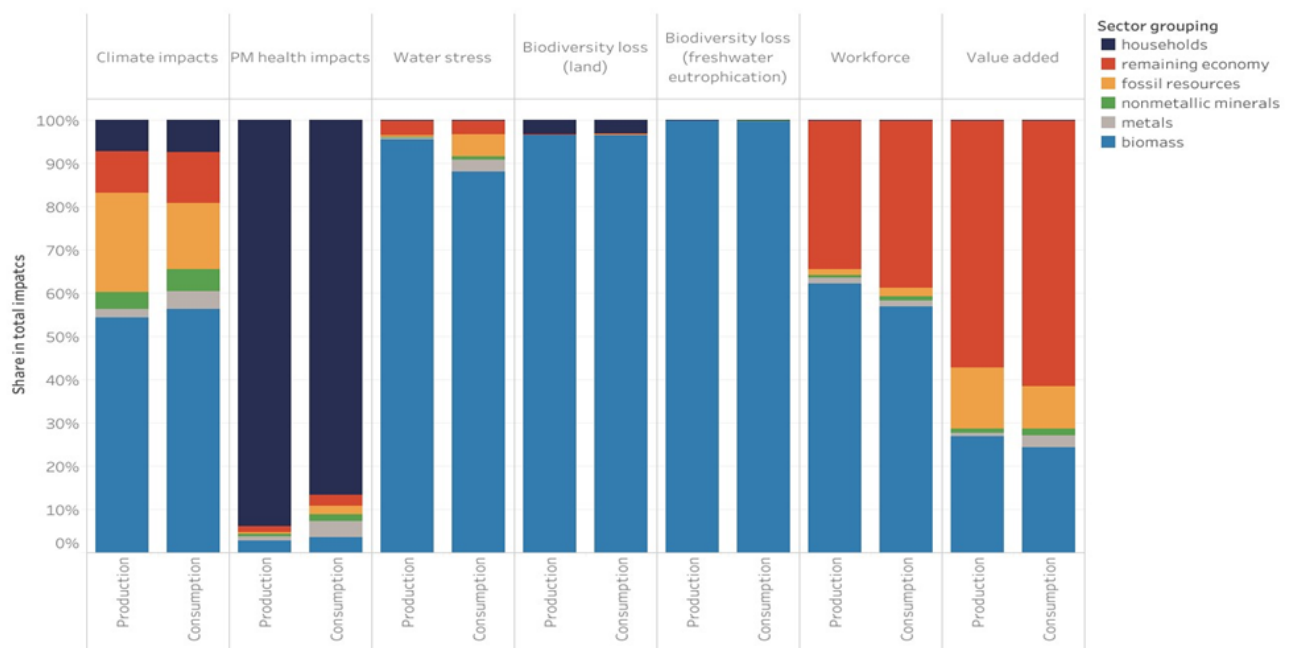


Figure 6.2: Relative contribution of different types of material resources (extraction and processing), the remaining economy (downstream chain of resource extraction and resource processing), and households to global environmental and socioeconomic impacts for the year 2022. Left columns: production-related perspective, right columns: consumption-related perspective. Data for Nigeria.

- Except for PM health impacts, biomass (agriculture and forestry) was the main contributor to the total share of environmental impacts both from the production and consumption perspective. The highest share was in biodiversity loss (land and freshwater eutrophication) with more than 90 % contribution. The sector contributed more than 50 % of climate impacts from both the production and consumption perspective. The agricultural sector was also providing 60 % and 57 % of employment from the production and consumption perspective, respectively.
- Households contributed over 85 % from both the production and consumption perspective to PM health impacts. The use of wood for cooking and private mobility are the main drivers of this situation.
- The remaining economy downstream of resource extraction and processing contributed significantly to the value-added by 57 % (production) and 61 % (consumption). The remaining economy was also an important contributor to the workforce.
- The extraction and processing of fossil fuel resources contributed mainly to climate impacts.

⁴⁹ <https://www.pwc.com/ng/en/assets/pdf/nigerian-mining-progress-but-still-a-long-way-to-go1.pdf>

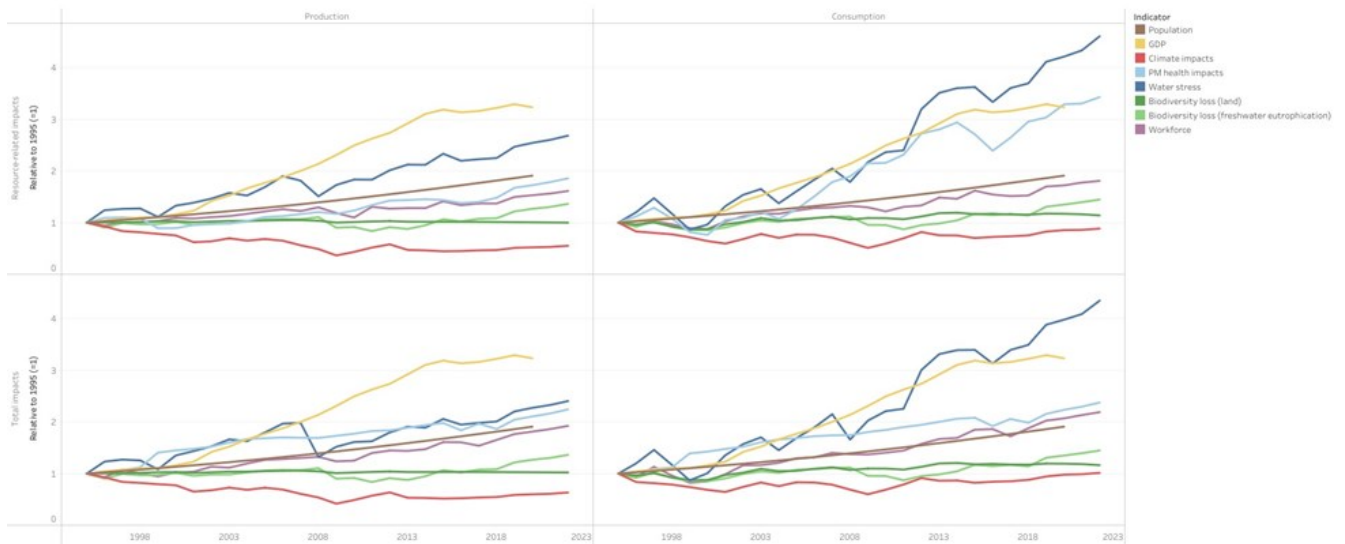


Figure 6.3: Temporal development of environmental impacts and socio-economic indicators from 1995 to 2022, from a production (left) and consumption (right) perspective. Data refers to resource use (top figures) as compared to the total economy (bottom figures). Data for Nigeria.

- GDP grew faster than most environmental impacts from a production perspective. Over the period, GDP almost tripled. While most environmental impacts exhibited an increase, the climate impact remained stable or decreased slightly. It can be said that there was an absolute decoupling between GDP and climate impact and a relative decoupling between GDP and other environmental impacts.
- From the consumption perspective, water stress grew faster than GDP. Water stress impact more than quadrupled over the period. The other environmental impacts increased, but slightly, compared to water stress. Rapid urbanization experienced in the country might explain this. The climate impacts remained stable from the consumption perspective.



Emmanuel Odama

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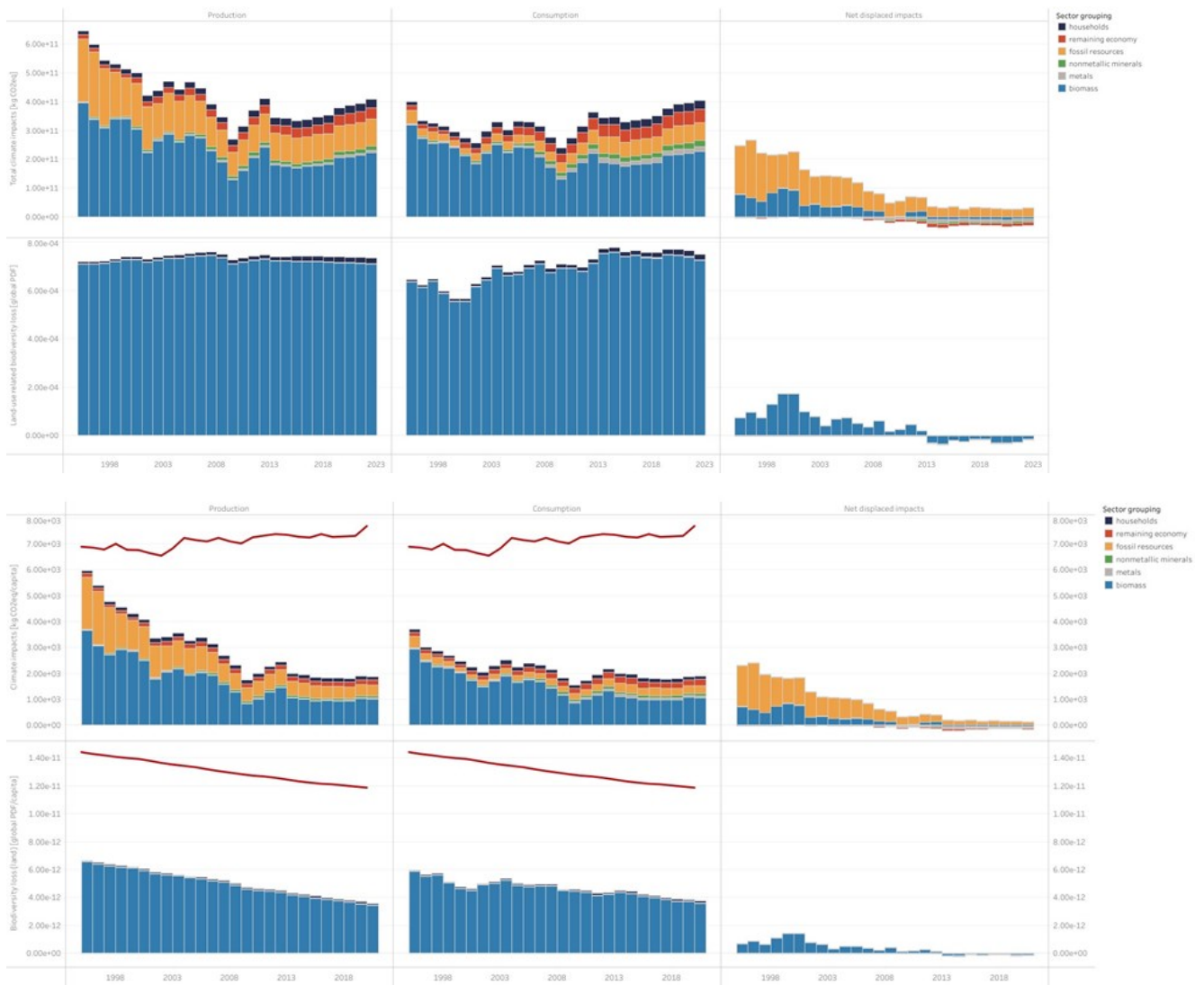


Figure 6.4: Time series of absolute (above panel) and per capita (below panel) values of climate change and land-related biodiversity loss split by resource group (cultivation, extraction, and processing) and downstream use (remaining economy and households). Moving averages over five years used for land occupation and change. Left: Production perspective. Middle: Consumption perspective (footprints). Right: net trade impacts (positive values indicate that impacts occur in these locations for producing exported goods, negative values indicate that goods are imported to these regions causing impacts and value added elsewhere). The red lines show the global per-capita average values. Data for Nigeria.

- Production impacts from a footprint perspective (left figure) used to be much higher than the consumption impacts (middle figure) indicating that goods were exported from Nigeria causing impacts in Nigeria. This is supported by the positive values in the right figures. However, in recent years the impacts in the production and consumption perspective became very similar.
- On a per capita basis, Nigeria's contribution to climate and biodiversity impact shows a very remarkable declining trend between 1995 and 2020. Impacts were below the global average (only about 25% of global average for climate change and 30% for biodiversity loss) for both the production and consumption perspective.
- Biomass extraction dominated entirely land-use-related biodiversity loss.
- Net displacement impacts are positive for climate impacts and have become slightly negative in recent years and almost completely absent. For biodiversity loss impacts, while generally positive and declining, the net displacements were quite small.

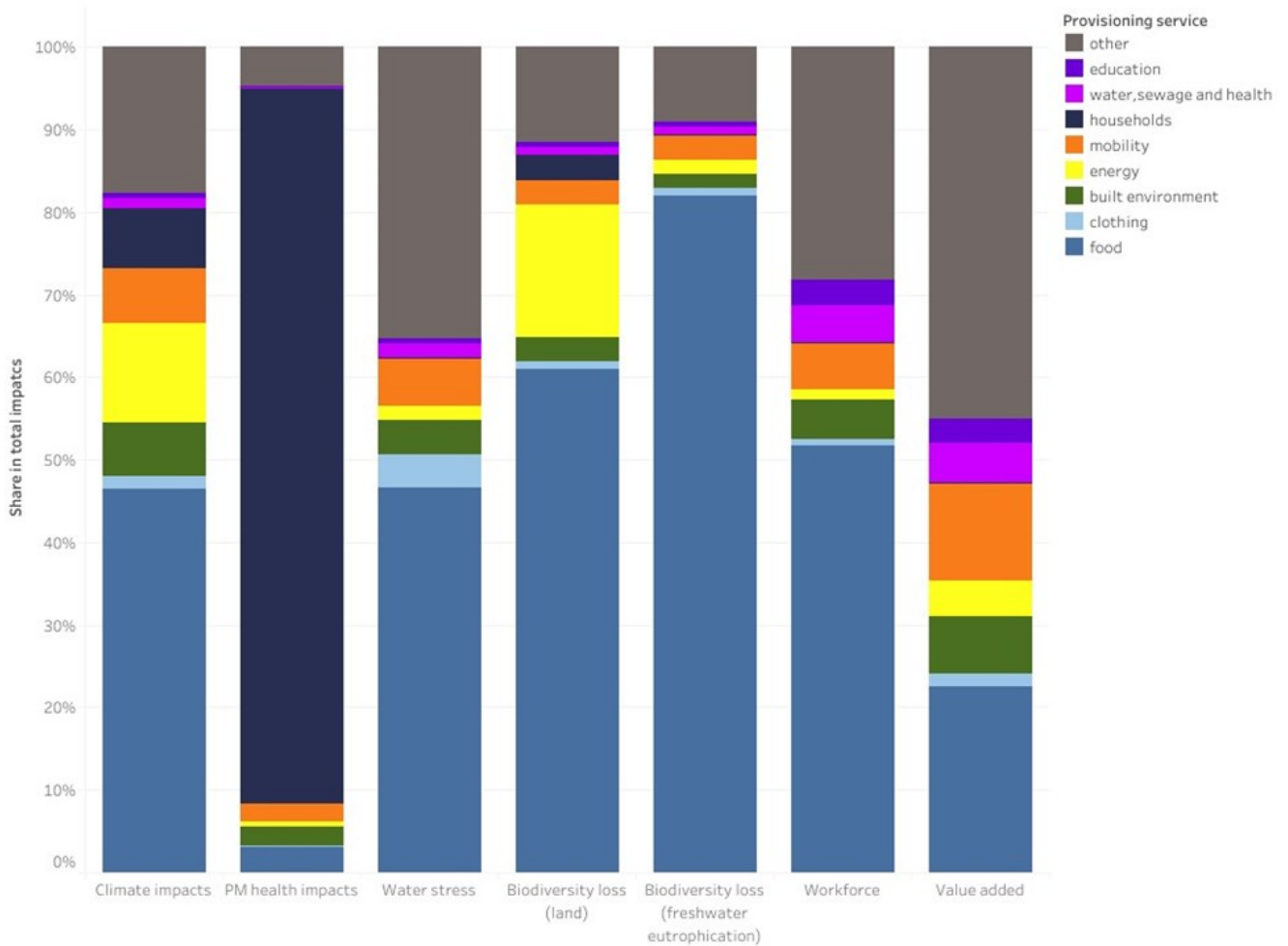


Figure 6.5: Relative contribution of different types of provisioning systems to global environmental and socioeconomic impacts for the year 2022. Household consumption includes emissions from mobility and energy (adding to the separately shown impacts of these provisioning systems). Data for Nigeria.

- Food provisioning systems contributed the most to all environmental impacts except PM health impacts. They contributed 47% to climate impacts and water stress, 61 % to land-related biodiversity loss, and 82% to freshwater eutrophication biodiversity loss. They also contributed 52 % of the workforce and 23 % to value added.
- Cooking and private mobility provisioning systems consumed by households were the single most important contributor to PM health impacts with more than 90 % of the share of total impacts.
- Energy provisioning systems contributed more than 16% of biodiversity loss (land), mainly due to biomass use for energy. Mobility (excluding private automotive mobility) contributed about 12 % to value-added.
- Other provisioning systems made significant contributions to value-added (42 %), workforce (about 28 %), and water stress (28 %).

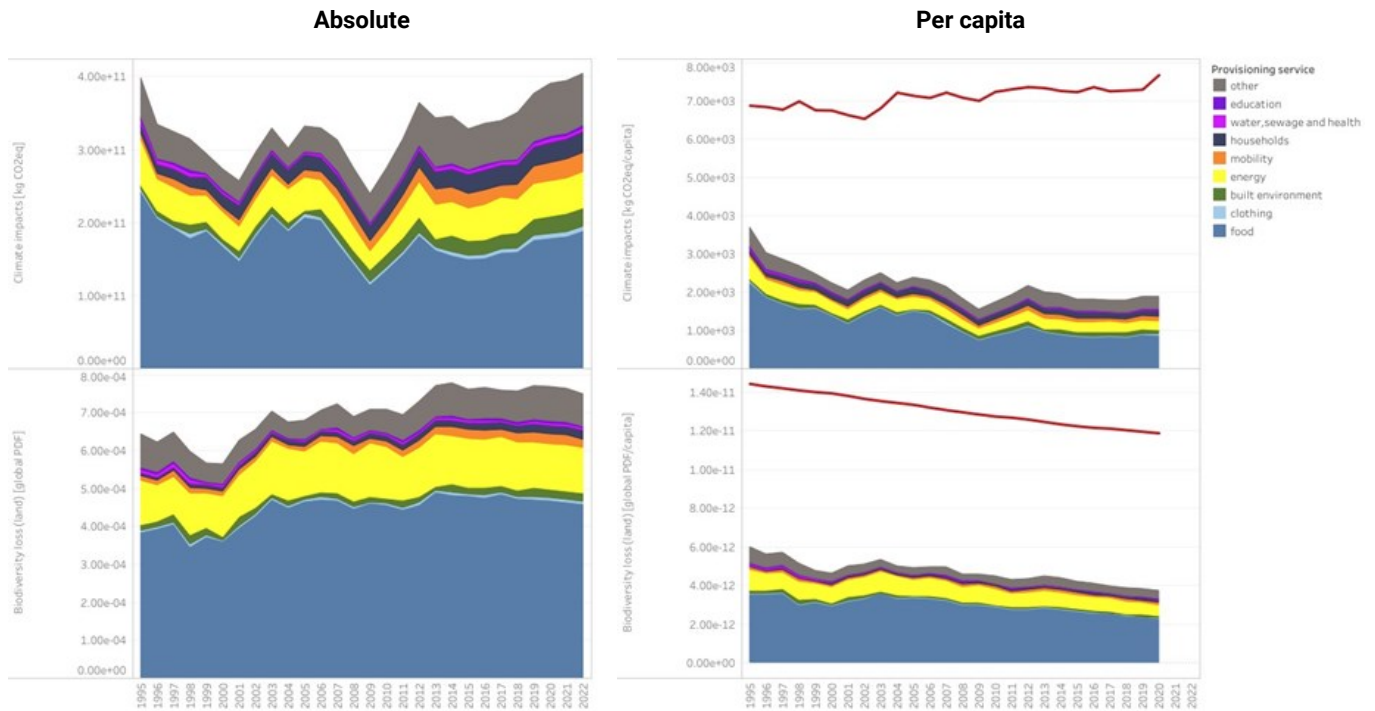


Figure 6.6: Time series of climate change (top) and land-related biodiversity loss (bottom) split by provisioning system. Household consumption includes emissions from mobility and energy (adding to the separately shown impacts of these provisioning systems). Left figures: absolute impacts. Right figures: per capita impacts, compared to global per-capita average, indicated by the red lines. Data for Nigeria.

- Total climate impacts remained relatively stable over the period with food provisioning being the major contributor. Biodiversity loss increased steadily until 2016 when it started declining and the food sector was the major contributor.
- Per capita climate impacts decreased steadily and were lower than the global average (only about 25 % of global average).
- Total biodiversity loss (land) increased and remained stable during recent years, but per-capita impacts were much lower (only one third of the global average).



Mathias Owa Martins
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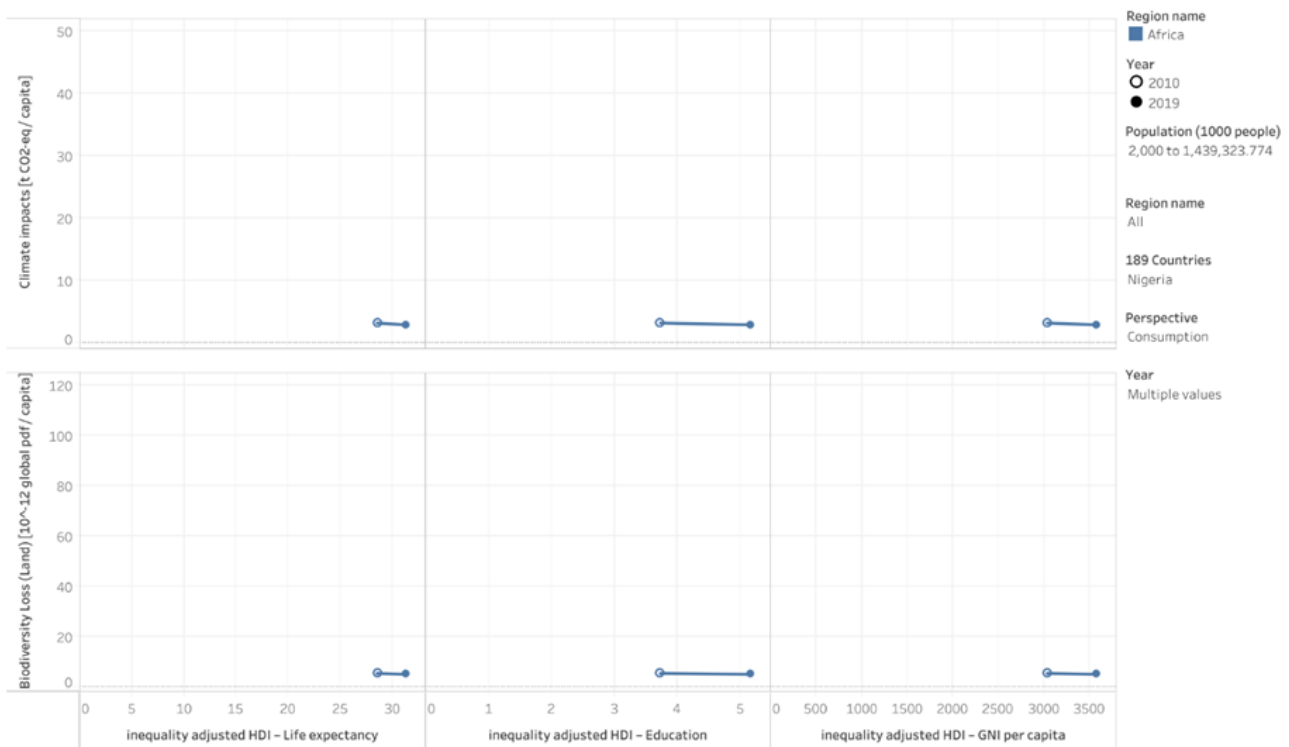


Figure 6.7: Per-capita impacts (consumption perspective) against well-being trajectory from 2010 to 2019. Data for Nigeria.

- Some progress was observed in inequality-adjusted life expectancy, education, and GNI per capita between 2010 and 2019. Both per capita climate and biodiversity impacts remained rather stable during this period.

6.3. Additional remarks on material flows and environmental impacts

From a production perspective, Nigeria’s GDP grew faster than other environmental indicators suggesting relative decoupling. On the consumption side, water stress grew faster than GDP and other indicators, especially beginning in 2012.

The food sector is the major driver of climate impacts. Nigeria has put a lot of emphasis on ensuring food security for its growing population which is mainly found in the urban areas.

Nigeria’s per capita climate impact and biodiversity loss were significantly smaller than the global average for these two indicators. Overall, the net displacement of impacts used to be positive, but is now balanced.

Life expectancy, education, and per capita GNI have all increased with education showing the highest growth.

Overall, the Nigerian government recognizes the importance of decoupling economic growth from the environmental impact. The government has developed several policies in line with this. The policies include the Water Policy, National Forestry Policy, Nigerian Mining and Minerals Act, National Climate Change Policy, National Policy and Solid Waste Management, and the National Policy on the Environment.

6.4. Examples of related policies

Nigeria is highly endowed with both renewable and non-renewable resources. It is also a heavily populated country with many urban areas where air pollution is a concern. Climate change impacts are real and biodiversity loss through deforestation and land degradation is high. In 2021, the Government of Nigeria promulgated the Climate Change Act. The Act provides a framework for climate action in the country and builds on the Revised National Climate Change Policy, national climate change programs, the 2050 Long-Term Low Emission Vision, and the Nationally Determined Contributions. A brief description of the National Climate Change Policy follows:

Under the National Climate Change Policy⁵⁰, the Government of Nigeria undertook several policy measures aimed at mobilizing financial resources to tackle climate change. These included: developing and implementing a National Climate Finance Strategy that is gender-responsive and socially inclusive; facilitating the establishment of the National Climate Change Trust Fund; facilitating investment to meet climate financing needs; mainstreaming climate finance into national and subnational budgets; exploring private sector participation in the use of Green Bonds and other innovative financial instruments; and strengthening existing national institutions for climate financing for enhanced capacities to mobilize finance from national and global windows. The Green Bonds have had significant success.

Among key results, one can highlight the issue of Green Bonds by the Government of Nigeria. The first set of green bonds was issued in 2017 for \$US35 million and a second set of \$US49 million in 2019. These funds have been used to support projects related to renewable energy (solar, wind, hydropower); energy efficiency (efficient building energy management); sustainable waste

management (pollution prevention and control); sustainable land use (forestry, agriculture and aquaculture); conservation (biodiversity and natural systems); clean transportation (rail, mass transit system, bus rapid transit (BRT) schemes); and sustainable water (water treatment plants, water distribution infrastructure, water capture and storage infrastructure). The results of this case, e.g., a decrease in biodiversity loss are a testimony to some success of these policies,

Several other resource policies have also been put in place in Nigeria. Nigeria is one of the founding fathers of the African Circular Economy Alliance. It has developed initiatives such as the Nigerian Circular Economy Working Group to design a national policy framework to promote circular economy principles in the country.



Bright O'feranmi Nejo

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⁵⁰ [https://climatechange.gov.ng/2020/09/21/brief-on-green-bonds/#:~:text=The%20Nigeria%20Sovereign%20Green%20Bond,Recovery%20Growth%20Plan%20\(ERGP\).Accessed 10/07/2023](https://climatechange.gov.ng/2020/09/21/brief-on-green-bonds/#:~:text=The%20Nigeria%20Sovereign%20Green%20Bond,Recovery%20Growth%20Plan%20(ERGP).Accessed 10/07/2023)



Obinna Okerekeocha

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International
Resource
Panel

Global Resources Outlook 2024

Country Profile: Poland

Joanna Kulczycka, International Resource Panel



Andrea Anastasakis
Unsplash

07 Country Profile: Poland

7.1. Domestic extraction, domestic material consumption and material footprint

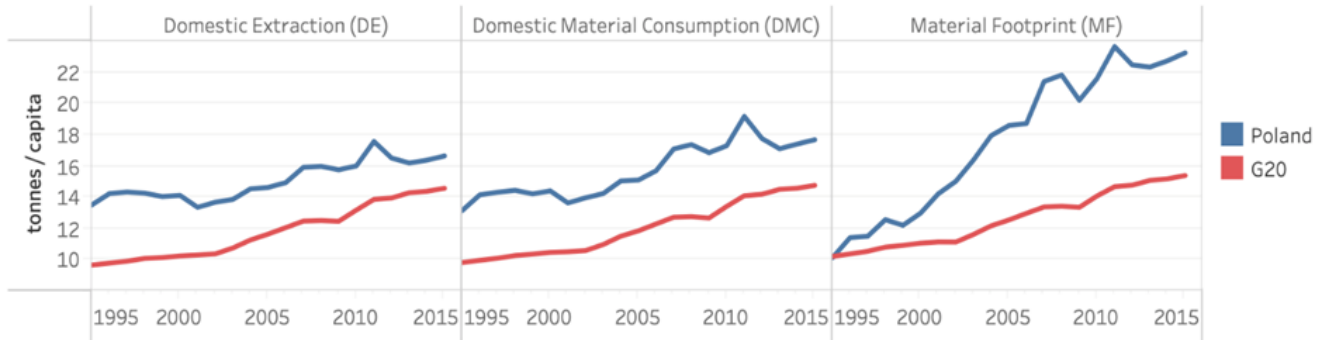


Figure 7.1: Per capita domestic extraction, domestic material consumption, and material footprint. Data for Poland.

- Poland's domestic extraction of materials increased by about 20% between 1995 and 2019.
- Fossil fuel domestic extraction decreased by over 40%.
- Non-metallic minerals almost doubled and contributed the most to domestic extraction.
- Poland's per-capita material footprint more than doubled, mainly due to consumption of non-metallic minerals increases.
- Fossil fuel material footprint remained at the same level.
- Metals ore material footprint varied +/-25% but decreased in the last 2 years, and reminded about 40-50% higher than domestic extraction.



Maksym Harbar
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7.2. Environmental impacts

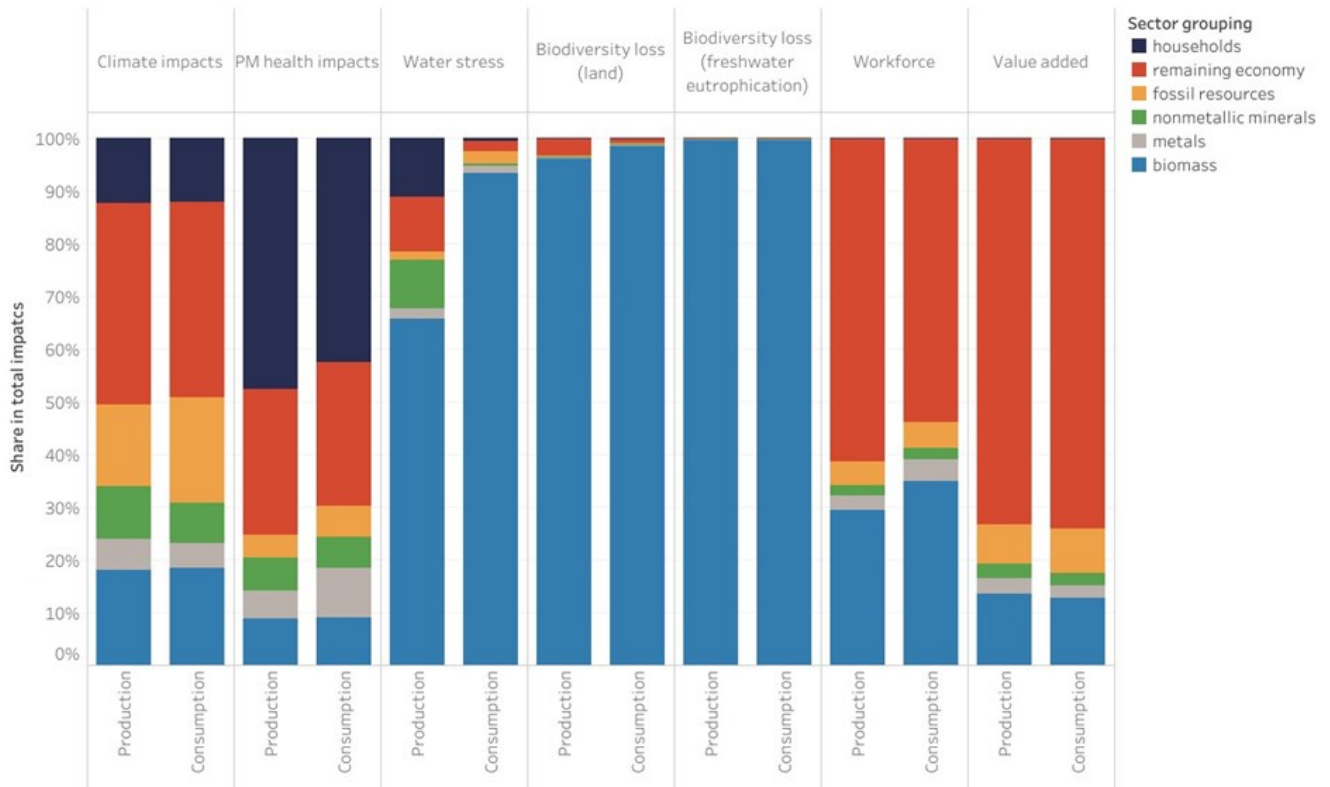


Figure 7.2: Relative contribution of different types of material resources (extraction and processing), the remaining economy (downstream chain of resource extraction and resource processing) and households to global environmental and socioeconomic impacts for the year 2022. Left columns: production-related perspective, right columns: consumption-related perspective. Data for Poland.

- The highest impact on climate was related to the remaining economy both in the production and consumption perspective, which can be explained by the large share of hard and brown coal in the electricity mix.
- PM health impacts were caused by the households and the remaining economy, it is mainly associated with household heating and road transport. Some Polish cities are included in the list of the most polluted cities in the European Union.
- Water stress and biodiversity loss (including freshwater eutrophication) were dominated by biomass production and consumption.
- Workforce was employed mainly for the remaining economy in the production and consumption perspective, creating the highest value-added.
- The biomass sector contributed to a workforce slightly higher in consumption than in production perspective.

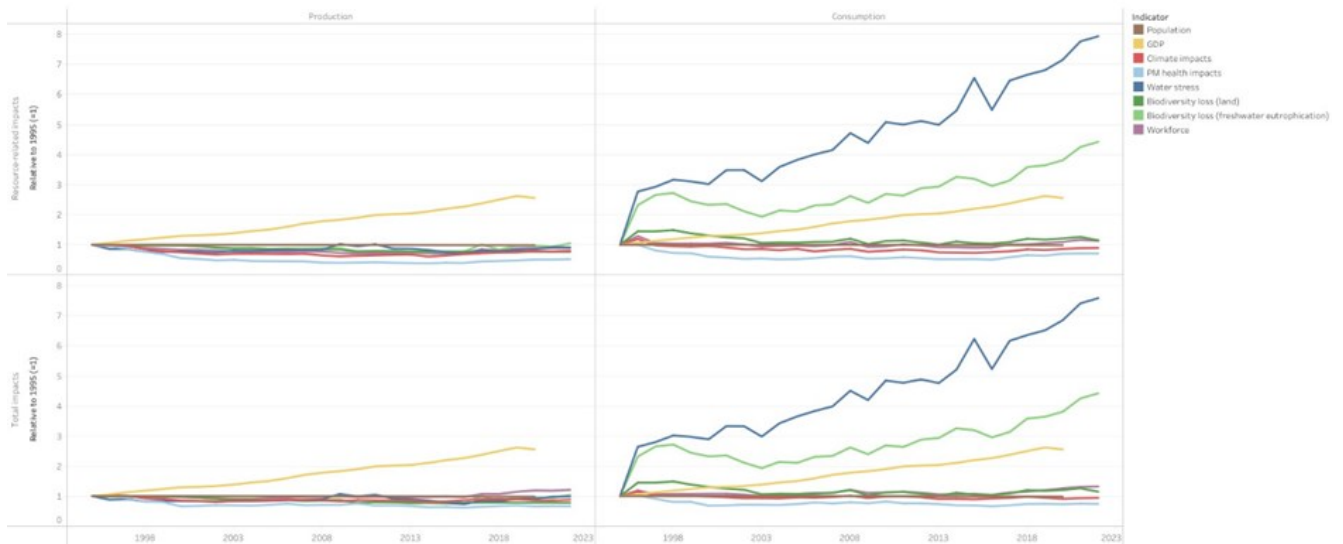


Figure 7.3: Temporal development of environmental impacts and socio-economic indicators from 1995 to 2022, from a production (left) and consumption (right) perspective. Data refers to resource use (top figures) as compared to the total economy (bottom figures). Data for Poland.

- In a production perspective, Poland achieved decoupling due to a significant increase in GDP (increase by 155% in 1995-2022; 101% globally) and a decrease in resource-related impacts, due to increase efficiency in many industry sectors⁵¹.
- In a consumption perspective, Poland's water stress footprint increased by a factor of 8, the second was biodiversity loss in freshwater with a factor >4 increase both in resource-related and total impact. This tendency is in line with global trends, however, in Poland the increase was a few times higher. The reason is an increase in imports of agricultural products from water-stressed regions.
- Resource-related and total PM health impacts decreased between 1995 and 2022, whereas globally it increased by more than 50% and 100%, for total and resource-related PM health impacts, respectively.
- Workforce for the extraction and processing of resources remained stable and slightly increased in total impact in a production perspective, whereas the workforce in a consumption perspective slightly increased, but remained much lower compared to the global tendency.



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⁵¹ <https://www.odyssee-mure.eu/publications/efficiency-trends-policies-profiles/poland.html>



Figure 7.4: Time series of climate change (top) and land-related biodiversity loss (bottom) split by material resource group (cultivation, extraction and processing) and downstream use (remaining economy and households). Moving averages over five years used for land occupation and change. Left: Production perspective. Middle: Consumption perspective (footprints). Right: net trade impacts (positive values indicate that impacts occur in these locations for producing exported goods, negative values indicate that goods are imported to these regions causing impacts and value added elsewhere). The red lines show the global per-capita average values. Data for Poland.

- Total climate impact decreased by about 20%, both from a production and a consumption perspective with a similar structure - the remaining economy with the highest share.
- Regarding net displaced climate impact, fossil resources imports were responsible for more than metal exports. Import of fossils are mainly oil and gas from various countries linked to investment in the LNG terminal and Baltic Pipe, and high-quality coal for local heating purposes and households
- Consumption of biomass is responsible for over 90% of land use related to biodiversity loss, the remaining is fossil fuel resources, although, compared to the global share, the impact of biomass is much lower both in the production and consumption perspective.
- Climate impact of non-metallic minerals metals in production and consumption perspective is on a relatively constant level in Poland even though the production has been increasing, which can be explained by the more efficient use of raw materials from primary and secondary sources.
- The climate impact is rather similar in the production and consumption perspective, whereas biodiversity impacts from land use are higher in the consumption perspective due to significant imports.

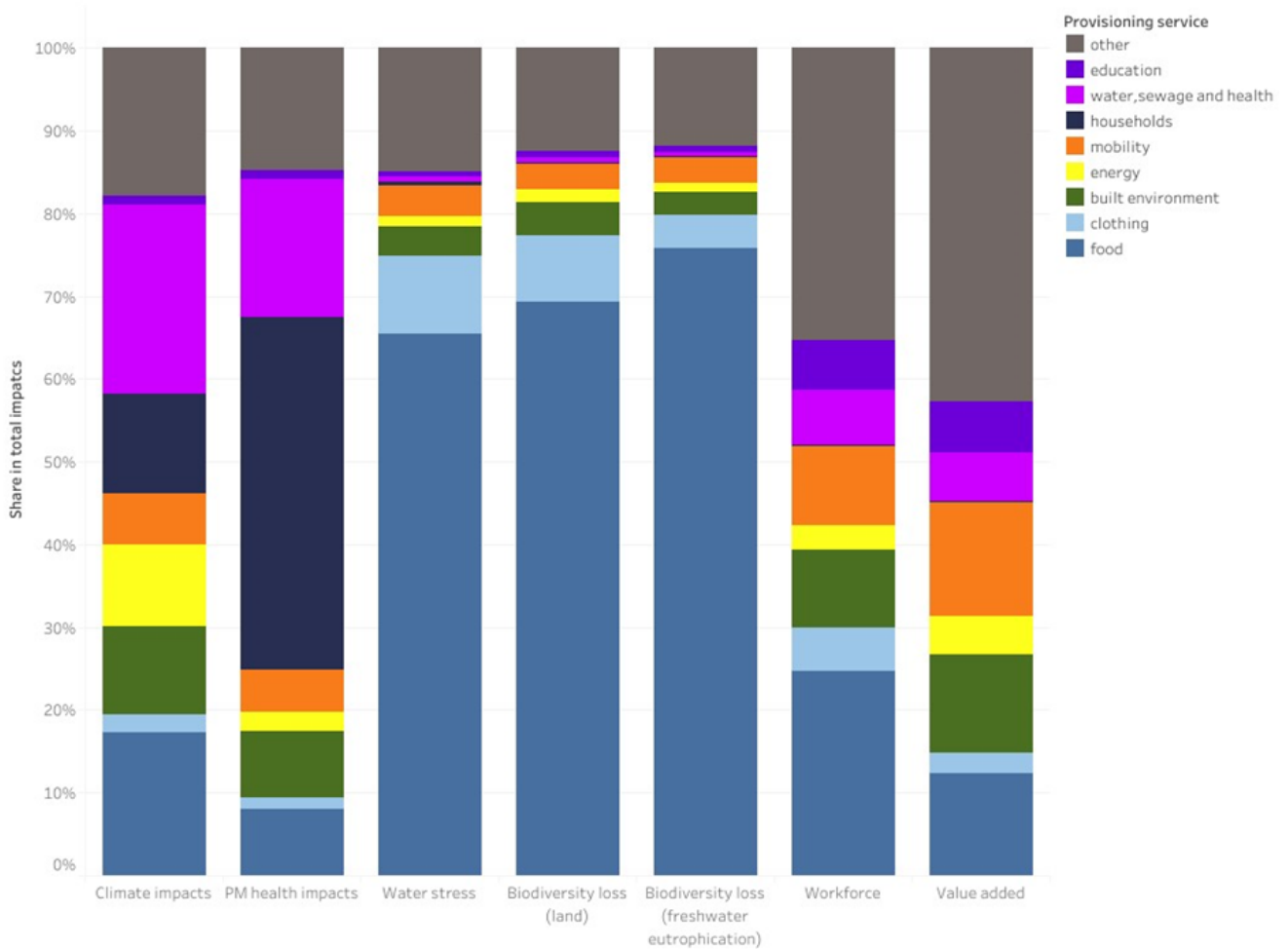


Figure 7.5: Relative contribution of different types of provisioning systems to global environmental and socioeconomic impacts for the year 2022. Household consumption includes emissions from mobility&energy (adding to the separately shown impacts of these provisioning systems). Data for Poland.

- Water, sewage and health provisioning systems have the highest share in climate impact and significant in PM health impact. It is a much higher share compared to the global average even, after the modernization of water and wastewater infrastructure which was conducted in the last years mainly with the support of EU funds.
- Household PM emissions are much higher than in the rest of Europe, but consistent with the global average. It is due to coal use, however, there are some cities, like Kraków, which have introduced a ban on using coal.
- 70% water stress and biodiversity loss impacts were caused by the provision of food, which has also an impact of about 20% on climate change, whereas it creates 12% of value-added and 25% of the workforce. These values are similar to global trends.
- Built environment has a similar share in four categories climate, PM health impact, workforce and value-added and are similar to the European average.
- Education has negligible environmental impacts but provides significant employment and value-added, mainly in public but also private schools. Other provisioning systems have the highest role in value-added and workforce.

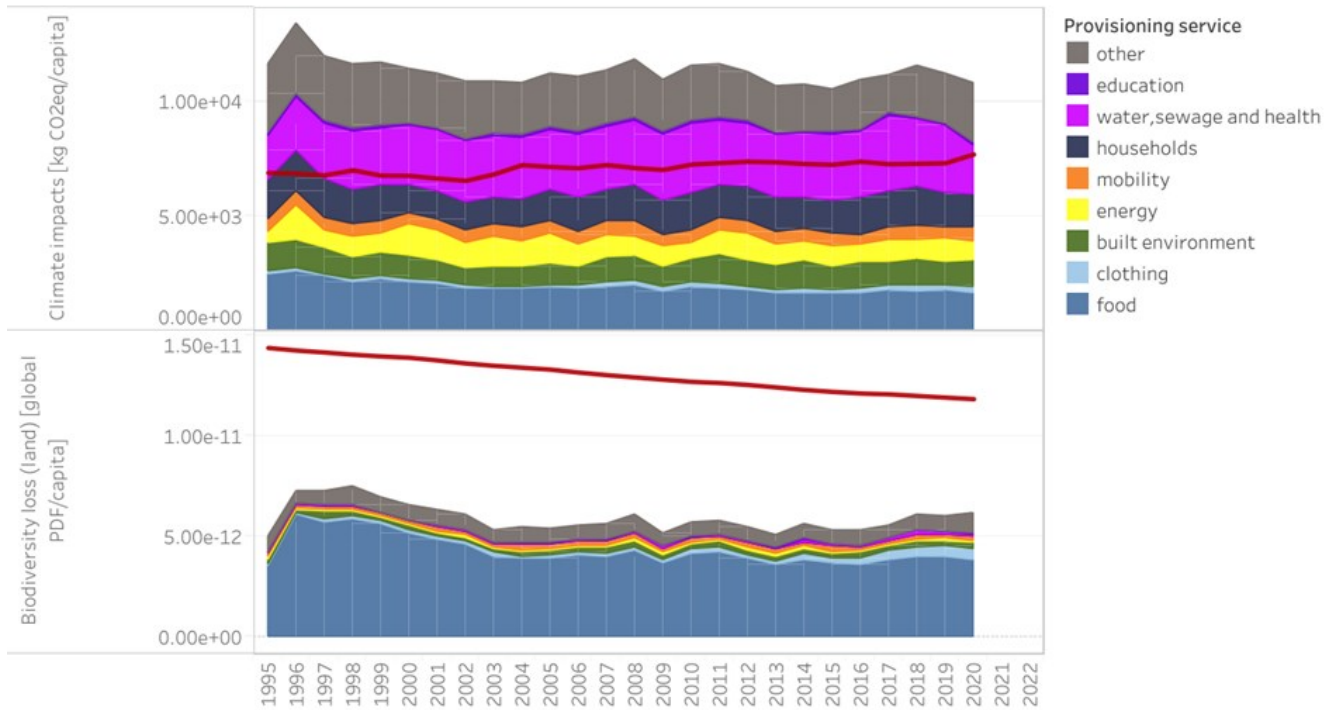


Figure 7.6: Time series of climate change (top) and land-related biodiversity loss (bottom) split by provisioning system. Household consumption includes impacts from mobility&energy (adding to the separately shown impacts of these provisioning systems). The red lines show the global per-capita average values. Data for Poland.

- Biodiversity loss in Poland has dropped between 1998 and 2003 and stabilized or slightly increased during COVID-19 period; food is the dominant provisioning system for biodiversity loss, but clothing has been increasing.
- Climate impacts also decreased by over 20% mainly due to slowly declining investments in water, sewage sludge (though still higher than the global average) and less mobility and heating GHG emissions from households.
- Poland's trends show improvement in both categories compared to the global trends, but at a similar rate as other EU member countries.
- Per-capita climate impacts are higher than the global average, but biodiversity impacts lower.



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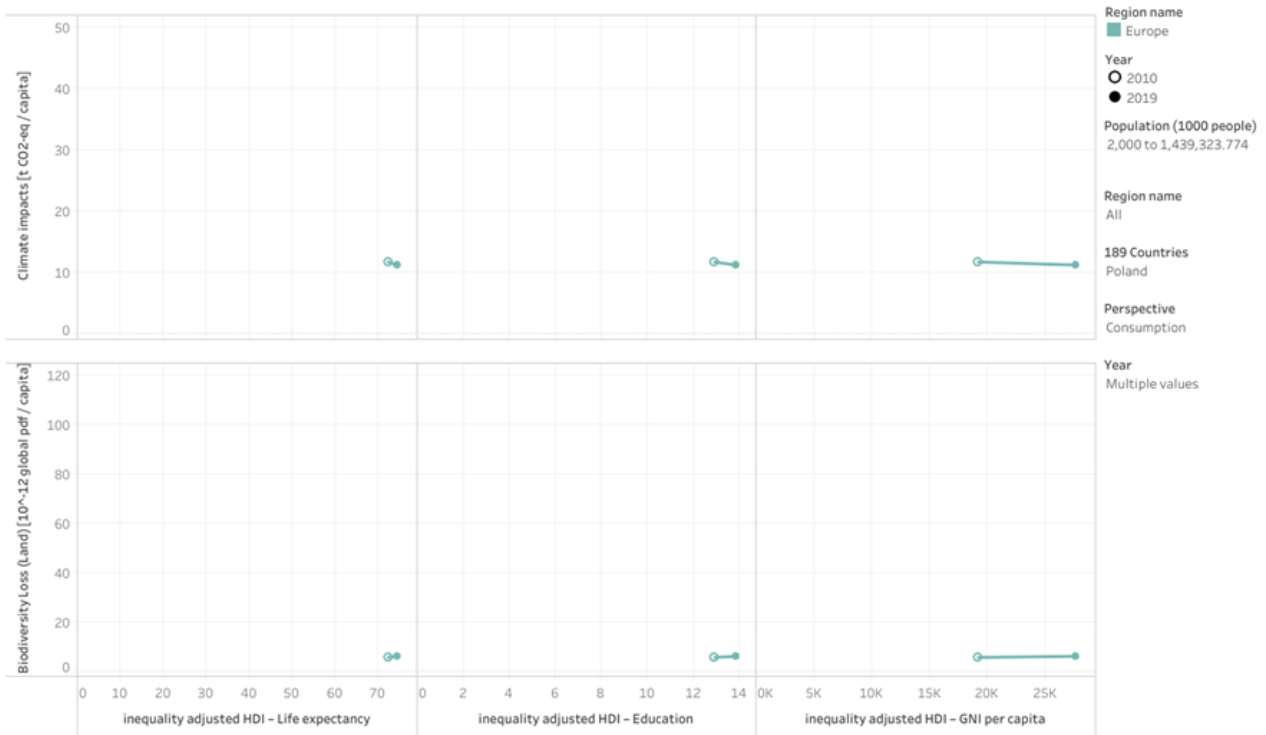


Figure 7.7: Per-capita impacts (consumption perspective) against wellbeing trajectory from 2010 to 2019. Data for Poland.

- Poland has improved concerning all wellbeing dimensions (inequality-adjusted life expectancy, education and income) between 2010 and 2019 while lowering slightly its per-capita climate footprint.
- Life expectancy and education are comparable to other European countries, whereas GNI per capita is much lower.
- Climate impacts (around 10 t CO₂ eq per capita) are comparable to other European countries, while biodiversity impacts are lower.

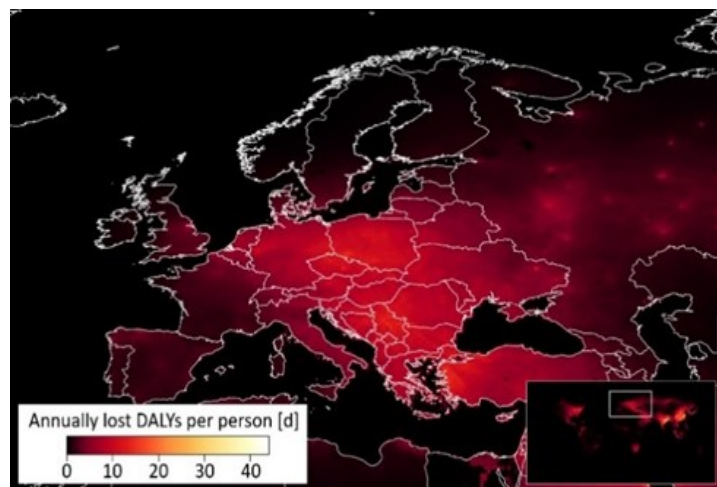


Figure 7.8: Per capita human health impacts in Disability Adjusted Life Years (DALYs) from primary and secondary particulate matter in 2019 caused by six main types of industrial activities (coal power, gas power, oil power, cement production, steel production, petroleum refining). The colors indicate the days that are lost per year and person.

- Major impacts arise due to lignite and hard coal combustion for power generation, especially in the central and more southern regions of Poland, even though the total emission decreased significantly in the last 20 years⁵².
- As absolute emissions of SO₂ and to some degree also NO_x are especially high for the large Polish coal power plants and as these pollutants travel over long distances, the resulting secondary PM_{2.5} health impacts are spread over wide regions in contrast to more local impacts caused by primary PM_{2.5} emissions.
- Polish steel-making is another major contributor to PM_{2.5} human health impacts, whereas other types of fossil power generation as well as petroleum refining and cement-making are less impactful.

7.3. Additional remarks on material flows and environmental impacts

Poland's GDP constant growth in the last 20 years (till COVID-19) – started after deep structural economic reform in the 1990s and accelerated markedly after EU accession.

Poland's resource use has been growing since 2011 and presently stands around 30% above the EU average. Many environmentally friendly investment projects were supported by the National Fund of Environmental Protection and Water Management created in the 1980s (based on environmental fees and fines) and by EU projects.

Environmental and social aspects are underlined in most of the national and regional strategies, whereas legislation and regulations are fragmented, outdated and unstable.

Due to burning coal in households there are many cities with Europe's lowest air quality; some cities like Kraków, introduced a ban on using coal.

A diminishing share of coal is foreseen in energy generation and heating (coal exit in 2049), therefore in some regions, just transition plans are implemented.

7.3. Additional remarks on material flows and environmental impacts

In 2022, the National Raw Materials Policy to 2050 and the Productivity Strategy 2030 were assessed and reinforced. While the National Raw Materials Policy supports the sourcing raw materials from anthropogenic deposits and the development of a circular economy, the Productivity Strategy monitors resource efficiency based on a set of indicators.

In addition, the Polish system of financing environmental protection⁵³ introduced via Environmental fees and fines in the 1980s, established the National Fund of Environmental Protection and Water Management in 1989 as the pillar of the Polish system of financing environmental protection.

⁵² <https://mappingair.meteo.uni.wroc.pl/2020/05/kwasny-oddech-przemyslu/>

⁵³ <https://www.gov.pl/web/nfosigw-en/nfepwm73>

The Polish system of financing environmental protection involves a purposeful, strictly defined disbursement of funds originating from charges and fines for the use of the environment in the area of sustainable development. In this way, “the polluter pays” principle has been implemented in Poland from the beginning of its political transformation and funds thus obtained are earmarked for projects that limit environmental pollution.

Environmental funds, both the National and Voivodeship ones, also play a fundamental role in the distribution of foreign funds earmarked for environmental protection and water management.

The System of Funds constitutes a financial instrument and organizational tool for the Minister of the Environment that supports the implementation of the National Environmental Policy. This system has allowed qualitative and quantitative improvement of surface and underground water resources, reduction of the amount of waste sent to landfills through recycling of municipal solid waste, improvement of air quality and purity, preservation and restoration of biological diversity at the scale of environment systems, engaging several million people in educational activities, etc.



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International
Resource
Panel

Global Resources Outlook 2024

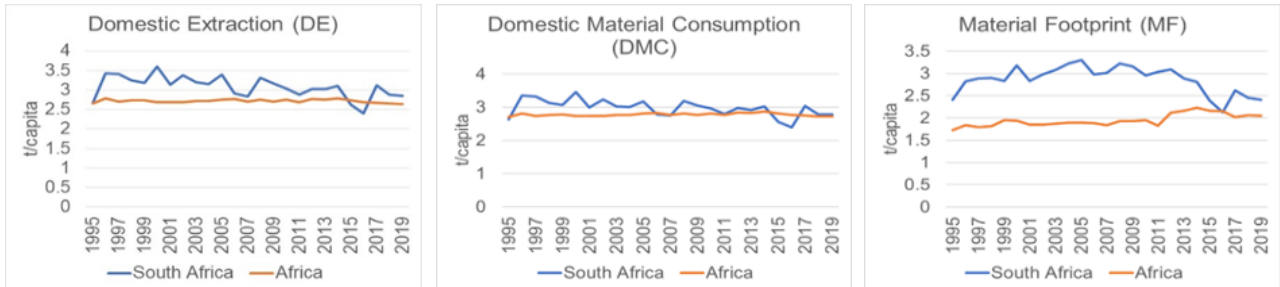
Country Profile: South Africa

Elias T. Ayuk, IRP, and Kwabena O. Asubonteng,
University for Development Studies, Tamale, Ghana

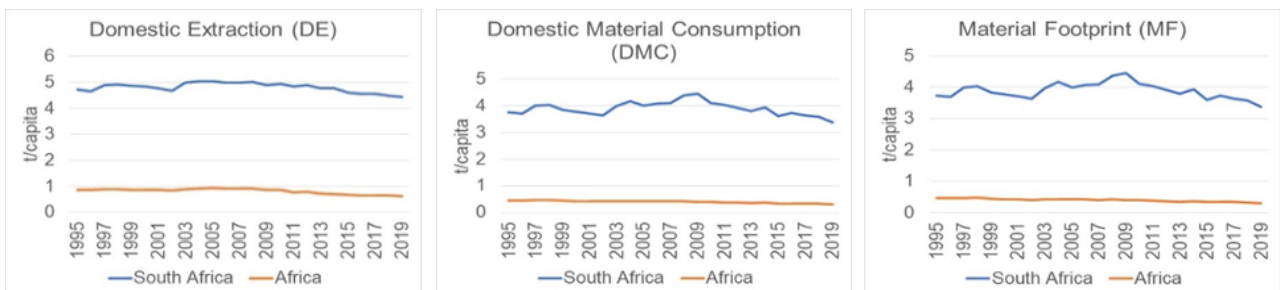


8.1. Domestic extraction, domestic material consumption and material footprint

Biomass



Fossil fuel



Metal ore

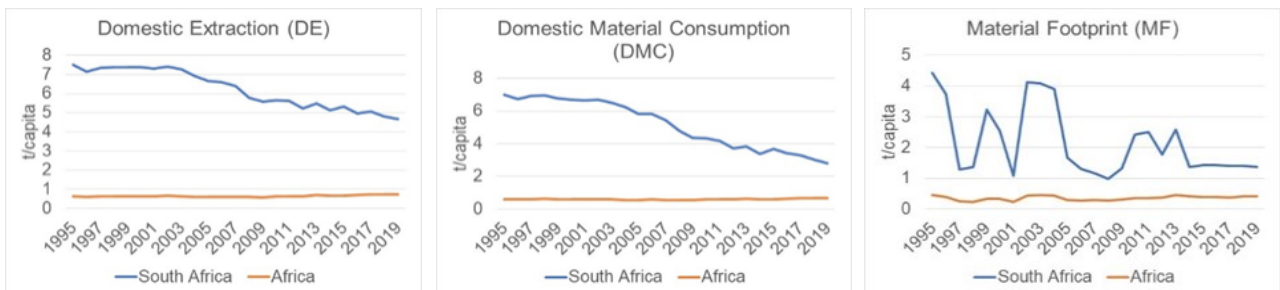


Figure 8.1: Per capita domestic extraction, domestic material consumption, and material footprint for biomass, fossil fuel, and metal ore. Source: UNEP IRP Global Material Flows Database. Data for South Africa.

- South Africa's domestic extraction, domestic material consumption, and material footprint exceeded the average for the African continent for biomass, fossil fuels, and metal ores. This could be explained by a more vibrant industrial sector and high-level downstream processing compared to other African countries.
- Per capita biomass extraction remained relatively stable over the period, oscillating between 2.5 tonnes and 3.5 tonnes. It reached 3.5 tonnes in 1996 and slightly over 3.5 tonnes in 2000. Over the other years, it remained relatively stable. The material footprint per capita was stable over the 1995 – 2019 period. It fell slightly to about 2.2 tonnes in 2016.
- The relatively similar patterns observed in biomass extraction and consumption suggest that biomass that is extracted is mostly consumed in the country, i.e., biomass consumption is based on domestic extraction.

- Fossil fuels extraction peaked in 2004 with a little over 5 tonnes per capita. Thereafter, it declined considerably by about 12 % to a little over 4.4 tonnes per capita. The per capita material footprint also peaked in 2004 and thereafter fell gradually.
- Per capita domestic extraction of metal ores has declined continuously from about 7.5 tonnes in 1995 to about 4.5 tonnes in 2019. The material footprint per capita oscillated considerably but exhibited an overall declining trend. This could be a result of global market prices and demand.

8.2. Environmental impacts

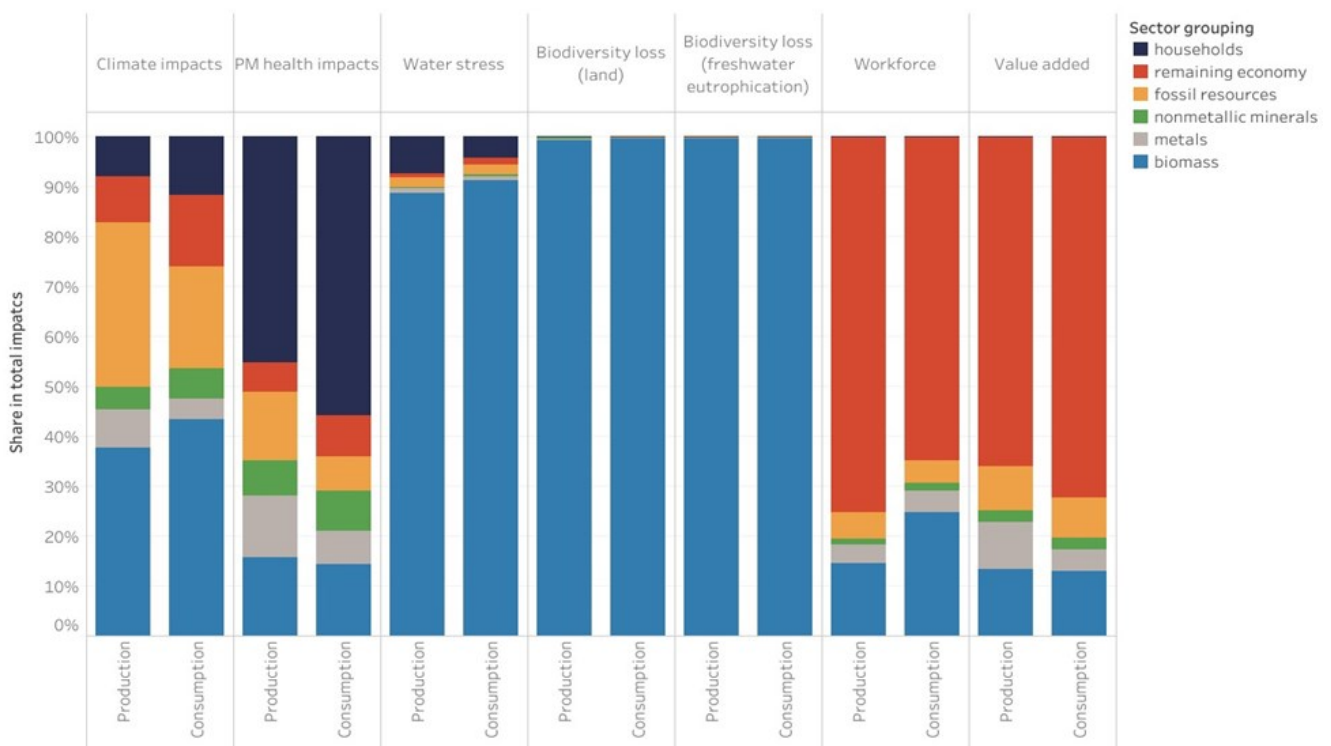


Figure 8.2: Relative contribution of different types of resources (extraction and processing), the remaining economy (downstream chain of resource extraction and resource processing), and households to global environmental and socioeconomic impacts for the year 2022. Data for South Africa.

- biodiversity loss (land) from both the production (92 %) and consumption (95 %) perspective; to biodiversity loss (freshwater eutrophication) from both the production (about 91 %) and consumption (about 91 %) perspective; to water stress by about 90 % for the production perspective and by about 92 % from the consumption perspective. The share in climate impacts of biomass was about 40 % (production perspective) and 45 % (consumption perspective).
- The remaining economy contributed much more significantly than resource extraction and processing to the workforce and value-added from both perspectives.
- More than 50 % of the share of impacts on PM health impacts were attributable to the household sector (without accounting for indoor PM exposure).
- Fossil fuel resources contributed to the climate impacts by about 32 % from the production perspective and about 20 % from the consumption perspective.
- Resource extraction and processing dominate climate impacts in South Africa with the country among the top-five coal-producing countries in the world.

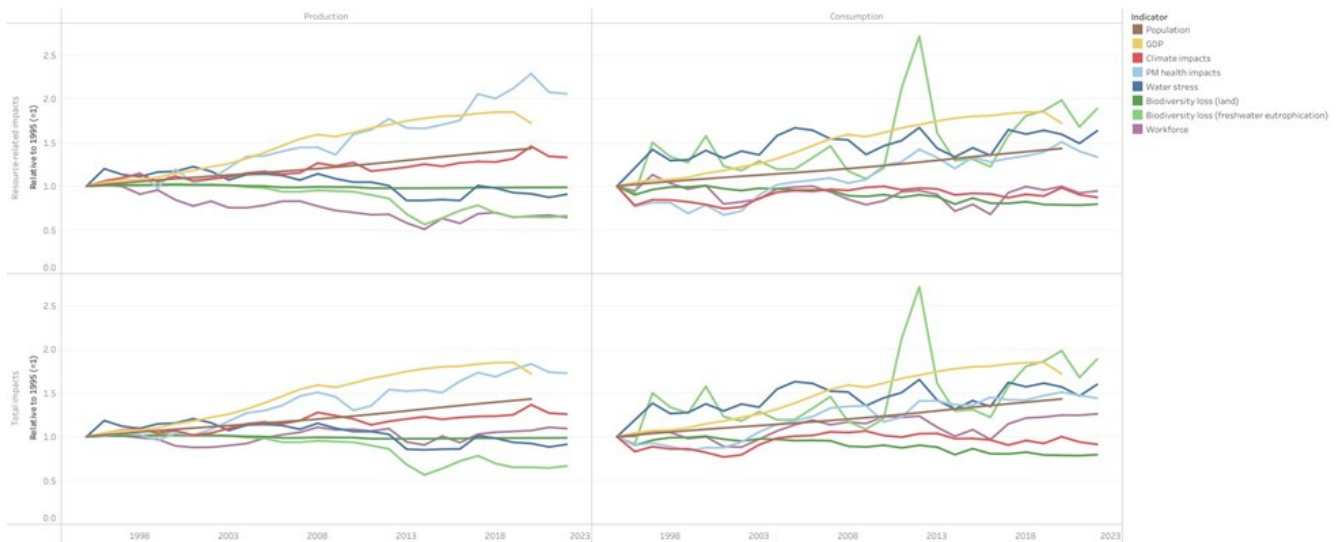
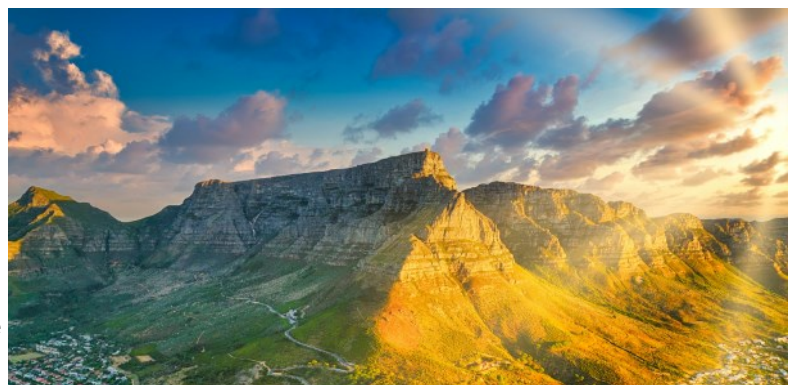


Figure 8.3: Temporal development of environmental impacts and socio-economic indicators from 1995 to 2022. from a production (left) and consumption (right) perspective. Data refers to resource use (top figures) as compared to the total economy (bottom figures). Data for South Africa.

- For total impacts, and from the production perspective, GDP grew faster than all environmental impacts.
- In the case of resource-related impacts (production perspective), GDP grew relatively faster than most environmental impacts. But GDP growth was surpassed by PM health impacts (resource-related impacts). Coal production is widely known as a major polluter in South Africa as over 90 % of its electricity is generated from coal burning⁵⁴.
- Climate impacts increased as well as population. There was a broad decline in water stress, biodiversity loss, and workforce.
- From the consumption perspective, biodiversity loss (freshwater eutrophication) experienced a sharp rise in 2013 and a rapid decline. This could have been a result of the increased import of P-intensive food. Many studies show that nutrient overload and/or over-fertilising⁵⁵ are key factors driving freshwater eutrophication in South Africa. Fertilizer use was quite high in 2013 and fell thereafter until 2018. Climate impacts, workforce, and biodiversity loss (land) remained stable and declined slightly.
- The relationship between GDP and the environment shows a mixed picture. There is more decoupling from the production than from the consumption perspective.



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⁵⁴ <https://energyandcleanair.org/publication/air-quality-impacts-of-the-new-largo-coal-mine/>

⁵⁵ Van Ginkel, C.E. (2011). Eutrophication: present reality and future challenges for South Africa. *Water SA*, Pretoria, v. 37, n. 5, p. 693-701. Available from <http://www.scielo.org.za/scielo.php?script=sci_arttext&pid=S1816-79502011000500010&lng=en&nrm=iso>. access on 26 Oct. 2023.

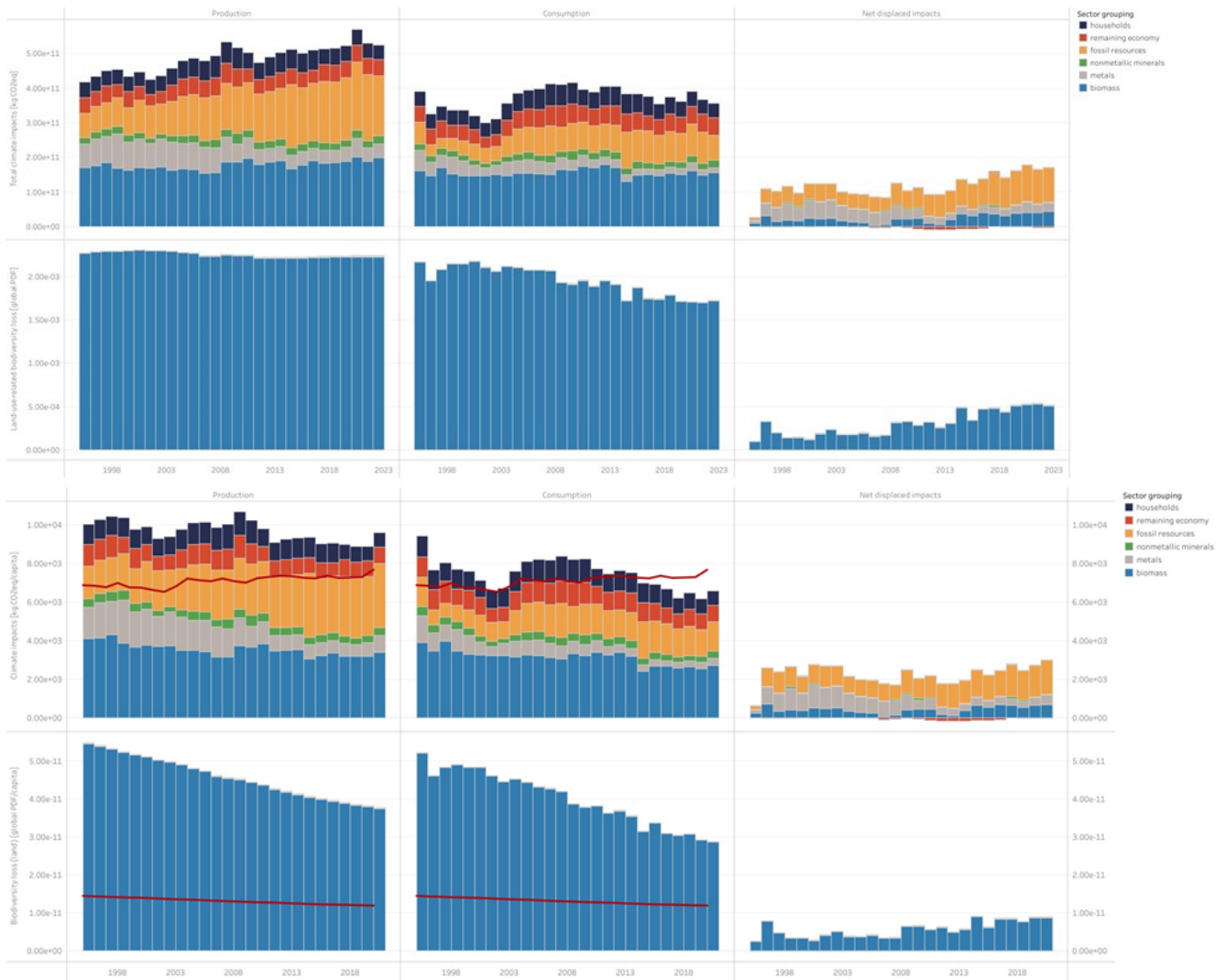


Figure 8.4: Time series of absolute (above panel) and per capita (below panel) values of climate change and land-related biodiversity loss split by resource group (cultivation, extraction, and processing) and downstream use (remaining economy and households). Moving averages over five years used for land occupation and change. Left: Production perspective. Middle: Consumption perspective (footprints). Right: net trade impacts (positive values indicate that impacts occur in these locations for producing exported goods, negative values indicate that goods are imported to these regions causing impacts and value added elsewhere). The red lines show the global per-capita average values. Data for South Africa.

- The per capita climate impacts in South Africa exceeded the global average by about 25 % from the production perspective and are slightly lower than the global average from the consumption perspective. In general, the per capita climate impacts declined slowly over the period.
- From both the production and consumption perspectives, climate and biodiversity total impacts increased. Total impacts were much higher from the production perspective compared to the consumption perspective. These impacts were higher than the global average.
- For biodiversity loss, the country exceeded the global average by more than 3-fold from the production and consumption perspectives.
- Net displacement impacts are positive indicating that impacts occurred in South Africa due to the production of exported goods.

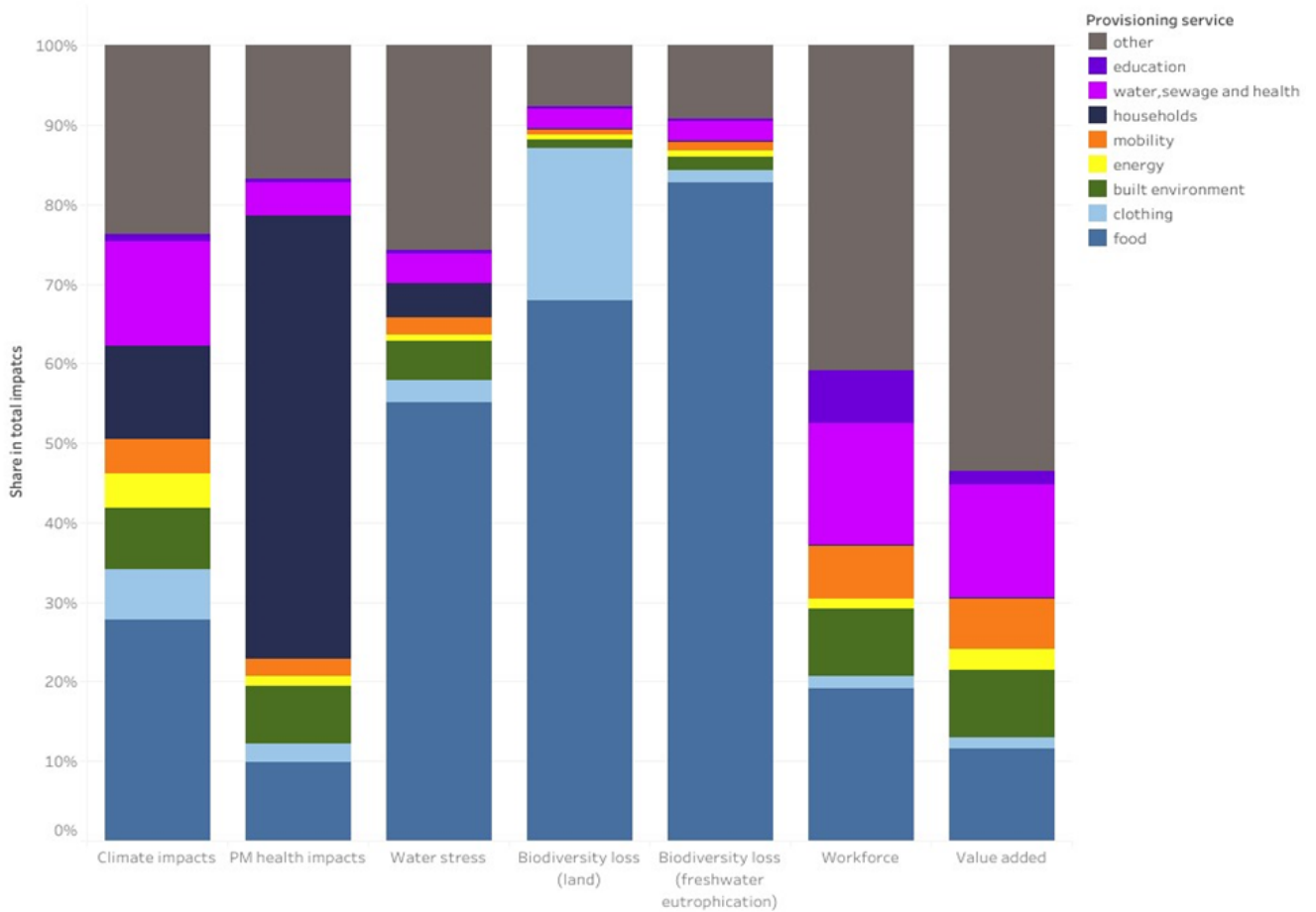


Figure 8.5: Relative contribution of different types of provisioning systems to global environmental and socioeconomic impacts for the year 2022. Household consumption includes emissions from mobility and energy (adding to the separately shown impacts of these provisioning systems). Data for South Africa.

- The share of total impacts of the food provisioning systems in South Africa was 83 % for biodiversity loss (freshwater eutrophication), 68 % for biodiversity loss (land), 55 % for water stress, and 28 % for climate impacts. Food provisioning systems were, therefore, a key contributor to many impacts, while also contributing to workforce (19%) and value-added (12 %).
- “Other” provisioning systems are a significant contributor to value added (50 %), workforce (41%), water stress (26 %), and climate impacts (24 %).
- Water, sewage, and health provisioning services systems contributed more to value-added and workforce than to environmental impacts overall – yet with some significant contribution to climate impacts. This could be due to recent efforts to build the necessary infrastructure for wastewater treatment in South Africa.
- The built environment contributed at low levels to most impacts.

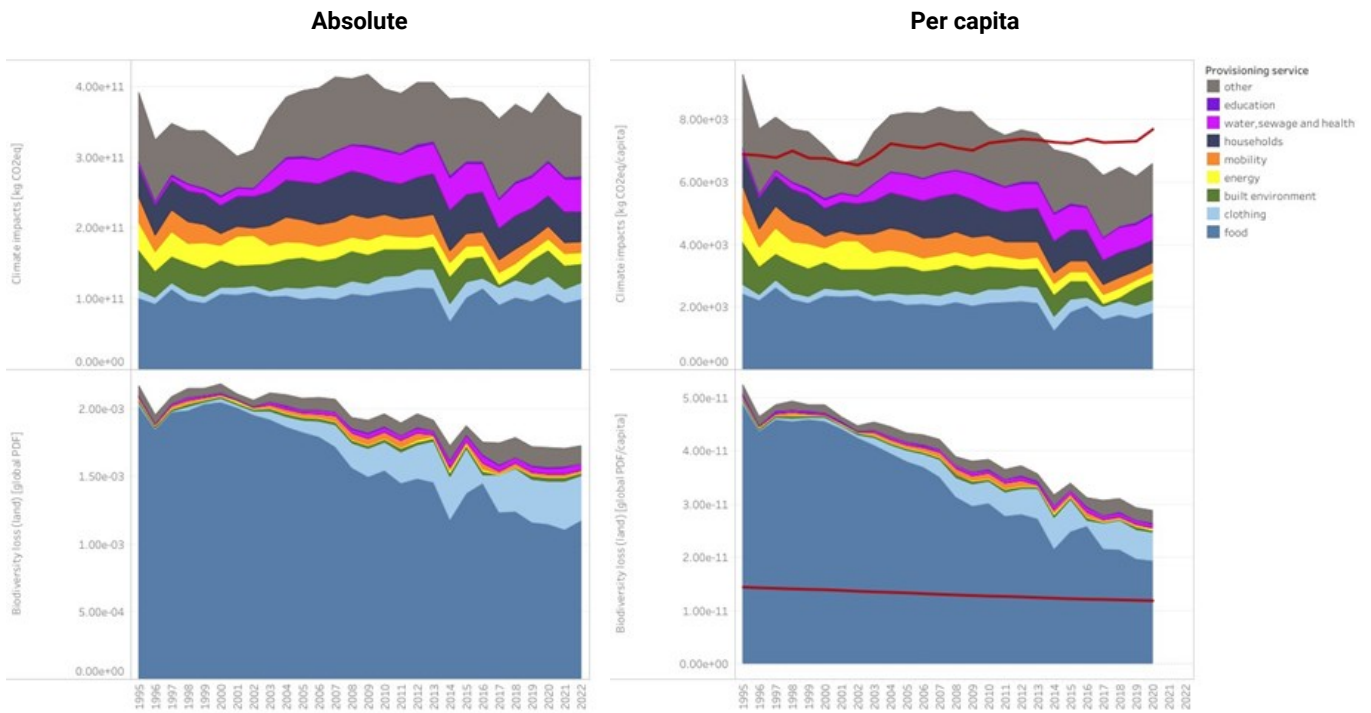


Figure 8.6: Time series of climate change (top) and land-related biodiversity loss (bottom) split by provisioning system. Household consumption includes emissions from mobility and energy (adding to the separately shown impacts of these provisioning systems). Left figures: absolute impacts. Right figures: per capita impacts, compared to global per-capita average, indicated by the red lines). Data for South Africa.

- Climate impacts rose slowly until 2007 and stabilized for the remaining period. Biodiversity loss declined slowly and fell about 30-35 %.
- On a per capita basis, South Africa's climate impacts mirrored the global average. However, the biodiversity loss level was more than double of the global average.



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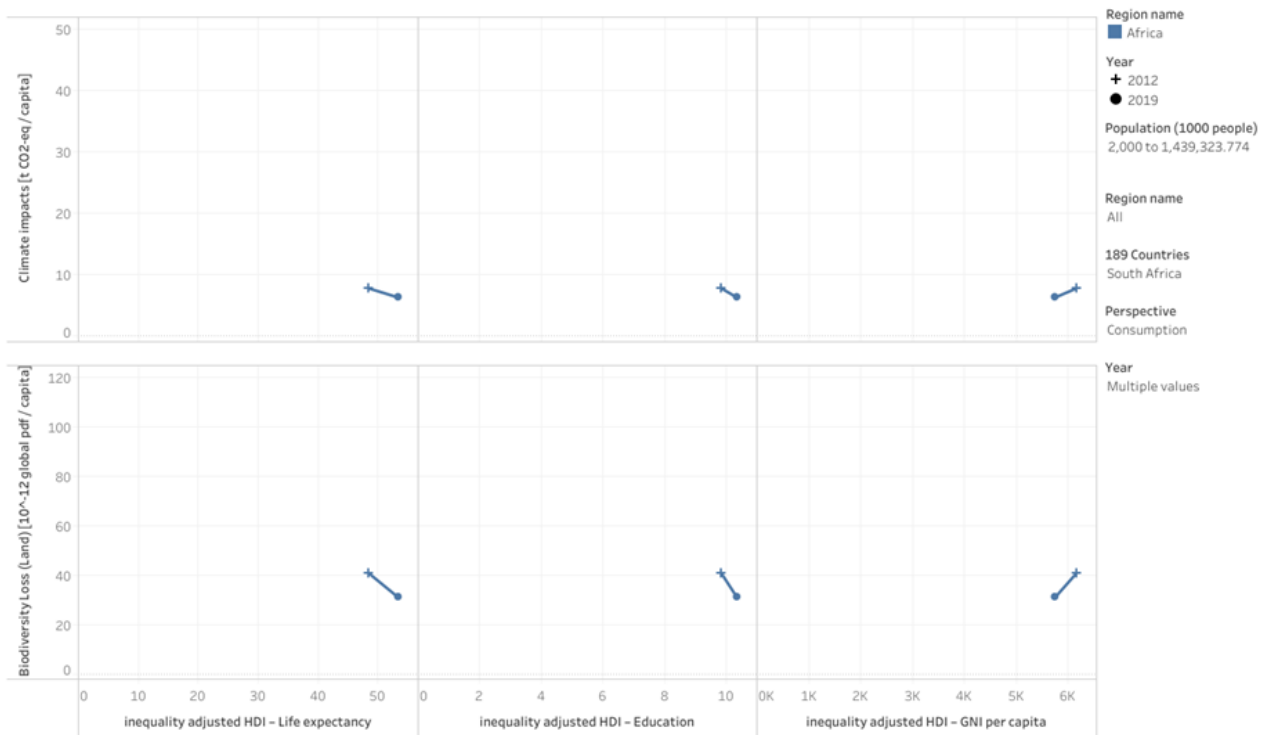


Figure 8.7: Per-capita impacts (consumption perspective) against wellbeing trajectory from 2012 to 2019. Data for South Africa.

- Between 2012 and 2019, South Africa witnessed improvements in inequality-adjusted life expectancy and education. There was, however, an uptick in income inequality.
- Biodiversity loss (land) impacts declined sharply. Climate impacts declined slightly but there was an uptick in income inequality.
- There is a need to pursue policies that reduce emissions and arrest biodiversity loss.

8.3. Additional remarks on material flows and environmental impacts

The domestic extraction, domestic material consumption, and material footprint for biomass, fossil fuels, and metal ores were consistently larger than the average for the African continent. For fossil fuels and metal ores, the difference between the country's impacts was 4 to 5-fold.

While South Africa's GDP grew over the period, the environmental indicators also grew.

Biomass (agriculture and forestry) was the major contributor to four of the seven environmental impacts. Biomass resources contributed more than 80% to water stress, biodiversity loss (land), and biodiversity loss (freshwater eutrophication). The remaining economy contributed more than 60% of the workforce and value-added.

South Africa's per capita climate impact and per capita biodiversity loss (land) significantly exceeded the global average in the production perspective. From the consumption perspective, South Africa's climate change impact is below the global average.

The overall evidence from this study suggests that South Africa needs to continue pursuing strategies to ensure that economic growth is decoupled from the environment.

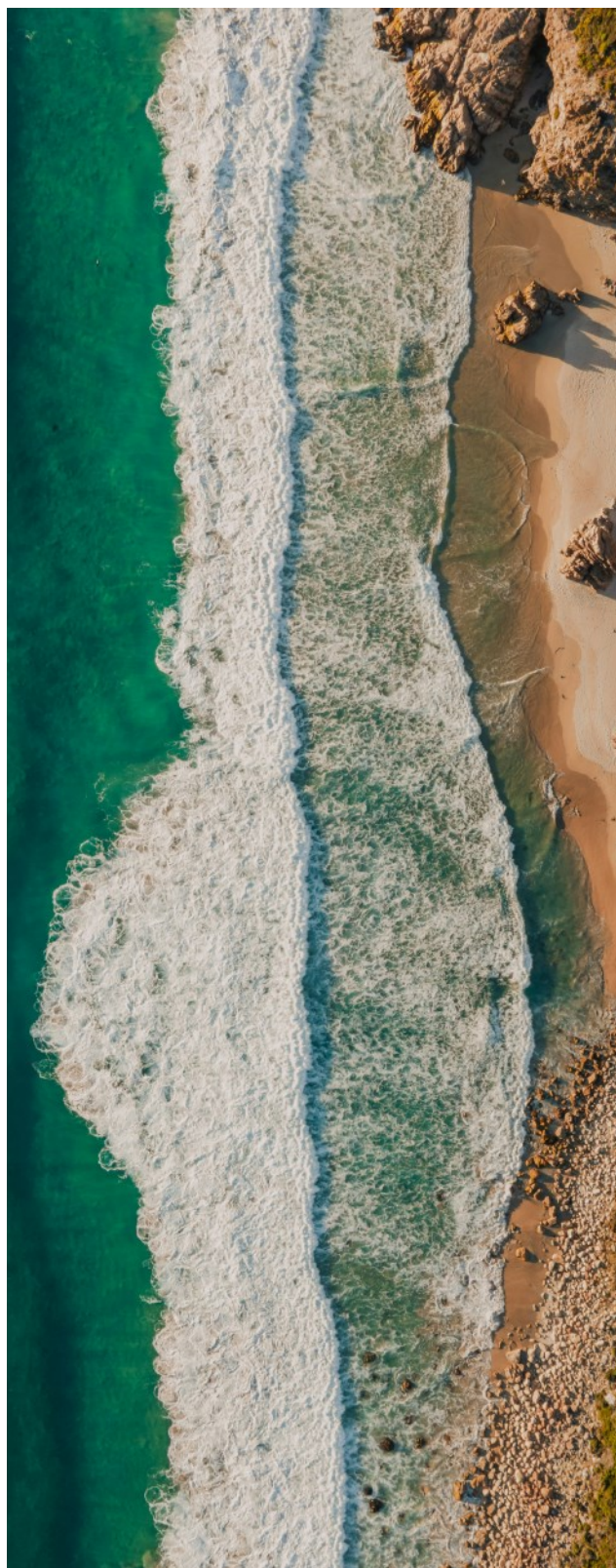
The Government of South Africa has developed a National Framework for Sustainable Development (NFSD) and a National Strategy for Sustainable Development (NSFD). The overall goal is to ensure that resource and impact decoupling occurs.

8.4. Examples of related policies

The Government of South Africa has put in place several resource policies including those that aim to address the triple planetary crises. The National Water Policy, the National Waste Management Policy, the Forest Policy, the Minerals and Mining Policy, and the Climate Change Policy are examples of these. Below, we highlight the Green Tax Reform Policy.

South Africa's New Growth Path articulated the country's strategy to ensure a more inclusive and greener economy. The main priorities included promoting 'environment-growth-employment synergies by expanding the production of technologies for solar, wind, and biofuels'⁵⁶. This responded to the environmental challenges facing the country and the need for economic growth to reach a wider segment of its population. South Africa is in the top 20 of the world's largest emitters of greenhouse gases (GHGs)⁵⁷; the per capita country's GHGs emissions are higher than that of Brazil; the largest source of CO₂ emissions is the energy sector, mainly dominated by coal; and the share of renewables such as biomass and waste in energy supply remains low.

The Green Tax Reform applies taxes on energy products, vehicles, air travel, and waste. Green taxes account for 2.92 % of GDP and constitute 10.11 % of total tax revenue based on 2020 figures⁵⁸. This is close to the average in OECD countries. The green tax provides incentives for key actors in the energy sector to clean up and reduce air pollution and manage waste efficiently. The Green Tax Reform will also address South Africa's nationally determined contributions as per the Paris Agreement.



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⁵⁶ OECD (2013). Environmental Performance Review, South Africa Highlights 2013. OECD

⁵⁷ <https://www.OECD.Stat/>

⁵⁸ <https://www.oecd.org/environment/tools-evaluation/environmentaltaxation.htm>



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