IPBES nexus assessment
Chapter 2, data management report 5 – Trends in indirect drivers: impacts on trends in direct drivers and the associated impacts on the status and trends of nexus elements

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Description

The objective of the underlying analysis is to synthesize established knowledge on how trends of the most important indirect drivers affect direct drivers and finally how this is affecting nexus elements. Trends of selected indirect drivers were quantitively assessed using times series data of appropriate indicators (see Table 1 for more details, including data sources).
Impacts of trends of indirect drivers on direct drivers and impacts of direct drivers on nexus elements were assessed using confidence statements based on scientific literature.
Results are presented in the following tables and figures:

- **Figure 2.10:** Synthesis of established knowledge from a global perspective on how trends of important indirect drivers (Figure 2.6) affect trends in direct drivers
- **Figure 2.11:** Synthesis of established knowledge from a global perspective on how trends in indirect drivers (since 2001) (see Table 2.2) affect the nexus elements (coloured icons) via the impact of indirect drivers on the trends in direct drivers (see Figure 2.4 & Figure 2.10).
- **Figure 2.12:** Data from Figure 2.11 displayed as a Sankey diagram: synthesis of established knowledge from a global perspective how trends in indirect drivers (since 2001) (see Table 2.2) affect the nexus elements via the impact of the indirect drivers on the direct drivers (see Figure 2.4 & Figure 2.10).

Process overview

Note to reviewers: Process diagram will be added for the final draft of the assessment.

Protocol

- **Type of analysis/search/review:** Literature review; Linear Regression
- **Search language(s): English**

- **Search engine:** Scopus, Google (including google scholar and google dataset search), data catalogues and portals (World Bank, FAO, World Resource Institute, UN Environment Program, Earth Data, CSRIO Data Access Portal, Global data lab, IWRM Data Portal, Climate Change Dashboard, Food System Dashboard)
- **Date:** March 2023 - September 2023
- **Step by step analysis**
  - **Identification of important indirect drivers** according to previous synthesis reports (i.e., IPBES 2019a) and illustrated by an appropriate indicator for each of these chosen on the state of knowledge. Indicator data was selected because of their well-established importance as component of indirect drivers. Note, however, that therefor the selection of indirect drivers was dependent on the availability of appropriate indicators, notably of indicators for which time series data is available (needed to quantitively assess a trend). Indicator data was selected because of their well-established importance as component of indirect drivers.
  - **Identification of most important direct drivers** impacting nexus elements following (IPBES, 2019b): land/sea use change, direct exploitation of resources (resource extraction), climate change, invasive alien species and pollution.
  - **Trend analysis of indirect drivers:** temporal trends of indicators of indirect drivers (see Figure 2.4) were assessed using linear regression over time. Long-term trends were calculated considering data from 1981 to the most recent year and short-term trends were calculated from 2000 to the most recent year. See chapter Table 2.2 for regression results. Depending on the calculated annual change rate seven trend categories were defined:
    - strong positive trend: > + 3%
    - small positive trend: 1 to 3 %
    - stable trend: -1 to 1 %
    - small negative trend: -1 to –3 %
    - strong negative trend: < -3 %
    - no significant trend
  - **Impacts of indirect drivers on direct drivers and subsequently on nexus elements** were assessed based on a) an extensive literature review, summarised in Table 2 (IPBES_NXS_DMR_2.5_Table 2.docx); and b) expert judgement by chapter authors, based on the available literature. Confidence statements following the IPBES confidence framework (IPBES, 2019a, chapter 1) in Table 2 (IPBES_NXS_DMR_2.5_Table 2.docx) refer to the impact of the indirect driver trend on the direct driver, and how changes in direct drivers impact Nexus elements (Table 3 (IPBES_NXS_DMR_2.5_Table 3.docx)). Confidence statements were made by the authors based on the literature review (a). In particular, an impact was assessed as well established when it is backed by previous IPBES or IPCC reports, or peer-reviewed literature reviews. Colours indicate how the trend of direct drivers affects the individual nexus elements.
  - **Results** of the impact assessment were visualized as a table (chapter 2 2 Figure 2.7) and as a Sankey diagram (chapter Figure 2.8)

- **Additional information**
  - The nexus element ‘Food’ includes quantity and nutritional quality. Likewise, for water we differentiate freshwater quantity and quality, while for health we assess impacts on physical and mental health in humans.
  - Neither land-/sea-area use, nor resource extraction, invasive species or pollution are direct drivers of climate, beyond their impacts on climate via climate change. Therefore ‘climate’ as a nexus element is not included in this table.
  - The terms land-use and sea-use, and direct exploitation of resources (resource extraction) are not always used unambiguously, with sea-use being a relatively new term in the literature (often referring to area changes alone). Land-use change sometimes refers to both

area (land cover) changes and changes in management intensity, whereas in other contexts land-cover changes are treated separately from land use (IPCC Glossary Search, 2023) (CBD/WG2020/5/4). Here we separate explicitly area changes both on land and in marine ecosystems from changes in management and resource extraction. The latter includes fisheries and harvesting in land ecosystems (both wild and domesticated species), agricultural practices of varying intensities but also extraction of non-biological materials through mining.

- For most of the trends of indirect drivers, effects on direct drivers and nexus elements can be identified with a level of evidence at least "established". For some indirect divers, however, in addition to a (more or less strong) impact on direct drivers a clear **direct** impact on nexus elements can also be found. In these cases (e.g., poverty), one finds an impact on a nexus element (such as health), despite the trend via the direct driver being neutral or constant.
- Within the analysis drivers' trends and nexus impacts are assessed from a global perspective; assessments done at regional scales would in some cases result in a different outcome.

- The number of indirect indicators of different categories differs as for economic indirect drivers more quantitative data (needed to assess trends) is available than for other indirect drivers, especially cultural ones. Due to lack of proper indicator data on e.g., "Institutional capacity" or "Connectedness with Nature" had to be excluded from the assessment for example. Hence an economic perspective seems to dominate.
- Feedbacks (e.g., increased consumption because of increasing material intensity) were not included.

File(s) attached

Note to reviewers: The respective R code (linear regression analysis to quantitively assess trends of indirect drivers; Sankey diagram) will be included for the final draft of the assessment.

ID	File name	File type	File size	Description
1	IPBES_NXS_DMR_2.5__Table 2	.docx	200 KB	Impact of indirect drivers on direct drivers, and magnitude of the impact in nexus elements
2	IPBES_NXS_DMR_2.5_trend_plots	.docx		Plots of trends of indicators on indirect drivers
3	IPBES_NXS_DMR_2.5_Table 3	.docx	100 KB	Summary of the impact of changes/trends in direct drivers on nexus elements.

Table 1 List of used indicators on indirect drivers and their data sources.

Nexus Component	Index	Indicator	Type of data / Unit	Resolution	Time period	Data source

Drivers, indirect	J	Population	Total number	National level data	1960 - 2021	(World Bank, 2023f)
	K	Population living in liberal democracies	% of total population	Global data	1950-2018	(Herre, 2022; World Bank, 2023f)
	L	Urban Population	% of total population	National level data	1960 - 2022	(World Bank, 2023g)
	M	GDP	current US$	National level data	1960 - 2021	(World Bank, 2023a)
	N	Poverty	Poverty headcount ratio (2017 PPP) (% of population) (poverty line = 2.15 $)	Global data	1984 - 2022	(World Bank, 2022)
	O	Merchandise exports	current US$	National level data	1960 - 2021	(World Bank, 2023d)
	P	Armed conflicts	Number of deaths	Global data	1946 - 2020	(Our World in Data, 2023)
	Q	Environmental regulations & legislations	Number	Global data	1900 - 2022	(FAO, 2023)
	R	Material Intensity	Domestic material consumption per Unit of GDP: metric tonnes per US$	National level data	1970 - 2019	(UNEP, 2023)
	S	Education: Literacy rate	% of adult population (ages 15 and above)	Global data	1970 - 2021	(World Bank, 2023c)
	T	Protein Supply	Average supply of protein of animal origin (g/cap/day)	National level data	2000 - 2022	(FAOSTAT, n.d.)
	U	Energy consumption	Gigajoule per capita	National level data	1965 - 2021	(bp, 2022)
	V	Patent applications	Number	National level data	1980 - 2021	(World Bank, 2023e)
	W	Renewable Energy	Petawatt hours	National level data	1965 - 2021	(bp, 2022)
	X	Access to ICT: individuals using the internet	% of population	National level data	1960 - 2020	(World Bank, 2023b)

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