Affluence and consumption of natural resources

Lessons from the Global Resources Outlook 2024 about the drivers behind the Great Acceleration

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Abstract: *A predominant focus on "rich" and "poor" tends to distort the perception of the link between affluence and the consumption of natural resources. Based on the findings of the Global Resources Outlook 2024, the author argues that global material consumption is no longer dominated by high-income economies; instead, middle-income countries now account for the largest share. This underlines the relevance of the IPAT equation as a heuristic tool for analyzing the driving forces behind the Great Acceleration of the Anthropocene. The article discusses the political and communicative challenges arising from the shift in focus from the rich-poor dichotomy towards a complementing consideration of growing populations and affluence of middle-income economies.*

1. Introduction

The connection between affluence, consumption of natural resources, and global environmental change is strongly supported by a substantial body of literature (Constanza et al., 1997, Herwich, 2005, Jackson & Michaelis, 2003, Sattherwaite et al., 2010). Globally, the growth in affluence over the past half-century has consistently driven an increase in resource use and pollutant emissions at a rate that far outpaces reductions achieved through technological advancements. High production and consumption rates require large inputs of materials and energy which has physical consequences. The high-input industrialization of production and consumption patterns is a primary determinant and accelerator of global environmental change. A significant and direct relationship exists between per capita impacts on the environment and economic growth (Hertwich, 2010). Generally, increased affluence leads to greater resource consumption due to enhanced purchasing power and a higher demand for a wider array of goods and services. Affluent societies produce and consume goods and services that require more resources for their production, infrastructure as well as for their operations. Around 70% of the environmental impacts from high-income industrialized societies primarily occur in housing, transport, and the food sectors (Tukker et al., 2006). Specific resource-intensive consumption patterns are linked to affluence. For instance, in the food sector the increased demand for meat exerts significant pressure on limited water resources and international grain supplies (Myers & Kent, 2003). An integrated assessment of environmental and socio-economic effects arising from final consumption of food products by European households have shown that even when technological developments and changes in the mix of consumed food products result in reductions in environmental pressures, positive effects are offset by an overall growing volume of consumption (Schepelmann et al., 2020). Wiedmann et al. (2015) showed that for every 10% increase in a nation's Gross Domestic Product (GDP), its average material footprint expands by 6%.

Due to the strong connection between affluence and resource consumption literature often contrasts the stark differences in resource consumption between high-income countries, often referred to as the "Global North" and low-income countries, in the so-called "Global South". The disparity in per capita resource consumption between affluent and less affluent nations is often perceived as inequitable. For example, the per capita resource consumption in North America is substantially higher than that of an individual residing in Africa. Consequently, high-income countries, despite having smaller populations, account for disproportionately large material footprints putting higher environmental pressure on the planet than low-income economies. The United Nations Environment Programme (UNEP) confirms this view in the headline of its press release of 1st of March 2024 in which it announces the publication of the Global Resources Outlook 2024:

> "Rich countries use six times more resources, generate 10 times the climate impacts than low-income ones."[1]

1 https://www.unep.org/news-and-stories/press-release/rich-countries-use-six-times-more-resources-generate-10-times

This article will show that this headline is misleading. One would expect that a press release for an important UN report such as the Global Resources Outlook would indicate its most important news. We will show that this is not the case. It is rather confirming a popular shared belief on the expense of important but inconvenient findings of the report. The headline is an expression and promotion of what Rosling et al. (2018) refer to as the "gap-instinct". This phenomenon is not an instinct in a biological sense, but rather a widespread bias or a popular misconception leading to the preference of dividing the peoples of the world into rich and poor, with a gap between the two groups. However, as we will show, most people and the largest share of resource consumption are in the middle. Rosling explains:

> "The gap instinct is very strong. The first time I lectured to the staff of the World Bank was in 1999. I told them the labels "developing" and "developed" were no longer valid (…). It took the World Bank 17 years and 14 more of my lectures before it finally announced publicly that it was dropping the terms "developing" and "developed" and would from now on divide the world into four income groups. The UN and most other global organizations have still not made this change. So why is the misconception of a gap between the rich and the poor so hard to change? I think this is because human beings have a strong dramatic instinct toward binary thinking, a basic urge to divide things into two distinct groups, with nothing but an empty gap in between. We love to dichotomize. Good versus bad. Heroes versus villains. My country versus the rest. Dividing the world into two distinct sides is simple and intuitive, and also dramatic because it implies conflict, and we do it without thinking, all the time. Journalists know this. They set up their narratives as conflicts between two opposing people, views, or groups. They prefer stories of extreme poverty and billionaires to stories about the vast majority of people slowly dragging themselves toward better lives. Journalists are storytellers. So are people who produce documentaries and movies" (Rosling et al, 2018, 52).

The quotation shows that for overcoming the "gap-instinct" Rosling recommends dropping the binary distinction between "developing" and "developed" countries in favor of a more granular classification system with four income groups. As Rosling indicated, the World Bank already implemented such a system. Further information on the World Bank income groups can be found in the following chapter. They are further explained in the book "factfulness" (Rosling et al., 2018) from where the quotation above is taken as well as the online tool "Dollar Street", which can be visited at the portal of the Gapminder Foundation[2]. "Dollar Street" helps to understand the implications of the four income groups by means of visual exemplification showing what different incomes in the four categories mean for the lifestyle and everyday consumption of the people in each group. Factfulness and Dollar Street make a convincing case that four income groups are a considerable progress compared to a binary distinction.

The research question that this article would like to answer is: What changes if analysis shifts from a binary North-South/rich-poor perspective towards a view on four income groups as promoted by Rosling and the Gapminder Foundation? Does this reveal any relevant information on affluence and resource consumption that would not be considered from a binary perspective and if so, what could be the consequences for evidence-based policymaking as well as research and teaching on global environmental change?

For this purpose, we will use data from the Global Resources Outlook 2024 (GRO 2024) by the United Nations Environment Program (UNEP), accompanied by the press release quoted above. So ironically, we will set into contrast on one hand the binary view expressed by the headline of the UNEP press release and the more differentiated view of at least parts of the International Resource Panel (IRP) by analyzing and comparing resource consumption and its drivers in four different income categories as implemented in the Global Resources Outlook 2024.

Over the past decade, Rosling and the Gapminder Foundation have discovered widespread and persistent misconceptions about population dynamics, the development of affluence and quality of life in a series of so-called misconception studies including the Gapminder Misconception Study (2017), the Global Misconception Study (2019), the European Health Misconception Study (2019), the Sustainable Development Misconception Study (2020), and the Refugee Misconception Study (2023). The studies revealed considerable misconceptions and biases including the so-called "gap-instinct". The Gapminder research raises the question whether the discussion surrounding affluence, resource consumption, and global environmental change may also be biased and affected by misconceptions, potentially leading to misguided discourses and policies. This article aims to uncover what the headline of the press release is concealing. By doing so, it will be possible to understand how

2 https://www.gapminder.org/dollar-street

common misconceptions, such as the gap instinct, impede the recognition of recent trends in global affluence and resource consumption. Furthermore, the acknowledgement of the dramatic shifts in global resource consumption described in the Global Resources Outlook (GRO) is key for comprehending one of the most significant ecological phenomena of our time: the Great Acceleration of the Anthropocene, which we will discuss in the concluding chapter of this article.

2. The quantification of resource consumption in four income groups

The International Resource Panel (IRP) covers in the Global Resources Outlook 2024 (GRO 2024) over 180 countries which are grouped into seven world regions and four country income groups. The seven world regions are:

1. Africa
2. Asia and the Pacific
3. Europe
4. Latin America and the Caribbean
5. North America
6. West Asia (Middle East), and
7. Eastern Europe, Caucasus and Central Asia (EECCA).

The World Bank annually classifies the world's economies into four primary income groups. This classification, which is updated annually, is based on the gross national income (GNI) per capita. The classification serves primarily statistical and analytical purposes. However, it also has far-reaching implications for development research, the international perception of countries, and the definition of development strategies.

The annual gross national income (GNI) per capita is a measure of the total income earned by a country's citizens, regardless of where the income is earned. It includes not only domestic income but also income earned by citizens abroad.

The World Bank uses GNI per capita because it is available for most countries and is considered a reliable indicator of a country's economic capacity and level of development. Although it is not a perfect measure, it typically correlates strongly with other key development indicators, such as child mortality, life expectancy, and access to basic services.

Despite its widespread use and usefulness, GNI per capita has significant limitations as a measure of development. As an average, it cannot indicate inequalities in income distribution within a country. A high GNI per capita does not imply that the entire population enjoys a high standard of living and resource consumption.

For 2020 the World Bank classifies countries according to the following ranges of annual Gross National Income (GNI) per capita:

1. low income, $1,045 or less
   Economies in this category are typically characterized by high levels of poverty, heavy dependence on agriculture, limited infrastructure, and often political instability
   Examples: Afghanistan, Burundi, Democratic Republic of Congo, Malawi, Niger, Sierra Leone, Syria, Yemen
2. lower middle-income, between $1,046 and $4,095
   This category is extremely heterogeneous and includes countries that are in transition from predominantly rural to urban societies and from an agricultural to an industrial base.
   Examples: Egypt, El Salvador, Honduras, India, Kenya, Nigeria, Pakistan, Philippines, Ukraine, Vietnam
3. upper middle income, between $4,096 and $12,695
   These are emerging economies that play an increasing role in global production and consumption.
   Examples: Argentina, Brazil, China, Colombia, Costa Rica, Indonesia, Iraq, Mexico, Russia, South Africa, Turkey.
4. high-income, $12,696 or more
   These countries are generally characterized by advanced service and industrial sectors and high per capita GDP.
   Examples: Australia, Canada, Chile, France, Germany, Japan, Qatar, Saudi Arabia, Singapore, South Korea, United Kingdom, United States.

3. Material Flow Analysis

For quantifying resource consumption, the International Resource Panel uses different material flow indicators based on material flow analysis (UNEP, 2021). Material flow analysis (MFA) comprises a group of methods to analyze the physical flows of materials into, through and out of a given system. This can be applied at different levels of scale including products, firms, sectors, regions and whole economies. The analysis may focus on individual substances or materials, or aggregated flows such as resource groups (e.g. fossil fuels, metals or minerals). In the following we will focus on economy-wide MFA (ewMFA). EwMFA offers a comprehensive overview of the material inputs and outputs of an entire economy. It provides the basis for producing indicators on the metabolism of countries in terms of material inputs such as raw materials and products, consumption and output, such as products, waste and emissions. By analyzing all material flows, ewMFA can help in assessing the overall environmental impacts associated with the extraction, use, and disposal of materials. Therefore, it can serve as a general proxy of an economy's environmental impacts, not just climate change.

For global governance, economy-wide Material Flow Analysis is used for monitoring progress towards two related United Nations Sustainable Development Goals:

- SDG 12.2 on the sustainable management and efficient use of natural resources. The MFA indicator used for this goal is Domestic Material Consumption (DMC).
- SDG 8.4 on improving resource efficiency in consumption and production. The indicator used for this goal is Material Footprint (MF).

In the following we will concentrate on the results of the GRO 2024 related to these two UN SDG indicators. Therefore, we will briefly introduce DMC and MF.

3.1 Domestic Material Consumption

Domestic Material Consumption (DMC) is a key indicator used to measure the total amount of materials directly used within an economy. This includes various material categories, such as metals, non-metallic minerals, biomass, or fossil energy carriers. It represents the annual quantity of raw materials extracted from a country's territory, plus all material imports, minus all material exports. Essentially, it shows the direct consumption of materials within a country. Thus, it provides insight into the absolute level of resource use of an economy distinguishing resource requirements driven by domestic demand and the resources needed for exports. In national policymaking it helps to identify areas of excessive domestic material use where strategies for resource efficiency could be required. High DMC values can indicate significant environmental impacts, such as resource depletion, pollution, and habitat destruction, but it does not account for "hidden" flows, meaning the upstream materials used in the production of imported goods and their impact on the environment.

3.2 Material Footprint

Over the past ten years significant progress in material accounting has enabled science to go beyond the domestic use of material by tracking the materials used throughout entire supply chains, including those materials extracted in other countries for imported goods. This input-output-based accounting is referred to as footprinting (Giljum et al., 2015). Thus, the ewMFA-indicator "material footprint" (MF) indicates the total amount of raw materials extracted globally to satisfy an economy's demand for final consumption of households and the public sector. In essence, it complements assessments of resource use within a territory by including "hidden" non-domestic material flows required to support the affluence of the people living in that territory. It complements the territorial perspective of the DMC indicator with a consumption-based perspective, highlighting domestic demand as reason for non-domestic material flows in various categories, including biomass, fossil fuels, metal ores, and non-metallic minerals.

4. Affluence and the IPAT equation

Economic wealth of a given population can be expressed as affluence with the indicator Gross National Income (GNI). In plain language affluence means that the population of a country can afford a certain volume of products and services which is expressed by the size of its GNI. The frugal heuristics behind this indicator are that a population can afford less products and services is less affluent than a population which can afford a larger volume of products and services. Consequently, affluence as ratio between GNI and population depends on the size of the GNI (the numerator) and the size of the population (the denominator). A country with a larger GNI in relation to the size of its population is more affluent than a country with a smaller GNI. If a given GNI volume is divided among more people, the population is considered less affluent, because the per capita availability of goods and services is smaller. Thus, the affluence of a country increases either by a growing GNI or by a receding population. An important limitation of this frugal heuristic is that it ignores the quality and distribution of goods and services within an economy. Especially in countries with unequal income distribution it is likely that resource use is also unevenly distributed. Nevertheless, for macro comparisons between countries the GNI is widely accepted.

How does affluence impact on the environment?

The impact of an affluent economy on the environment is highly contingent. There have been several attempts to understand this relationship and competing frugal heuristics exist. For example, proponents of the environmental Kuznets curve (EKC) assume that there is a dynamic relationship between economic development and environmental protection depending on the stage of per capita income and development (Suri & Chapman, 1998). According to this hypothesis, as an economy grows and income levels increase, environmental degradation initially worsens, but after reaching a certain level of income per capita, the trend reverses, and environmental quality begins to improve. The EKC is based on the idea that in the early stages of economic development, industrialization and urbanization lead to increased pollution and resource depletion. As incomes rise, affluent societies invest in cleaner technologies, enforce environmental regulations, and adopt sustainable practices, reducing environmental degradation.

The simple heuristics that could be derived from the EKC could be caricatured as “get rich and clean up later!”. It neglects the causal relation between affluence in high-income economies and domestic as well as “hidden” material flows of production and consumption and overrates the positive impact of clean technology. The simple heuristics that global environmental change can be reduced primarily by deploying the right technology is too simple. However, it is still very popular, even though it was already contested by Ehrlich and Holdren more than half a century ago. In the late 1960ies Commoner argued similar to the EKC proponents that the environmental crisis was primarily due to faulty technologies used in post-World War II industrial societies, rather than population growth or rising affluence (Commoner et al., 1971/2010). He claimed that 95% of environmental problems were attributable to these ecologically inept choices of productive technologies. Commoner emphasized that changes in productive technology had a far more powerful effect on pollution levels than population or affluence. He believed that the pattern of economic growth and the technological transformation of the United States economy were the major reasons for the environmental crisis. Ehrlich and Holdren disagreed with Commoner's claim that environmental degradation was primarily caused by inappropriate technology. They argued that environmental problems are caused by the interaction of multiple factors, including population, affluence, and technology. They emphasized that neglecting any of these factors, or their interactions, is dangerous. In their paper "Impact of Population Growth" they introduced the IPAT equation (Impact = Population x Affluence x Technology) to illustrate the importance of considering three contributing factors simultaneously. They believed that addressing overpopulation, excessive affluence, and faulty technology together is essential for finding effective solutions to environmental crises.

Based on this understanding, IPAT heuristics have typically been utilized in quantitative research. There are various versions of the formula. IPAT heuristics are frequently applied through the Kaya identity to model greenhouse gas emissions in climate science. In material flow analysis, it is essential for modeling natural resource consumption. In the GRO 2024, the IRP has used Herendeen's (1998) logarithmic version of the IPAT formula to assess the significance of overarching drivers of material demand at an economywide level and to estimate associations between changes in impacts and drivers. It is important to note that in this context, the T in IPAT does not specifically refer to technology but encompasses all drivers other than population and per capita income.

5. Results of the Resources Outlook 2024

According to the UNEP press release quoted above:

> "Extraction of the Earth's natural resources tripled in the past five decades, related to the massive build-up of infrastructure in many parts of the world and the high levels of material consumption, especially in upper-middle and high-income countries. Material extraction is expected to rise by 60 per cent by 2060 and could derail efforts to achieve not only global climate, biodi-

> versity, and pollution targets but also economic prosperity and human well-being".

Outstanding is the increase in total domestic material consumption in Asia over the past fifty years. In absolute terms the Asia Pacific region increased resource consumption almost by a factor of seven from about 8 (1970) to almost 54 billion tons. In the West Asia region, the increase in DMC has been tenfold.

The Asian growth in domestic resource consumption is most remarkable not only in absolute terms, but also in relation to the established industrialized world in Europe and North America. In 1970, Europe and North America each consumed about a quarter of the global DMC. These shares were equal to the DMC share of Asia and the Pacific. Over the past fifty years Europe and North America's share decreased to 10%, while the share of Asia and the Pacific rose to 60% of the global domestic material consumption. The IRP points out that Europe's and North America's contributions to the global DMC are now equal to Latin America and the Caribbean, where the share has remained stable since the 1970s.

The analysis of the IRP reflects a dramatic change in the distribution of regional natural resource consumption over the past fifty years:

> "In 1970, Asia and the Pacific had the lowest per capita DMC of all world regions (3.75 tons), which was even below Africa and West Asia (which both posted about 5 tons per capita in 1970) (…). In 2020 Asia and the Pacific posted per capita DMC of 12 tons, which was around the world average but slightly lower than in Latin America and the Caribbean and Europe, and around half that of North America." (UNEP, 2024, 33)

The increase of Domestic Material Consumption in Asia and Pacific over the past fifty years has a considerable impact on the distribution of contributions of countries to natural resource consumption in relation to their income. In 1970 more than half of the global DMC had occurred in high-income countries. In 2020 their share has halved to about a quarter of the global DMC. In the same period while the contribution of high-income countries decreased the upper middle-income countries increased their share from about a third to more than half of the global DMC. In other words, instead of high-income countries the upper middle-income countries now dominate global material consumption. The importance of domestic resource consumption of middle-income countries is even more pronounced, if the increased share of lower middle-income countries is additionally considered.

In contrast to the rise of domestic resource consumption in middle income countries, the DMC in low-income countries has over the past fifty years remained at 3% of global DMC.

In relation to their material footprint overall trends are similar to domestic resource consumption. The Asia and Pacific region accounted for almost 60% of the material footprint in 2020. The shares of Europe and North America dropped to about 10%. Corresponding to the DMC assessments, the demand of middle-income countries creates the largest material footprint, while the share of high-income countries has been reduced to about a third:

> "In 2000, high-income countries accounted for 51% of the global footprint and upper middle-income countries for 34%. By 2020, these numbers had practically reversed." (UNEP, 2024, 33)

In summary, over the past fifty years the global extraction of natural resources tripled resulting in an absolute increase in environmental pressure. Dramatic changes of global resource consumption occurred not only in terms of quantity but also in terms of its geographical expansion and distribution among income groups. The contribution of domestic resource consumption of high-income economies to global resource consumption has halved in favor of the share of middle-income economies, which now dominate global resource consumption with more than half of the global resource demand. Roughly speaking, North America, Europe as well as Latin-America and Caribbean countries each contribute about 10% of global domestic resource consumption, while Asia and the Pacific contribute 60%.

Globally, rising population and affluence drive material demand. While affluence is the key driver in Europe, North America, and Asia-Pacific regions, population growth is more significant in Africa, West Asia, Latin America and the Caribbean.

Over the past fifty years per capita resource demand (DMC) increased worldwide by 50% from 8 to 12 tons per capita. According to the IRP assessment there are only two exceptions:

- Between 2000 and 2020 the per capita DMC of North America decreased by 20% (from 32 to 26 tons per capita). Yet, this is still more than twice the global average (12 tons per capita).

- Eastern Europe, Caucasus and Central Asia (EECCA) are a unique case where a decline in economic prosperity as consequence of the post-Soviet transition during the 1990ies resulted in a substantial and prolonged reduction in per capita resource consumption at regional level.

6. Discussion of results

The International Resource Panel's analysis of the Domestic Material Consumption of 1970 and 2020 reveals dramatic dynamics of global resource consumption (Table 1):
a) **Global resource consumption has increased at a faster rate than world population.** While the world population has doubled over the past fifty years, the consumption of natural resources has tripled. If we assumed constant per capita resource consumption by simply multiplying the total resource consumption of 1970 by the population growth rate (factor 2.1) this would explain two thirds of the delta between 1970 and 2020. Consequently, one third of the additional growth would be attributable to the increased per capita consumption of a more affluent world population.
b) Population and economic dynamics have resulted in major shifts in global resource consumption over the past fifty years:

1. **Dominance of resource consumption in middle-income countries**
   In absolute terms, the population of high-income economies has slightly increased as well as their per capita resource consumption. However, in relative terms their contribution to global resource consumption has halved in favour of the share of middle-income economies. Between 1970 and 2020 the population of lower and upper middle-income economies increased from 2.4 to 5.8 billion people, which is more than the total world population of 1970 (3.6 billion). The increased demand of populations with a middle-income has not only been driven by high birth rates but is also a consequence of increasing affluence coupled with growing per capita resource demand, which has most significantly increased. In upper middle-income economies per capita resource consumption in 2020 is even higher than in high-income economies. Thus, population growth coupled with an increasing per capita demand has resulted in global resource exploitation, which is now dominated by the demand of middle-income economies.

2. **Marginalization of North America and Europe—rising importance of Asia**
North America, Europe as well as Latin-America and Caribbean countries each contribute about 10% of global domestic resource consumption, while Asian and Pacific countries contribute 60%. Its share of global resource consumption now corresponds to its share of the world population. In absolute terms domestic resource consumption in Asia and the Pacific increased by a factor of 7 from 7.7 to 53.5 billion tons, which is more than 170% of the total resource consumption of humanity in 1970.
3. **Continuous low resource consumption in low-income countries**
Over the past fifty years the total population of low-income countries increased by a factor of three, their relative share in the total world population has increased from 4 to 7%. At the same time their per capita resource demand has remained the same which resulted in a continuously small contribution of low-income countries to global resource consumption of less than 4%.

Table 1: Population and DMC per capita in 4 income groups

	Population 1970	DMC per capita 1970	Population 2020	DMC per capita 2020
high-income	1.0	17	1.4	19
upper middle-income	1.4	8	2.8	20
lower middle-income	1.0	3	3.0	5
low income	0.2	5	0.6	5
World	**3.6**	**8**	**7.7**	**12**

Source: UNEP, 2024, https://fred.stlouisfed.org/[3]

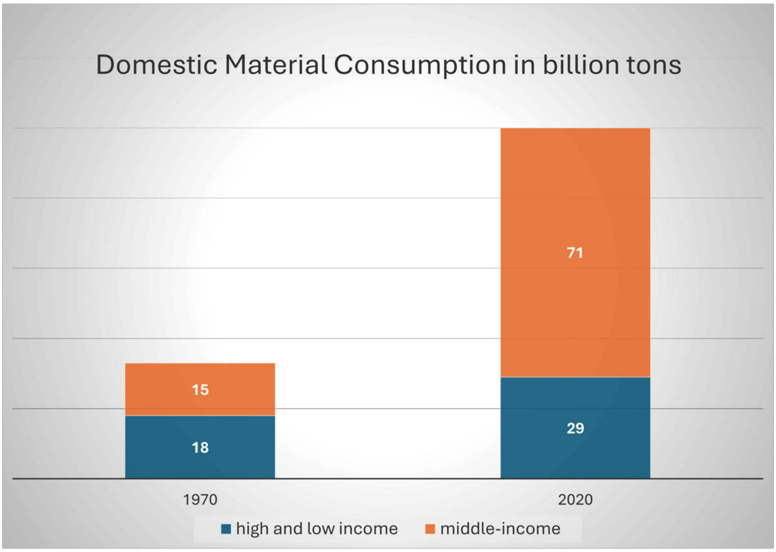
3 The methodological annex of the GRO 2024 does not contain data on the population of the four income groups of countries. Therefore, the FRED has been chosen as a source of Worldbank statistics easily at hand. Consequently, the absolute numbers deviate from the GRO 2024, which is also due to rounding, however the proportions remain similar.

Table 2: Domestic Material Consumption (DMC) in four income groups

	DMC in billion tons 1970	DMC in billion tons 2020
high-income	17.2	26.5
upper middle income	11.5	55.7
lower middle-income	3.1	14.8
low income	0.7	2.8
World total	**32.5**	**99.8**

Source: UNEP, 2024, https://fred.stlouisfed.org/7

Figure 1: DMC 1970 and 2020 in high/low and middle-income countries



Source: IRP, https://fred.stlouisfed.org/[7]

What makes the difference between a binary North-South/rich-poor perspective towards a fourfold view on different income groups?

In 1970 the population of high- and low-income economies had been 1.2 billion people in 2020 this number has increased to 2.1 billion, which would be roughly one third of the population. In terms of the world's natural resource consumption (1970) it would have covered more than half (Figure 1). A focus on the high resource consumption of the rich in contrast to the poor could be justified, because most of the resource consumption would be addressed and the large differences in per capita resource consumption of more than a factor 3 could be highlighted, with meaning for the rest of the population living in middle-income countries with comparable low per capita resource use. Today, with a view on the 2020 data, the situation has completely changed. A focus on 27% of the population living in rich and poor countries would address less than one third of the world's natural resource consumption (Figure 1). Therefore, a binary perspective North-South/rich-poor has two major disadvantages:

- It neglects 70% of the world's natural resource consumption by more than 70% of the world population living in middle-income economies
- It addresses a factor four inequality in per capita resource consumption between high-income and low-income economies, but it would neglect the same difference in per capita resource consumption between higher and lower middle-income countries (Table 1).

7. Conclusions and outlook

This article has started referring to the research of Hans Rosling and the Gapminder Foundation about significant misconceptions regarding the development of global affluence and its worldwide distribution. We may conclude that the bias which Rosling referred to as the "gap instinct" also affects the associated ecological debate and risks to contaminate related discourses. The concluding chapter of this article takes up more space than usual, because it aims at outlining implications and possible solutions for overcoming widespread misconceptions.

7.1 The established dichotomy

Framing the discussion about affluence and resource consumption primarily as antagonism between a rich Global North and a poor Global South offers several advantages. It allows analysis to be embedded in established historical and geopolitical contexts. It connects to existing discourses on colonialism, inequality, and global justice, making the discussion more accessible and relevant to a wider audience. According to Rosling et al (2018) binary views appeal to people's preference to divide populations into two opposing groups. This makes dichotomies more intuitive and emotionally engaging, which can increase public attention and appeal. The Global North-South framing is widespread and well-established. It is frequently used by media, political decision-makers, and civil society, which facilitates its acceptance and the dissemination of matching narratives. Therefore, we may conclude that the decision of UNEP to use a headline which appeals to the gap-instinct for introducing the Global Resources Outlook in its press release of March 1st 2024 is understandable to improve acceptance and dissemination.

However, taking a binary perspective also has disadvantages. The focus on 30% of the population living in high and low-income economies neglects 70% of the world's population using 70% of the world's natural resources. The headline of the press release with a focus on "rich countries" and "low-income ones" distracts from the real news of the GRO 2024 which are that global material consumption is now dominated not by high-income but middle-income economies (Figure 1). Furthermore, it does not offer an explanation why the difference between per capita resource consumption in high-income and low-income economies is worth a headline, while a similar difference between upper middle-income and lower middle-income countries[4] is not (Table 1).

7.2 The World Bank income groups

The more nuanced classification of countries into four income groups, as applied by the International Resource Panel, enhances the understanding of natural resource consumption and leads to a more accurate and comprehensive analysis of the dynamics of resource demand than established rich-versus-poor dichotomies. This offers the chance to develop more realistic assessments of global resource challenges as precondition for evidence-based policies. However, categorizing countries into four income groups might complicate the understanding and communication of the dynamics of global resource demand. So far, there seems to be a lack of appealing narratives

4 This refers to DMC for the year 2020: the difference between high-income (19 t per capita) and low-income economies (5 t per capita) – for upper middle-income (20 t per capita) and lower middle-income (5t per capita). If the consumption-oriented Material Footprint is considered the difference among the two middle-income group is slightly less pronounced: high income (24t per capita) and low-income (4 t per capita) – upper middle-income (19t per capita) lower middle-income (5t per capita).

and frugal heuristics which could replace the North-South dichotomy. While blaming the luxury and overconsumption of a rich elite in the "Global North" is tempting, it is harder to problematize the rising consumption of a growing volume of middle-income households ("the vast majority of people slowly dragging themselves toward better lives", see quote by Rosling above). It is socially acceptable to condemn private jets or large mansions for their resource-intensity and high emissions, while material and energy-intensive development of decent housing and infrastructure is considered to be an expression of social progress, e.g. for reaching the so-called Sustainable Development Goals. However, not only the waste of resources for rich elites deserves public attention but also waste of resources for the masses such as the Evergrande incident in China's building sector, which resulted in a massive loss of energy, materials and land. This raises general questions about resource-efficiency, governance, and corruption in real estate and infrastructure development in emerging economies which could deserve further research and analysis.

7.3 Between rich and poor: a new world order

The focus on the North-South divide obscures the view of new political, economic and ecological realities which are increasingly shaped by the rise of middle-income economies. As a result, research and discourses about environment and development are often deficient.

The GRO data clearly indicates that the tripling of resource demand over the past twenty years is more due to increasing affluence of highly populated middle-income economies, while the physical marginalization of the established high-income world formally known as "the Global North" proceeds. On the one hand income distribution and resource intensive lifestyle of the rich elites, and on the other hand the growing affluence of the total population in middle-income economies is increasingly relevant. The data suggests that they are the largest drivers of global environmental change of our time and future generations. Not only the luxury yachts for leisure of the rich, but also the container shipping giants providing goods for the masses would be an appropriate symbol of accelerating global resource demand.

The rise of the BRICS expresses the ambiguity of current resource trends which are insufficiently reflected by theory, research and media. The BRICS alliance has been established by middle-income countries as a consequence of their growing economic and political importance. Initially it comprised Brazil, Russia, India, China, and South Africa. The group has expanded to include Egypt, Ethiopia, Iran, and the United Arab Emirates, with the latter being the only high-income member. Additionally, Indonesia joined the group in 2025. As of early 2025 around 3.64 billion people live in BRICS member countries. This accounts for approximately 45% of the world population. In line with Rosling's critique the BRICS are insufficiently reflected in scientific and popular literature as well as public media which tends to focus on the rich versus poor dichotomy. However, the BRICS alliance does not fully align with established binary narratives, given the differing historical backgrounds and economic, cultural, and social diversity of its member countries. A possible approach to address the limitations of existing theories would be to supplement them with frugal heuristics like the IPAT equation and develop new evidence-based narratives (Schepelmann et al, 2021).

7.4 Relevance of the IPAT equation

The GRO 2024 demonstrates the explanatory potential of the IPAT equation not only for quantitative analysis of past developments but also for forward-looking agenda-setting, analysis and policy formulation.

As demonstrated in the GRO 2024 the decomposition analysis of population, affluence and technology is a rich source of data and insight. Quantifying and comparing drivers and their manifestation in specific production and consumption patterns, both in absolute and relative terms, enables evidence-based assessments of proportions. This approach allows for prioritization and the deduction of targeted strategies tailored to the distinct social, ecological, and economic realities of low-, medium-, and high-income countries.

However, the International Resource Panel exhibits in the GRO 2024 some inconsistencies in the application of IPAT. Particularly, the evaluation of population and affluence presents mixed conclusions. On one hand, the IRP asserts that "globally, population and affluence growth had a similar impact on material demand" (UNEP, 2024, 39). On the other hand, it claims that "affluence is the main global driver of environmental impacts" (UNEP, 2024, 63).

The examples given in the GRO illustrate the difficulties of separating population and affluence. "For instance, in China, the rise in material footprint is predominantly attributed to affluence. In contrast, Africa's impacts are largely influenced by its growing population". However, it needs to be considered for both Africa and China, that it is always the product of the factors population, affluence and technology that eventually determines the contribution to global resource extraction. For instance, assuming a similar technological level a significant increase in affluence in Luxembourg has minimal impact in absolute terms due to its small population. In contrast, a slight rise in affluence in China substantially affects global material flows. The projected doubling of the population in Africa from 1.5 to 3 billion people by 2070 will have a considerable ecological impact, particularly if coupled by socially desirable increases in affluence, including the development of housing, infrastructure and industrialization resulting in higher per capita resource consumption.

7.5 Factor P

While the GRO 2024 clearly identifies population as a major driver of global material flows, it fails to treat it as a manageable factor. Even though the IRP considers population to be less important than affluence, the GRO 2024 offers no explanation as to why population is not addressed as an area for target setting, policy formulation, or implementation. This seems representative of the current resource policy debate. However, with regards to population dynamics synergies of SDGs such as poverty reduction, education as well as sexual and reproductive health and rights (SRHR) offer opportunities for social policies (Rosling, 2018). In the domain of SDG 3 on "Good Health and Well-being" target 3.7 specifically aims to "ensure universal access to sexual and reproductive health-care services, including for family planning, information and education, and the integration of reproductive health into national strategies and programmes". Furthermore, SDG 5 on "Gender Equality" seeks to "achieve gender equality and empower all women and girls". Sexual and reproductive health and rights are a key aspect of women's and girls' empowerment, allowing them to control their bodies, make their own choices about their sexuality and reproduction, and live free from violence and discrimination. Target 5.6 emphasizes "universal access to sexual and reproductive health and reproductive rights".

Since population is an important driver of resource consumption in Africa, West Asia, Latin America and the Caribbean there is a discrepancy between its empirical significance and its treatment in the public resource debate, for which the GRO 2024 is a prominent example. It shows that beyond its importance for regional and country-specific design of evidence-based policies, the IPAT-equation is relevant for a more general reflection of values and human development. This concerns not only population, but also affluence and technology.

7.6 Factor T and A

It is largely accepted that global environmental change is a technological challenge, for example, renewable energy sources such as solar and wind power can reduce reliance on fossil fuels and decrease greenhouse gas emissions. Electric vehicles can replace traditional gasoline-powered cars, reducing air pollution and greenhouse gas emissions (Muratori, 2021). Additionally, technologies such as carbon capture and storage can help to reduce emissions from industrial processes (Dziejarski et al., 2023). Yet, it also seems to be accepted that problems arising from global environmental change cannot be fixed by technology alone (e.g. Dobson, 2003). There is a growing awareness that not only the factor T (technology) of the IPAT equation needs to be addressed but also factor A (affluence). This belief is usually labelled as "degrowth" (Busk, 2023). Based on the IPAT equation Hickel & Kallis (2020) discuss the theoretical possibility of green growth and the potential for efficiency improvements. They conclude that existing empirical evidence does not support the theory of green growth neither in terms of Domestic Material Consumption (DMC) nor in terms of carbon emissions. The authors suggest that policies relying on green growth assumptions need to be revisited. They propose to explore alternative strategies, such as degrowth to shift away from growth-focused development agendas. In line with several authors (Ekins, 1993) they recommend a focus on decoupling prosperity and development from growth.

7.7 The Great Acceleration of the Anthropocene

Another example of mainstream debates about environment and development which could profit from the application of the IPAT equation and its decomposition relates to the so-called Anthropocene. The flagship publication by Steffen et al. of 2015 presents a collection of graphs to underpin the hypothesis of a "Great Acceleration" (Steffen et al., 2015). As contribution to the International Geosphere-Biosphere Program (IGBP) synthesis project, inspired by Paul Crutzen's introduction of the term "Anthropocene", the graphs track socio-economic and earth system trends from 1750 to 2010. They aim at capturing the comprehensive human impacts on earth systems, particularly after 1950, which marks a significant acceleration in human activity and its impacts on earth system trends. It connects to the Anthropocene discourse by noting the continued post-industrial shifts in the state and functioning of the earth systems beyond Holocene variability. Based on the graphs the authors conclude that the beginning of the Great Acceleration in 1950 would be the most compelling start date for the Anthropocene. Given the importance of the Great Acceleration for the Anthropocene concept it is remarkable that the authors simply stress the correlation between socio-economic trends and Earth system changes but offer no convincing systemic understanding with a causal explanation for the Great Acceleration. This weakens the argument of a Great Acceleration, because correlations cannot substitute for causality. In addition, the authors stress the importance of comparative analysis of socio-economic trends to address equity issues in the OECD, BRICS, and the rest of the world. Even though the authors realize the emerging shift in production and consumption towards BRICS nations they claim that OECD countries drive most of the Earth system impacts by dominating global consumption. The Great Acceleration graphs are an example, how the analysis and evidence of the GRO 2024 presented in this paper could enrich the Anthropocene research as well as teaching on global environmental change in general, especially if comparative analysis of four income groups according to the World Bank methodology would be applied:

1. The causality of the IPAT equation could replace the simple correlation of socio-economic and earth systems trends. Not as a general theory but as robust and frugal heuristics the IPAT equation could introduce an evidence-based perspective on the drivers of the Great Acceleration in the different regions of the world.
2. Introducing IPAT causality in portraying the Great Acceleration would be necessary to critically reflect existing values and objectives related to technological development, economic growth and population. Consistently using frugal IPAT heuristics could raise awareness on the problem that affluence and population are not only the main drivers of resource use and environmental destruction, but also the most widely accepted and popular indicators of collective strength. In contrast, declining population and GDP are seen as signs of weakness. As long as sufficiency, degrowth and depopulation remain political taboos, the only logical option left is disruptive technological shifts that aim at an overall dematerialization of economies in the order of magnitude of a Factor 10 (Schmidt-Bleek, 2008). However, this is also unlikely, not only because of the scientific arguments against green growth and technology fixes quoted above. Poor and middle-income economies are currently developing resource-intensive large-scale infras-

tructure and housing schemes with little concern for resource efficiency and green agendas.

3. Persistent misconceptions on the dominance of OECD consumption of natural resources could be corrected to clear the view on the new realities of a world after the successful industrialization of many middle-income economies. This could also lead to realistic assessments of the continuous expansion of populations and economies as well as the likelihood of emerging new waves of the Great Acceleration of human activity and global environmental change.

Targeting the consumption of the rich parts of humanity is understandable and may be a moral necessity, but it will not contribute to decrease environmental pressure generated by the vast majority of middle-income households. On the contrary, focus on high income usually results in calls for a redistribution of income to poorer segments of the population, which would eventually fuel further consumption. This may have positive effects on social cohesion and justice, which may accelerate demographic shifts towards lower birth rates. However, the main message of the GRO 2024 is not that global resource consumption is primarily driven by the high-income countries but more than ever from the successful attempt to raise income and quality of life for the majority of people, who live in middle-income countries. In other words, global environmental change is not primarily a result of greater inequality. Rather, it is the result of greater equality in terms of rising income for people and states, enabling increased production and consumption including the development of infrastructure, housing, education and healthcare.

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