United Nations University
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WATER, SOIL AND WASTE
DRESDEN NEXUS CONFERENCE

POLICYBRIEF

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ECONOMIC GROWTH AND RESOURCE USE: EXPLORING THE LINKS

Dr. Janez Sušnik (UNESCO-IHE)

HIGHLIGHTS

- Historically, there is no denying the fact that Gross Domestic Product (GDP) and resource use are correlated. But an important question that arises is: What could be the resource use trend for the future with the developing GDP?
- Should there be policies aiming to either restrict future GDP growth to minimise resource use or decouple GDP and recent resource use growth trends?

This policy brief aims at exploring the relationship between GDP and GDP-per-capita with the resource metrics and projected resource use related to water, food and energy till the year 2100

THE CHALLENGE

In 2013 about one billion people lacked access to safe drinking water, and in 2006 over 2.5 billion lacked reasonable levels of sanitation (Moe and Rheingans, 2006; UN Water). Likewise, about 840 million people are chronically malnourished (World Hunger, 2010) and approximately one billion lack access to a reliable electricity supply (World Bank, 2010). In a fast growing world, population is projected to reach over nine billion people by 2050 (UNPD, 2013) and to meet the expected increase in demand for water, food and energy efforts to improve lifestyles must be more efficient (Population Institute, 2003; RAEng, 2010).

This scenario is further stressing the knowledge regarding finite global resources and over-exploitation of water resources around the world (Gleeson et al. 2012). The shortage of freshwater and land for viable agriculture competes with the demand for land for growing urbanisation and the undergoing desertification, as well as wastage and traditional energy supply, sources, security and prices (Falkenmark and Molden, 2008). The risk of a global water shortage is critical, especially when climate change is considered. Water scarcity is considered the most important societal risk because, it has knock-on implications for a wide range of sectors including food, energy, health and economic development (WEF, 2015). Water resource use predictions covering multiple sectors would lead to a better understanding of the severity of global water scarcity, enabling the formulation of plausible development scenarios. These scenarios may help strategic planning for natural resources shortages, thus leading to water scarcity mitigation though the reduction of resources exploitation. A main challenge for predicting these scenarios is to identify a standardized metric that can be globally used to tentatively estimate future resource use.

CURRENTLY USED METRICS

At the present, the common metric in use is the quantification of selected parameters as (citing a few of them) electricity usage is measured in kilowatt-hours (kWh, or some appropriate multiple), total energy in gigajoules (GJ), water in millions of gallons or cubic meters, food in tons of production. These quantifications require knowledge of the underlying processes and considerable data availability as well as continued monitoring efforts. Moreover, the data are often extrapolated from different sources that are not always consistent. For these reasons, we believe that the development of a global metric which would not require all the above cited information and that instead rationalizes datasets via the generation of relationships between GDP and water, food and energy use metrics could lead to a consistent measurement. This in turn would simplify the overall process for predicting global scenarios.

USE OF ECONOMIC METRICS AS A NEW AVENUE

The use of economic metrics, such as GDP or GDP-per-capita, is a promising avenue for the prediction of water withdrawals. Thus this idea is used and expanded upon for this work.

Retrieval of data from open-sources databanks (e.g. The World Bank, FAOSTAT and FAO AQUASTAT, the UN EIA database) was adopted in this study and relationships between economic metrics (GDP and GDP-per-capita) and resource-related statistics (water, food and energy related) were generated. All primary data used are at national level and on spatial and temporal (annual) resolution.

This work includes over 170 countries for 1960-2008, and includes multiple water-related metrics. Whereas previous works often focus only on selected countries and only on single-year based statistics. Moreover, while other studies (Gleick, 2003; Duarte et. al. 2013; Katz, 2015) have also used big datasets, the focus was centred on per-capita water withdrawals and per-capita GDP, whereas our work make use of many other water, food and energy metrics, and it also includes total national GDP.

THE METHOD

Economic metrics and huge resource datasets are exploited to come up with plausible predictions for resource use in the future. GDP and GDP-per-capita are related to 19 different resource metrics from the water, food and energy sectors (e.g. the amount of water withdrawn per-person and nationally, food production and the amount of electricity generated and used). From robust historical trends, predictions to 2100 are generated based on seven likely GDP growth scenarios. This research makes use of extensive open-source data from the FAO 'FAOSTAT' and 'AQUASTAT' databases, the World Bank, the International Monetary Fund and the US Energy Administration.

THE OUTCOME

Main outcomes from the data elaboration are:

1. There is no apparent long-term global level relationship between GDP-per-capita and any of the 19 resource metrics.
2. GDP was shown to be related to the 19 metrics, with the strength of the relationships varying by metric (e.g. see Figure 1). Correlation equations between GDP and each metric were derived.
3. Using the correlation equations between GDP and the resource metrics, global historical trends were well replicated (e.g. Figure 2) when compared against the test set of data. This helped confirm the validity of the relationships so that they could be used for estimating future scenarios.

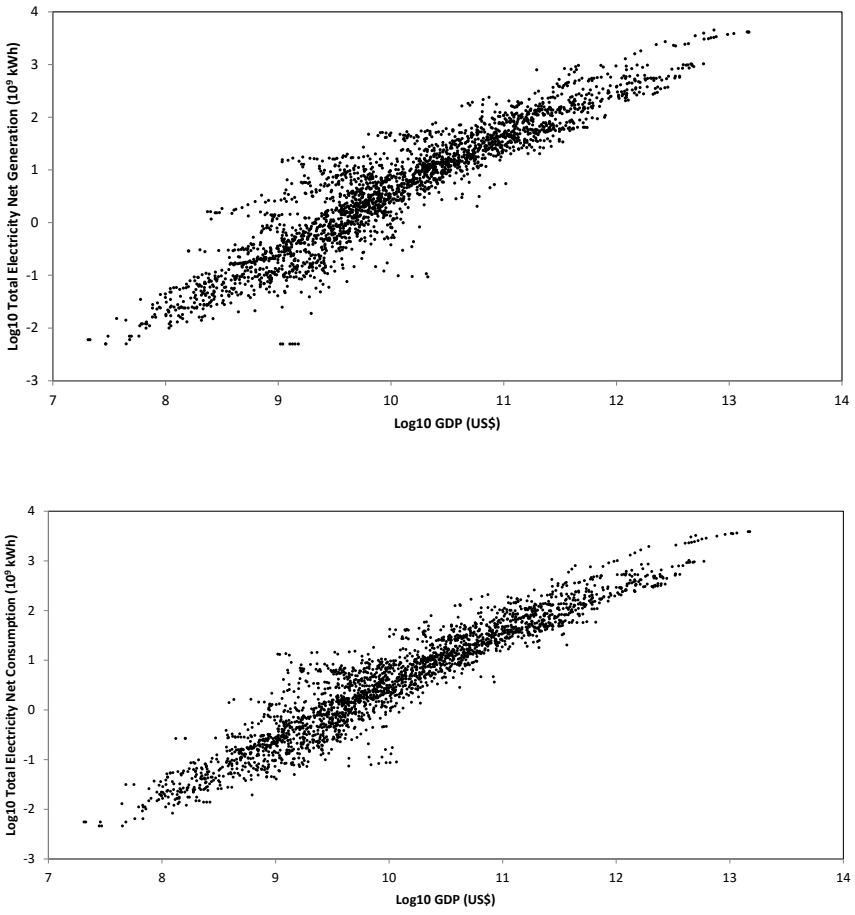

Figure 1: GDP related to net electricity generation (top) and consumption (bottom)

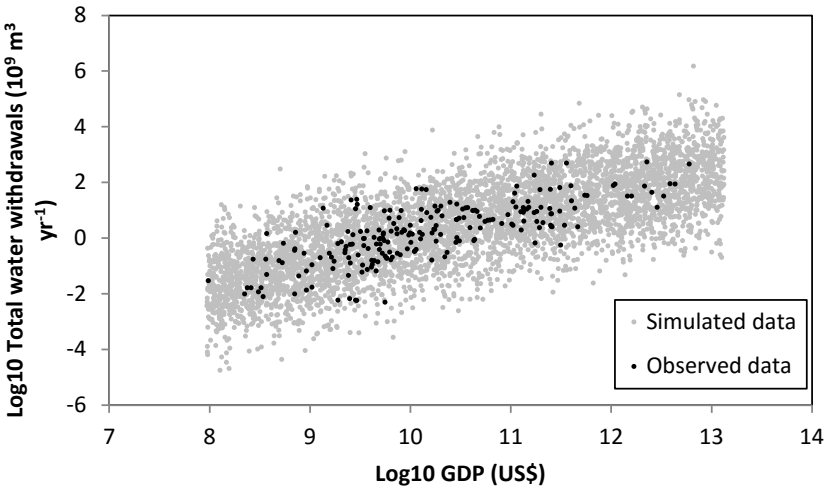

Figure 2: Replicated historical data for GDP and total global water withdrawals

4. These correlations were used for each of the seven GDP growth projections[1] in order to forecast resource use to 2100 (e.g. Figure 3). Results are within the same range of other studies using different methodologies and show that sustainability of resource use is strongly linked to the GDP growth scenario assumed.

5. Results are strongly GDP growth dependent. Strong growth leads to excessive resource use. As an example, the 'safe global' limit for water withdrawals (Steffan et al. 2015) exceeded more frequently under strong GDP growth rates.

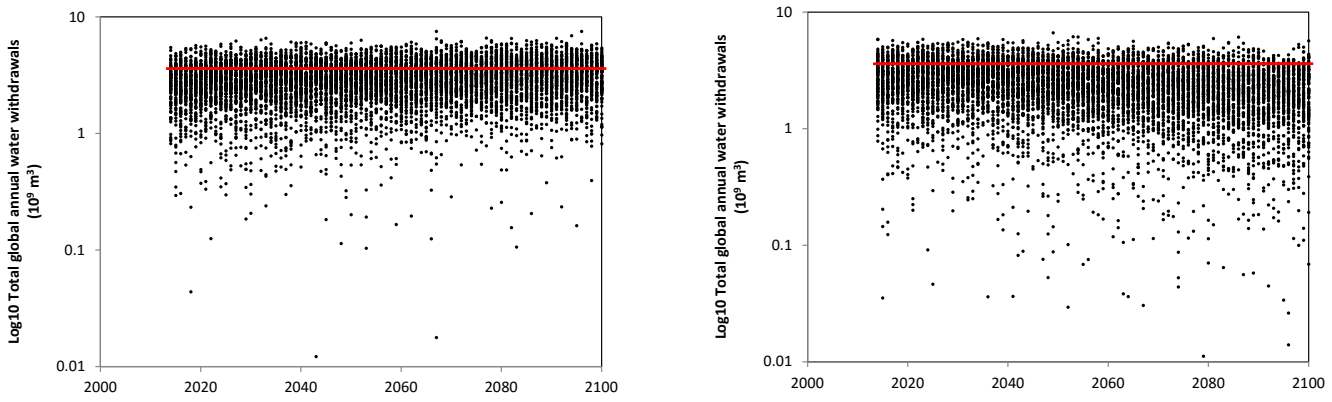

Figure 3: Example results for future global estimates of total global water withdrawals to 2100. Top figure assumes a 'business as usual' economic growth scenario while the bottom figure assumes a future negative GDP growth rate. Red line indicates the 4000 km3 yr-1 safe planetary boundary of Steffan et al. 2015. In scenarios of negative growth, the safe limit is exceeded less frequently

[1] Seven GDP growth scenarios were used to account for the most likely socio-economic development futures. One is based on recent historical average growth, one is based on the global average short term forecast from the IMF, two are constant positive growth scenarios, two are constant negative growth scenarios and the final scenario sums up short-term country-specific forecasts from the IMF

DR. JANEZ SUŠNIK (j.susnik@unesco-ihe.org)

Integrated Water Systems and Governance Department, UNESCO-IHE Institute for Water Education, Delft, The Netherlands

United Nations University
Institute for Integrated Management
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POLICY RECOMMENDATIONS

Given the strong correlation between GDP and resource use globally, it seems wise to follow policy that either:

a. Limit economic growth such that resource use growth is also minimised; or
b. Aim to decouple resource use from the economy

Neither are easy options, but this work and recent work suggests ever-increasing resource use globally due to population change and improving lifestyles. If growth does indeed track GDP, and assuming it continues to do so, then option (a) must be sought. However, the possibility to decouple GDP from resource use is also plausible, but its implications are still unclear.

One glaring omission of this work is considering water, food and energy together. We are aware of their intimate interconnection on a global level and therefore it will be explored in further works.

REFERENCES & FURTHER READING

This Policy Brief is based on a presentation made at DNC2015 and a scientific paper published by the author. The reference for the full paper and analysis is:

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As a hub for initiatives on the Nexus Approach, UNU-FLORES is not only committed to strengthening its own network but also to providing an international platform to foster cooperation and networking amongst all actors working on or with the Nexus Approach to managing environmental resources. That platform is the biennial Dresden Nexus Conference (DNC).

Ammonstrasse 74, 01067 Dresden, Germany
Tel.: + 49-351 8921 9377
Fax: + 49-351 8921 9389
e-mail: flores@unu.edu

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