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Ethics, sustainability and the water, energy, food nexus approach – a new integrated assessment of urban systems

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Abstract

Current global developments put increasing ecological, economic and social pressures on urban systems. The density of urban areas concentrates these pressures especially on water, energy and food (i.e., the nexus) resources as if in a ‘burning glass’.

The integrated assessment approach is used to frame, study and solve issues such as climate change, water and air quality, land and public health challenges, which are at the core of the approach. To meet these targets, in the last few decades a wide array of assessment tools has been developed. Most of these approaches, however, pursue national or at best regional perspectives and only rudimentarily provide for considerations of local effects. In our integrated assessment approach based on the Nexus City Index we combine an ethical derivation with participatory and accounting tools to grasp and operationalize the complexity of urban areas from a bottom-up and top-down perspective in order to derive a holistic picture of the nexus challenges in urban areas.

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1. Introduction

The Brundtland commission defined sustainability as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs [1]” and thus bases its definition on intra- and intergenerational justice as central human rights principles.

However, today almost one billion people are undernourished, 0.9 billion do not have access to safe drinking water and 1.5 billion have no source of electricity [2-4]. According to current calculations, by 2030 the human demand for water will exceed the foreseen availability of water resources by approximately 40% [2, 5]. Demand for water is expected to grow by 30% to 40%, for energy to grow by 40% to 50%, and for food to grow by 35% to 50% until 2030 [3, 6-8]. In Europe, by 2040 several countries will face significant water stress [9]. This nexus among food, energy and water requires improved management concepts as pressure on demand will further increase in the future: “The urban population in 2014 accounted for 54% of the total global population and it is estimated that by 2017, even in less developed countries, a majority of people will be living in urban area.^b” Today, 827.6 million people live in slums and often lack adequate water and sanitation services. This number will likely increase to 888 million in 2020.^c And, already today, “cities account for two-third of the world’s overall energy consumption.^d” These figures well exemplify the increasing pressures on the discussed nexus sectors anchored in different, but interdependent, dynamics of global and regional change [3]. The dynamics encompass a broad spectrum of trends including “demographic changes, urbanisation, industrial development, agricultural modernisation, international and regional trade, markets and prices, technological advancements, diversification and changes of diets, and climate change as well as more context-specific drivers, like governance structures and processes, cultural and societal beliefs and behaviours” [7]. All of these developments result in a growing pressure on limited resources. If current trends continue, the pressures on natural resources and ecosystem services will have far reaching consequences [10] and may “drive social-ecological systems across critical thresholds, e.g., via land degradation, water scarcity or food-crises” [3].

Although the specific effects of population growth will be mitigated substantially by other social and economic factors (as will be discussed below), the increasing population will be a key driver of strain on natural resources: “It is not just about the size of population but also about the way in which people behave” [2]. Roughly half of the population currently lives in rural areas [11]. However, the current urbanization trend especially into megacities will likely continue and thus aggravate challenges like sewage disposal, traffic congestion or air pollution [5]. Domestic and other industrial uses account for roughly 20% of water abstractions. Although the volumes in these sectors are comparatively low, their quality and reliability demands are very high; furthermore, these uses “carry significant weight in deciding how water should be allocated because of their importance for inclusive growth, continuing urbanisation (by 2030, over 60% of the world’s population will live in urban areas) and the persistent lack of access to safe drinking water in some regions” [2]. Urban lifestyles offer attractive options, but are generally more resource intensive and consumption and waste production are concentrated and thus pose additional challenges for sustainable city design [3]. Resolving this challenge will require a global framework of justice as one important step towards achieving sustainable development.

^b http://www.who.int/gho/urban_health/situation_trends/urban_population_growth_text/en/

^c UN-water factsheet: http://www.un.org/waterforlifedecade/water_cities.shtml

^d <http://www.worldbank.org/en/topic/urbandevelopment/brief/low-carbon-livable-cities>

2. Theory

In the following we will derive the ethical background for an integrated nexus assessment of urban areas. It is based on the ethical foundation of sustainable development: intra- and intergenerational justice.

2.1. Intragenerational justice

Intragenerational justice refers to a very pressing challenge of justice, that is the unequal spatial distribution of resources: “The 12 percent of the world’s population that lives in North America and Western Europe accounts for 60 percent of private consumption spending, while the one-third living in South Asia and sub-Saharan Africa accounts for only 3.2 percent [12].^e” The Worldwatch Institute Report [12] confirms the unequal distribution of resources and living opportunities resulting from the use of these resources. The World Summit on Sustainable Development in Johannesburg 2002 summarized the intragenerational challenges for politics: “security, stability, peace and respect for human rights, as well as good governance, are basic requirements for sustainable development. Justice for the world’s poor must be ensured so that poverty can be eradicated” [13].

2.2. Intergenerational justice

In the context of intergenerational justice we are confronted with the challenge that the urban living conditions of future generations are path dependent on and thus crucially determined by today’s generations and their lifestyle decisions. This, however, also implies that welfare losses of the current urban population to the benefit of future generations will, vice versa, not be compensated for, since the present generation will then no longer exist [14].

Neumayer derives a possible answer to this ethical question from the categorical imperative of Immanuel Kant [15], stating: “Act only according to that maxim by which you can at the same time will that it should become a universal law.”^f From the categorical imperative, Neumayer derives that the current generation should indeed in their decision consider the future by ensuring the preservation of capacities that enable future generations to achieve a non-decreasing welfare level. This normative behavior also serves the interests of today’s generations [16].

3. Operationalization

3.1. The Nexus City Index background - UN Habitat approach

To operationalize Kant’s categorical imperative for managing urban areas to enable resilient development [17], we use the UN-Habitat prosperous city approach [18]. The UN demands in its State of the World’s Cities Report a redefinition of urban prosperity: “Re-thinking prosperity in those terms requires a shift away from the current dominant perspective, which is outdated and unsustainable on many grounds with its combination of cheap fossil fuel, heavy dependence on the motor car, highly segmented urban forms, socially and economically segregated spaces, endless urban peripheries that consume land, resources and in many cases natural protected areas – and all largely steered by private, not public interest” [18]. The UN United Nations Human Settlements Programme measures the prosperity of a city

^e <http://www.worldwatch.org/node/810>

^f Handle nur nach derjenigen Maxime, durch die du zugleich wollen kannst, dass sie allgemeines Gesetz werde. Translation by Neumayer, 1999

using the following five key issues: productivity, infrastructure development, quality of life, equity and social inclusion and environmental sustainability [18]. Energy, water and land, the key issues of the nexus concept, are important elements of urban planning models [19-21] and central aspect of the UN Habitat approach as the following table shows.

Table 1. Defining prosperity

Defining a prosperous city - UN Habitat		
Key issues	A prosperous city is one that provides	UN-Habitat Indices
Productivity	Productivity Contributes to economic growth and development, generates income, provides decent jobs and equal	Productivity Index
Infrastructure development	Provides adequate infrastructure – water, sanitation , roads, information and communication technology in	Infrastructure Development Index
Quality of life	Quality of life Enhances the use of public spaces in order to increase community cohesion, civic identity, and guarantees the safety and security of lives and property	Quality of Life Index
Equity and social inclusion	Ensures the equitable distribution and redistribution of the benefits of a prosperous city, reduces poverty	Equity Index
Environmental sustainability	Values the protection of the urban environment, use energy more efficiently , minimize pressure on surrounding land	Environmental Sustainability Index
Source: UN Habitat 2012		IEK-STE 2015

The UN Habitat calculated these indices for 69 cities, of which 22 are located in Europe, two in North America, five in South America, 18 in Asia, 20 in Africa and two in Oceania.

Based on this data base, we developed a Nexus City Index (NCI) to measure the prosperity and sustainability of the 69 cities and their regions in the nexus sectors.

Measurability of sustainability constitutes the core objective of our integrated assessment approach and the implementation of a sustainable management concept for the nexus sectors, because “if current systems of economic indicators do not clearly signal that the economy is on an unsustainable path, the policy errors will be made and perpetuated [22].” The developed NCI serves to avoid these errors.

3.2. The Nexus City Index

The Nexus City Index is based on the UN-Habitat City Prosperity Index and aggregates the following UN-Habitat indices to one index.

- infrastructure development index (water, sanitation)
- equity index (operationalization of Kant’s categorical imperative), weighting factor based on the cities Gini-coefficient
- environmental sustainability index (energy, land)

The infrastructure development index contains the water and sanitation infrastructure as one of the major nexus management aspects. The environmental sustainability index contains the nexus sectors energy and land. Hence, the two indices contain information about the respective development of the analyzed cities related to the nexus sectors. In addition to water, energy and land, we further considered

equity in our nexus index in order to also account for Kant's categorical imperative. The nexus city index thus allows an analysis of the cross sector development of the nexus system for the selected cities.

We further developed the World Region Prosperity City Index (WRPCI) and Nexus City Index (NCI) to compare the development of the nexus sectors with the overall development of UN Habitat key issues. For this purpose, we have also included an adjustment factor in our nexus index, so that the meaning of the subindices for the overall development can be adjusted in the measuring process. In our case, the adjustment factor is 1, i.e. every index is treated equally in both indices.

The following figure shows our findings. Our index enables us to analyze the nexus gap and the prosperity gap of the average city of the six world regions in comparison to the average city of the world.

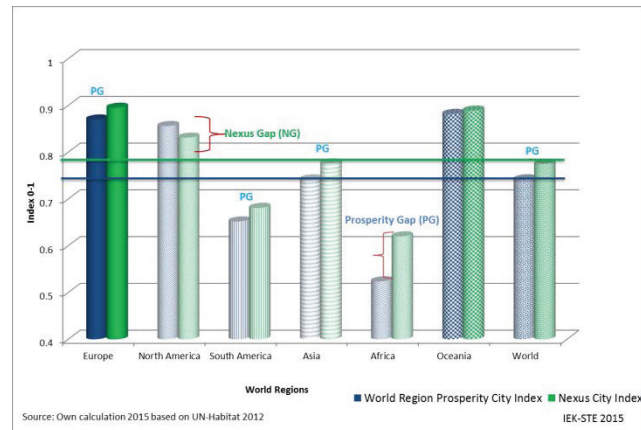


Fig. 1 World City Indices

1. The figure shows that, on average, cities in Europe, North America and Oceania are above the World average for both indices (WRPCI, NCI).
2. South American and African cities are, on average, below the world average and Asian cities level at the world average.
3. The figure also shows that in most regions the NCI is higher than the WRPCI. In Oceania both indices are equal, whereas in North America the NCI is smaller than the WRPCI.
4. Our measuring results enable us to define a nexus gap (NG) or a prosperity gap (PG) of the cities of various regions.
 - a. The figure shows that Europe, Asia and especially Africa have prosperity gaps, i.e. productivity and quality of life of cities lack behind the nexus sectors. This is also true for the world average city.
 - b. North America, in contrast, is characterized by a nexus gap, i.e. the nexus sectors do not develop at the same rate as productivity and quality of life. The nexus gap in North America is mainly caused by the equity gap of New York.

4. Conclusions

Our two indices enable us to define the nexus and prosperity gap of the cities of various world regions. The Habitat single indices for the cities enable us to compare individual cities, whereas the NCI enables us to compare world regions. We thus receive a top down and bottom up picture for the development of the prosperity of cities and of the nexus sectors. Our indices enable decision makers to reduce the

complexity of presenting the analyzed system without reducing the underlying complexity of the analyzed system, since the indices are based on the comprehensive UN data base.

The Habitat data base and our indices provide information for planning and managing the urbanization process of the cities of the world with a special focus on nexus development. The UN encourages policy makers to develop distributive mechanisms of prosperity which can contribute to poverty reduction [18]. UN Habitat assumes that “urban planning and appropriately developed institutions and regulations can play major roles, improving urban equity through the capture and redistribute on of rising land values [18].” Urban planning is central for the nexus sectors [23-26].

Our nexus measuring concept enables the assessment of the energy, water and food nexus in urban areas. Furthermore, our approach provides a means to operationalize Kant’s categorical imperative by considering the equity index in the nexus analysis. The UN-Habitat explained: “Highly unequal cities are a ticking time bomb waiting to explode [18].” Our approach delivers data to develop political measures to start closing the prosperity and nexus gap. These measures should be in line with Kant’s categorical imperative and the requirement of the Brundtland definition of intra- and intergenerational justice.

We encourage the UN to extend the data basis especially for South America in order to receive a more comprehensive picture of the cities of the world, because – as alluded to in the introduction – in urban cities the problems of the 21st century are concentrated as if in a burning glass.

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