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Ecosystem participation in vulnerable geographies

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Abstract: With urgent urban challenges such as climate adaptation, energy transition, and continued urbanisation, the need for integrating planning and design with urban engineering increases. The implementation of new technological interventions and the utilisation of the natural system is hampered by the lack of an integrated approach which incorporates urban planning and design decisions. Meanwhile, urban sprawl and economic growth increasingly compete for infrastructure and environment, affecting the success or failure of the daily operating systems of cities and regions, and thereby urban competitiveness. The challenge is to fundamentally rethink the urban landscape in light of new technologies – as material and ecological practices. The question is how to renew existing urbanized areas by integrating parameters of the natural system and technological innovations directly into urban development opportunities arising from spatial planning and design. The ecological, climate and urban crisis in especially vulnerable geographies benefit from a new ‘ecosystem participation’ approach. In order to get grip on what this could entail, explorative research has been employed to study critical relations between nature and culture.

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1. Introduction

The environmental crisis is composed out of direct and indirect impact of human action on the ecosystem. The direct impact is: biodiversity loss, pollution, conservation, landscape use and exploitation of natural resources; with focus on terrestrial, freshwater and marine realms (Domingues, 2017). The indirect impact is the human impact on the climate inducing climate change that impacts the ecosystem in: timing of seasonal life-cycle events, range shifts of species territories, food web disruptions, buffers and threshold effects for wildfires, flooding and drought, spread of pathogens, parasites, and disease: shifts in ecological conditions could support the spread of pathogens, parasites, and diseases and plant and animal extinction risks (EPA, 2017)

With this urgent challenge to respond to the environmental crisis with strategies like climate adaptation, energy transition, and continued but sustainable urbanisation, the urgency of integrating planning and design with urban engineering increases. The implementation of new technological interventions and the utilisation of the natural system in urban development is hampered by the lack of an integrated approach incorporating urban planning and design decisions. This can be illustrated in decision making concerning changing to decentralized systems of water and energy. Meanwhile, urban and economic growth increasingly competes for infrastructure and environment, affecting the success or failure of the daily operating systems of cities and regions and thereby affecting urban competitiveness (Kresl & Ietri, 2014). In light of new technologies,

the challenge is to fundamentally re-think the urban landscapes material and ecological practices.

In this sense, the question is how to renew existing urbanized areas by integrating parameters of the natural system and technological innovations directly into urban development opportunities arising from spatial planning and design.

The working hypothesis for this question is the concept of “**ecosystem participation**”. This moves away from the notion of ecosystems as services to be deployed in a human-nature dichotomy, and instead, it acknowledges the fact that people and urban systems are part of the ecosystem and stipulates on the fact that we need to engage with nature as nature, thus participate. Furthermore, the notion of participation purposefully engages with local sensitivities and culture, re-establishing a new harmonious relation between traditional/indigenous practices and technology.

Ecosystem participation thus is an important new perspective that not only gives natural systems a better position as a stakeholder in urban development, but it also acknowledges the fact that extreme landscapes are complex ecosystems that need to be contextually understood, demanding tailor-made solutions. In this regard, the instrument of ‘nature based solutions’ as such can be re-defined for each context.

To achieve inclusive and sustainable urban development, the introduction of water related Nature Based Solutions (NBS) have proven to be effective in specific urban contexts. Different sources point out their contribution to various SDG’s in Europe, Australia and the United States, all of which are regions with high GDP levels with strong institutional contexts. However, in regions that are underdeveloped, have weak institutional contexts, high social and economic inequality and are situated in more vulnerable or extreme landscapes, the so called ‘**vulnerable geographies**’, the experience with Nature Based Solutions is less extensive (PBL, 2018). This paper presents the results of a literature review that aims at providing a first (broad) exploration of NBS in contexts outside the regions mentioned above.

This paper introduces the term ‘vulnerable geographies’ in which geographies are understood as both the human system (governance, socio-economic situation) and the environment (natural system, climate) as an acknowledged reciprocal relation. The notion of ‘extreme landscapes’ is defined as urbanizing landscapes under extreme climatic conditions.

The aim of this paper is to present the results of a preliminary literature research and casting light into the following question: *How can nature-based solutions be understood as instruments of ecosystem participation in vulnerable geographies in extreme landscapes?* To this purpose first the concept of ecosystem participation is theoretically described. After that the main conclusions of the literature research into NBS in vulnerable geographies are presented. In the discussion these are positioned in other ideas about context, which leads to drawing the conclusions on ecosystem participation in vulnerable geographies.

2. Theories

Human technologies and understanding of the natural systems have allowed humans to adapt, survive, and populate in dense areas. This understanding has, however, also created a culture and economy in approaching the natural system in a specific way. It has become a second nature and might even be called the Anthropocene lifestyle in which human actions relentlessly affect the environment and ecosystems without taking notice of the global consequences.

Since the Enlightenment humans have placed themselves outside of the natural systems, by defining the notion of ‘conscious’ and ‘non-conscious’ creatures. The Enlightenment or the Age of Reason was an intellectual and philosophical movement that emerged around the 17th and 18th centuries as a result of a European intellectual and scholarly movement known as Renaissance humanism.

During this period a series of humanists thinkers within a scientific and philosophical perspective, become key enablers of this movement shaping what we define today as the Scientific Revolution and Enlightenment: the work of Francis Bacon (1561 – 1626), the philosophy of ‘Cogito, ergo sum’ (‘I think, therefore I Am’) by René Descartes (1637), and Isaac Newton's Principia Mathematica (1687) annotate a human centred movement, and the conviction of the possibility to control and predict nature.

Since the 1970s (Holling 1973, 1978) the negative impact of human control over complex and non-linear natural systems have been recognized (Holling and Meffe 1996). From this point, ecosystems are acknowledged as complex, dynamic, adaptive systems with nonlinear feedback and thresholds (Costanza 2008) tightly interlinked with human systems (Menzel and Teng 2010).

The ecosystem services approach recognises the interactions of natural structures, processes, and services of an ecosystem across the landscape (Turner and Daily 2008, Fisher et al. 2009). Since many frameworks that give insight in the drivers, trade-offs, and synergies between services have been developed. However, there is still disjointed knowledge, and uncertainty about how different kinds of governance structures, levels of participation, and adaptive strategies affect ecosystems (Paavola and Hubacek, 2013). A downside of the ecosystem services approach is that there is much emphasis on the quantification of services, of which the development of environmental accounting and performance systems (Boyd and Banzhaf 2007), economic valuation for environmental decision making, planning and policy (Balmford et al. 2002, Turner et al. 2003) and attainment of multiple conservation objectives (Fisher et al. 2009), are examples.

However, it is necessary to understand and enhance the adaptability and resilience of social-ecological systems in the face of disturbances and associated fluctuation of ecosystem services, changing of societal preferences, changing needs of local communities and other stakeholders, and distributional impacts of different management options and governance regimes (Hubacek et al. 2009).

The application of the ecosystem participation approach implies a more critical focus on environmental governance and participation (Wesselink et al. 2011) in which humans participate within systems instead of making use of them.

Empirical studies suggest that successful ecosystem change, resource management, and implementation of resilience/coping strategies can be achieved only when social and ecological systems are interlinked (Rechkemmer and von Falkenhayn 2009, Biggs et al. 2012). Menzel and Teng (2010) have emphasized that the human dimension has to be included early and explicitly in ecosystem service projects, for example, through the involvement of stakeholders in research.

Therefore, the concept of ecosystem participation considers power and distributional issues, considering a broader participation, and reconceptualizing social-ecological systems so as to anticipate to undesired changes and take steps to either reduce their probability or minimize their impact once they occur.

The term ecosystem participation as such in general, and specifically related to infrastructure and environment, is not yet underpinned by research, debate and design. The term is important to support a clear approach that is contextual with the inclusion of the natural system as an important stakeholder and not reaching out to applicable solutions from nature. The use of the concept ecosystem services supports a shift towards a more 'sustainable' lifestyle but does not create 'stewardship' in which understanding of their role and consequently actions as participant in the ecosystem acknowledged and executed.

3. Results

As part of Africa's Great Green Wall program, the Sahel community needs were successfully combined with the selection of suitable native species for large-scale natural capital restoration. The restoration of degraded land and increase of plant diversity research went hand in hand with the analysis of 120 beneficiary village communities through the organization of diagnostic meetings. The community participation led to the selection of 170 native plant species that were not only suitable for enriching and restoring those village lands, but they also provided with food, medicine, fodder, and fuel for the villagers Sahel (Sacande and Berrahmouni, 2016).

In that sense the ecosystem participation concept is the spatial design counterpart of the more sociology oriented approach of 'Civic ecology practices' (Krasny et al., 2014): community-based and environmental stewardship actions taken to enhance green infrastructure, ecosystem services, and human well-being in cities and other human-dominated landscapes. Examples include tree planting in post-Katrina New Orleans, oyster restoration in New York City, community gardening in Detroit, friends of parks groups in Seattle, and natural area restoration in Cape Flats, South Africa.

Capacity building is also an important tool in which ecosystem participation can be supported. The project 'Capacity Building to Strengthen Resilience of Coastal and Small Island Communities against Impacts of Hydro-Meteorological Hazards and Climate Change' by the Asia-Pacific Network for Global Change Research is facilitating cooperation among scientists and non-scientists in Indonesia, Japan, the Philippines and Timor Leste. Aim is to develop educational and awareness-raising materials on disaster risk reduction and climate change adaptation by integrating scientific knowledge with local and indigenous knowledge (UN, 2016).

The literature research into NBS in vulnerable geographies delivered a long list of case studies that gave insight into three spheres of implementation in which NBS can take place: as policy guidelines, spatial interventions and community practices (Hooimeijer et al., 2021). The Policy guidelines are instruments that recognise, protect and manage systemic water-soil relations at different scales. Examples of this are:

- Catchment protection policies
- Sponge City Concept
- Regulation/Recognition of Peri-Urban Agricultures in planning
- Coastal zone development regulations
- Mangrove zone protection regulations
- Groundwater regulations
- Support of traditional land management practices and ITEK

Spatial interventions are structures, aggregates or surfaces that physically transform the current status and create the conditions for dealing with the water-related challenges, either for flood protection/buffering, for water de-pollution or for ensuring water availability. Examples of this are:

- Sand-dams that retain and store groundwater for irrigation
- Re-vegetation of buffer areas (river banks and floodplains)
- Constructed wetlands
- Restoration of water ponds
- Permeable, low-cost structures that fixate sediment and reclaim new land
- Low-cost green roofs

Community practices are found mostly in the form of land management practices, which either enabled by planning guidelines, and sometimes by means of physical interventions, include the livelihoods of inhabitants most affected by the water-related challenge. These are key for strengthening the adaptive capacity of the inhabitants, where risk and livelihood come closest, delivering long-term social/behavioural change. Examples of this are:

- Sustainable agricultures ensuring livelihoods under flood conditions
- Collection of waste
- Cultivation of new land reclaimed to protect the coast

The research outcome gave this main structure on how to frame the water problem in the specific context of 'vulnerable geographies', and the three types of solutions or ways of implementation. The notion of ecosystem participation could be grasped by the reflection on the co-benefits these NBS have in terms of SDG terms. However, this analysis turned out to be very general in the sense that it did not give out the necessary insight in the ecosystem participation. The literature did however put forth point of discussion considering the relation between GDP and environmental vulnerability, the role of local knowledge and the term vernacular design that are taken into the discussion.

4. Discussion

The study into vulnerable geographies in the book *Green Cities* by Kahn (2006) delivered insight into the relation between GDP and environmental vulnerability. The Environmental Kuznets Curve (EKC) is based on the relationship between per capita income growth and the impact (pollution) on the environment. This can be considered the opposite of ecosystem participation, moving away from nature. Market forces play a fundamental role in shaping the urban EKC (Kahn, 2006). Rising income levels lead to changes in the urban economy's consumption and production patterns that may have the unintended benefit of greening the city. Most importantly, people in richer cities are more likely to consume higher-quality products and to work in the service sector. These behavioral changes help offset the pollution-causing effects of increasing scale and put the economy on the downward slope of the EKC. But other varieties of urban growth—notably population and spatial growth—also help identify local environmental quality. The population growth affects urban "greenness," particularly in developing countries where it is commonly accompanied by increasing population density in urban areas.

In the vulnerable geographies the notion of ecosystem participation is degrading due to the fact that they that are supported by countries with a high GDP and often local knowledge is replaced by knowledge that requires a higher Technological Readiness Level (TRL). This is a methodology developed by NASA (1970s) to estimate the maturity of

technologies to enable consistent, uniform discussions of technical maturity across different types of technology.

Blaikie et al. (1992) distinguishes five common trends and shocks in which the utility and maintenance of local knowledge is extremely challenged:

- Areas of very rapid population growth, may require adaptations of new agricultural technologies to increase food production and diversify livelihoods. In this situation local knowledge needs to develop, and adapt very quickly. High population density and reduced field sizes often lead to a reduction in crop diversity in favor of main staple crops. High-yielding crop varieties have the potential negative effects on agrobiodiversity and local knowledge.
- Circumstances in which rapid immigration to a particular area has meant that the repertoires of knowledge for agricultural/pastoral production and environmental conservation, are out of focus with a new set of opportunities and constraints. People find themselves in a new situation, where their local knowledge is no longer relevant.
- Disasters and other extreme events cause a disjuncture, both materially and culturally. Such instances are both opportunistic as well as limiting.
- There are other processes of slower moving environmental changes such as climate change, widespread deforestation or land degradation, that challenge the resilience and adaptability of local knowledge systems.
- Rapid commercialization and economic shocks may also undermine local knowledge. The marketing of local products in a global market will necessarily disconnect the product from its related knowledge context. With the decline in crop diversity, the importance of local knowledge has been reduced (Wooten, 2003).

Balancing the relation between GDP and environmental vulnerability, NBS are supportive in enhancing the ecosystem participation concept in two ways:

- 1) the use of natural solutions in vulnerable geographies can prevent the environmental impact to go up because of potential mainstreaming of natural processes and ecological restoration ;
- 2) the level of TRL can be understood differently due to the fact that often natural solutions are also traditional vernacular solutions.

The integration of local and scientific knowledge strengthens the ability of adaptation to respond to more geographic, ecological and socio-economic sensitivities. Also publications like Lo-Tek (Watson, 2020) highlight the key role of vernacular nature based solutions in the maintenance of millennial knowledge. The fact that the wealth in 'modern' societies and physical appearance or technologies (consumerism) are strived after by following economies is a form of obstruction for implementing nature based solutions that are vernacular. The vernacular solutions often are based in natural ones, showing how to participate with the ecosystem better.

The most illustrative example of replacing vernacular with 'modern' can be found in Thailand. Two of the largest rivers, Chao Phraya and the adjacent Mekong, have abundant water but the major usage is for agriculture. The withdrawal of water for irrigation, especially for wet-rice cultivation, and its release during harvesting has, first, increased the fluctuations on the supply side of the water balance equation, and, second, the released water is often contaminated with fertilizers and pesticides used in agriculture. In either case, the problem is not simply a matter of deduction of consumptive use from runoff. It is more complex and is related to the land use pattern in the river basins, where the urban enclaves generally receive the brunt of the problems because of their location downstream (ENW, 2012).

Large parts of the Chao Phraya river basin have urbanized rapidly over the past decades. Where once rice fields and marshy areas determined the landscape, now a patchwork of larger and smaller cities, industrial estates, suburban residential estates, agricultural areas exists next to still unused, mainly swampy land. Especially the southern part, where Bangkok is located, is highly urbanized. Most of the urbanization is initiated and realized by private parties: developers, businesses and individual households (Askew, 2002; Douglass and Boonchuen, 2006).

The major current problems concerning flooding occur also due to the fact that people do not want to live in houses on piles any more. The vernacular Liquid Perception (Thaitakoo & McGrath, 2010) in which urbanisation was also in harmony with the natural cycles and dynamics of the water, is replaced by a Solid Perception in which urban use is blocking the dynamics of water. People like to live in ground bound houses that take the

storage capacity out of the landscape upstream. At the same time the government is building a concrete dike infrastructure along the (urban) rivers to prevent flooding which actually reduces the storage capacity of the river.

The ‘Monkey Cheek’ project is a study that resulted from the 5th International Conference on Sustainable Energy and Environment 2014 (Shinawatra, 2014). It proposes the creation of new lagoons in the Gulf of Thailand, which can accumulate water from the rivers even during high tide. During low tide the basin can gradually be emptied into the sea. It involves the Liquid Perception in which the landscape and urbanization is adaptive to the changing water dynamic because of climate change.

The term ‘vernacular’ is originally related to the native language of a particular country, region or locality. Vernacular design is characterized by the fact that humans had to work with the matter at hand and respond to the climate or landscape extremes. Over centuries, a trial-and-error evolution was able to produce “vernacular” design solutions that are climatically appropriate, culturally relevant and aesthetically pleasing (Emmanuel, 2012). In fact, our ancestors were able to control the climatic environment in buildings they designed when there were no mechanical systems invented. Vernacular architecture is an architectural style that is based on interrelations between ecological, economic, material, political and social factors (Asquith and Vellinga, 2006) and it provides a good solution to the climatic constraints. History shows that vernacular techniques and materials have been shaped by the local culture, weather and geographical location. The selection of these techniques and materials for such a building is usually dependent on the desired benefits, as well as the local availability of construction materials and skilled labor (Alrashed et al, 2017). Replacing architecture with landscape architecture, vernacular landscape architecture as an approach would involve NBS automatically and lead to execution of the concept of ecosystem participation.

5. Conclusions

Exploring the concept ‘Ecosystem Participation’ delivered the insight in how it could be functional and especially what it is in vulnerable geographies in relation to nature-based solutions. The literature analysis into cases delivered three levels of participation: as planning guidelines, as community practice and as physical intervention. Especially community practice can be considered aided self-help in which most durable relationships with the ecosystem can be established and continued. Considering practical output of Ecosystem Participation in vulnerable geographies gave a range of solutions by studying cases, scaling these up and relating them to theory in the discussion paragraph showed a few important insights. Traditional solutions from the past are in vulnerable (and strong) context exemplary of how humans without dominant technology responded and participated in the given extreme climate and ecosystem conditions. Temporality is an important aspect to the concept of ecosystem participation. Part of the Anthropocene perspective is the building of value that is durable, economic value with cost/benefit analysis, life cycles etcetera. Living with extreme conditions in vulnerable geographies delivers the insight in how social and physical temporality is part of this landscape and how in the current approach this is paradoxical. Physical temporarily is not beneficial and social temporality undermines desired social coherence. Designing with seasons is ecosystem participation.

Even if we recognise that traditional ways of dealing with the extreme landscape is an important aspect of ecosystem participation, the question is to which landscape can we return? What is nature? This question in severely altered landscapes is difficult to answer. What was, is and should be the new equilibrium between man and nature in the extreme landscape, how can nature profit from us? In cities we see nature adapting to our environment, birds that live in mountains can live in high-rise and eat our leftovers. During the Covid-19 lock down many animals came to cities to find food that was not given to them anymore. Moving away from Anthropocene approach to an **eco-centric** approach with the consciousness that humans benefit from restoration of the natural systems.

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