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18 – URBAN INFRASTRUCTURE AND BASIC SERVICES, INCLUDING ENERGY

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ISSUE PAPER ON URBAN INFRASTRUCTURE AND BASIC SERVICES, INCLUDING ENERGY

KEY WORDS

Urban infrastructure, basic services, access, demand, resources, human rights, investment, policy reform, business models, institutional capacity, sustainable infrastructure provision, resilience, technological innovation, infrastructure systems, networks, green infrastructure.

MAIN CONCEPTS

This paper defines the means by which infrastructure, as the pivotal enabling force and delivery vehicle of a resilient urban environment, can rise to meet both existing and rapidly increasing future challenges presented by urbanization, population growth and climate change, with the aim to support equitable, inclusive and sustainable development.

The Habitat II Agenda[1] refers to basic infrastructure and services to include the delivery of safe water, sanitation, waste management, social welfare, transport and communications facilities, energy, health and emergency services, schools, public safety, and the management of open spaces. However, the prevailing understanding of infrastructure has been typically based upon a limited view of infrastructure as discreet sectors which contain physical structures and facilities. Over the last decade, infrastructure has evolved to a more increasingly system based understanding which consists of networks of assets, knowledge and institutions.

Infrastructure systems: assets, knowledge, and institutions.

Assets:

Assets must not be confused as being only the structures and facilities of infrastructure. Assets are systems of infrastructure, which include the physical structures as well as the internal linkages between these physical structures. These linkages are critical to ensure the function of the overall system of infrastructure[2].

[1] The Habitat II Agenda: Istanbul Declaration on Human Settlements, Istanbul, 1996
[2] Bristol University, Systems Centre. Integrated infrastructure systems. Website, May 2015

Knowledge of infrastructure:

The knowledge of infrastructure is defined as not only the human resources who are engaged within the systems of infrastructure (in the planning, design, construction and operation of infrastructure), but also the knowledge within the institutions which provide the enabling environment for infrastructure systems through the provision of the legal and regulatory frameworks. This includes all the planning, policy, legislation, regulations and codes, the overall strategic development plan for the country or region providing the decision making and prioritising guidance on what to invest in and when and where[3].

Institutions related to infrastructure and services

The quality of services provided by urban infrastructure is directly related to the capacity of the institutional frameworks. Institutional frameworks are key to ensuring the financial viability and effective regulation, planning, management and operation of urban infrastructure.

Infrastructure interdependence

The networks of infrastructure: Networks represent the existing interdependencies between the assets (systems) of infrastructure; these interdependencies can be both physical and subtle and non-physical in nature. Network interdependence can most easily be understood as the output from one part of infrastructure becoming the input to another part of infrastructure, by this means again ensuring the overall function and cohesiveness. In terms of the more obvious physical interdependence this could be the reliance of the health system of infrastructure requiring water as a vital input to ensure effective function. In terms of the non-physical subtle interdependence this is exampled by the knowledge required as an input to the regulation of infrastructure within institutions.

Resilience and link to urban infrastructure:

The increasing need for cities of the 21st century to manage and adapt to the effects of climate change and growing urbanization illustrates the concepts explained above. There is a requirement that we move our focus from a reactive one focusing on effective disaster response to a proactive one, through which we develop an understanding of what, when and where infrastructure needs to be put in place and how to address urban infrastructure to prevent or minimise the effects of a natural event. Only by understanding why the cost of disasters is rising can we begin to address the causes. When, for example, the weather interacts with the built environment it may cause damage resulting in financial loss or loss of lives – why did this happen? Was the infrastructure poorly built (asset problem)? Was the infrastructure poorly maintained so it could not perform as designed (capacity problem)? Was the response to the event ineffective? (knowledge and institution problem), was the scale of event bigger than anticipated? (knowledge problem), were the building codes not reflective of the changes in the environment or new technologies (knowledge problem) or were the codes adequate but not effectively regulated and implemented (institution problem)?

[3] Hall J.W., Nicholls R.J., Tran M., Hickford A.J., 2015. The Future of National infrastructure: a system-of-systems approach. Cambridge University press.

Thus, to design, implement and operate sustainable and resilient infrastructure effectively it is necessary to understand how infrastructure systems and their networks function, as well as to simultaneously integrate risk management into the development and operation of infrastructure, across the 3 key component parts of infrastructure systems (assets, knowledge and institutions).

FIGURES AND KEY FACTS

- 1.2 billion people gained access to improved sanitation in urban areas from 1990 to 2012, while those without sanitation in urban areas has increased by 542 million[4].
- Between 1990 and 2012, 1.6 billion people gained access to piped drinking water; whereas 720 million urban residents do not have access to a piped water supply[4].
- Wastewater generation is increasing steadily, while only 2% of the globally collected 165 billion m^3 is recycled. Wetlands could substantially lowering costs of sewage treatment by retaining up to 96% of the nitrogen and 97% of the phosphorous in wastewater if preserved[5].
- Cities generate over 2 billion tons of municipal waste; this is predicted to double over the next 15 years[6].
- Over 75 % of total global energy generated is consumed in cities[7]; 2.5 billion people rely on biomass to meet their energy need resulting in deforestation and environmental degradation[8].
- Around one quarter of the world's urban population continues to live in informal settlements[9], lacking basic services and infrastructure.
- The World Bank projects that, in cities in developing countries, the number of people exposed to cyclone and earthquake risks will more than double from 2000 to 2050[10]
- Some 60% of the area expected to be urbanized by 2030 has yet to be built[11]; $57 trillion in global infrastructure investment will be required between 2013-2030[12]
- $1 trillion annual savings from a viable 60 percent improvement in infrastructure productivity[12]

[4] WHO & UNICEF, 2014. Progress on Drinking Water and Sanitation, 2014 update, WHO Library Cataloguing-In-Publication Data.
[5] Ewel, K.C. 1997. Water Quality Improvement by Wetlands. Pp. 329-344. In G. C. Daily ed. *Natures Services: Societal Dependence on Natural Ecosystems*. Island Press. Washington DC.
[6] UN-Habitat, 2010. Solid Waste Management in the World's Cities: Water And Sanitation in the World's Cities. Earthscan, 2010
[7] UNU-IASS, http://urban.ias.unu.edu/index.php/cities-and-climate-change/ accessed on 27/05/2015)
[8] OECD-IEA, 2006. World Energy Outlook 2006: Chapter 15 -Energy For Cooking In Developing Countries, pp419
[9] UN-Habitat, 2013. Streets as Public Spaces and Drivers of Urban Prosperity.
[10] Habitat III, UN task team, 2015. Issue paper 17 : Cities and Climate Change and Disaster risk Management
[11] UN-Habitat, 2013. State of the world cities 2012/2013.
[12] McKinsey and Company, 2013. Infrastructure productivity: How to save $1 trillion a year.

ISSUE SUMMARY

The challenges facing urban infrastructure over the past 20 years have been shaped by a number of factors. These include an increase in the scale of urbanization with growing urban informality, a rising demand for services, the increasing unit costs of infrastructure provision associated with the sub-optimal expansion of cities, a legacy of under-investment in asset replacement and infrastructure extensions, poor operational management and maintenance, high and inefficient consumption of services among middle and high income consumer classes, slow inclusion of a green infrastructure approach, inequitable distribution of services and infrastructure, which continues to exacerbate the spatial and socio-economic segregation in cities. Moreover, the effects of the continuing reliance on outdated and inappropriate policies and business models, have been compounded by the effects of climate change on services such as water supply, wastewater management, hydro-electric power generation, storm-water management and flood protection.

Some of these challenges are not new, but their scope and complexity have been exacerbated by the rapid urbanization of the past 20 years and continuing weaknesses in understanding infrastructure and its associated governance and regulation, resulting in a lack of comprehensive long term demand-based infrastructure planning. The rising demand for infrastructure services is directly related to the increasing population, GDP growth and rising per capita usage of infrastructure services associated with increasing incomes[13]. The gap between demand and supply, and the inaccessibility and unaffordability of services and infrastructure to segments of the population, represents a major weakness in policy, planning approaches and institutional capacity. The sectoral approach to infrastructure planning, investment and management also poses a constraint with increasing problems in achieving effective inter-sectoral coordination and communication aligned with a weak or non-existent understanding of the linkages between infrastructure planning and urban planning at the city level.

The rising demand for urban infrastructure has not been matched with a commensurate improvement in the financial and institutional capacity to manage urban infrastructure services. For example, revenue generation for services such as solid waste management, water and electricity, typically lag behind the cost of service delivery. Thus, there is a need for more innovative and inclusive business models, especially models which can more effectively mobilize finance for investment and which can involve the private sector and community groups in the financing and management of services.

The whole life costs of the systems of infrastructure such as water supply, electricity, drainage and sewerage can be correlated to the pattern of urbanization, with compact cities providing the most cost-effective solutions to infrastructure investments. Inefficient consumption practices in urban areas are indicative of excessive consumption of electricity and water by high income households while many low income households either have no access or are faced with intermittent or unaffordable supplies. These trends call for more rigorous approaches to demand management and the use of policy and economic instruments to discourage waste and promote more balanced investment strategies, including investment at the household,

[13] Zuo C., Birkin M., 2015. Modelling the long-term economica and demographic impacts of major infrastructure provision: a simultaneous model approach. GISRUK2015, submission 96.

institutional and community level in areas such as renewable energy, water supply, decentralized wastewater treatment and waste management.

KEY DRIVERS FOR ACTION

A truly holistic approach to infrastructure requires stepping away from a silo/sector-based approach and understanding that infrastructure is made up of not just physical things or assets, but consists of three major parts: assets, knowledge and institutions. Embracing this concept provides the clarity required to further understand how infrastructure underpins the function of society and acts as the enabling vehicle for desired societal changes and development outcomes. Seeking appropriate, affordable and accessible services and infrastructure systems requires a holistic approach to understanding, designing and planning networks of infrastructure and services, as well as solidly linking infrastructure provision and urban planning. This will allow us to then apply a proper risk management process, taking appropriate mitigation measures to reduce vulnerability and strengthen resilience of infrastructure systems.[14;15].

The continuing and increasing pressure of population growth make the efficient consumption of natural resources by infrastructure systems absolutely essential if conflict rooted in the issues surrounding equitable access to and use of natural resources is to be understood and managed. There are also further benefits that can be gained through approaches such as that proposed by McKinsey and Company[16], by understanding and implementing improvements in efficiency and rationalization of existing infrastructure systems.

- Understanding the linkage between availability, accessibility, affordability and adequacy of basic services for the realization of human rights. Basic services are central to the realization of a wide range of human rights, including water, sanitation, housing, health and education. It is therefore crucial to ensure that these services:
    - are available and physically accessible to all;
    - are affordable to all;
    - are culturally adapted to various groups of the populations;
    - do not discriminate in their access or delivery;
    - are safe to use for all, including for women and children.

  Policies and programmes should be developed with and for urban dwellers, should prioritize the ones the more in need of them, and be mindful of the gender issues surrounding them[17]. .

[14] Habitat III, UN task team, 2015. Issue paper 15 : Urban resilience.
[15] The Sendai Framework for Disaster Risk Reduction 2015-2030 (SFDRR);
[16] McKinsey Global Institute, 2013. Infrastructure productivity: How to save $1 trillion a year.
[17] Realizing the human rights to water and sanitation: A Handbook
www.ohchr.org/EN/Issues/WaterAndSanitation/SRWater/Pages/Handbook.aspx

- Policy reform. In the face of the challenges posed of rising demand for services, the current inequitable distribution of services and infrastructure, the existing spatial and socio-economic segregation and failure to implement future demand based planning, there is a need for a comprehensive reform of urban infrastructure policies to:
    - improve the enabling environment for investment;
    - create more effective incentives for greater efficiencies in supply and consumption, as well as the payment of services;
    - impose more effective methods for infrastructure planning and service delivery by state, regional and municipal governments and public utilities;
    - create stronger model regulatory frameworks;
    - remove institutional rigidities and create space to attract and enable the private sector, NGOs, community groups and households to play a greater role in financing and service provision.

  Policy reform further needs to be based on and take guidance from the Sendai Framework for Disaster Risk Reduction 2015-2030 (SFDRR).

- Building viable and well-managed institutions aligned with infrastructure systems knowledge. One of the lessons learnt from the past 20 years is that the quality of services provided by urban infrastructure is directly related to the capacity of the institutional frameworks and knowledge. While some progress has been achieved in the past two decades, much remains to be done in ensuring the financial viability and effective management of the institutions responsible for the regulation, planning and management of urban infrastructure. Some sectors have made little progress in addressing the need for institutional reform and financial sustainability, these include urban sanitation, solid waste management in low and middle income countries, and urban drainage.

- Legal and regulatory frameworks within which development takes place. Understanding that the provision of services and infrastructure does not solve all issues created by poor urban planning or a lack of, for example development in unstable or high-risk areas. Thus, the where and how the assets are created and who decides which assets to create, are as important as the network of assets themselves.

- Developing effective and integrated infrastructure planning. Urban infrastructure is capital intensive and facilities need to be continuously improved and expanded through balanced programmes of demand-based planning for the extension of services to meet increasing urban populations and needs. Effective infrastructure planning requires a complete mind set change, all forms of infrastructure need to be considered and planned beyond the current limitations of a sector based approach, to provide an 'enabling vehicle' for societal change and development. New planning approaches and technologies will support progress in the need to reduce the unit costs of infrastructure provision, improving efficiency and quality, ensuring that services are aligned with urban plans and to plan for an optimal expansion of infrastructure to support the urbanization process. Infrastructure and services interventions have a strong impact on city form and city development and thus need to be tied to an

overall urban planning and city development strategies, shaping a sustainable and equitable future that addresses a wider communities' rights[18].

- Enhancing coordinated implementation of urban infrastructure. Beyond the planning process, there is need to ensure that the infrastructure is developed and implemented through the understanding of the assets, knowledge and institutions of infrastructure. In addition, the recognition and understanding of the critical interdependence amongst all spheres of governments is needed. This is particularly relevant for metropolitan areas where fragmentation creates missed opportunities for service provision efficiencies; spillovers across jurisdictional boundaries; and regional income and service level inequalities. Coordination mechanisms are emerging: inter-municipal cooperation, legal incentives for cooperation, planning and development agencies, cost sharing arrangements for metro-wide service delivery, metropolitan development funds, coordinated tax agreements, pool financing, improved linkages between national and local governments' programs and policies to ensure efficiency and reduce imbalance..[19]

- Developing new business models and strategic partnerships. Rapid urbanization has increased the scope and complexity of service provision. New business models are now needed to integrate the strengths and capacities of the public sector, private companies, NGOs, and Community-Based Organizations. New approaches are particularly needed in sectors such as urban drainage, sanitation, solid waste, mobility, clean energy provision and in delivering services to the informal settlements.
  Although governments in developing countries generally provide, own and operate all infrastructure, there are alternative approaches that are effective in the provision of services and infrastructure. These alternatives address the need for new business models, such as financial returns on land value increase provided by new infrastructure, green infrastructure and investment guarantee schemes. Green infrastructure is a low-cost, and often high-return, investment approach that has been used to great effect in many cities worldwide. Particularly with regard to the private sector, the development and provision of investment guarantee schemes to attract private investment and to enhance the capacity of governments to make the necessary legal and contractual arrangements aligned with a capacity to regulate and manage private sector entities that provide the physical services, provides achievable benefits and opportunities. These approaches have the added advantage of freeing up government capacity to undertake fully integrated networks and systems of infrastructure planning that further ensures that the vital bottom up validation of such planning is implemented.

- Fostering and applying technological innovation. Technological innovation has become a critical driver for action in the light of emerging challenges[20], such as water shortages, the unsustainability of energy systems based on fossil fuels, the need to increase the reuse and recycling of waste, and the increasing frequency and intensity of climate change effects. However, while much is being done to develop new technologies to address these problems, there is a growing need to create platforms to

[18] Habitat III, UN task team, 2015. Issue paper 8 : Urban and spatial planning and design
[19] Habitat III, UN task team, 2015. Issue paper 6 : Urban governance.
[20] Habitat III, UN task team, 2015. Issue paper 21 : Smart cities

bring together the researchers, the policy makers, the decision-makers, the infrastructure managers and regulators and the knowledge management agencies to more effectively target research to the problems being encountered and to create platforms for pilot testing, application and dissemination of the innovative technologies. The increasing demand for energy in urban areas, estimated at 8% annually in African cities, could be addressed in part by making use of renewable energy potentials that exist in cities. In fact transforming municipal waste into energy, dual repurposing such as rain and grey water recycling, replacing linear water supply systems with closed circuit systems, exploiting the water-waste-energy nexus are key potentials. Green infrastructure, seen as networks of multifunctional green spaces[21], has been shown to offer a range of ecological, social, and economic benefits that enhance 'grey' urban infrastructure, if strategically planned and managed[22,23] . Green roofs, permeable vegetated surfaces, street trees, public parks, community gardens and urban wetlands can offer 'ecosystem service benefits' as diverse as improving residents' health and wellbeing, providing food, lowering wind speeds, reducing storm-water run-off, modulating ambient temperatures, reducing energy use and sequestering carbon[24]. Green infrastructure thus holds the potential to cushion cities against many expected climate change impacts[25].

- Adopt inclusive participatory processes, and increased access to information for all residents: In addition to improving transparency as well as the access and diffusion of information, public participation has contributed to improved planning outcomes in the formulation and implementation of plans by addressing the distinct needs of various groups, especially marginalized populations.

PLATFORMS AND PROJECTS

Infrastructure Transitions Research Consortium;
Global Water Operators Partnership (GWOPA)
Sustainable Sanitation Alliance (SuSanA)
The Infrastructure Consortium for Africa (hosted by the African Development Bank)
Global Expanded Monitoring Initiative for the Water SDGs (hosted by UN-Water)
UNESCWA-UNOPS National Agenda for the Future of Syria;
UNOPS-McKinsey Diagnostic – Occupied Palestinian Territories, Costa Rica
UNOPS Infrastructure Assessment Methodology
EU-funded joint programme on support to District development programme (EU-SDDP) in Sri Lanka

[21] Matthews T., Yo A., Byrne J., 2015. Reconceptualizing green infrastructure for climate change adaptation: Barriers to adoption and drivers for uptake by spatial planners. *Landscape and Urban Planning*, *Volume 138*, *June 2015*, *Pages 155-163*.
[22] Kambites, C., & Owen, S., 2006. Renewed prospects for green infrastructure planning in the UK 1. Planning, Practice & Research, 21, 483–496;
[23] Tzoulas, K., Korpela, K., Venn, S., Yli-Pelkonen, V., Ka´zmierczak, A., Niemela, J., et al. (2007). Promoting ecosystem and human health in urban areas using green infrastructure: A literature review. Landscape and Urban Planning, 81, 167–178.
[24] Mell, I. C. (2013). Can you tell a green field from a cold steel rail? Examining the "green" of Green Infrastructure development. Local Environment, 18, 152–166.
[25] B Brown, R., Vanos, J. K., Kenny, N. A., & Lenzholzer, S. (2015). Designing urban parks that ameliorate the effects of climate change. Landscape and Urban Planning,. pii:S0169-2046(15)00037-7.

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UN-Habitat Water for Cities Programme

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