The Urban Nexus

Integrating Resources for Sustainable Cities

UNITED NATIONS ESCAP
Economic and Social Commission for Asia and the Pacific

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DEUTSCHE ZUSAMMENARBEIT

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ICLEI Local Governments for Sustainability

The Urban Nexus

Integrating Resources for Sustainable Cities

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Foreword

For centuries, energy, water, food and land have been the major resources contributing to life as we know it and serving as the basis for establishing social structures and economic systems. The sustainable use of these resources is necessary for maintaining a sustainable equilibrium on our planet. However, overexploitation and resource-intensive growth patterns have highlighted the Asia-Pacific region's vulnerability to resource volatilities, resulting in negative impacts on efforts to achieve poverty reduction, environmental integrity and ecological sustainability.

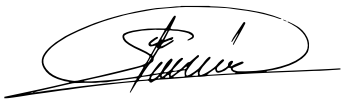
Profound economic development, population growth and urbanization combined have increased demand for limited natural resources. Rapid urbanization, particularly in the Asian and Pacific region where 60 per cent of the world's urban population resides, has been driving much of the demand for natural resources. The growth of cities is a key contributor to environmental degradation and climate change; however, cities provide the physical and institutional space where knowledge is created and diffused, infrastructure is developed, social structures are instituted, markets are established and interactions between people, technology, economy and environment are taking place. The Urban Nexus approach recognizes that cities must be part of the solution by examining and optimizing interdependencies and synergies between water, energy, food and land resources. The approach requires a shift from traditional, sectoral practices to cross-sectoral, integrated approaches that involve broad stakeholder and government engagement. Decoupling economic growth from environmental impact and valuing waste as a resource are fundamental to the Nexus concept.

Since 2013, our Integrated Resource Management in Asian Cities: The Urban Nexus project, supported by the German Federal Ministry for Economic Cooperation and Development (BMZ), has collaborated with representatives from 12 project cites and 7 countries to assess, design and implement innovative solutions in the areas of water supply, waste water, energy and solid waste management. Several Nexus pilot investment projects costing less than $1 million have been implemented and financed by the project cities, resulting in improvements in residents' lives and cost savings for the municipalities. Altogether more than 55 cross-sectoral investment projects amounting to $600 million have been jointly studied and elaborated, often still in the pipeline for financing. Dialogues, particularly between local and national levels of government, have laid the groundwork to introduce the required policy shifts needed to advance integrated resource management in cities, including to mainstream the Nexus approach into national initiatives for the implementation of the 2030 Agenda for Sustainable Development, the New Urban Agenda and the Paris Climate Agreement. Achieving national targets and global agenda commitments demands coordination and coherence with involved stakeholders from Governments, academic institutions, private sectors and civil societies, working together to ensure optimization of resource integration.

The Urban Nexus project evolved from initiating activities in project cities and increasing national-level engagement to collaborating with many sectors and groups, including youth and academia, to cultivate a mindset of lifelong learning needed to advance sustainable development. Many training institutes have already embraced transdisciplinary, integrated approaches in their curricula and teaching. Today's youth are the leaders of tomorrow, and students, teachers and schools are natural multipliers needed to mainstream sustainable development values.

The ideas, partnerships, networks and activities that have been initiated through the Urban Nexus project offer great potential for cities to take forward integrated approaches and develop innovative policies to reduce resource consumption. Work must continue on regulatory and incentivizing instruments to guide transparent urban development and conscious use of our natural resources, and we must recognize that waste and wastewater, if managed well in the context of a circular economy, can be a prosperous income source and foster market opportunities. Mainstreaming the Urban Nexus approach can lead to entrepreneurial solutions to resource management throughout Asia and the Pacific.

We hope that this publication will become a substantive contribution to the growing dialogue, work and training to support further application of integrated resource management within the Asia-Pacific region and beyond.



Stefanos Fotiou
Director
Environment and Development Division
ESCAP

Ruth Erlbeck
Project Director
Integrated Resource Management in Asian Cities: The Urban Nexus
GIZ

Emani Kumar
Deputy Secretary-General and Executive Director
ICLEI World Secretariat and ICLEI South Asia

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Supervision and coordination: Stefanos Fotiou, Curt Garrigan and Kyungkoo (Philip) Kang

Principal author: Eva Wong

Contributing authors: Ruth Erlbeck, Ralph Trosse, Rashane Sala Ngarm, Emani Kumar, Kyungkoo (Philip) Kang, Julia Tomalka, Samuel Law, Jinghong Lyu, Alexander Nordt, Tserendash Sugarragchaa, Werner Haberzettl, Yuxia Yin, Suarni Daeng Caya, Phong Le Van, Vic Aquitania, Ritu Thakur, Ranell Martin Dedicatoria, Joy Baldo, Steven Gu and Duangta Pawa (graphics)

Technical assistance and editing: John Loftus

Graphic design and layout: Jeff Williams

Support staff: Sirikul Suvarnanetra, Paradee Pethaibanlue, Orani Potchapornkul and Nattawan Chantochoto

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Contents

Boxes

Figures

Tables

Acronyms and abbreviations

ADB	Asian Development Bank
BAPPENAS	Ministry of National Development Planning, Indonesia
BISCAST	Bicol State College for Applied Science and Technology, Philippines
BMA	Bangkok Metropolitan Administration
BMZ	Federal Ministry for Economic Cooperation and Development, Germany
CDIA	Cities Development Initiative for Asia
COP 21	Twenty-first session of the Conference of the Parties to the United Nations Framework Convention on Climate Change (2015)
CPI	City Prosperity Initiative of UN-Habitat
CSO	civil society organization
ECE	Economic Commission for Europe
ESCAP	Economic and Social Commission for Asia and the Pacific
EU	European Union
FAO	Food and Agricultural Organization of the United Nations
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
ICIMOD	International Centre for Integrated Mountain Development
ICLEI	International Council for Local Environmental Initiatives – Local Governments for Sustainability
IAEG-SDGs	Inter-agency and Expert Group on Sustainable Development Goal Indicators
IFC	International Finance Corporation
IFES	integrated food and energy systems
IRM	integrated resource management
IWMP	Integrated Watershed Management Programme, India
LLDA	Laguna Lake Development Authority, Philippines
MASM	Mongolian Agency for Standardization and Metrology
MNS	Mongolian national standard
MoHURD	Ministry of Housing and Urban-Rural Development, China
MYT®	Maximum Yield Technology®
NDC	nationally determined contribution
NEDA	National Economic and Development Authority, Philippines
NGO	non-governmental organization
RAC	room air conditioner
SDGs	Sustainable Development Goals
TC	technical cooperation
TICA	Thailand International Cooperation Agency
UCLG-ASPAC	United Cities and Local Governments Asia-Pacific
UNC	University of North Carolina
UNDESA	United Nations Department of Economic and Social Affairs
UNDG	United Nations Development Group
UNEP	United Nations Environment Programme
UN-Habitat	United Nations Human Settlements Programme
UNU	United Nations University
VNR	voluntary national review
WBCSD	World Business Council for Sustainable Development
WEF	World Economic Forum

Introduction

The world is rapidly urbanizing, with the urban population projected to reach 6.7 billion in 2050 (United Nations, 2018c). The Asia-Pacific region is among those parts of the world growing most quickly, adding approximately 120,000 people to urban centres each day (IOM, 2015). The region is expected to reach a milestone in 2019, passing the 50 per cent urbanization threshold, with an urban population of more than 2 billion. As the largest region in the world, with 30 per cent of the Earth's land mass and a population of more than 4 billion people,[1] Asia and the Pacific is perhaps the world's most diverse region in terms of economy, environment, society and human settlements. Managing fast-growing cities and metropolitan areas is one of the most critical challenges facing the region, particularly regarding urban development and natural resource use.

Although the Asia-Pacific region is home to 60 per cent of the world's population, it possesses only 36 per cent of global water resources. The region has the lowest per capita water availability in the world.[2] More than 421 million residents of the Asia-Pacific region lack access to electricity (ESCAP, 2018), and nearly half a billion people (486 million) are undernourished (FAO and others, 2018). Demand for water, energy and food will increase given the region's rapid rate of urbanization. Coupled with the persistent challenges of climate change and the region's vulnerability to natural disasters, development gains risk being eroded (ESCAP and UN-Habitat, 2015).

Water, energy, food and land are essential resources needed to sustain development efforts, but they are also the most vulnerable to future demand and urbanization trends. By 2030, the demand for water, energy and food is estimated to increase by at least 40, 50 and 35 per cent, respectively, as discussed at the 2014 General Assembly thematic debate on water, sanitation and sustainable energy in the post-2015 development agenda.

Most municipal administrations in the Asia-Pacific region plan and manage along sectoral lines and rarely in a coordinated manner. Thus, they are unable to harness synergies in the water-energy-food/land sectors and benefit from potential co-benefits provided by integrated resource planning and management.

Nexus helps address resource challenges

Water, energy and food security are inextricably linked. Water is used for energy production, and energy is the dominant cost factor in providing water and wastewater services. Energy is needed for land conversion, construction and transportation, and energy and water are needed for agricultural productivity. Land is required for water, energy and food production but is becoming increasingly scarce. The Nexus approach is aimed at optimizing resource use by recognizing the interdependencies between water, energy and food/land resources. It is aimed at minimizing trade-offs and promoting synergies by working across sectors and between levels of government.

Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH in 2013 began implementing the project "Integrated Resource Management in Asian Cities: The Urban Nexus" in partnership with the United Nations Economic and Social Commission for Asia and the Pacific (ESCAP) and the International Council for Local Environmental Initiatives (ICLEI) – Local Governments for Sustainability, funded by the German Federal Ministry for Economic Cooperation and Development (BMZ). The project assisted 12 cities in 7 countries with developing and advancing integrated approaches to natural resource management, including mainstreaming the Nexus approach into strategies for the implementation of key global agendas. An evaluation of phase I (2013–2015) of the project concluded that it had been successful and acknowledged its positive impact while concurrently recommending phase II (2016–2019) to further assist cities in securing financing for identified projects and engaging national Governments to introduce required policy shifts.

Wastewater and solid waste management were foci of the project in addition to water, energy and food/land, as project cities often identified these as their most urgent problems. Wastewater and waste were viewed as resources to close the loops in Urban Nexus projects. A multilevel approach was applied, with the local level as the starting point. Nexus initiatives supported municipal administrations with analysing the cities' problems and identifying cross-sectoral solutions to address them. At the meso level, city associations, universities, training institutions and civil society organizations were central actors. At the macro level, national ministries and agencies were engaged to support advancement of the Nexus concept.

The need for integrated approaches to natural resource management was highlighted in the Rio+20 outcome document[3] as well as in the 2030 Agenda for Sustainable Development[4] that encompasses 17 Sustainable Development Goals, adopted in 2015. The Paris Agreement[5] and New Urban Agenda,[6] adopted in 2015 and 2016, respectively, also support integrated solutions with which Urban Nexus projects and initiatives are aligned. With reference to the ESCAP programme of work, the relevance of the Urban Nexus approach was highlighted in the Jakarta Call for Action, adopted at the Sixth Asia-Pacific Urban Forum in October 2015. The project is aimed at linking the Nexus approach with the Sustainable Development Goals in the hope that it is mainstreamed into national initiatives for the implementation of the 2030 Agenda for Sustainable Development.

Purpose of the publication

The present publication is aimed at sharing knowledge and experience accumulated from the project "Integrated Resource Management in Asian Cities: The Urban Nexus", providing cities, interested in advancing the Urban Nexus approach, with information to get started. The publication has relevance to national and local administrators and technical staff, development organizations and United Nations officials and other institutions promoting sustainable management of natural resources and efficient urban management.

Chapter I explains the relationships between water, energy and food security; highlights growing challenges within these sectors; and presents the evolution of the Nexus concept as a solution. It describes the current situation in the Asia-Pacific region and key concepts, such as decoupling, resource efficiency and a circular economy, which are relevant to understanding the Urban Nexus.

Chapter II highlights five landmark global agendas that were adopted in 2015 and 2016 and explains how the Urban Nexus approach contributes to achievement of these agreements. The Urban Nexus approach involves cross-sectoral collaboration and vertical integration – working with different levels of government, thus serving as a logical entry point to developing integrated policies and programmes needed to reach national commitments regarding sustainability and climate change.

Chapter III introduces the Urban Nexus Guidance Framework which outlines five enabling dimensions: governance; inclusive decision-making; science, technology and innovation; finance and business; and urban planning, all of which need to be considered when implementing Urban Nexus projects. The framework presents a project cycle with guiding questions to support local governments when taking initial action to advance integrated solutions.

The special "In Focus" insert following chapter II describes in detail the project "Integrated Resource Management in Asian Cities: The Urban Nexus".

Chapter I
The water-energy-food/land nexus and cities

"The population of the world is growing rapidly. More people will get out of poverty and receive a higher standard of living. This will also mean an increased demand for food production and household water, sanitation, industrial and energy production".

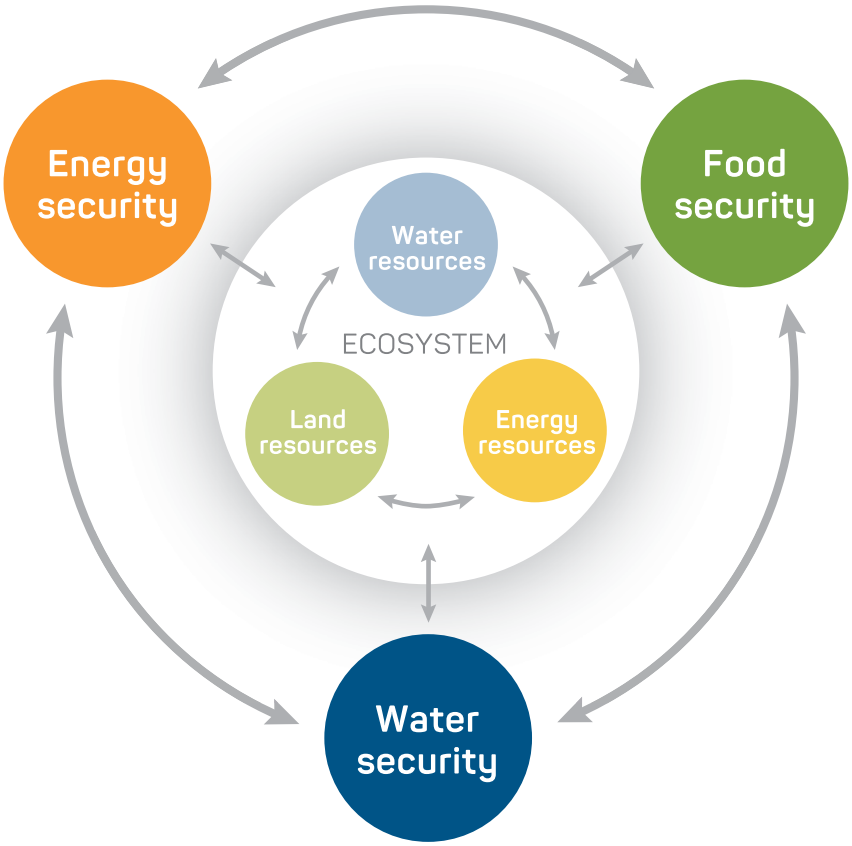
Isabella Lövin, Minister for International Development Cooperation, Sweden[7]

1.1 Natural resource linkages and scarcity

Rapid growth, without decoupling economic progress from environmental degradation, has accelerated wasteful use of natural resources and produced negative environmental and social externalities, straining supplies of water, energy and food/land. Water, energy and food/land are essential to sustain life and development but are also the most vulnerable to future demand. Globally, more than 2 billion people still lack access to safely managed drinking water (WHO and UNICEF, 2017), about 1 billion lack access to electricity,[8] and 815 million are undernourished (FAO and others, 2017). Population growth and climate change are having further adverse impacts on the future availability and sustainability of these key resources. Between 2015 and 2030, the global population is projected to increase by roughly 16 per cent (United Nations, 2015), and by 2030 the demand for water, energy and food is estimated to increase by at least 40, 50 and 35 per cent, respectively, as discussed at the 2014 General Assembly thematic debate on water, sanitation and sustainable energy in the post-2015 development agenda.

There is growing recognition that society cannot continue to extract and manage environmental resources in silos. Current production and consumption patterns may result in severe supply shortages by 2030, particularly regarding water, energy and food/land. Security of supply in these three resource sectors are interlinked, and these supply securities depend on ecosystems, of which water, energy and food/land are a part. These resources need to be protected and used in an efficient and balanced manner (figure I.1).

Figure I.1
Three resource supply securities



Source: Water, Energy & Food Security Resource Platform.

Water, energy and food/land are inextricably linked. Most types of energy generation (coal, gas, geothermal, hydro, nuclear, oil) consume water through raw material extraction, construction, operation and maintenance of the generating plant and for cooling during the process of generating electricity. On average, 15 per cent of the world's total water withdrawal is used for energy production (WWAP, 2016).

Energy is the dominant cost factor in the provision of water and wastewater services (extracting and conveying water, treating water, distributing water, using water and collecting and treating wastewater). Energy can account for up to 30 per cent of total operating costs of water and wastewater utilities (World Bank, 2012). Energy is also critical to development activities, such as land conversion, construction and transportation.

Energy and water are needed for agricultural productivity (processing, refrigeration and transportation; crop irrigation; and livestock production). Often energy and water are wasted due to poor irrigation equipment and/or operations. Land is required for water, energy, food production and housing, but it is becoming increasingly scarce (Schreiner, 2015).

1.2 A brief history of the Nexus concept

The nexus of natural resources is not a new concept. As early as 1983, the United Nations University's Food-Energy Nexus Programme conceptualized an integrated food-energy systems approach for sustainable development and supported action-oriented, interdisciplinary research that considered biophysical, social, ecological and institutional dimensions (Sachs and Silk, 1990). A series of milestone

events followed, advancing the Nexus concept and contributing to the dialogue leading to the adoption of the 2030 Agenda for Sustainable Development, which will be covered in chapter II. In particular, the United Nations Conference on Environment and Development (Rio Earth Summit) in 1992 galvanized the sustainable development movement. Representatives from Governments, academia and non-governmental organizations (NGOs) came together for this event to rethink economic development, find ways to curtail natural resource destruction and pollution and recognize the interrelationships between natural resources and growing scarcity.[9] The 2008 World Economic Forum annual meeting assembled the leading public sector, corporate, NGO and academic experts to examine the water crisis issue from different perspectives. Results included the Call to Action on Water to increase understanding of water's linkages to economic growth across a nexus of issues. The outcome report *Water Security: The Water-Food-Energy-Climate Nexus* forecast an impending water crisis by 2025, if society continues on a business-as-usual path of (mis)managing water resources (WEFWI, 2011). The report recommended solutions regarding how to manage the water-energy-food-climate interrelationships and emphasized linkages between water, energy, food and economic growth. In 2011 the World Economic Forum identified the lack of understanding about the nexus as a major economic challenge.

At the landmark Bonn Nexus Conference in 2011, a breakthrough was achieved regarding the term "Nexus", which was presented as a **solution** to address the **limitations** of existing approaches, including:

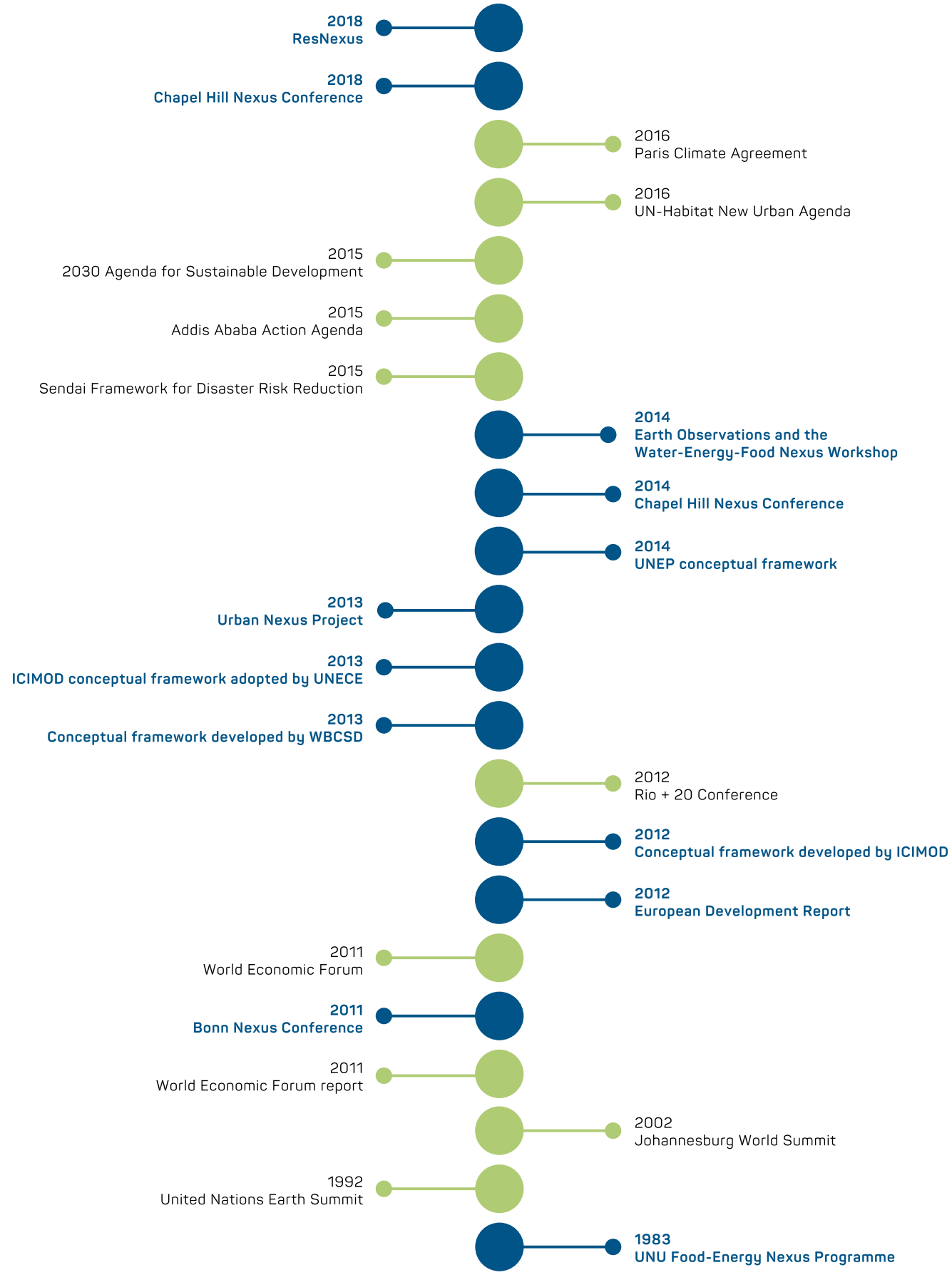
- Individual examination of resources
- Sector-based tools and methods without integration
- Institutions with sectoral mandates
- Microeconomic models focused only on economic flows
- Qualitative environmental models without quantitative approaches (Hoff, 2011)

Building on the growing momentum, the Nexus work of the Food and Agricultural Organization of the United Nations (FAO) and the University of North Carolina Water Institute's "Nexus 2014: Water, Food, Climate and Energy Conference" (with a follow-up conference in 2018) helped anchor Nexus as an approach within global agendas. The scope of dialogue on Nexus continues to expand and evolve, encompassing urban challenges ranging from waste, mobility and land use to education, health and social equity.

Figure I.2 highlights the progression of various Nexus-related conferences between 1983 and 2018. Annex I provides more detailed information on key resource Nexus events and frameworks.

Figure I.2

Key sustainable development and Nexus milestones



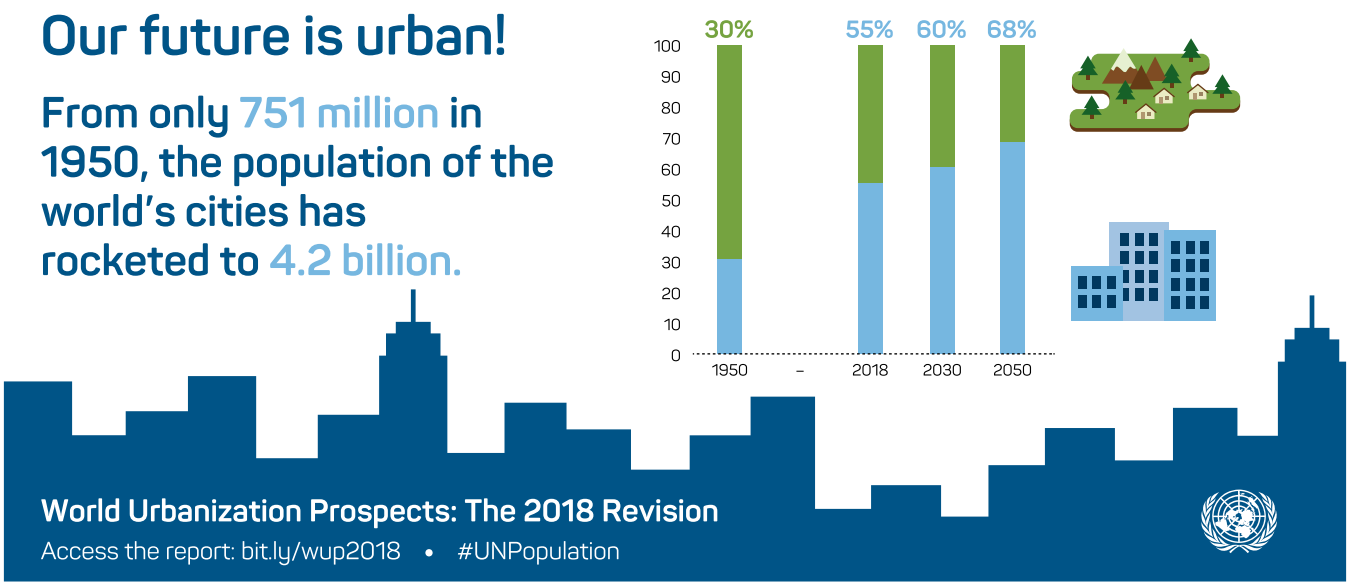
Source: ESCAP.

1.3 Urbanization in Asia and the Pacific

In the context of the previous sections of this chapter, which described global resource challenges, interlinkages between resources, and the Nexus concept as an entry point to advance sustainable development, this section covers new developments, obstacles and opportunities arising from urbanization in the Asia-Pacific region.

Figure I.3 illustrates how the world is rapidly urbanizing. The urban population has grown from 751 million in 1950 to 4.2 billion in 2018 and is projected to reach 6.7 billion in 2050 (United Nations, 2018c). Rapid urbanization entails the risk of further widening supply gaps for water and sanitation systems, energy, land and food. Unless drastic actions are taken to transform their economies, cities will continue to consume substantial amounts of resources under a business-as-usual, extractive economy scenario.

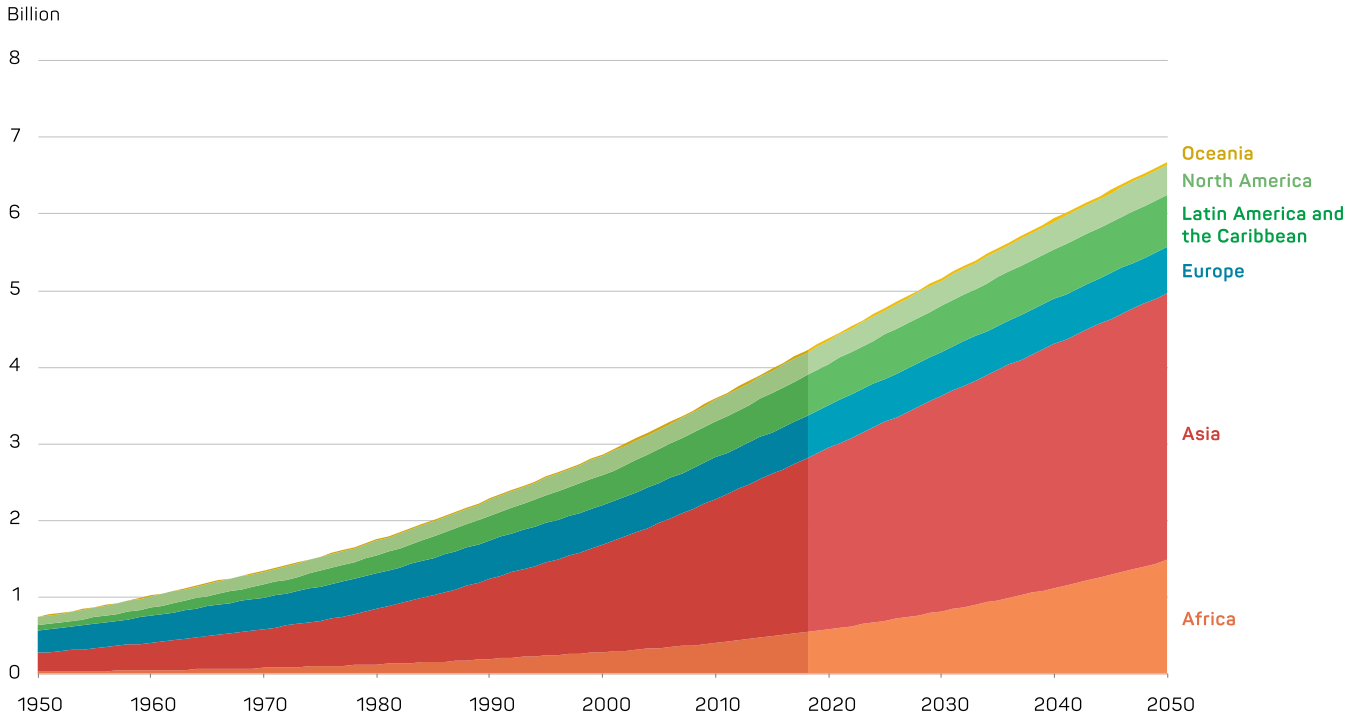
Figure I.3
World urbanization figures



Source: United Nations, 2018c.

The Asia-Pacific region has the second highest urban growth rate in the world. Between 1980 and 2010, the region's cities grew by more than 1 billion people (United Nations, 2018c). The urban population in South Asia and middle- and low-income countries in East Asia and the Pacific is growing by 2.6 per cent annually.[10] An additional 1.4 billion people will live in Asia's cities by 2050. That translates into 120,000 more people being added to urban centres each day (IOM, 2015), a number equivalent to the entire current population of Kiribati. In 2018, the Asia-Pacific region had more than 2.1 billion urban residents, or 60 per cent of the world's urban population (figure 1.4).[11]

Figure I.4
Urban population, by regions of the world



Source: ESCAP.

Despite growing economies providing greater opportunities, basic living conditions remain unmet for millions of people in the region's cities, and environmental consequences are becoming increasingly severe. Fortunately, for most cities in the Asia-Pacific region much of the needed infrastructure is yet to be built, providing a major opportunity to promote integrated solutions and leapfrog to more durable and efficient technologies and construction. As such, it is the urban environment where the pressure and opportunity for change lies.

Box I.1
Cities – centres of challenge and opportunity

Urbanization has created some of the world's greatest development challenges. Although the world's cities occupy only 3 per cent of the global landmass, they are responsible for 60-80 per cent of global energy consumption and 75 per cent of global carbon emissions.[a] Cities are often characterized by extreme poverty, unemployment and socioeconomic disparities, unsustainable patterns of consumption and production, and they are key contributors to climate change and environmental degradation. On the other hand, most of the world's businesses and informal enterprises are located in cities, which currently generate roughly 80 per cent of global GDP. Cities provide markets for industry and employment, foster technological innovations and support high-density habitation and efficient land use. Further, they generally provide better access to education, health, social services, income opportunities and cultural activities compared with rural areas.

[a] For more information, see www.un.org/sustainabledevelopment/cities/.

1.4 The Urban Nexus

Although researchers and practitioners have studied the water-energy-food/land nexus for some time, the emergence of the Urban Nexus approach has been more recent. In 2013, GIZ was commissioned by the German Federal Ministry for Economic Cooperation and Development to implement the Integrated Resource Management in Asian Cities: The Urban Nexus project in partnership with ESCAP and ICLEI – Local Governments for Sustainability in order to address pressing concerns in cities in the Asia-Pacific region. (See the "In Focus" insert for more details.)

The Urban Nexus approach examines the interdependencies between water, energy and food/land and the synergies and competing uses of these resources, requiring a shift from a sectoral to a cross-sectoral, integrated approach. It challenges existing structures, sector policies and procedures to promote the protection and use of water, energy and food/land in a balanced manner, countering traditional silo thinking and divided responsibilities that often result in poorly coordinated investments, increased costs and underutilized infrastructure and facilities (BMZ, 2014).

The Urban Nexus approach is an action-oriented guiding principle within the vision of a circular economy, where waste is viewed as a resource (see section 1.5 below). Multisectoral and multilevel approaches which integrate resources contribute to improved resource efficiency. With many project cities identifying wastewater and solid waste management as their most pressing problems, the Urban Nexus approach emphasizes how wastewater and waste can be converted into sources of energy and useful by-products, such as fertilizer (Schreiner, 2015).

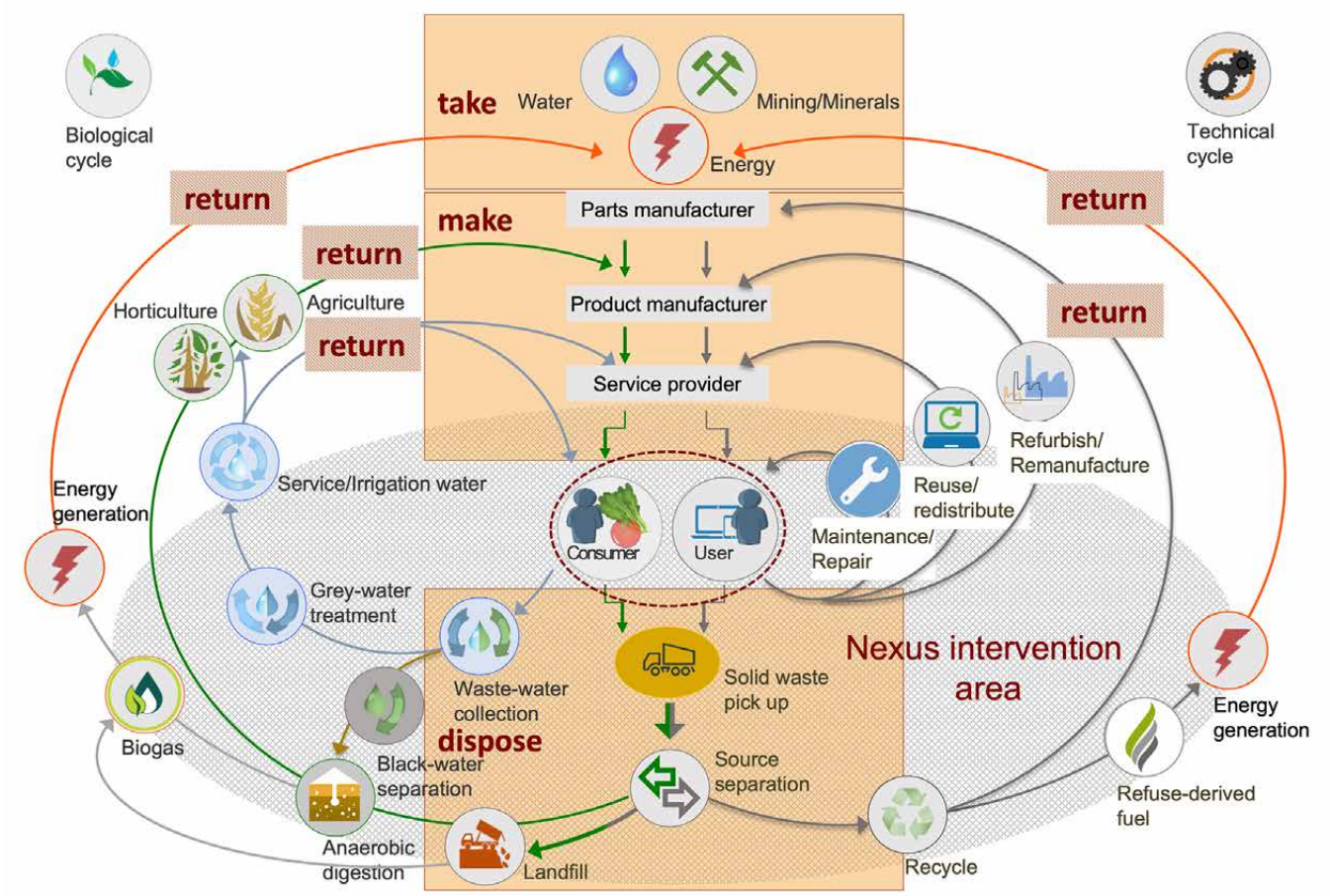
As an integrated and holistic concept, the Urban Nexus approach helps break barriers between sectors and stakeholders to take advantage of synergies.

1.5 Benefits of a circular economy

Transitioning from an extractive, linear economy to a circular economy is fundamental to promoting sustainable natural resource management and is intrinsically related to the Urban Nexus. A circular economy approach entails decoupling economic activity from the consumption of finite resources, "designing" waste out of the system. It involves moving away from the "take, make and dispose" extractive industrial model that generates waste and loses most material value to landfills towards sustainable production and consumption, which minimizes the use of natural resources, toxic materials, waste emissions and pollutants over the life cycle of the service or product in order to meet the needs of future generations. Keeping resources in use for as long as possible, extracting maximum value from them while they are in use and recovering and regenerating products and materials at the end of each service life are aspects integral to this approach.[12]

A circular economy distinguishes between biological and technical cycles. Biological cycles contain materials that can safely cycle in and out of the biosphere, such as food, fibres, wood and other biobased construction materials that can be fed back into the system through such processes as composting and anaerobic digestion, and regenerate living systems, providing renewable resources for the economy. Technical cycles contain material flows that cannot be appropriately returned to the biosphere, such as plastics, and involve recovering and restoring products, components and materials through such strategies as reuse, repair, remanufacture or recycling (Ellen MacArthur Foundation, 2017). A Nexus perspective to resource use in an urban context can help identify these cycles and synergize across waste, water, energy, food and land use (figure I.5).

Figure I.5
Circular economy with energy and mass flow cycles



Source: GIZ Urban Nexus Project.

Box I.2
Measuring resource efficiency

Resource efficiency can be determined using a material footprint measure, which presents a complete picture of material inputs needed to supply a country's consumption demand.

ESCAP has developed a simulation and scenario-building methodology to help policymakers understand the benefits of resource efficiency improvement in materials, energy and water. ESCAP has estimated that a 1 per cent improvement in resource efficiency of material resources (domestic material consumption) and energy combined can deliver benefits worth up to $275 billion.[a] To give an idea of the size of this impact, that amount of money translates into 51 per cent of the current foreign direct investment inflows into the region.

[a] These matters were considered at the fifth session of Committee on Environment and Development, based on the document entitled "Benefits of environmental action, including through enhanced regional cooperation", 12 September 2018, which is available at www.unescap.org/sites/default/files/CED5_2E_0.pdf.

In addition to saving natural resources, a circular economy can also create opportunities for economic growth, improve economic competitiveness and address emerging resource security and scarcity issues. Globally, a transition to a circular economy approach could provide material cost savings worth more than $1 trillion by 2025 (WEF, 2014). In the case of the fast-moving consumer goods sectors,[13] the potential material resource savings generated from transition to a circular economy approach could be worth up to $706 billion annually (Ellen MacArthur Foundation, 2013).

The Asia-Pacific region accounts for more than 60 per cent of fast-moving consumer goods globally (WWF, 2016), so most of these potential cost savings could be made within the region. Further, circular economies can generate both skilled and unskilled jobs. A global study estimated that the impact of transition to a more circular economy in just three to four material flows alone could deliver more than 100,000 new jobs globally (WEF, 2014).

Box I.3

Closing the loop on solid waste

In 2016, East Asia and the Pacific generated the most waste globally, with an average of 0.56 kg per capita per day. South Asia's average was 0.52 kg, with waste generation expected to rise. Viewing and using waste as a resource is essential. In the East Asian, Pacific and South Asian subregions, organic material, such as food and green waste, comprise the largest proportion of waste at approximately 53 and 57 per cent, respectively (Kaza and others, 2018). This organic content could provide valuable sources of nutrients and energy rather than being discarded. Further, a significant percentage of inorganic materials, including paper, plastic, glass and metal, could be recycled and returned to manufacturing processes. The waste-to-resource approach views waste as a valuable product that can be managed to provide sustainable benefits for a range of actors.

ESCAP, Waste Concern and their partners have promoted a waste-to-resource approach to sustainable solid waste management in towns and cities across the region, helping local actors deploy inclusive programmes and strategies for adopting 3R (Reduce, Reuse, Recycling) practices.[a] Further, an ESCAP initiative in partnership with the Stockholm Environment Institute Asia Centre and Kashtakari Panchayat – the local partner of Women in Informal Employment: Globalizing and Organizing, in Pune, India, explored ways to make waste management processes more inclusive and circular in order to increase the rate of recovery and reduce plastic leakage within that region of the country.[b]

[a] For more information, see www.unescap.org/waste-to-resource.
[b] For more information, see www.unescap.org/sites/default/files/Plastics_Nov19_ESCAP_PPT_0.pdf.

Chapter II
Global development agendas and the Urban Nexus

"We live in a world of changes so profound and rapid that no country can stand alone. The world's interlinked threats and challenges require everyone to share responsibility and contribute to a common vision".

Thomas Gass, United Nations Assistant Secretary-General for Policy Coordination and Inter-Agency Affairs[14]

Five key landmark agreements to advance sustainable development were adopted in 2015 and 2016. The Urban Nexus approach aligns with these agreements, as the commitments in the agendas are interconnected and require local government involvement, working across sectors and engaging stakeholders between government levels to advance integrated solutions and achieve the agendas' objectives.

2.1 2030 Agenda for Sustainable Development and the Urban Nexus

The 2030 Agenda for Sustainable Development contains 17 Sustainable Development Goals that are interlinked (figure II.1). No Goal can be attained in isolation, but rather only in conjunction with other Goals. Multisectoral engagement is required, and the Urban Nexus approach provides an ideal entry point, with its focus on working across and among different sectors, examining trade-offs and identifying synergies between resources and institutions. Although the Sustainable Development Goals rely on nationally led initiatives, such as sustainable development plans, policies and programmes, local governments, with their role in providing basic services, including water and sanitation, are essential to the process. It has been estimated that local level involvement is needed to achieve up to 65 per cent of the targets under the Sustainable Development Goals (Misselwitz and others, 2016).

Figure II.1
Sustainable Development Goals

Box II.1
The SDG Help Desk

The SDG Help Desk[a] is a one-stop, online platform that serves as a gateway to a wide range of knowledge and analytical products, including Sustainable Development Goal data portals, toolboxes, e-learning courses, multimedia resources, technical advice and opportunities for peer-learning and South-South cooperation.

ESCAP established the SDG Help Desk in response to requests for capacity development support from member States. Policymakers, sustainable development practitioners, academics, students and anyone seeking information and capacity support on the Goals and their implementation will find it a valuable resource.

[a] For more information, see https://sdghelpdesk.unescap.org/.

By engaging local governments in integrated planning and management of natural resources, the Urban Nexus approach directly addresses the urban and resource-related Sustainable Development Goals for food, water, energy and cities: Goals 2, 6, 7, 11 and 12. This approach also contributes to the Goals and targets in the periphery that are related to improving urban services and resource efficiency, building resilient infrastructure, mitigating environmental pollution and facilitating innovation and multi-stakeholder partnerships. The Urban Nexus approach supports cities in the process of decoupling economic growth from environmental degradation, reducing deaths and illnesses caused by pollution, upgrading infrastructure and adopting more environmentally sound technologies by addressing targets under Goals 3, 8 and 9. Goals 14 and 15, concerning life on land and ecosystems, are subject to impacts from misuse and mismanagement of land if urban planning is not conducted sustainably. Goal 16 ensures that Urban Nexus decisions are made in a responsive, inclusive and participatory manner at all levels of governance, and Goals 1, 13 and 17 have a mainstreaming effect to ensure that no one is left behind, the planet is healthy and that the global community works in closer partnership to achieve the rest of the Goals.

Figure II.2 provides a visualization of some of the interlinkages between the Sustainable Development Goals which the Urban Nexus approach addresses. It highlights some of the key relationships for consideration. As the diagram illustrates, the Goals closely related to the Urban Nexus are at the centre, while the other Goals that are indirectly associated are in the periphery. Further beyond the concentric circles are where three Goals that have overarching and mainstreaming values encompass and comprise the entire universe of the Sustainable Development Goals.

Figure II.2

Urban Nexus interlinkages with the Sustainable Development Goals

Source: ESCAP.

Box II.2
Mongolia and Ulaanbaatar integration efforts

In 2016, Mongolia approved its Sustainable Development Vision 2030,[a] and work has been ongoing to support policy coherence at the national and local levels through the development of the Sustainability Outlook of Mongolia in 2018.[b] Ulaanbaatar has developed its own Sustainable Development Goal targets and indicators, and efforts are under way to clarify how local progress contributes to national and global targets. The 2030 Agenda for Sustainable Development provides an opportunity to align policies that currently have different timelines. Mongolia's medium-term plan serves as a backbone policy to ensure cross-sectoral planning and implementation. Although resources are limited, having an interlinked plan helps the country prioritize activities for the next few years, including which of the Sustainable Development Goals to tackle first.

Mongolia is at the forefront of applying a scientific approach to assessing policies; it is scheduled to present its voluntary national review at the seventh session of the United Nations High-level Political Forum on Sustainable Development in July 2019. That meeting will provide an opportunity for Mongolia to inform others of the work needed to coordinate and align national and local policies, identifying leverage points and the use of systems thinking.

[a] For details, see www.un-page.org/files/public/20160205_mongolia_sdv_2030.pdf.
[b] For details, see www.unescap.org/resources/sustainability-outlook-mongolia.

Box II.3
Localizing the 2030 Agenda

A joint ESCAP and UN-Habitat project, "Integrating the Sustainable Development Goals into local action in support of the implementation of the 2030 Agenda in Asia and the Pacific", uses a sustainable urban resource management approach in five pilot cities: Battambang, Cambodia; Nasinu, Fiji; Ulaanbaatar, Mongolia; Naga City, Philippines; and Nadee, Thailand. The project's approach is aimed at strengthening local government and other urban stakeholders' capacities to apply a collaborative, evidence-based and systemic approach to localizing the Sustainable Development Goals. It goes beyond adjusting global Goals for the local level and calls for co-creating solutions through the generation of partnerships resulting in more inclusive, needs-driven, local-level responses to global challenges and objectives.

The sustainable urban resource management approach has four components that interlink urban resource use with the other sustainable development dimensions to ensure that processes and outcomes are equitable, inclusive and help to reduce vulnerability: (a) moving from linear to circular models of resource use; (b) recognizing the multidimensional nature of poverty by identifying the root causes and interlinkages between them; (c) being gender-responsive by systematically accounting for the different roles and needs of men and women and transforming relations to promote equity; and (d) increasing resilience to social, economic and environmental shocks and stresses by addressing the root causes of vulnerability and enabling people to deal with a range of uncertainties.

2.2 Paris Agreement

In addition to the 2030 Agenda, the Paris Agreement adopted under the United Nations Framework Convention on Climate Change serves as a landmark accord for countries that are trying to keep global temperature rise this century to well below 2°C of the temperatures of pre-industrial levels. These two agendas demand action and require local engagement. Urban Nexus initiatives support climate actions by optimizing the use of energy in water, wastewater, food/land and solid waste projects and through direct energy-saving efforts, such as promoting energy-efficient building design. Buildings use about 40 per cent of global energy and contribute approximately one third of greenhouse gas (GHG) emissions.[15]

Box II.4
United Nations Framework Convention on Climate Change and the Conference of the Parties

The United Nations Framework Convention on Climate Change (UNFCCC) is an international environmental treaty negotiated by the General Assembly and adopted in May 1992 that entered into force in March 1994, after a sufficient number of countries ratified it.

The Conference of the Parties (COP) is the supreme decision-making body for UNFCCC. Parties take decisions needed to promote implementation of the Convention, including reviewing the Parties' emission inventory submissions, assessing progress and making institutional and administrative decisions to promote implementation of the Convention. COP meets annually; the twenty-first session of the Conference (COP21) took place in Paris, from 30 November to 11 December 2015. At that session, a total of 195 countries negotiated and adopted the landmark Paris Agreement, a global accord to address climate change, which many see as a great success in multilateral diplomacy and a global milestone in the efforts to foster climate action.

The Paris Agreement acknowledges the local dimension of climate change by encouraging cities and subnational authorities to reduce GHG emissions and build resilience. At COP23 in Bonn, in 2017, ICLEI – Local Governments for Sustainability noted that success requires countries to set clear mechanisms for consulting and engaging with their local and regional governments, making them equal partners in a well-coordinated and effective effort.[16] City-led initiatives are responding to this call by monitoring and reporting on climate action. One example is the Non-State Actor Zone for Climate Action, which tracks commitments to climate action and has more than 12,000 stakeholders, including cities, regions, companies, investors and NGOs. Another initiative is the carbon*n*® Climate Registry, a public platform for local and other subnational governments to report their commitments, emission performance and other plans for climate change mitigation and adaptation. With 90 per cent of the world's urban areas being coastal, cities are at high risk of tsunamis, storms and flooding, which are intensified by climate change.[17] Many cities are already addressing climate change in their urban policies, helping to mitigate climate change causes and adapt to its impacts.

2.3 New Urban Agenda

Adopted in 2016, the New Urban Agenda provides the underpinning and framework that places sustainable urban development at the centre. In the New Urban Agenda, leaders committed to providing all citizens with basic services, such as housing, water, sanitation, health care and education; ensuring that all citizens have access to equal opportunities and face no discrimination; promoting safe, accessible and green public spaces; promoting measures that support cleaner cities; strengthening resilience to reduce the risk and the impact of disasters; and taking action to address climate change. The New Urban Agenda calls for an integrated approach, directly in line with the Urban Nexus approach, considering urban-rural linkages, environmental sustainability and circular economy principles. The Urban Nexus approach helps cities achieve the New Urban Agenda objectives, particularly in areas emphasizing sustainable management of wastewater and solid waste and the need for equitable and affordable access to basic infrastructure, including modern and renewable energy, nutritious and adequate food, and waste management.

Box II.5
Asia-Pacific Urban Forum recommends Nexus approach

The Sixth Asia-Pacific Urban Forum, which was held in Jakarta from 19 to 21 October 2015, was guided by the theme "Sustainable Urban Development in Asia-Pacific: towards a New Urban Agenda". More than 900 participants, including government ministers, mayors, academics, urban professionals, members of the private sector, civil society and international organizations, gathered to discuss emerging issues related to urban development in the region. Participants focused on implementation of the 2030 Agenda and outlined priority issues for consideration in the New Urban Agenda.

The Forum adopted a "Call for Action"[a] on sustainable, inclusive and resilient urban development that recommended a Nexus approach, stating that "meeting current and future natural resource demands in cities, in particular for energy, water and food, as well as housing and basic services, requires the adoption of a Nexus approach and a shift from sectoral to integrated and ecosystem-based planning. It also requires a shift from competitive to collaborative governance among neighbouring municipalities and across departments, including financing mechanisms". The Call for Action was presented at the Habitat III Asia-Pacific Regional Meeting, which was held in the same city on 21 and 22 October 2015; the importance of integrated approaches, to which Nexus contributes, was recognized in the New Urban Agenda.

[a] For details, see www.unescap.org/sites/default/files/ESCAP%202015%20APUF6%20Call%20for%20Action.pdf.

2.4 Sendai Framework for Disaster Risk Reduction

The Sendai Framework for Disaster Risk Reduction 2015-2030 was adopted to reduce disaster risk and losses in lives, livelihoods and health and in the economic, physical, social, cultural and environmental assets of persons, businesses, communities and countries. With its inherent integrated nature, the Urban Nexus approach provides integrated solutions, thereby reducing risks and potential losses. To achieve the aims of the Sendai Framework, local governments, urban stakeholders and civil society organizations need to work together to integrate policies and plans towards disaster risk management into urban planning, especially regarding natural resource management and the provision of basic infrastructure services, such as water, sanitation and energy.

Box II.6
"Ten Essentials for Making Cities Resilient"

The United Nations Office for Disaster Risk Reduction (UNISDR) is tasked with supporting the implementation, follow-up and review of the Sendai Framework for Disaster Risk Reduction 2015-2030. UNISDR developed an operational framework to accelerate implementation of the Sendai Framework at the local level.

That framework is known as the Ten Essentials for Making Cities Resilient;[a] they match directly the Sendai priorities of action and indicators for monitoring actions on disaster risk reduction. This toolkit provides the rationale for each of the 10 essentials, pointing out strategic areas of intervention and identifying key actions that should be part of the overall disaster risk reduction planning process and influence urban development planning and design.

[a] For more information, see www.unisdr.org/campaign/resilientcities/home/toolkitblkitem/?id=1.

2.5 Addis Ababa Action Agenda: funding the 2030 Agenda

The Addis Ababa Action Agenda (AAAA) of the Third International Conference on Financing for Development[18] lays out measures to address the financing gap by restructuring global finance practices and generating investments to support achievement of the Sustainable Development Goals. The 2018 report of the Inter-agency Task Force on Financing for Development indicates that public and private investment remain inadequately aligned with funding needed to reach the 2030 Agenda Goals and targets (United Nations, 2018a). AAAA includes concrete deliverables, such as a global infrastructure forum to enhance public and private sector cooperation around infrastructure and improve coordination to deliver the trillions of dollars in investment in sustainable infrastructure needed by developing countries. Investments in sustainable development will need to be made at the subnational level. Local governments often rely on transfers from national Governments to fund basic infrastructure services, such as wastewater management and solid waste management (UN-Habitat, 2015). AAAA calls for increased international and national cooperation to strengthen local government capacity to finance resilient and sustainable infrastructure, promoting opportunities for cross-sectoral approaches, such as the Urban Nexus approach. Integrated solutions can guide local governments to capitalize on synergies between different sectors, reducing costs and contributing to better financial management of urban development.

Table II.1 summarizes key aspects of landmark agendas.

Box II.7
Regional Roadmap for Implementing the 2030 Agenda for Sustainable Development in Asia and the Pacific

The Regional Roadmap for Implementing the 2030 Agenda for Sustainable Development in Asia and the Pacific, adopted by member States in 2017, strongly emphasizes the importance of an integrated approach to support implementation and partnerships regarding data and statistics, technology, finance and policy coherence. Efficient management of natural resources and regional cooperation can unlock opportunities for promoting policies and strategies with respect to resource efficiency and environmentally sound technologies.[a]

[a] For details, see www.unescap.org/sites/default/files/publications/SDGs-Regional-Roadmap.pdf.

2.6 From global frameworks to local actions

To maximize cross-sectoral benefits, leaders and practitioners need to work across the interlinked Sustainable Development Goals and other global frameworks. The Urban Nexus approach requires cross-sectoral collaboration, serving as an entry to achieving integrated policies and programmes.

This chapter outlined how cities and the Urban Nexus are linked to global development agendas and are essential to their achievement, delivering greater social equity, reducing urban poverty, contributing to environmental protection and supporting climate action. The following “In Focus” insert describes the Integrated Resource Management in Asian Cities: The Urban Nexus project and highlights project city activities, lessons learned and results that are described in chapter III, which presents a framework to support implementation of the Urban Nexus concept.

Table II.1

Key aspects of five global agendas

Sendai Framework	AAAA	SDGs	Paris (COP21)	New Urban Agenda
UN World Conference on Disaster Risk Reduction 2015 Sendai Japan	Financing for Development	Sustainable Development Goals	COP21 · CMP11 Paris 2015 UN Climate Change Conference	H III
Aim: to increase resilience to disasters	**Aim: to increase financing for sustainable development**	**Aim: to promote a globally comprehensive development agenda**	**Aim: to keep global temperature rise below 2°C above pre-industrial levels**	**Aim: to develop sustainable cities**
- Adopted 18 March 2015 - Voluntary, non-binding - 38 indicators, some aligned with SDG disaster indicators for coherent reporting - UNISDR tasked to support implementation, follow-up and review - Countries report against the indicators for measuring the global targets using the online Sendai Framework Monitor	- Adopted 16 July 2015 - Voluntary, non-binding - More than 100 measures on development financing and cooperation on issues, including technology, science, trade and capacity-building - Supports achievement of the Sustainable Development Goals - United Nations Inter-agency Task Force reports annually to monitor progress on AAAA financing measures	- Adopted 25 September 2015 - Voluntary, non-binding - 244 indicators linked to 169 targets that measure progress towards meeting 17 Sustainable Development Goals - Countries submit voluntary national reviews (VNRs) and many in the Asia-Pacific region have done so Multilevel process: national, regional global and thematic-level meetings with annual High-level Political Forum on Sustainable Development to review progress	- Adopted 12 December 2015 - Countries submit nationally determined contributions (NDCs) outlining short and long-term actions to reduce greenhouse gas emissions - NDCs are renewed every 5 years - All Parties to the Agreement have submitted NDCs and will submit updated NDCs by 2020	- Adopted 20 October 2016 - Voluntary, non-binding - Outlines guiding principles and key components to develop sustainable urban areas - Quadrennial reports by UN-Habitat evaluate progress and include inputs from Member States and different levels of government

In Focus

Integrated Resource Management in Asian Cities: The Urban Nexus Project

In Focus

Integrated Resource Management in Asian Cities: The Urban Nexus Project

The German Federal Ministry for Economic Cooperation and Development (BMZ) commissioned the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH to implement the "Integrated Resource Management in Asian Cities: The Urban Nexus" project in two phases between 2013 and 2019 in partnership with the United Nations Economic and Social Commission for Asia and the Pacific (ESCAP) and ICLEI – Local Governments for Sustainability.

Project cities and countries

During those years, the project targeted countries with emerging and developing economies in South and South-East Asia and East and North-East Asia that were exhibiting a relatively large and growing resource footprint and rapid urbanization, and thus needed to adopt integrated approaches to sustainably manage natural resources, particularly energy, water and food/land. The Government of Germany, with support from GIZ, selected target cities that generally displayed strong local leadership, an interest and willingness to adopt innovative infrastructure approaches, including structural governance changes to solve environmental and health challenges, and an inclination to work across sectors with a broad range of stakeholders (box A).

Figure A presents a map of project cities and countries.

Figure A

Map of project cities and countries

Source: https://www.un.org/Depts/Cartographic/english/htmain.htm.

Goal and project objective

The overall goal of the project is to enhance the capacity of local and national governments in developing countries in the Asia-Pacific region to formulate and implement integrated policies, plans and initiatives to sustainably manage natural resources in urban areas.

The project objective, according to the BMZ Commission, is to ensure that Nexus concepts are increasingly taken into account in selected Asian cities and by relevant stakeholders.

Partnership arrangements

The collaboration is unique, involving ESCAP, as a partner guiding implementation of the global agendas, particularly the 2030 Agenda for Sustainable Development; GIZ as an organization with grounded projects and advisory services; and ICLEI – Local Governments for Sustainability, with its broad network of cities to take solutions to the local level. The tripartite partnership enables the project to deliver solutions at the local level as well as align local action with the global agendas. All three partners contribute in a positive manner, with the project serving as both an initiative and platform.

During the project period, each project country has been supported by a national coordinator from GIZ Urban Nexus or ICLEI – Local Governments for Sustainability, who work closely with mayors and managerial and technical staff from different local and national government sectors; their aim is to promote intersectoral cooperation that is essential to developing Nexus projects. Some cities formalized – by mayoral decree –Urban Nexus task forces, which have served as consultation and support groups. Other cities nominated focal persons to serve as liaison officers for the project.

Towards the end of the project, colleges, training institutes and universities were identified as strategic partners to sustain uptake of the Nexus approach, as students, trainers and professors are "natural" multipliers. Some universities and training institutes with which the project partnered, in particular in India and the Philippines, included or enhanced existing integrated approaches in their teaching and curricula, often in collaboration with cities.

Project approach and activities

The three partners have supported creation of economically, socially and ecologically resilient cities. Local governments have served as entry points to receive advisory services from GIZ Urban Nexus to improve their resource management in the areas of energy, water, food security/land use. Several cities identified wastewater and solid waste as urgent concerns, thus measures often have been focused on these areas, promoting waste as a resource within the vision of a circular economy approach.

GIZ Urban Nexus collaborates with international experts and relevant stakeholders to conduct pre-feasibility and feasibility studies to design cross-sectoral infrastructure solutions and build capacity. These studies calculate capital expenditures and operating expenses and identify the importance of appropriate tariffs and fees to create an enabling environment for infrastructure investment and to highlight, in discussion with development banks, the mobilization of finance. Resource and financial benefits from an integrated approach are often considered.

Physical infrastructure, hardware and measures that project cities explored include the following:

- Wastewater, water reuse, energy generation and application of nutrients for agriculture
- Wastewater and drinking water supply system improvements, including leakage detection and replacement of old, inefficient pumps
- Mechanical biological treatment system and incineration technologies (waste to energy)
- Promotion of energy efficiency of buildings, including renewable energy

The social infrastructure, or software (governance), measures involve people-centred development and promote decentralization along the lines of subsidiarity principles and the empowerment of cities within the framework of a circular economy (concepts that are explained in chapters I and III).

Trainings, study tours and technical workshops have been organized to introduce cities, particularly technical staff, to new technologies and infrastructure; advance coordination across sectors (horizontal integration); and improve communication between local authorities on governance processes. Peer-to-peer exchanges and South-South dialogues help to facilitate experience exchange and the learning of best practices of neighbouring cities and countries (highlights of some of these events are shown in box B).

With the aim of developing independent policy recommendations on integrated resource management and respective enabling factors, ESCAP organized expert group meetings to engage external expertise from various fields to explore state-of-the-art research and analysis to solve problems. ESCAP collaborates with regional and international organizations, including United Nations agencies and programmes, and harnesses and capitalizes on its convening power to bring member States together to discuss issues of regional concern and share best practices in line with its mandates. ESCAP supports introduction of the required policy shifts needed to advance integrated resource management in cities, including to mainstream the Nexus approach into national initiatives for the implementation of the 2030 Agenda for Sustainable Development, the New Urban Agenda and the Paris Agreement (as explained in chapter II).

National dialogues have been held to improve coordination across government levels – vertical integration, which is critical to advancing policy reforms. These dialogues address local and national issues, such as financing local infrastructure projects. Municipal, provincial, regional and national actors as well as private sector entities, including banks and NGOs, have joined these forums which are aimed at supporting alignment of local, provincial and national strategies, creating acceptance for the Nexus approach and mobilizing finance for improved urban services.

In demonstrating their commitment to integrated resource management, partner cities have taken turns hosting regional workshops that brought together project stakeholders to exchange experiences and enable cross-sectoral, multi-stakeholder dialogues between cities, provincial/regional and national governments, meso-level organizations, academia and research institutions, the private sector and international financial institutions. (See annex III for links to the workshop webpages which contain background information, presentations and reports.)

On 19 June 2015, at the fifth regional workshop in Chiang Mai, Thailand, project cities signed the Nexus Partnership Declaration, entitled "Developing Integrated, Resource-efficient and Inclusive Cities for a Better Future", through which they agreed to raise the level of ambition at the local level in order to design and implement programmes and projects applying Nexus principles.

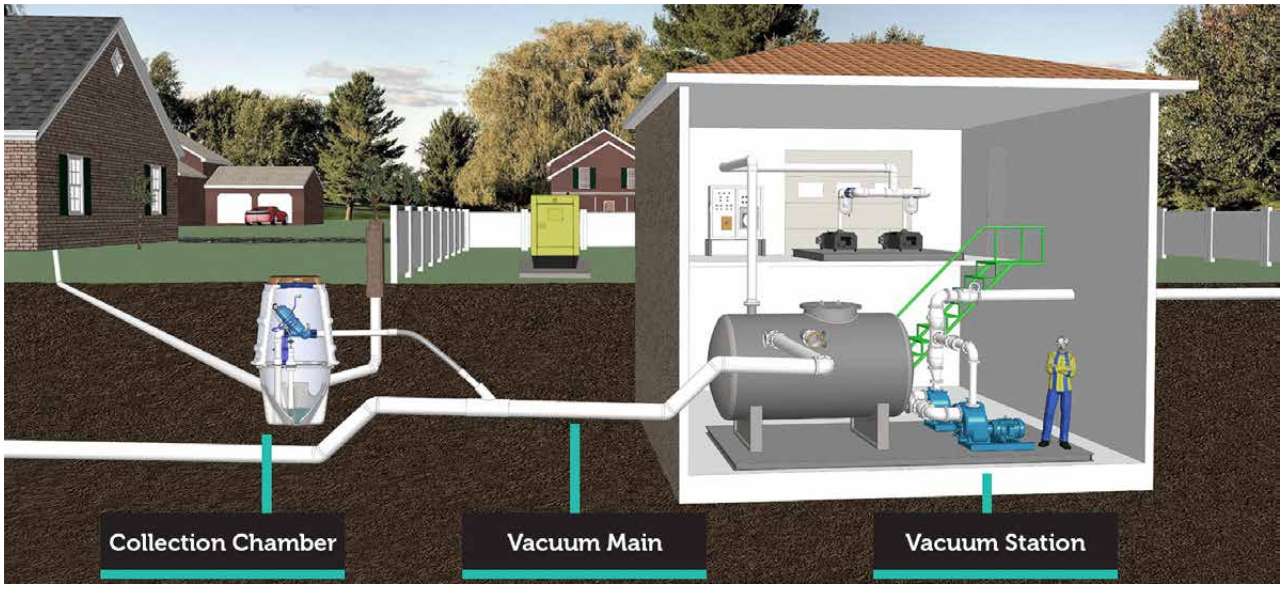
Box A

Innovative infrastructure introduced by GIZ Urban Nexus to project cities

GIZ Urban Nexus introduced solutions that were new to cities, some of which are highlighted below.

Innovative wastewater management using vacuum sewer systems is one such solution. A vacuum sewer system is a mechanized wastewater system that transports sewage from individual households to wastewater treatment plants. Unlike conventional systems that use gravity (inclines) to transport wastewater, a vacuum sewer system uses negative air pressure to draw sewage to collection points. These systems collect storm water and wastewater separately, helping to maintain high organic loads in the wastewater and prevent sewage overflows during storms. Vacuum collection systems require smaller and shallower trenches and less land. Initial construction is quicker than with gravity systems, making them suitable for low-rise, densely populated, flat areas and/or areas with high groundwater tables.

Example of a vacuum sewer system

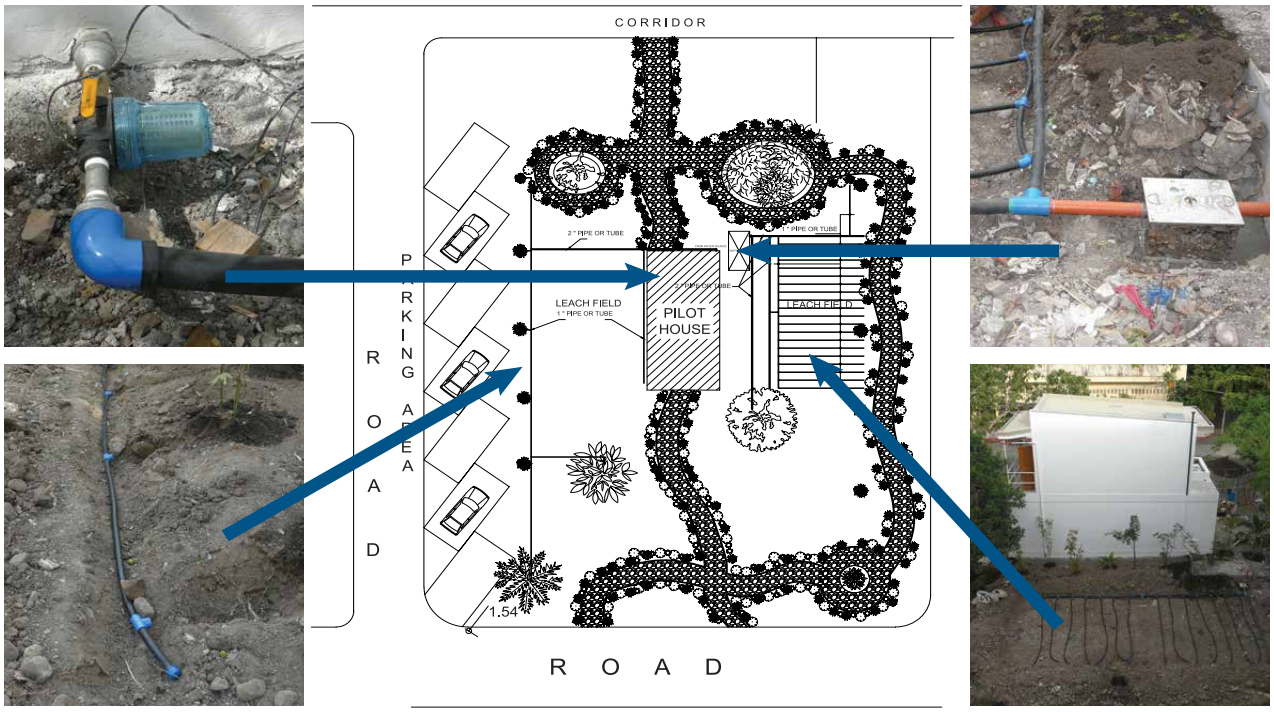


Source: Adapted from AIRVAC. Available at https://www.aqseptence.com/app/en/products/airvac-vacuum-sewer-system/.

A vacuum sewer system by itself is not a sustainable wastewater management system. It can be a vital component, however, as the system facilitates separation of black from grey water, supporting optimization of the anaerobic digestion process and production of biogas and fertilizers.

While wastewater has long been considered a health and environmental hazard, a change in mindset is under way that considers wastewater as a potential resource stream. Wastewater provides many opportunities to recover resources and close loops. Treated wastewater can be reused, reducing the demand on potable water and augmenting water supplies. Through anaerobic digestion, sewage sludge can be converted into biogas and fertilizers. Thus, combined with a vacuum sewer system, wastewater and sludge can produce renewable energy and other valuable co-benefits.[a]

Wastewater treatment and utilization



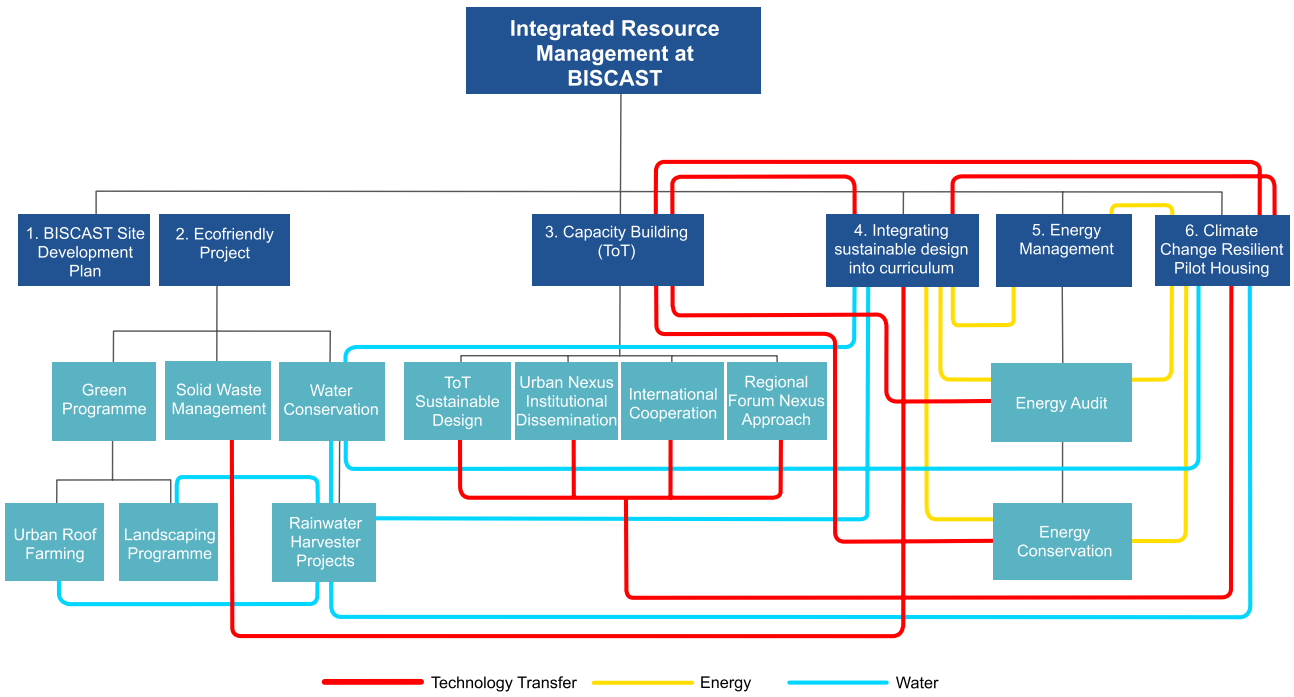
Source: BISCAST.

Another solution is the climate change-resilient pilot house (CCRPH) developed by Bicol State College for Applied Sciences and Technology in Naga City, Philippines, with GIZ Urban Nexus support. It serves as an alternative to conventional housing to help protect the poor from the adverse impacts of climate change and to strengthen the city's resilience. CCRPH applies a household-level wastewater treatment and utilization system, including rainwater harvesting, septic tank with strainer and a leach field, enabling reuse of clarified wastewater for irrigation and fertilizer, reducing waste material on site by up to 30 per cent. Construction costs per square metre are reduced by up to 40 per cent.

CCRPH employs additional climate-adaptive and energy-efficient devices and uses environmentally friendly construction technologies (prefabricated beams and hollow blocks) without wooden formwork to facilitate quick construction and lower costs. The technology's specific advantages include the following:

- Modular architectural system that reduces the number of different building parts, leading to a reduction in different types of formwork
- Reduction of waste material and wastewater on site by up to 30 per cent
- Approximately 50 per cent reduction in the amount of mortar used due to the use of hollow concrete blocks
- Reduction by 40 per cent in the use of concrete and 30 per cent of steel works for slab construction due to the use of the hollow concrete block-slab system
- 30 per cent increase in the use of cement for hollow concrete blocks to achieve the required strength for load-bearing walls
- Natural ventilation (cross-ventilation throughout the building)
- Natural illumination, window/wall ratio of 40 per cent and roof lights
- Energy-efficient devices (LED lights and occupation sensors)
- Reduction of electricity consumption by more than 25 per cent through the use of a photovoltaic system
- Water conservation via rainwater harvesting

The BISCAST Nexus Model: The CCRPH Example



Source: BISCAST.

Yet another solution is a mechanical biological treatment system, which is a type of waste-processing system that combines sorting processes with a form of biological treatment, such as composting or anaerobic digestion. Mechanical biological treatment plants are designed primarily to process mixed household (municipal) wastes, but can be applied to process commercial and industrial waste as well. Depending on

features and the efficiency of different system designs, the yield from an efficient mechanical biological treatment process includes recyclable material (such as plastic, paper, metal and minerals), fuel sources (biogas and refuse-derived fuel) and fertilizer. Maximum Yield Technology® (MYT®) is based on mechanical biological treatment.[b]

[a] For more information, see www.unescap.org/sites/default/files/Vietnam_Danang_1410_Report%20on%20vacuum%20sewer%20collection%20system.pdf.
[b] For details, see www.kahlenberg-ringsheim.de/media/myt_eng.pdf.

Box B
Highlights from select peer-to-peer exchanges and study tours

In September 2014 and November 2018, representatives of Weifang/Binhai, China; Tanjung Pinang; Indonesia; Chiang Mai and Nakhon Ratchasima (Korat), Thailand; and Da Nang, Viet Nam, along with national-level representatives from Indonesia, participated in a study tour to Dubai, United Arab Emirates, to visit Palm Jumeirah, site of the world's largest vacuum sewer wastewater collection system installation.

In 2015, the Philippine city of Santa Rosa hosted two peer-to-peer learning activities on gender and development as well as the clustering approach to address water-food-energy nexus issues. These activities were attended by other Nexus cities, namely Tanjung Pinang; Naga City, Philippines; Chiang Mai; and Da Nang.

In 2015, representatives from Pekanbaru, Indonesia; Tanjung Pinang; Naga City; and Santa Rosa learned more about the sustainable sanitary landfill-to-energy system applied in Chiang Mai.

In November 2016, representatives of Rajkot and Nagpur, India; Tanjung Pinang; Naga City; Santa Rosa; and Da Nang, and national-level officials from India and the Philippines joined a visit to Hangzhou and Zhejiang, China, to learn more about Maximum Yield Technology®, or MYT ®.[a]

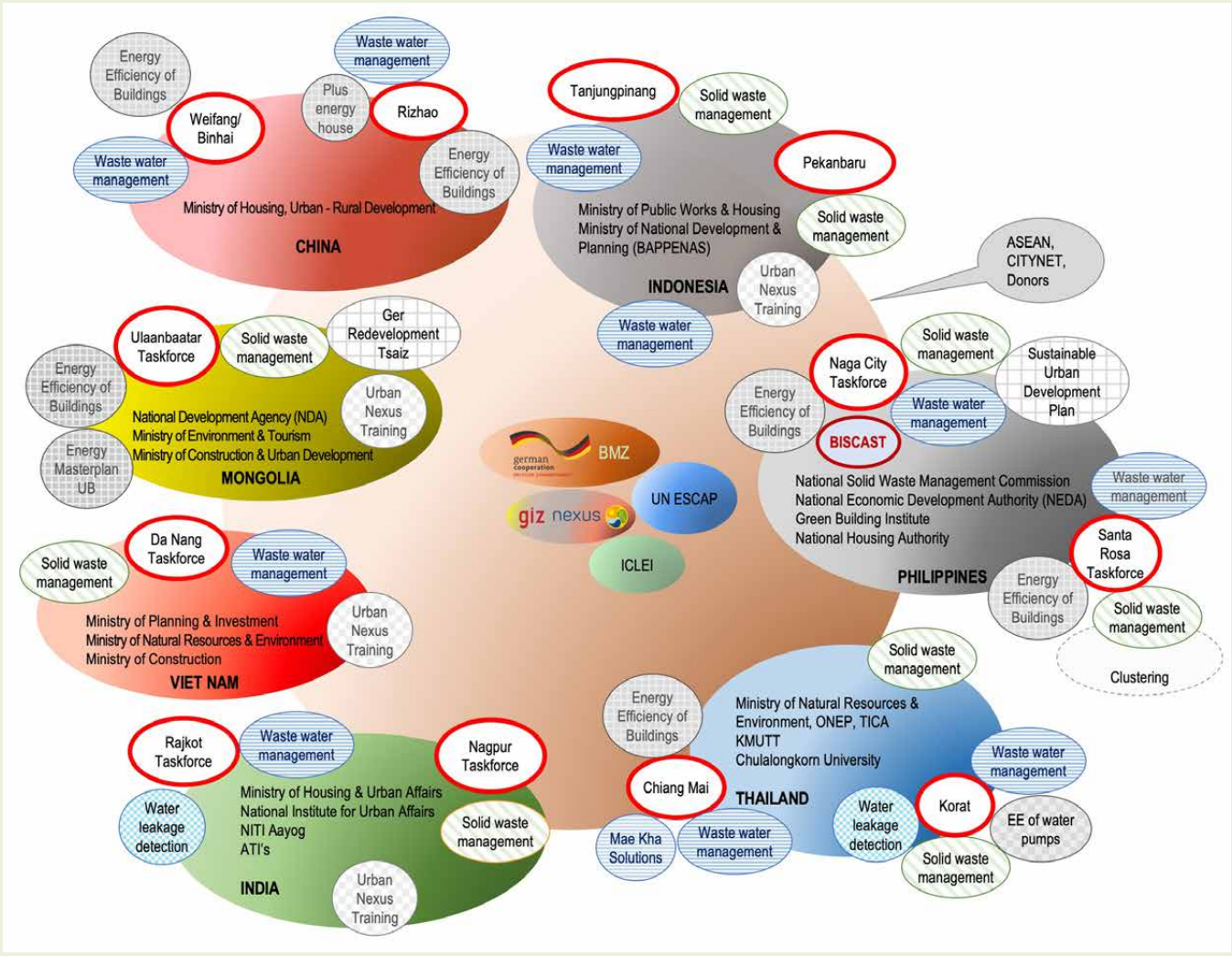
In September 2018, representatives from India, Thailand and Viet Nam attended a training programme at Ringsheim, Germany, that was organized to introduce the MYT® technology and build the capacity of officials. MYT® has proven successful in Germany and is applicable in the Asian context. The training provided information on mechanical and biological waste treatment of mixed municipal solid waste, the recovery of valuable and recyclable material and the production of high-quality, refuse-derived fuel (alternative fuel) and its applications.[b]

GIZ Urban Nexus supported more than 85 studies examining the feasibility of these innovative solutions in the project cities.

[a] For details, see http://seas.iclei.org/logos/logos-10/nexus-cities-learn-about-chinas-solid-waste-management-practices.html.
[b] For further information, see www.water-energy-food.org/news/urban-nexus-innovative-municipal-solid-waste-management-training-on-maximum-yield-technology-myt/.

Figure B

Project cities and Urban Nexus measures



Source: GIZ Urban Nexus.

Project impacts

The project taps global and regional outreach events to further disseminate the Urban Nexus approach, lessons learned, policy recommendations and project results reaching thousands of local and national policymakers and other relevant stakeholders from around the world.

Successes range from the project cities improving efficiency and reducing costs of drinking water supply systems to certifying a green, affordable housing design, with construction costs reduced by more than a third compared with conventional construction. The project has elaborated more than 55 projects with capital expenditures amounting to €600 million, also considering operating expenses, in each case to be borne by the municipalities concerned. Proposed solutions include innovative solid waste management (e.g. mechanical and biological solid waste treatment and waste-to-energy projects); vacuum sewer technology and wastewater reuse; building energy efficiency and renewable energy; and efficiency improvements in energy, water and wastewater systems leading to monetary savings – the most important aspect for local governments.

At the seventy-first session of the Commission, ESCAP member States highlighted the importance of the Urban Nexus approach and put forward specific policy recommendations in a note by the secretariat entitled "Towards a sustainable, inclusive and resilient urban future for Asia and the Pacific" (E/ESCAP/71/13).[19] Moreover, the Commission emphasized sustainable management of natural resources, in particular of water, energy and food, as a key sustainable development priority, reflecting increased agreement among ESCAP member States on the importance of an integrated approach to resource management.

Box C

The Urban Nexus Project and ESCAP resolution 70/12

The Integrated Resource Management in Asian Cities: The Urban Nexus project contributed to fulfilling ESCAP resolution 70/12, which called on ESCAP to, among other things, (a) continue to analyse conditions and trends regarding human settlements and sustainable urban development in Asia and the Pacific across all three dimensions of sustainable development, as well as identify strategies to address persistent and emerging challenges; and (b) continue facilitating regional understanding and action on issues critical to housing and sustainable urban development through, among other modalities, the sharing of good practices and lessons learned and the convening of expert group meetings and regional multi-stakeholder dialogues. The project also supported national and local governments with implementation of the 2030 Agenda for Sustainable Development, in particular Goals 2 (end hunger), 6 (clean water and sanitation), 7 (affordable and clean energy), 11 (sustainable cities and communities), 12 (responsible consumption and production) and 13 (climate action).

To further enhance understanding of the Nexus approach, the three project partners along with the project cities developed fact sheets, case studies and other outreach materials to share broadly with interested parties.[20]

Lessons learned

Although the project cities face common challenges, such as failing infrastructure and resistance to innovation, they differ in other aspects, including commitment of local champions, political will, ability to coordinate across government levels and existing regulations. Nexus projects have been tailored to each city's unique circumstances: cultural setting, available resources, technical knowledge, political leadership and financial support. There is no one-size-fits-all solution, and each project city has taken a tailored approach with varying degrees of progress. Lessons learned from the project cities, as well as the three project partners, are presented below, and recommendations for moving forward are shared in chapter III.

- Water, energy and food/land are interconnected in a non-linear manner. Focusing on only one resource may result in unexpected, negative consequences. These resources need to be examined with a systems approach that addresses these interrelationships

- Many cities are overwhelmed with the many road maps and regulations from the national level and other mandates that are on top of their core responsibility of providing urban services. Efforts that help cities provide urban services more efficiently and effectively, such as the Urban Nexus project, provide opportunities and solutions to achieve sustainable development

- Horizontal and vertical administrative fragmentation emerged as a major risk to implement Urban Nexus approaches. Many governance structures require changes to improve management of resources, such as water, energy and land. Intensity of cooperation within and among local governments in urbanizing agglomerations needs to be enhanced and sustained

- Customized institutional arrangements, based on unique local and subnational governance contexts, available capacities and the needs identified through projects (e.g. special-purpose vehicles formed under the "Smart City" initiative in India) helped to advance the Nexus approach

- Further capacity-building among government agencies, especially at the national level, should continue to be carried out in order to increase understanding of Urban Nexus as a concept and approach, not only technology. Training and capacity-building are needed to discontinue business-as-usual approaches to urban development and adopt an integrated approach to improve resource efficiency and overall quality

- Since "seeing is believing", the implementation of pilot projects, exposure visits and technical tours to showcase good practices make an impact on decision-making, especially in respect of large infrastructure projects

- Public-private partnerships are another form of financing investment that is becoming more popular; however, the different partnership models should be studied thoroughly before being applied

- Housing schemes are the "best" Nexus as they require a multisectoral approach (finance, space, infrastructure, water, wastewater, energy, solid waste management, roads, community development etc.)

City-specific experiences are described in the profiles that follow.

Weifang/Binhai, China

The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations.

Established in August 1995, Weifang/Binhai, with approximately 96,600 residents, was approved as a national economic and technological development area by the State Council of the People's Republic of China.

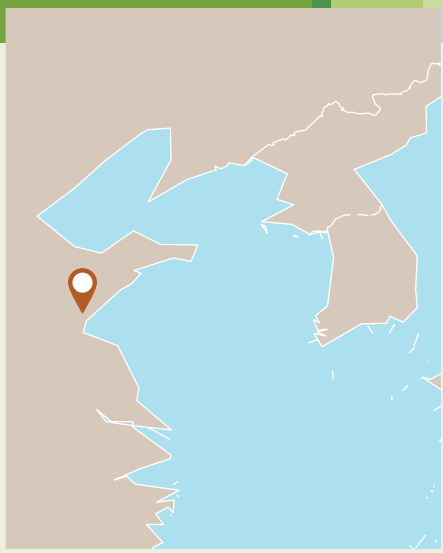
Covering an area of 677 km^2, much of its coastland is flat and undeveloped. Innovative wastewater management and building energy efficiency are the two focus areas of the Urban Nexus project interventions. Vacuum sewer wastewater collection is apt for the terrain. After a technical workshop on vacuum sewer wastewater collection in June 2017, the Weifang/Binhai authorities decided to support a respective pilot project. Preparations for project implementation are under way, and construction is scheduled to start in 2019.

The Bureau of Housing and Urban-Rural Development of Weifang/Binhai coordinated the involvement of other bureaus and departments of the Weifang/Binhai government and State-owned companies in Nexus activities. At the national level, the Ministry of Housing and Urban-Rural Development and Ministry of Commerce supported the dissemination of the Nexus approach in China.

Weifang/Binhai representatives joined study tours and also hosted trainings on building energy efficiency and innovative wastewater management to build their capacity to advance these measures.

Source: GIZ.

Rizhao, China

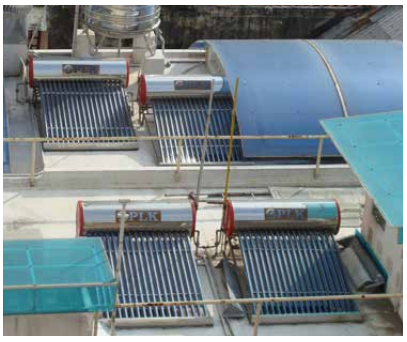


The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations.

Rizhao is a dynamic coastal city in Shandong Province with approximately 800,000 residents in the city centre. Water management is the focus area of Urban Nexus project interventions for Rizhao. The Government of China set ambitious targets for energy conservation and emissions reduction, and Rizhao, as an industrial city, was also delegated energy and climate targets.

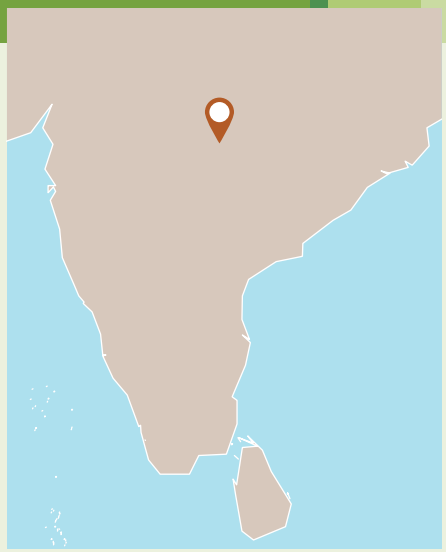
Rizhao officials work with GIZ Urban Nexus to identify ways to improve the energy efficiency of its public and private buildings and advance integration of renewable forms of energy. GIZ Urban Nexus in collaboration with the Fraunhofer Institute for Building Physics elaborated the concept of the "Nexus Energy Plus House". Officials from the Bureau of Housing and Urban-Rural Development Rizhao and local real estate developers are advised on how to elaborate climatically adjusted designs and integrate photovoltaics into walls and roofs to produce green energy that can be fed into the local electricity grid. Technical and financial solutions have been sought throughout the project.

In addition to Nexus energy-plus houses, the Bureau seeks innovative solutions to its wastewater system, which was showing deficiencies regarding the lowering of sewer manholes. The vacuum sewer wastewater collection system is therefore of particular interest. Through consultations, study tours and trainings, representatives from Rizhao have enhanced their understanding of innovative wastewater management systems.



Source: (Left and center) GIZ. (Right) Kyungkoo (Philip) Kang.

Nagpur, India



The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations.

The city of Nagpur has a population of about 2.5 million and generates approximately 900-1,000 metric tons of waste per day (TPD), of which only 150-200 TPD is processed. Irregular collection services along with limited processing and disposal facilities has led to open dumping, posing a significant threat to public health and the environment. The project is focused on supporting Nagpur to improve its existing solid waste management situation.

The Nagpur Municipal Corporation led the formation of a Nexus task force to ensure active interdepartmental communication and a coordinated planning approach. The mayor chairs the task force, and department heads representing the water supply, waste management, sewerage and other sectors actively participate. The Nexus task force was well constituted comprising political, administrative and technical representatives. National and subnational organizations, including the Ministry of Housing and

Urban Affairs, the National Institute of Urban Affairs, the National Environmental Engineering Research Institute, the National Institute for Transforming India Aayog, the State Government of Karnataka and the Department of Urban Development, Maharashtra, were engaged to enhance discussions on integrating the Nexus approach into planning frameworks and improve coordination across different government levels.

Arcadis NV and Zweckverband Abfallbehandlung Kahlenberg (Kahlenberg Waste Treatment Association) work with Nagpur's Nexus task force to assess the suitability of several prevalent waste management technologies on the basis of waste composition, reliability of the technology, state of the art, value chain, regulatory compliance, marketability of by-products, social acceptability and environmental sustainability. The analysis indicated that MYT® based on the principles of mechanical-biological treatment was relatively more suitable, adaptable and flexible for the type of waste which the city generates. The study indicated that a total input of 800 TPD of municipal solid waste into the MYT® system would generate 8.36 MWh of energy and 213 TPD of refuse-derived fuel with a calorific value of 10,000 to 12,000 kJ/kg, which could be used for on-site energy generation or supplied to cement, steel and power plants. The feasibility study indicated a capital cost of €66.36 million for setting up an 800 TPD MYT® processing plant in Nagpur. The annual operating costs, including manpower cost, was estimated at approximately €0.19 million. The study was aimed at helping develop a Nexus-compliant project supporting Nagpur in making well-informed decisions, while selecting an appropriate technology that promotes maximum resource utilization and improved efficiency.

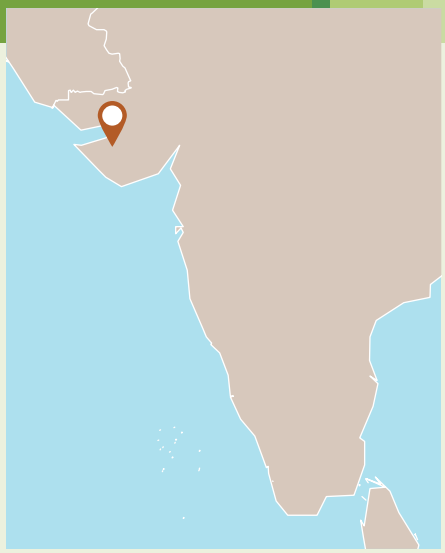
Nagpur City also organized and promoted regional exchange and dissemination of successful, practical approaches to integrated resource management. A delegation from Ulaanbaatar visited Nagpur to learn about reusing and recycling treated wastewater for power plants. The Mongolian delegation visited the wards where 24/7 water was supplied under another initiative launched by the Nagpur Municipal Corporation. The delegation also visited the National Environmental Engineering Research Institute and observed the use of the "Smart Strip" being developed under the Smart City initiative.

"Urban Nexus project has helped us to identify synergies and to take advantage of the co-benefits arising from integrated resources management and planning. SDGs have targets that are functions of local governments. We understand how an integrated approach impacts the sustainability of the city and could actually help us in moving towards a circular economy thereby achieving our targets as well as SDGs".

Nanda Jichkar, Mayor, Nagpur Municipal Corporation

Source: (Left) Kibae Park. (Right) GIZ.

Rajkot, India



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With approximately 1.28 million residents, Rajkot is the fourth largest city in the state of Gujarat. The city's high growth rate, climate and spatial location in an arid zone with erratic rainfall makes water supply a major challenge. The city was able to provide only 106 litres of water per capita per day, with intermittent supply for an average of 20 minutes per day. Local water resources met approximately one third of the city's demand, and groundwater was an unsustainable source due to the low water table, and fluoride and nitrate risks. To meet demand, Rajkot drew from distant water sources, a process which required large amounts of energy.

The Rajkot Municipal Corporation led the formation of a Nexus task force to ensure active interdepartmental communication and a coordinated planning approach. The mayor chairs the task force, and department heads representing the water, wastewater, solid waste and other sectors constitute the group. Political, administrative and technical representatives are involved, and national-level organizations, including the Department Housing and Urban Development, Gujarat, and the Ministry of Housing and Urban Affairs, are engaged. Frequent discussions ensure the support of provincial and national governments.

In focusing on the potential to optimize water and energy resources, a tool was developed to help track water usage, leaks and non-revenue water. GIZ Urban Nexus and ICLEI South Asia worked with Rajkot to study and develop recommendations regarding reuse of treated wastewater for gardening or agricultural purposes and proposed district metering in areas to improve water demand management and use of a supervisory control and data acquisition system as a performance indicator. Officials joined trainings to enhance their capacity to apply the tool and use it to balance Rajkot's water system at the zonal level, focusing on areas with high levels of non-revenue water. More efficient water systems save energy. Rajkot scaled up the metering initiative to five more wards, and the Corporation's tax department started preparing and maintaining geo-referenced information at the household level to be linked with Corporation-provided services.

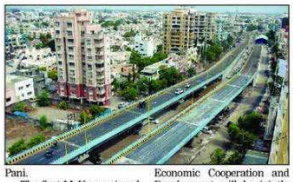
Rajkot also explored the feasibility of using vacuum sewer technology in the forthcoming greenfield area under the city's Smart City plan. Experts from Aqseptence conducted a two-day technical training programme, providing insight into the technical, managerial and financial aspects of the technology. More than 60 participants from Indian cities beyond Rajkot (e.g. Jamnagar Municipal Corporation and Ahmedabad Municipal Corporation) attended this event, which provided a platform for knowledge-sharing and exchanging technical know-how.

Lesson learned from India: To ensure successful implementation of the project, it is necessary to engage with political as well as administrative wings of the urban local body throughout the project period. This will ensure their continuous support of the activities as well as provide critical practical local knowledge.

Rajkot takes leap towards becoming a Smart City

Three MoUs Inked With Int'l Agencies

TIMES NEWS NETWORK



Rajkot: Saurashtra's commercial capital, Rajkot, took an important step towards becoming a 'Smart City' on Thursday when the Rajkot Municipal Corporation (RMC) inked three memorandum of understandings (MoUs) with Pani.

The first MoU was signed as a part of 'capacity building Economic Cooperation and Development will be jointly implemented by German firm as an important urban centre and working towards becoming a Smart City. These MoUs entail using global technologies along with traditional resources to improve the quality of life of the citizens," the spokesman said.

The Switzerland government had recently selected Rajkot for its low carbon and climate resilient city development projects in India. Under the low carbon projects, lot of focus would be on the local foundry industry, pump manufacturing, mainly for agricul-

Source: GIZ.

Pekanbaru, Indonesia

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Pekanbaru has approximately 1 million residents who produce 700 tons of solid waste per day. The landfill in Rumbai district has been operating for 20 years and is quickly running out of land for waste disposal. Moreover, in the next 20 years, the average amount of solid waste for Pekanbaru is estimated to exceed 1,200 tons per day.

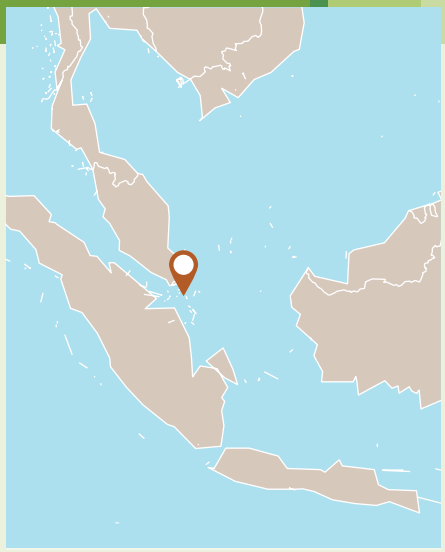
The increasing amount of waste, land limitations and adverse impact of open dump sites on the environment, health and safety make the concept of the sustainable sanitary landfill-to-energy system as well as the Maximum Yield Technology® highly relevant to Pekanbaru's needs.

The government of Pekanbaru City created an Urban Nexus task force to lead the Integrated Resource Management in Asian Cities: The Urban Nexus project. The project supported an assessment and recommendations to address the city's solid waste management situation. Officers from Pekanbaru participated in various capacity-building workshops and trainings and visited a waste-to-energy model site in Bantan Sanitary landfill in Chiang Mai, Thailand. The privately run sanitary landfill produces 2 MWh of electricity per day from 600 tons of solid waste. The company profits from selling electricity to the Provincial Electricity Authority. Pekanbaru expressed interest in applying a similar model and is in the process of purchasing land for a future sustainable solid waste management site that will include installation of efficient methane gas collection and an energy production system.

Staff changes early in the project contributed to periods of inactivity, but the Vice-Mayor, Head of BAPPEDA, the development planning agency at the subnational level in Pekanbaru, joined the seventh regional workshop held in Tanjung Pinang, Indonesia, in July 2017, and expressed the city's interest to continue applying the Nexus approach in the city.

Source: (Left) Shutterstock. (Right) ESCAP.

Tanjung Pinang, Indonesia



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Tanjung Pinang is the capital of Riau Islands Province, with roughly 280,000 inhabitants. Under the project, the city has addressed wastewater and solid waste management, as both sectors face infrastructure challenges.

BAPPEDA, the development planning agency at the subnational level, plays an active role in maintaining the Nexus task force throughout the project and beyond. To ensure a coordinated approach to planning in cities, department heads representing the water, wastewater, solid waste and other sectors, as well as political, administrative and technical representatives meet frequently.

Studies of Tanjung Pinang's wastewater challenges have been focused on Senggarang subdistrict. Homes in this coastal area are located on stilts. Results indicated that a vacuum sewer system would be the most suitable to collect domestic wastewater. Such a system is new to the country, and Indonesia requires that laboratory-scale research be conducted by the Research Centre for Knowledge and Learning Network for Community Empowerment in Housing and Urban Development under the Ministry of Public Works and Housing before new technologies may be applied. On 12 September 2017, the Director of the Residential Environment Sanitation Development, Directorate of General Human Settlements of that Ministry, recognized the vacuum sewer system as a proven technology to address sanitation problems in coastal areas. The Director of Urban, Housing and Settlements of BAPPENAS recommended that the vacuum sewer system be adopted following a step-by-step process, with the first step involving a pilot project in Senggarang; the Research Centre would act as the lead agency in cooperation with GIZ Urban Nexus.

In addition to wastewater management, GIZ Urban Nexus with Wehrle Umwelt GmbH collaborated with local and provincial officials from Tanjung Pinang and Riau Islands, respectively, to identify solutions to solid waste challenges. A study, which included cost estimates, was conducted; subsequently it was recommended that Tanjung Pinang City and the province should adopt MYT® and apply a clustering approach. This aligns with the provincial government's programme to create regional solid waste management facilities that will cover Tanjung Pinang City and the Bintan Regency.

Capacity-building activities included many trainings and workshops, with the most recent being in late 2018, involving GIZ Urban Nexus collaborating with the Center for Planner's Development, Education and Training of BAPPENAS to provide training on the Urban Nexus approach and training of trainers. Representatives from all government levels and academia participated. In part due to these recent trainings, the Government of Indonesia recognized the Urban Nexus concept as a relevant approach for urban development in Indonesia via the Center.

Lesson learned from Indonesia: To introduce and apply new technologies in Indonesia, laboratory tests must first be conducted by the Research Centre for Knowledge and Learning Network for Community Empowerment in Housing and Urban Development of the Ministry of Public Works and Housing. Bureaucracy can be extensive from the national to local levels, and frequent staff turnover in government agencies can contribute to delayed implementation of projects and programmes. Institutionalizing mechanisms to sustain momentum through change is important.

Source: City of Tanjung Pinang.

Ulaanbaatar, Mongolia

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More than 60 per cent of the 1.4 million residents of Ulaanbaatar live in poorly organized settlements of ger (a portable, round tent covered with skins or felt) on the city's periphery; these settlements are expanding in an uncontrolled manner mainly due to urban migration. This situation is contributing to major environmental and social problems, including air pollution and soil and groundwater contamination. Through the project, Ulaanbaatar examined a community-driven, land readjustment effort, studied the city's energy master plan and identified possible solutions to improve Ulaanbaatar's management of solid waste.

The residents of ger districts generally have legal title to their plots but desire to live in detached homes with basic infrastructure connections. Due to capacity and budgetary shortages, decentralized solutions, especially for heating and wastewater management, are needed. These settlements often lack basic services, except for electricity supply. The community-driven land readjustment involved Tsaiz village in Khoroo 19 (a khoroo is the smallest administrative unit in Ulaanbaatar) and was conducted within the framework of the Ulaanbaatar city housing and infrastructure development subprogramme adopted in 2018, incorporating energy-efficient and ecological principles. The objective is to improve land use, increase land value and develop neighbourhoods that will be livable, competitive and attractive to investors. Designs for respective, environmentally friendly neighbourhoods and energy-efficient housing will help the owners to raise funds required to finance their own housing improvements. The use of land title deeds as collateral for loans from financial institutions is seen as the main way for land owners to raise funds to finance construction.

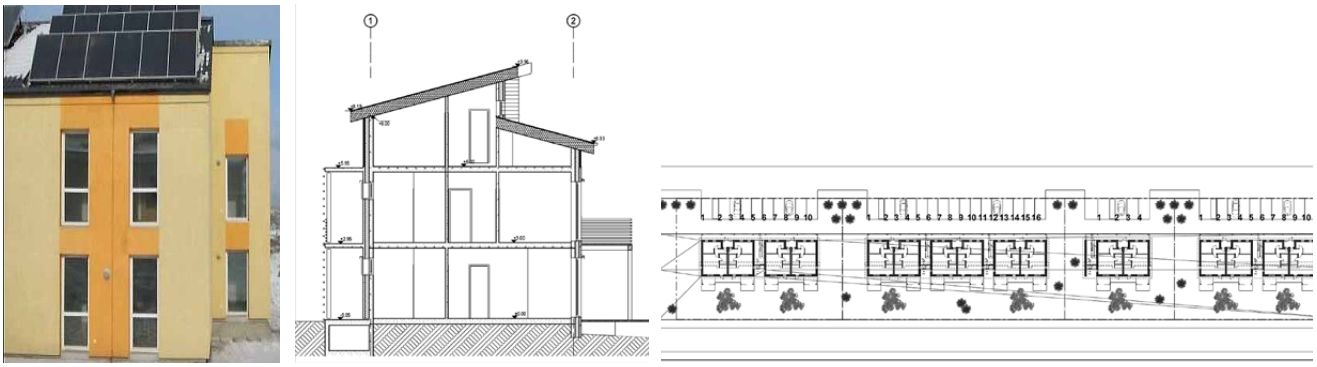
In Tsaiz village, about 180 households on 12 hectares of land are participating in the land readjustment process. A citizens' interim council and a cooperative of landlords have been created to join the efforts and communicate with Ulaanbaatar City and other stakeholders. A memorandum of understanding for the "Tsaiz Ecovillage" project was signed on 30 March 2018 by the Housing Corporation of the Capital City, Erel LLC (a construction company and developer), Arig Bank (a private commercial bank), Eco-village cooperative (cooperative of landlords) and GIZ Urban Nexus. Community surveys and interviews have been conducted, and a preliminary study "Ecovillage Project in Khoroo 19", analysing the current situation and challenges, was conducted; it was presented to the stakeholders in July 2018. Arig Bank developed two-tier financing options for the developers and home buyers, and a model two-storey, energy-efficient building was presented to the Housing Corporation of the Capital City. After negotiations with landowners, six households expressed their readiness to provide their land for the pilot house construction.

The Housing Corporation of the Capital City intends to mobilize funds from the city budget for basic infrastructure construction, and the first pilot townhouse project consisting of 20 units is scheduled for construction in 2019.

Regarding energy supply, Ulaanbaatar is dependent on fossil fuel; power plants and heat-only boilers operate at levels below international standards producing carbon dioxide emissions and air pollution. Transformation from a coal-based to a mainly renewable energy-based system is needed to address existing challenges. The project supported a pre-feasibility study on Ulaanbaatar's energy master plan, which is aimed at providing a comprehensive, impartial inventory of the initial situation regarding demand, provision and distribution of heat and electricity and a determination of the renewable energy resources available. After that assessment, the German Fraunhofer Institute for Solar Energy Systems provided recommendations regarding technologically possible options that would promote emissions reduction and the establishment of a sustainable energy supply that includes renewable energy sources.

Local and national government stakeholders, energy sector experts, engineers, utilities, international organizations, banks and the private sector were involved in the study, providing energy consumption data, among other inputs. An optimized design of the target energy system for the year 2050, based on modelling the most cost-effective and robust system to achieve the system's goals, was provided. Findings indicate that solar and wind will become the main energy sources for Ulaanbaatar; however, wind potential within the city is limited. Thus, the wind potential of the areas adjacent to Ulaanbaatar should be tapped as well.

Some recommended that the next steps should include: (a) increasing energy efficiency through a building insulation programme and reducing energy losses in the entire energy system; (b) electrification of the heating sector and strengthening of the electrical grid where necessary; (c) installing renewable energy systems; and (d) building capacity in elaboration of energy-efficient building designs and elaboration of energy balances before and after the buildings are erected.



Source: GIZ.

Key policies needed to kick-start the energy system transformation include: (a) further development of the Energy Conservation Law, revision of the Mongolian National Standard on Energy Efficiency of Buildings and revision of the Renewable Energy Law to stimulate private investment in photovoltaic and wind power systems; (b) development of energy balances before issuing building permits; (c) consumption-oriented and cost-covering heat energy tariffs; (d) enforcement of existing laws and standards, rules and regulations; (e) introduction of electric heaters for gers and detached houses; (f) development of a grid expansion policy to enable the use of electric heaters; (g) advancement of a photovoltaic installation programme on public buildings; and (h) evaluation of geothermal potential.

Huge amounts of waste are collected, transported and disposed on Ulaanbaatar's three large and many small-sized dumps, without separation and classification. This situation has led to many environmental problems. The Government of Mongolia and that of Ulaanbaatar City are considering the construction of additional landfills showing interest in waste-to-energy technologies.

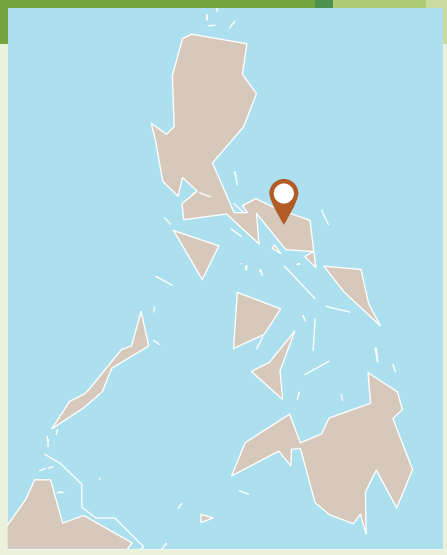
The National Development Agency of Mongolia in May 2018 requested GIZ Urban Nexus to provide advisory services with regard to solid waste management. Arcadis Germany GmbH was selected to study options to improve solid waste management in Ulaanbaatar, focusing on the potential of waste incineration and public private partnerships. A diverse group of stakeholders was engaged in this process, including the National Development Agency, Ulaanbaatar officials, private companies from the waste management sector and international donors and banks. By building an eco-friendly incineration plant (combining heat and power), with the fuel being derived from municipal waste, the "Waste-to-Energy Project" could simultaneously solve environmental problems and the shortage of power and heating capacities, thus contributing to Ulaanbaatar's green development policy.

The city intends to address challenges, including social acceptability, high ash content in household waste from ger areas and financing. Before a suitable private sector partner can be selected, however, it is necessary to set up a technical, institutional, legal and environmentally protective framework. Owing

to the lack of a public-private partnership and waste-to-energy experience on the national and municipal levels, it was strongly recommended that this process be facilitated with the support of an external firm.

Lesson learned from Mongolia: There is a need for improving community problem-solving capacity through participatory processes. Appropriate decentralized infrastructure solutions should consider not only the capital expenditures but also operating expenses.

Naga City, Philippines



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Located near the centre of the Bicol region, Naga City is an area frequently affected by typhoons. A bustling centre of socioeconomic activities, with a population of about 196,000, Naga City's rapid urban development calls for more integrated and innovative solutions. To this end, the city is formulating a 30-year sustainable urban development plan as a basis for its long-term growth. Naga City is integrating the Nexus approach into its work to identify solutions to address challenges, as discussed below.

Naga City's Planning and Development Coordinator led a large and diverse Nexus task force comprising sectoral experts, school board and People's Council representatives, and other bureau and department representatives. The task force reports directly to the mayor and wants to ensure a coordinated planning approach.

"Pursuing a waste-to-energy project is one of the flagship undertakings that we want to push. We are thankful for the technical assistance provided by GIZ Urban Nexus as we embark on this challenging but exciting initiative as a means to realize long-term sustainable urban development. Coupled with our vision of good governance, we will continue to live up to our vision of being a 'maogmang lugar' [happy place] for the future generation of Nagueños" [citizens of Naga City].

Mayor John Bongat, Naga City

Prior to its selection as one of the Nexus project sites, Naga City administrators agreed with Habitat for Humanity and the Home Development Mutual Fund to develop a low-cost housing project in Barangay Del Rosario.[21] A 5,200 m^2 site was procured by Naga City. Recognizing the immense potential of a housing project to exemplify the Nexus approach, GIZ Urban Nexus introduced possible structural and design amendments to make the proposed housing more disaster resilient. Further, a study was conducted on the possibility of employing a vacuum sewer system in the housing project as a means of centralized wastewater collection and as a way of avoiding the conventional gravity system which tends to be more costly.

Beyond the housing project, a household survey on sanitation and wastewater services was conducted by GIZ Urban Nexus and the Bicol State College of Applied Sciences and Technology covering three barangays. Results helped establish a baseline for further development of the city's innovative wastewater management. Keen to "lead by example", Naga City is exploring demonstration initiatives, such as piloting an innovative wastewater management project in its public market. Further, the city is partnering with the Metro Naga Water District on ways to generate energy from sludge.

Naga City is also working with the Water District to tap the National Sewerage and Septage Management Program of the Department of Public Works and Highways to improve water quality and protect public health in urban areas of the country by 2020. That programme provides a 50 per cent subsidy (as of October 2017) for sewerage and septage projects.[22]

Consciousness has been created among decision makers that an innovative wastewater management system is required to improve the sanitation system, as current practice has been leading to increased contamination of groundwater, rivers and soil.

In addition to wastewater management, addressing solid waste management, particularly through waste-to-energy, has been one of Naga City's priorities. GIZ Urban Nexus supported work to help identify suitable technologies and models that could be applied on the existing and new landfill site. Recommendations on how to close the existing Balatas landfill, design the new San Isidro sanitary landfill and capacitate management and labourers of the landfill were shared with relevant stakeholders. Armed with enhanced understanding of the different options for using the waste-to-energy model, Naga City is now more prepared to implement a Nexus approach that adheres to national laws and standards concerning solid waste management. The city government officially approved implementation of a sanitary landfill with a waste-to-energy facility valued at 260 million pesos (approximately €3.9 million) that will occupy 4.85 ha of land and is projected to accommodate a maximum of 508,064 m^3 of municipal solid waste for a period of 10 years after it starts operation. The waste-to-energy component will use gasification technology. Naga City will invite prospective bidders for the waste-to-energy project on the condition that it should be constructed under a national joint venture framework.

As gleaned from local stakeholders and studies conducted under the project, Naga City's growing concerns regarding its wastewater management and solid waste challenges are very much linked to the ecological integrity of its river system and the health of its populace. The Nexus approach helped the city examine its sanitation problems from multiple perspectives, thereby enabling it to design sustainable solutions that will steer the city towards its vision of becoming a "*maogmang lugar*" (happy place).

The 30-year sustainable development plan is part of Naga City's efforts to localize the "AmBisyon Natin 2040" vision of the National Economic and Development Authority; it covers a broad range of issues, including sanitation and urban planning. AmBisyon Natin 2040 represents the Filipino people's collective long-term vision and aspirations for the next 25 years. GIZ Urban Nexus supported Naga City in formulating its development plan by introducing "design thinking" to solicit inputs from various segments of the population in a creative manner, with the end goal of formulating a long-term plan that is both people-driven and responsive to the city's urban development trajectory.[23]

Lesson learned from the Philippines: In terms of solid waste management, visits and discussions with local authorities in the Philippines showed how difficult it is, especially for smaller cities and municipalities, to implement sustainable waste management technologies. Thus, the co-development of waste treatment concepts for neighbouring communities working together is crucial to implement a modern, technically efficient, sustainable and environmentally friendly treatment technology. This supports the national policy on clustering as promulgated by the National Solid Waste Management Commission.

Source: (Left) Naga City. (Right) Kyungkoo (Philip) Kang.

Bicol State College of Applied Sciences and Technology, Naga City, Philippines

Bicol State College of Applied Sciences and Technology (BISCAST) is a meso-level educational institution selected to disseminate the Nexus concept within and outside of academia. As a state college, BISCAST is mandated to provide advanced and higher education services as well as to undertake research and extension services within its service areas in the Bicol region. BISCAST primarily focuses on capacity-building in energy and water conservation, waste management and sustainable as well as climate change-resilient architecture. To achieve the Nexus goals, BISCAST created a Nexus task force which has a cross-sectoral structure to overcome existing institutional silos and to monitor integrated resource management and support its partners' projects, such as Naga City.

BISCAST integrated the Nexus approach into its systems and processes, encouraging collaboration and synergies among departments, increased stakeholder engagement and improved information-sharing. The college focuses on six project components that are interconnected and implemented by the academic and administrative divisions in a cross-sectoral manner.

To integrate the Nexus approach into the development of resilient housing, BISCAST initiated the design and construction of a climate change-resilient pilot house (CCRPH) based on the principles of climate change resiliency, affordability and green buildings (see box A). CCRPH has the capacity to resist, absorb and respond to the adverse effects of climate hazards without significant changes to its basic functions and structures and is intended to serve as an alternative model for low-cost socialized housing projects in the Philippines. CCRPH was inaugurated in June 2016 in the presence of key project partners. It received the highest rating from the Philippine Green Building Initiative for green building standards as well as for "climate change resiliency". BISCAST also developed a "low-cost housing building design system", which in December 2017 received accreditation for innovative housing technologies from the National Housing Authority.

BISCAST engaged with Naga City by supporting the following:

- Redesign of an affordable housing system for Barangay Del Rosario housing project
- Survey on water and wastewater services and facilities in three barangays
- Preparation of Naga City's 30-year sustainable urban development plan
- Workshops on applied Nexus technologies, which included the local government and the private sector

Naga City and other municipalities, such as the Canaman local government, have expressed interest in adapting the design of CCRPH of BISCAST.

Source: Kyungkoo (Philip) Kang.

With the aim of disseminating information on the Nexus approach, BISCAST has facilitated events, such as the Urban Nexus Regional Forum: "Sharing the BISCAST Experience in the Framework of the Urban Nexus Approach", which engaged other academic institutions in the Bicol region (Sorsogon State College, Catanduanes State University and Memorial State College of Agriculture and Technology). BISCAST collaborated with other organizations and private institutions, such as Supermalls Naga City, Department of Trade and Industry, Partido Development Administration, Commission of Higher Education and the Metro Naga Water District, to advance integrated resource management through regional forums, trade fairs, site visits and local workshops.

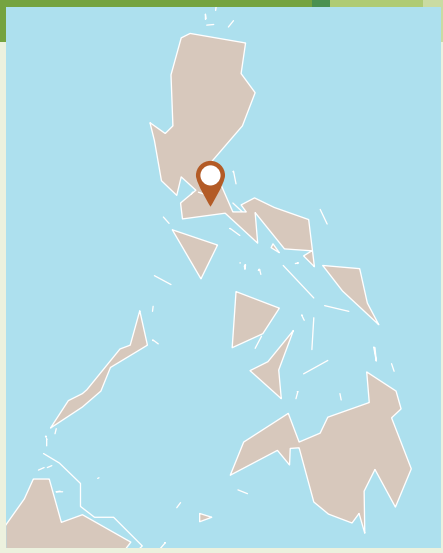
Through its "Build Environment Course", BISCAST has integrated the Urban Nexus approach into its curriculum.

"The Urban Nexus approach is an innovative platform for BISCAST to overcome 'silo thinking' in our institution and to combine the expertise of our staff. With our Integrated Resource Management Plan, we were able to implement projects with the consideration of energy and water efficiency, available resources and their efficient use. As an educational institution, our mission is to disseminate our experience with the Nexus approach to other institutions, local government units and the community. To reach this goal we are establishing now the BISCAST Nexus Center which will be the converging point for our institutional Nexus activities, the regional network of educational institutions as well as non-academic institutions. Furthermore, it will be also the gateway to connect with international partners and in particular with the academe".

Richard H. Cordial, BISCAST President

Santa Rosa City, Philippines

With a population more than 350,000, Santa Rosa is one of the fastest-urbanizing cities in the Philippines. It is politically subdivided into 18 barangays, with three situated along Laguna de Bay. Rapid development coupled with urban migration has increased pressure on the city's services and natural resources.



The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations.

The Santa Rosa Nexus task force was created by an executive order signed by the mayor in 2013 and is composed of local government representatives from the Environment and Natural Resource, Urban Development and Housing, Planning Development, Engineering, Health, Agriculture, General Services, Social Welfare and Development Offices, as well as the Laguna AAA Water Corporation.[24]

Santa Rosa is relocating residents of Barangay Labas, an area prone to flooding, to an adjacent government-purchased property (13,842 m^2) in the centre of the city. The City Urban Development and Housing Office is surveying potential beneficiaries' capacity and willingness to pay, working with the Home Development Mutual Fund, a Philippine government-owned and controlled corporation responsible for providing access to shelter financing.

GIZ Urban Nexus provided technical support by developing designs and affordable housing models that promote space optimization and water, energy and cost-efficiency. This housing project is envisioned to showcase green building principles, innovative wastewater management, public-private partnerships and an all-inclusive city. Additionally, aspects of operation, maintenance and repair of the infrastructure systems to be installed have been considered, even during the pre-construction phase. The possibility of forming a public-private partnership has also been contemplated.

Santa Rosa City lacks centralized wastewater treatment. Most residential areas have pit latrines and septic tanks, with more modern developments employing decentralized wastewater treatment. Laguna AAA Water Corporation, the authority responsible for the city's water supply and wastewater discharge, is proposing the development of a modern system. The proposed housing project incorporates vacuum sewer wastewater collection, enabling reuse of treated water for urban agriculture and energy generation from black water. The city hopes to partner with the Corporation to treat the consolidated domestic wastewater. Santa Rosa completed a technical questionnaire aimed at obtaining accurate data on influents and effluents at peak flows to correctly size the envisioned vacuum station and sewer network. The results serve as a basis for the initial feasibility study, including budget proposal, for the system. The cost calculation needs to be revisited, however, when the housing design is finalized.

Through this project, the living conditions of selected low-income families in Barangay Labas, as well as local government families, will be improved, empowering them to defend their interests by integrating them into livable urban structures.

In addition to wastewater, solid waste management is a priority issue for the city. Based on 2015 data, Santa Rosa City's estimated solid waste is 246 metric tons per day. This is equivalent to 0.6 kg/person/day of waste generated. Currently, the city disposes its solid waste in Pilotage, a landfill located in the adjacent city of San Pedro, Laguna. In considering the volume of waste that the facility receives vis-à-vis its carrying capacity, Pilotage will potentially be closed between 2021 and 2023. Santa Rosa City is keen to explore innovative technical solutions to address this plan in the framework of the clustering approach of the National Solid Waste Management Commission. The city also cooperated with the Commission to ensure that the solutions identified are aligned with national policies and regulations.

GIZ Urban Nexus supported a technical study that examined the status of solid waste management for Laguna Province. The study was focused on Santa Rosa's case and further assessed Pilotage's current situation to provide sound recommendations on technical solutions that may be applied. One general treatment concept that contains several process stages that can be combined so that each local government unit adopts the best-suited solution. Thus, one concept can be used to cater to the different needs of individual local units. These solutions considered the technical and financial possibilities of waste management authorities. All options assumed that recyclable substances would be segregated at the household level. Recyclables and reusable substances that were not segregated at the point of origin should be separated and converted into usable products (e.g. compost for agricultural use, recyclable materials or substances with an optimum condition for energy recovery in industrial processes) at the waste treatment plant.

"The creation of the Santa Rosa Nexus task force has been a significant milestone for the city because it became a platform for us to collaborate more strongly, particularly in terms of identifying and implementing integrated solutions to help manage the city's limited resources while also ensuring that we protect the environment".

Erlinda Creencia, City Environment and Natural Resource Office, Santa Rosa

Source: GIZ.

Chiang Mai, Thailand

The city of Chiang Mai, with just over 131,000 residents, has a thriving tourism industry: the province and city welcomed more than 9 million visitors in 2017. This has increased pressure on the city's natural resources and contributed to rising pollution levels. Through the Nexus project, the city explored a variety of activities to support the community, save energy and reduce water pollution.

Chiang Mai's Office of the Mayor and Department of Public Works were actively engaged throughout the project, bringing together representatives from multiple agencies and organizations, including from the health and tourism sectors, the wastewater management authority, and water and wastewater companies. The city collaborated well between municipalities and across government levels, particularly with Chiang Mai Province and the Ministry of Natural Resources and Environment's Office of Natural Resources and Environmental Policy and Planning.

The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations.

Chiang Mai's many hotels, guest houses, residences, restaurants and markets discharge wastewater and septic tank effluent into the Mae Kha Canal, which leads to environmental and health problems. In 2017, the Chiang Mai governor deemed the Mae Kha Canal wastewater problem a top priority to address. The province and city established a task force to find integrated solutions to this critical problem. GIZ Urban Nexus, a member of that task force, proposed solutions, such as channellizing the Mae Kha Canal with fresh water flow on top and creating meadows to absorb flooding, as well as connection of more neighbourhoods via innovative wastewater collection (vacuum sewer) and improved management. The city has taken up the proposals to the provincial level for further discussion and possible implementation.

The city's main wholesale market, Muang Mai, is discharging wastewater and organics into the drainage system, which causes heavy blockage within the market's drainage/sewage system. Muang Mai market has become one of the main contributors to the contamination of Mae Kha Canal. To find a sustainable solution, GIZ Nexus studied the situation and recommended a wastewater vacuum sewerage collection system to manage wastewater in this flat terrain, with little open space. The treated water could be used to flush the Mae Kha Canal and the moat of the old city, and/or it could be used to dilute the polluted water in the canal and the city moat.

Tourism and economic growth of Chiang Mai bring with them pollution, and wastewater management is becoming a critical problem of the communities. Problems in Chiang Mai Old City – the heart of Chiang Mai – range from clogging of the combined drainage system and lack of effective sewerage infrastructure to inadequate septic tanks, resulting in contaminated groundwater and water wells contaminating the Mae Kha and its tributaries. GIZ Urban Nexus conducted a household survey in two communities (Chiang Mun and Lam Chang) to gather baseline data and elaborate a feasibility study on innovative wastewater treatment for the Old City and to promote communication between the local, provincial and national levels.

The moat surrounding Chiang Mai's Old City contained 66 inefficient pumps that were continually overheating and breaking down, resulting in high electricity bills and costly operation and maintenance costs. With support from the Nexus project, consultants collaborated with the city to identify the most cost-effective option, which was to replace inefficient pumps with submersible, energy-saving models. The project piloted installation of one energy-efficient, submersible fountain pump to gather data. Chiang Mai Municipality agreed to replace the remaining pumps in the Old City moat if the pilot proved successful. Anticipated benefits would include saving the equivalent of $90,000 annually in electricity costs. The city has now allocated 10 million baht (about $312,500) to replace all remaining pumps with models similar to the pilot pump.

As Thailand's population is rapidly ageing, Chiang Mai Municipality designed a three-storey health centre building to provide physical therapy services, day care and Thai traditional medicine for the elderly. GIZ Urban Nexus worked with the city to include passive and active energy-efficient features, proposing the use of natural daylight and shading, insulation, concrete cooling, LED lighting and a heating, ventilation and air-conditioning evaporator with inverter, which would improve on the initial building designs. With an additional $35,000 investment in building improvements, the health-care centre could achieve energy savings of more than 40 per cent with a payment period of less than five years.

Source: GIZ.

Nakhon Ratchasima (Korat), Thailand

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The city of Nakhon Ratchasima, popularly known as Korat, is the gateway to the northeastern region of Thailand; the city has a registered population of about 128,400. However, Korat Municipality services about 450,000 people, as other municipalities also subscribe to its water supply service. With rapid population growth, the land-use pattern has been changing from agriculture to an urbanized residential pattern. The local government is aware of the increasing stress on natural resources and foresees the sustainable provision of water, energy and food to the people as a priority. GIZ Urban Nexus introduced an integrated approach, working with the city on sustainable water management and innovative solid waste management solutions.

Since the project's inception, the mayor of Korat has been actively engaged, and several municipal departments, including water supply, public works, public health and social welfare, among others, worked in an integrated manner to collaborate with the GIZ Urban Nexus team and the relevant consultants to collect baseline data and come to a consensus on how to implement solutions to their urban development problems. Korat is fairly autonomous compared with the other project cities and GIZ Urban Nexus partner cities, especially in terms of financing activities that involve less than $1 million per project. The city was able to source funds to implement almost all of the proposed solutions, totalling an investment of $1.5 million.

The main source of water supply for Korat City is from Lamtaklong Dam. The municipality pays 3 million baht (about $93,750) per month for Makham Tao Station to pump/distribute tap water to consumers. Pumping the water requires large amounts of electricity. However, half the pipe network leaks, which forces the plant to produce and pump more water into the network than is actually required. Through the technical assistance of the project, system efficiency was analysed, and operational fine-tuning solutions were implemented with the municipality's own budget. As a result of system analysis, a rearrangement

and fine tuning of Makham Tao pumping station's operations was implemented. The adjustments enabled the municipality to save maintenance costs that were incurred by the station and reduce the formerly high levels of electricity consumption. The electricity bill has been reduced on average by 29 per cent, or more than 1 million baht per month.

Building on the success of the system efficiency analysis and implementation at Makham Tao in terms of water production and distribution, the intervention was scaled up to include broader water supply distribution management. In total, 48 million m^3 of water were produced and treated in fiscal year 2015. However, the financial department indicated that only 21 million m^3 of the produced water was consumed and paid for, indicating significant water loss of 27 million m^3. By addressing the water loss problem, Korat has the potential to save 50 per cent of its water resources, 50 per cent of the energy used for transporting and distributing raw and fresh water and 50 per cent of the chemicals used for water treatment. Short- and long-term measures were proposed, starting with replacement of outdated water meters to record accurate volumes and fees for water consumption. The municipality institutionalized the GIZ Urban Nexus recommendation of replacing the old water meters by amending a by-law of the city to allow the municipality water supply department to purchase new meters to replace the old ones. Prior to this change, the city did not have the legal right to change the water meters because they belong to the respective subscribers. The water supply department has so far replaced 4,000 water meters. As a result, the municipality now receives accurate data on residents' water consumption, which can contribute to an appropriate production volume and ensure that the municipality will receive correct and higher revenue – already an increase of more than 10 per cent.

In addition to addressing water supply issues, the project sought improvements in Korat's wastewater management system. Korat's Central Waste Water Treatment Plant has a capacity of 75,000 m^3 per day. The average daily inflow, however, amounts to only about 21,000 m^3 per day and is therefore much lower than expected and only 28 per cent of the design flow. That plant is not functioning at its optimum efficiency because it receives and treats diluted water. Only septic tank overflow enters the sewer system. The activated sludge system's sludge scrapper machine constantly breaks down and therefore does not enable proper treatment processes. Baseline data were collected and procedures for the plant's rehabilitation were proposed. One of the proposed measures for increasing the organic load was to collect the wastewater directly from neighbourhoods near the plant by using a vacuum sewer collection and transport system. A comprehensive survey on vacuum sewer implementation was conducted in those neighbourhoods jointly by the GIZ Urban Nexus team, Department of Public Works and Department of Social Welfare. The rehabilitation of the plant showcases practical and sustainable solutions that prompted the city to commit a budget to fix the problems, as recommended. The activated sludge system is now functioning, increasing the amount of sludge and enabling proper wastewater treatment.

Lesson learned from Thailand: Combined sewers impede opportunities to produce energy from wastewater treatment, as the organic load of wastewater reaching the treatment plant is often too low with these systems due to dilution of wastewater with storm water.

Source: GIZ.

Korat's Solid Waste Management Facility (biogas plant and landfill) receives about 400 tons of municipal solid waste per day. Due to system failures and maintenance work, the amount of treated waste is 41 per cent of that amount, whereas 59 per cent is dumped directly into the landfill without separation. Some of the landfill cells are not up to sanitary standards, that is, they lack methane or leachate collection. Within the biogas plant, several improvements are also required for the plant to operate efficiently. Recommendations were made by GIZ Urban Nexus to have an efficient biogas process with low disturbance potential, such as would be possible with the installation of shredder and agitator machines. Korat invested in a shredder (18.3 million baht or about $572,000) and agitators (about 8.9 million baht, or about $278,000) to improve the process of organic waste separation, biogas production and electricity generation.

Lesson learned from Thailand: Local administrations often need technical support, at least with conducting feasibility studies, to prove the viability of solutions. Especially for smaller infrastructure projects (costing up to $1 million), once a viable solution has been identified, sourcing from budget is not a problem. If decision makers are convinced that sustainability measures can improve people's livelihood, environmentally, socially and especially economically – where investments have clear monetary and non-monetary returns – sourcing for finance is a secondary issue.

Da Nang, Viet Nam

Most households in Da Nang rely on individual, leaking septic tanks, with less than 20 per cent of households connected to the municipal combined sewerage system, which is prone to frequent overflows, thus also contributing to unhygienic living conditions. Further, the city predicts that its landfill will reach installed capacity before 2020, leading to a crisis. Under the Nexus project, the city initiated two efforts, an innovative wastewater management solution and a solid waste-to-energy project.

The Da Nang People's Committee signed a memorandum of understanding to formalize and structure the cooperation between GIZ Urban Nexus and Da Nang's Department of Planning and Investment, creating a Nexus task force to implement the projects. Da Nang officials also frequently coordinated and collaborated with national-level agencies, particularly from the Ministry of Natural Resources and Environment and the Ministry of Construction, to promote integrated solutions.

The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations.

Source: (Left) Shutterstock. (Right) GIZ.

Da Nang and the GIZ Urban Nexus team worked closely with the community, gathering input from all households that would be impacted by the innovative wastewater management project. Wastewater management surveys and studies were conducted, and recommendations from the reports were that a vacuum sewer system that separates wastewater and storm water collection should be adopted for the eastern coastal area of the city. The Department of Planning and Investment and the Sustainable City Development Project Management Unit of the World Bank will implement a vacuum sewer wastewater collection pilot project with 71 households in the An Hai Bac ward to test the system before scaling it up. Through a strengthened partnership, the pilot project on vacuum sewer wastewater collection as a first step to integrated resource management will be completed by July 2019, and thus become the first project involving vacuum sewer wastewater collection in South-East Asia.

For more information on project city activities, including access to over 85 studies led by GIZ Urban Nexus, see:
www.unescap.org/urban-nexus

Chapter III
Urban Nexus Guidance Framework

"[...] the complexities of today's challenges call for a holistic systems-approach rather than siloed approaches. Too often policies to manage water, food and energy resources are developed and implemented in isolation when we know that they are interlinked. Decision-makers have to foster policy coherence, and enhance coordination and collaboration among diverse actors to ensure that co-benefits and trade-offs are considered and that appropriate safeguards are put in place".

Kofi Annan, former United Nations Secretary-General[25]

3.1 Enabling the Urban Nexus

Achieving urban- and resource-related objectives and strategies requires a holistic, system-wide approach. The Urban Nexus wheel, shown in figure III.1, was developed to illustrate a conceptual framework based on five enabling dimensions important to implementing the Urban Nexus approach.[26] In the middle of the wheel is the resource Nexus centred on optimizing water-energy-food/land. The five dimensions: governance; inclusive decision-making; science, technology and innovation; finance and business; and urban planning are described below.

Figure III.1
Urban Nexus wheel

Source: ESCAP.

3.1.1 Governance dimension

The Urban Nexus approach goes beyond resource efficiency: it is about connecting policies, practices, organizations and institutions to work together horizontally and vertically in order to optimize resource use (Hezri, 2016). Minimizing trade-offs and optimizing synergies requires managing conflicts that may involve one or any combination of sector-based, actor-based and scale-based tensions. Capacity- and institution-building on multiple levels – micro (municipal administrations), meso (city associations, training institutions, non-governmental organizations and the like) and macro (national and international level) – are needed to build a reform constituency, accountability and improved communications (Willems and Baumert, 2003).

Good urban governance involves efficiency, transparency, accountability, popular participation, equality, security and subsidiarity. Political leadership and commitment are also important.

Horizontal integration, working across sectors at the same level and vertical integration, coordination and collaboration between different administrative or other units that represent the same or different sectors at different levels (United Nations, 2018b) are often emphasized when discussing integrated resource planning and management. Thailand has made progress with horizontal policy coherence, integration and partnerships as its institutional framework incorporates and coordinates the country's many strategies and plans. At the national level the Prime Minister chairs a committee comprising several government ministers who meet annually to improve understanding concerning the Sustainable Development Goals, set priorities and targets, and integrate the country's work on the global agendas. Thailand has a long history of integrated planning and management, as demonstrated by the "Sufficiency Economy Philosophy" introduced in 1974 by His Majesty the late King Bhumibol Adulyadej. Its 20-year strategy (2017–2036), 12th National Economic and Social Development Plan (2017–2021) and other coordination mechanisms are well aligned to support the country's achievement of the Sustainable Development Goals and related global initiatives.

While the local level can advance a Nexus approach to some degree without broader involvement, meso- and macro-level involvement are often needed to succeed. The provincial, state or regional levels of government can play a key role in bridging local and national activities, whether that involves aligning local and provincial projects with global agendas or translating national policies and guidelines into a subnational context. Coordination between levels of government helps to overcome common challenges, including unclear responsibilities, conflicting regulations, weak local capacity, lack of awareness of national intentions and lack of consultation. Through the Integrated Resource Management in Asian Cities: The Urban Nexus project, ESCAP, GIZ Urban Nexus and ICLEI organized a series of national dialogues to provide a platform for exchange between government levels.

The Urban Nexus concept recognizes the importance of decentralization – the process through which authority and responsibility for some functions is transferred from the central Government to lower levels of government, communities and the private sector (World Bank, 2001) – and the principle of subsidiarity, which is aimed at ensuring that decisions are taken as closely as possible to the citizen and is crucial to empowering cities. In the New Urban Agenda, it is stated: "We will take measures … to enhance the ability of Governments … and to empower them as policymakers and decision makers, ensuring appropriate fiscal, political and administrative decentralization based on the principle of subsidiarity".[27] Decentralization is context- and country-specific and can range from fiscal decentralization – providing adequate revenues to local government or private organizations that have been given power to carry out decentralized functions – to administrative decentralization, which redistributes authority. Having supportive constitutional and legislative frameworks which provide for local government autonomy and decentralization are key to enable cities to develop and implement innovative and sustainable solutions.

3.1.2 Inclusive decision-making dimension

In its application, the Urban Nexus approach is inclusive and brings together a broad range of stakeholders, which may include women, marginalized groups, the urban poor and youth, among others. Women in particular play a critical role in the management of resources at the household level and are often most severely affected by limited water, sanitation, energy and food supplies.

Participatory planning, where all affected stakeholders of an urban plan take part in its development, can increase citizens' understanding of the social and environmental impacts of government decisions that affect them, thus helping to inform the process, influence decision-making and improve the plan and its execution (Ondrik, 1999). Many national Governments are promoting inclusive urban development in their plans and policies. For example, in 2000, the Government of Indonesia initiated a programme to make cities slum-free and inclusive (Nasution, 2016). Some key considerations with inclusive and participatory planning are as follows:

- Social inclusion and Urban Nexus governance go hand in hand
- Applying participatory approaches helps to ensure that Urban Nexus projects are in line with the needs of local communities affected by the Urban Nexus project
- Involving citizens in planning processes and gender-responsive participatory budgeting can lead to better infrastructure solutions and empower communities
- Integrated and resource-efficient urban development can create equitable access to basic urban services and improve the standard of living for all
- Inclusive urban governance and planning can create co-benefits for sustainable development

Box III.1
Gender mainstreaming essential to creating inclusive and sustainable cities

Gender mainstreaming seeks to promote gender equality and the empowerment of women in population and development activities by integrating gender concerns into analysis, formulation and monitoring of policies and projects. It is critical to sustainable development and the recognition of human rights for all. Access to opportunities and life changes should not depend on, nor be constrained by, a person's sex. Gender mainstreaming requires addressing the condition and position of women and men in society and rectifying inequalities and gaps in all areas, including the division of labour, access to and control over resources, services, information, opportunities, distribution of power and decision-making. More equitable relationships need to be based on a redefinition of the rights and responsibilities of women and men in all spheres of life, including the family, the workplace and society at large (UNFPA, 2005).

The Integrated Resource Management in Asian Cities: The Urban Nexus project has reviewed the gender dimensions of the Urban Nexus approach, in particular during the project's fourth regional workshop in Ulaanbaatar. Participants agreed that gender equality is critical to development and relevant to the promotion of the Nexus approach. Women play an important role in managing resources – especially water, energy, food, waste and sanitation – at the household level. GIZ Urban Nexus supported various gender studies and analyses, available on the project website.[a]

[a] For further information, see www.unescap.org/urban-nexus.

3.1.3 Science, technology and innovation dimension

Cities can be drivers and platforms for innovation, which is essential to sustainable urban development. As the world's cities and metropolitan areas grow, so does the need for new and scalable innovations to manage water, wastewater and solid waste. Many cities are yet to be built, a situation offering tremendous opportunities for innovation in urban infrastructure in the future. New technologies, including clean and renewable energy and energy efficiency, advanced materials and the digital revolution, are set to deliver transformative solutions at every scale.[28]

The term "Smart City" generally refers to a city that has integrated and coordinated traditional infrastructure with information and communications technology and other digital technologies to automate routine functions, as well as monitor, understand, analyse and plan that city in order to optimize the efficiency and delivery of its operations and services while reducing adverse environmental impacts and emissions (Batty and others, 2012). Smart City technology enables city officials to interact more directly with residents and urban infrastructure to assess how the city is evolving. Applying the Urban Nexus approach should be part of planning a Smart City, which involves continuous calibration of appropriate governance mechanisms. Nagpur and Rajkot are part of India's Smart City initiative. Nagpur has extensively engaged its citizens in visioning exercises to plan interventions, and Rajkot has applied many Nexus principles regarding reuse of wastewater in its Smart City planning.

Another innovative application is nature-based solutions, which the International Union for Conservation of Nature describes as "actions to protect, sustainably manage, and restore natural or modified ecosystems, that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits". The project's eighth regional workshop explored this approach, including the East Kolkata wetlands in India, which contain more than 250 aquaculture ponds and present a traditional circular economy approach with excellent resource recovery, employment and tourism opportunities. Chulalongkorn University's Centenary Park in Bangkok, with its green infrastructure and "sponge city" features designed to passively absorb, clean and use rainfall in an ecologically friendly way in order to reduce polluted run-off, is another example of a nature-based solution.

Box III.2
Water, Energy & Food Security Resource Platform

The Water, Energy & Food Security Resource Platform[a] is an initiative of BMZ in collaboration with GIZ. It serves as an independent information and facilitation platform on Nexus work, funded by BMZ and the European Union. The Resource Platform is a global information hub operated by the Global Nexus Secretariat as part of the Nexus Dialogues Programme. The Secretariat supports the Regional Nexus Dialogues with knowledge exchange and global analysis on the topic of resource nexus across the participating regions and beyond.

[a] The platform may be accessed at www.water-energy-food.org.

Box III.3
Innovation and the Urban Nexus

Innovation plays an important role in advancing uptake of an Urban Nexus approach. At the Urban Nexus project's eighth regional workshop, project partners led sessions focused on the theme "Leveraging innovation and broadening stakeholder engagement to build the business model for Urban Nexus efforts". Participants noted that cities and regions have started to transform from being manufacturing hubs to centres of global leadership in education, science, technology and innovation. In particular, universities, training institutes and other organizations that comprise the academe have been evolving from being educators to becoming agents of change, innovation and entrepreneurship. Universities can serve as living laboratories and support startups and develop business models.

3.1.4 Finance and business dimension

Challenges to financing local governments have gained recognition with the adoption of global agendas, particularly the Addis Ababa Action Agenda on Financing for Development (AAAA), which highlights the importance of enabling and strengthening institutional capacities of cities to access financing – essential

to achieve more equitable and sustainable development outcomes. In addition to funding, fiscal and government reforms are needed, including the assignment of revenues, expenditures and local government financial autonomy in setting taxes, tariffs and fees – own-source revenue generation – as well as national and subnational allocations and transfers and access to subsovereign lending mechanisms.

The Nexus approach can generate efficiencies resulting in resource and financial savings. The interrelationships and coordination across and within institutions, which the Nexus approach inherently supports, can result in substantial benefits. With their productive economies, potential returns on investment and high economies of scale, local authorities have the potential to attract significant private investment. The role of credit markets and public-private partnerships is also increasingly relevant to financing capital-intensive urban infrastructure projects. Further, the high value of urban land can be mobilized through land-based financing mechanisms.

The Asia-Pacific region faces enormous financing gaps in the water and sanitation, transportation and energy sectors. The Asian Development Bank has estimated that the region will need $22.6 trillion in infrastructure investment over the next 15 years (ADB, 2017). Focus should be on local governments improving their own-source revenues, rationalizing intergovernmental transfers and advancing regulations for a borrowing framework that attracts long-term capital.

3.1.5 Urban planning dimension

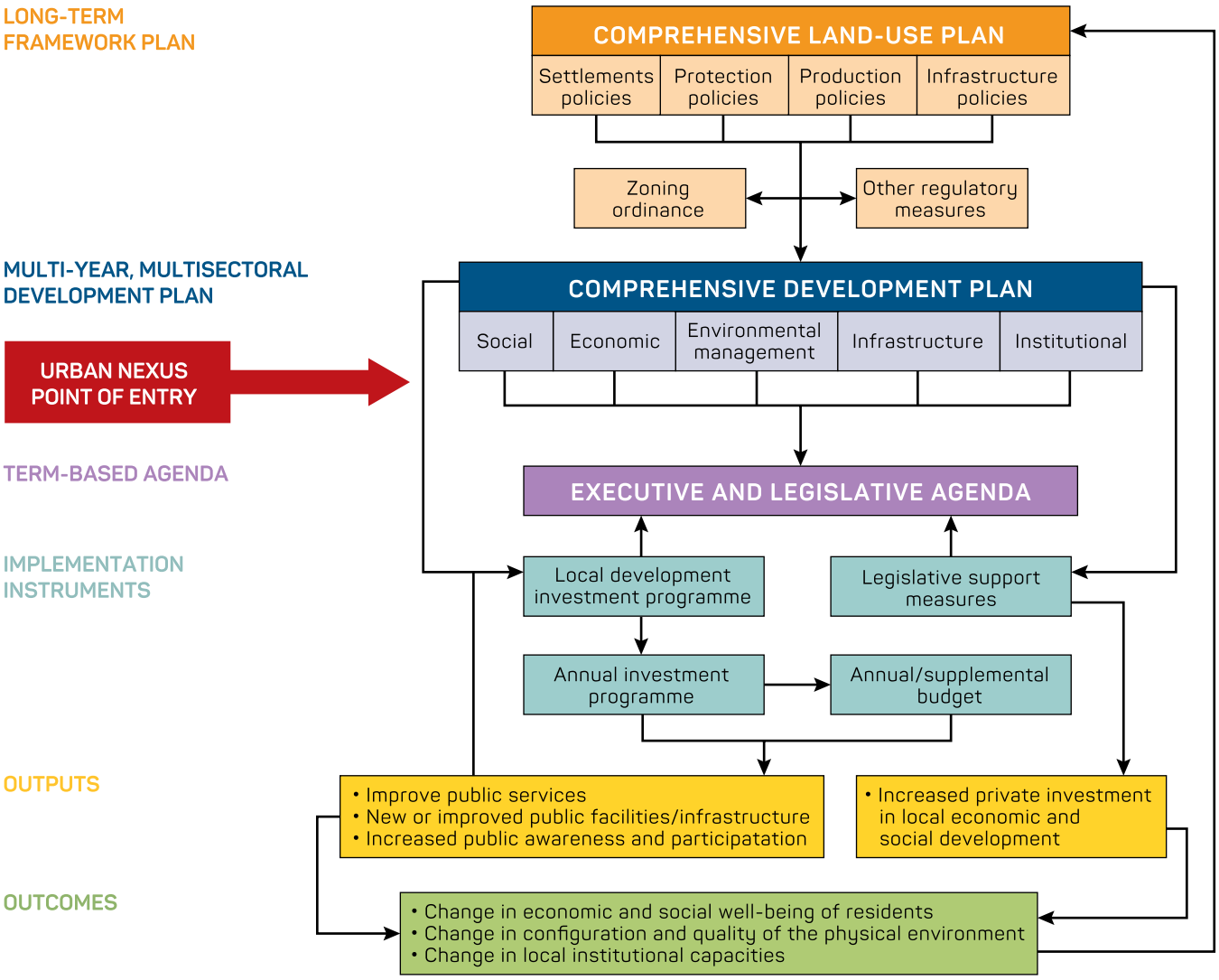
Managing resources requires good spatial mapping and integrative and well-organized spatial planning as well as institutional coordination and political will. Planners at the local and subnational levels are starting to integrate Nexus thinking into their comprehensive land-use plans. This dimension addresses strengthening urban-rural relationships, important to developing integrated solutions and promoting resilience with such measures as peri-urban agriculture and sustainable land-use planning. Effectively and efficiently addressing water, energy and food/land security involves understanding urban-rural linkages, as resources cross scales and boundaries, and cities' increasing consumption demands require drawing from supplies in the rural hinterlands.

Cross-sectoral and planning ministries play a key role in promoting the Nexus approach as well as the agencies and ministries mandated to coordinate the Sustainable Development Goals and the implementation in each country of nationally determined contributions (NDC) under UNFCCC. Apart from planning and finance ministries, the ministries of natural resources and environment also have significant cross-sectoral functions, although they often lack power.

Figure III.2 depicts the Philippines Naga City framework for integrated budgetary planning. Key investment decisions on infrastructure projects are formed by infrastructure policies from the long-term spatial comprehensive land-use plan and the non-spatial comprehensive development plan (CDP), which lists programmes and project proposals. In the Philippines, it has been suggested to locate the "point of entry" for addressing Urban Nexus concepts between CDP and the local development investment programme (LDIP), as indicated by the arrow in the figure. Ideally, staff would work across sectors and form interdisciplinary teams to review infrastructure proposals, fostering systemic thinking that addresses Nexus dimensions and interrelationships in a holistic way, before they move further towards implementation by becoming part of LDIP.

Figure III.2

Naga City's planning framework



Source: Adaptation of presentation by Mr. Wilfredo Prilles, City Planning and Development Coordinator, Naga City, Philippines, at the Urban Nexus Training, 16 June 2015, in Chiang Mai, Thailand.

Box III.4

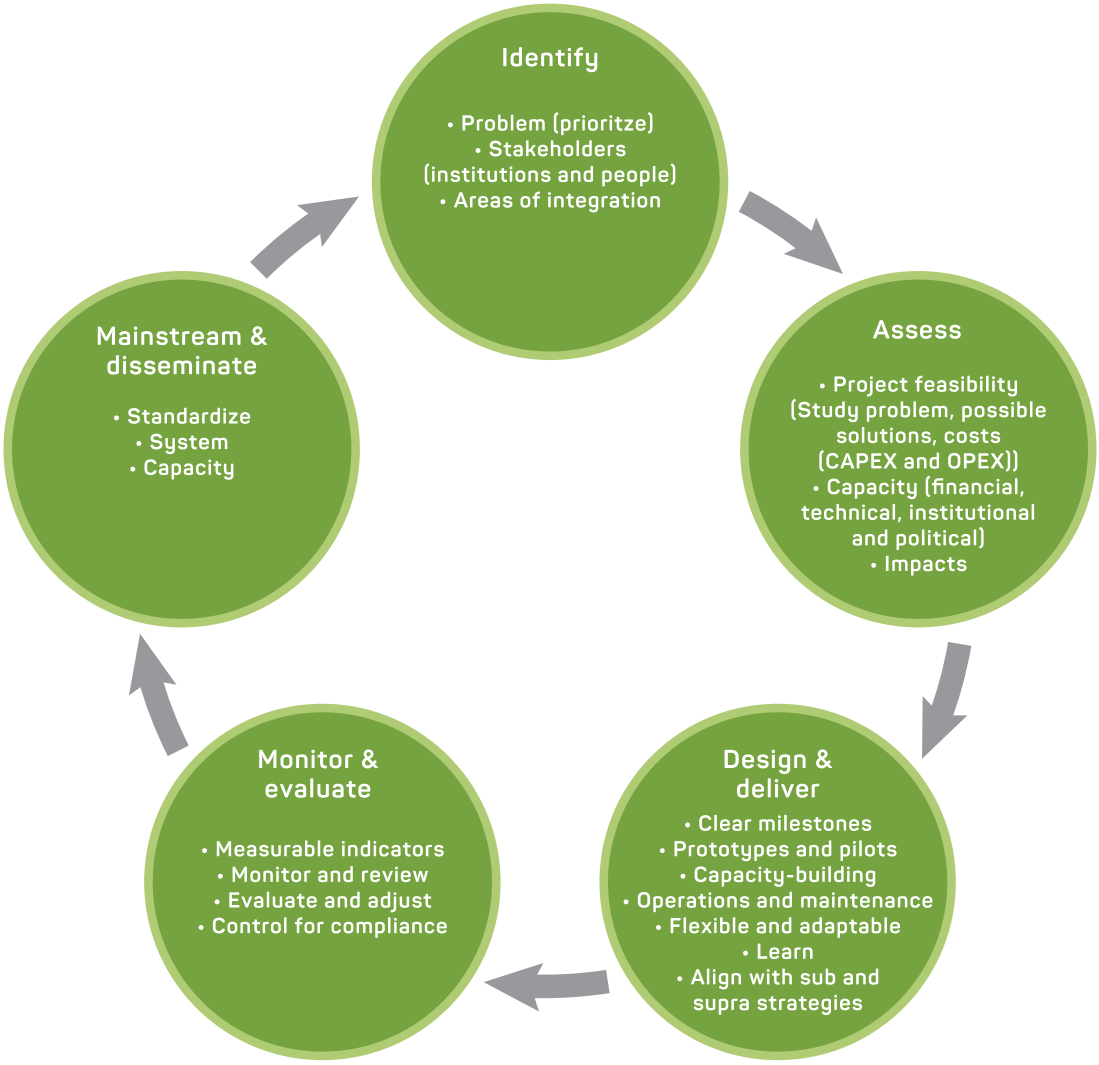
Evolution of urban planning

As the complexities of cities become more fully understood, urban planning has evolved from a discipline of architecture and civil engineering to include public health specialists, economists, sociologists, lawyers and geographers. Contemporary urban and regional planning techniques for survey, analysis, design and implementation have developed to form an interdisciplinary synthesis of these fields. Today, urban planning can be described as a technical and political process concerned with people's welfare, control of land use, design of the urban environment, including transportation and communication networks, and protection and enhancement of the natural environment (Brebbia and Sendra, 2017).

3.2 Urban Nexus project cycle

Local administrators and specialists are the target audience for applying the Urban Nexus approach, as they are the key actors involved with applying cross-sectoral infrastructure planning and management projects. The Urban Nexus project cycle[29] (figure III.3) is aimed at assisting local governments with implementing Nexus projects. The actions in the project cycle are not discrete; they overlap and may be iterative. Further, the following text is not meant to be prescriptive but instead to provide suggestions for consideration when applying the Nexus approach.

Figure III.3
Urban Nexus project cycle



Source: ESCAP.

3.2.1 Action: Identify

A common first step in project development is to **identify** the following:

- **Core problems** that can be addressed with a cross-sectoral infrastructure solution
- **Stakeholders** who can help brainstorm, identify and prioritize the problems to which a city could apply the Nexus approach
- **Areas of integration** needed to tackle the problems, particularly the sectors and levels of government

A focal person or team, most often local government staff working on water supply, wastewater and/or solid waste management, environment, planning and/or cross-cutting issues, such as green buildings, can bring together stakeholders to identify urgent problems for the city to address with a cross-sectoral solution. The problems can be prioritized based on urgency – for example landfill will reach capacity soon – political support, ease of implementation or other factors. It is critical to recognize who should be involved throughout the project, particularly in the identification phase. Some cities may form formal Urban Nexus task forces. Others may have less formal arrangements with the main focal person/team engaging relevant stakeholders when needed. The solution should minimize trade-offs and benefit multiple sectors.

Box III.5
Stakeholder coordination within project cities

With the Integrated Resource Management in Asian Cities: The Urban Nexus project, the GIZ Urban Nexus team and national project coordinator held initial meetings with project cities to identify priority problems that could be addressed with cross-sectoral infrastructure solutions within the framework of the Nexus sectors. Relevant stakeholders, who generally were or would become members of the Urban Nexus task force, were engaged.

Often the project cities identified solid waste and wastewater as primary problems. Some cities also stressed the need to increase water and energy system efficiency. The cities worked with stakeholders to rank and prioritize proposals until they agreed on one or two main problems that could be resolved with an integrated solution addressing two or more sectors. The areas of integration included working with different sectors and sometimes levels of government and involving other stakeholders from academia and the private sector. (See the "In Focus" insert for more information.)

Some questions to guide the Nexus approach are as follows:

- Who can help brainstorm and identify the most pressing problems that involve water/wastewater, energy, food/land and/or waste?
- How do the stakeholders relate to each other?
- What are their interests and values, and do their interests and values resonate or conflict?
- What potential environmental impacts will there be, and how can they be addressed?
- Who are the vulnerable, marginalized and disenfranchised in our community (e.g., women, racial/ethnic groups, poor) that need to be included?
- What are preliminary ideas for cross-sectoral infrastructure solutions to address the prioritized problem?
- How will anticipated short- and long-term changes (e.g., political changes, institutional reforms) influence project outcomes?

Table III.1 summarizes stakeholder roles, potential areas of involvement, assets, gaps and incentives.

Table III.1

Stakeholder analysis and capacity assessment

Stakeholders	Type and level of project involvement	Capacity assets	Capacity gaps	Desired future outcomes	Incentives
National-level policymakers	Main beneficiaries	Sector expertise (e.g. energy, water)	Limited capacity to develop integrated and cross-sectoral policies	Enhanced capacity to develop integrated and cross-sectoral policies	Policies and initiatives better geared to implement the Sustainable Development Goals and achieve sustainable development, increased personal knowledge and career advancement opportunities
Local government decision makers and officials	Main beneficiaries	Knowledge of local issues	Limited capacity to develop urban plans and initiatives in an integrated, cross-sectoral and collaborative manner	Enhanced capacity to develop urban plans and initiatives in an integrated, cross-sectoral and collaborative manner	Plans and initiatives better geared to respond to current and future needs of citizens, improved governance, potential cost savings and re-election
Municipal associations, city networks	Involved in outreach and dissemination activities	Links with local governments within country/region	Limited awareness of integrated plans and approaches	Enhanced awareness and knowledge of integrated plans and approaches	Enhanced ability to serve beneficiaries with new knowledge and opportunities
Academia	Involved in national and regional policy dialogues and in technical assistance to local governments, drivers of change and innovation, “natural” multipliers	Technical knowledge and analytical capacities, research mandate	Limited knowledge of Nexus approaches Limited opportunities to develop integrated solutions	Enhanced knowledge of Nexus approaches Enhanced opportunities to develop and disseminate integrated solutions	Increased knowledge, potential to expand curriculum material, consulting opportunities and become “game changers”
Private sector	Involved in national and regional policy dialogues and in infrastructure investment technical assistance to local governments	Technology, know-how and financing, service delivery	Limited opportunities for investment due to unconducive regulatory and fiscal environment, lack of transparency and legal security	Enhanced opportunities for investment thanks to a more conducive regulatory and fiscal environment, more transparency and legal security	Business opportunities, increased efficiency
Civil society organizations	Involved in national and regional policy dialogues	Knowledge of local issues and links to communities	Limited knowledge of Nexus approaches Limited opportunities to contribute to planning and policy formulation	Enhanced knowledge of Nexus approaches Enhanced opportunities to contribute to planning and policy formulation	Enhanced ability to serve and represent beneficiaries, more commissions and more support from donors

Note: Adapted from ESCAP phase II project document..

3.2.2 Action: Assess

After a city identifies a primary problem to address with an integrated approach, the team will need to **assess** the following:

- The **feasibility** of the project, which may require an environmental impact assessment
- The **capacity to support the project**, which includes financial, technical, institutional and political abilities to implement the project
- **Impacts** of the project, considering environmental, social and economic dimensions

Cities can review pre-feasibility and feasibility studies, reports and case studies from the Urban Nexus project to collect ideas and information about approaches that the project cities took. They also can gather information from cities that are implementing projects similar to those they would like to explore. Related initiatives may have produced studies that provide information that the city could use to assess the feasibility, capacity and impact of the Nexus project under consideration. Working with an academic or research institution in the region, such as Naga City partnering with BISCAST, can support an assessment. This type of institution would have knowledge of local conditions and could be involved for the duration of the effort, including being part of the Urban Nexus task force.

Some questions to guide the Urban Nexus approach are as follows:

- Is the project in compliance with designations in municipal plans, such as comprehensive spatial master plans, development plans and other municipal plans?
- What other cities, with similar conditions, such as climate and governance structures, have explored implementation of this project?
- What are the estimated costs to construct, operate and maintain the project?
- Who can realistically support project implementation?
- What are the potential impacts on the Nexus integration areas, such as water, energy, land, air quality, climate and waste?
- What are the potential political, environmental, social and economic impacts that can affect delivery?
- How does the project affect the livelihoods of women and girls, the urban poor and other vulnerable groups?

Annex II lists some Urban Nexus tools and methods that cities may consider to support their assessments.

3.2.3 Action: Plan and design

Some considerations important to **planning and designing** the project are:

- Establish **clear and realistic milestones** to provide structure to the process
- Be **flexible and adapt** as needed. Each project should define strategies best suited to the local context
- **Include capacity-building** throughout the project development cycle to address gaps identified in the assessment phase
- **Develop prototypes and pilots**
- Incorporate **operation and maintenance** into the plan and budget from the beginning of the project
- **Align** the project with provincial, national and global agendas, where possible

It is important to develop clear milestones within a realistic schedule at project inception. Many of the project cities' activities met delays due to changing political circumstances, funding streams, national policies, staff turnover and other factors. It is therefore vital to develop a long-term strategy to predict and anticipate future changes and to be prepared to adapt. Capacity development can help overcome challenges and should be designed into the project (see section 3.4).

Prototypes and pilots can help cities gather information about the Nexus solution, determining real-world requirements and responses with minimal disturbance to established infrastructure. In Da Nang, Viet Nam, for example, the Department of Planning and Investment and the Sustainable City Development Project Management Unit of the World Bank plan to implement a vacuum sewer wastewater collection pilot project for 71 households in the An Hai Bac ward to test the system before scaling it up. The pilot will provide information on operation and maintenance procedures and costs that can be factored into project design and delivery to help ensure its success.

Some questions to guide the Nexus approach are as follows:

- What is the joint goal to orient the work?
- What are realistic objectives and milestones?
- What capacities, skills and behaviours are required to adopt a Nexus solution?
- What innovations, measures and reforms are required to enable integrated resource management?
- Where are there capacity gaps, and how can those gaps be addressed?
- Are there already locally piloted technical and operational solutions on which the project can build and improve?
- What is the most cost-effective prototype or pilot that can be designed and delivered?
- What are the prospects for productivity-enhancing synergies and benefits that can be gained by integrating two or more operations or systems?
- Is the project in line with provincial, national and global agendas?

3.2.4 Action: Monitor and evaluate

Monitoring and **evaluation** are required of almost every project and can involve the following:

- Define **measurable indicators** in accordance with project goals, objectives and results
- **Monitor and review** the project with the help of these indicators, and modify indicators, if needed
- **Evaluate and adjust** relevant aspects of the project, if needed
- **Learn** – Progress can be achieved only if those involved are willing to learn from stakeholders and previous mistakes

The Philippines formulated its long-term vision, AmBisyon 2040, and mainstreamed the Sustainable Development Goals into the midterm Philippine Development Plan. Goal targets have been incorporated into a monitoring framework with priority given to Goals that are relevant and achievable.

Some qualities of good indicators are listed below:

- **Relevant:** The indicator should measure an important aspect of an objective or output
- **Objective:** The indicator should be measurable, based on facts as opposed to feelings or impressions: measuring the same indicator using the same tool should produce the same results
- **Available:** Indicators should be based on data that are readily available, or on data that can be collected with realistic additional effort as part of the project implementation
- **Realistic:** It should not be difficult or costly to collect the information
- **Specific:** The measured changes should be attributable to the project, and they should be expressed in precise terms (quantitatively and qualitatively)
- **Timebound:** There should be a clearly defined time frame within which changes are expected and measured (Doran, 1981)

Providing detailed guidance on developing indicators is beyond the scope of this publication. There are many indicator frameworks and initiatives that exist or are being developed to support cities with monitoring their progress on sustainability efforts (see box III.6).

Monitoring provides data to evaluate the current situation and the progress made. It is important to have an efficient system to collect, store and convert data into useful information that provides evidence and can convince decision makers of the next steps that they need to take.

Evaluation criteria must be defined in line with the goals of the project and the local context. These criteria should be integrated. Where possible, multidimensional indicators should be developed to integrate environmental, social and economic aspects into the assessment. Projects should be adjusted based on results of monitoring and evaluation.

Some guiding questions to consider when monitoring and evaluating the project are as follows:

- Have Nexus dimensions been considered when developing monitoring indicators?
- Are the indicators easily measurable? Who will measure them? At what frequency? In what format?
- How will the data feed into follow-up measures?
- How often will the project be reviewed?
- What are the different reporting requirements, and who will evaluate?
- What system performance measures will be used to evaluate system-wide outcomes?

Box III.6

Initiatives for measuring progress on global agendas

Cities need good-quality data and metrics to make informed decisions about the best policies needed to measure progress on global agendas and to advance sustainable urban development. However, existing data on sustainability are often not adequately detailed, documented, harmonized or available to cities to use for assessments (UN-Habitat, 2013).

Over the years, many indicator frameworks and initiatives have been, or are being, developed to support local and national governments. These resources include initiatives, guidance reports, networks and websites that provide tools, methodologies and approaches to gather relevant data and to apply quantitative methods to make informed decisions on sustainable urban policies. For example, the City Prosperity Initiative developed by UN-Habitat provides a metric and policy tool for local governments to develop a monitoring mechanism for urban development. Many organizations, including the United Nations Development Programme and the United Nations Development Group, have developed guidance reports and frameworks, such as Guidance Note: Data for Implementation and Monitoring of the 2030 Agenda for Sustainable Development and Mainstreaming the 2030 Agenda for Sustainable Development – Reference Guide for UN Country Teams, which are aimed at assisting Member States with gathering data and statistics to adapt the Goals to national contexts. Networks, such as the Inter-agency Expert Group on Sustainable Development Goal Indicators, have developed Goal indicator frameworks to assist Member States with assessment and monitoring.

3.2.5 Action: Mainstream, disseminate and scale up

Lastly, when a city determines that its pilot project is successful, it can **mainstream, disseminate and scale up** to continue the momentum and broaden the impact. Mainstreaming, for the purposes of this publication, refers to moving the Urban Nexus approach from the margins to conventional, more common, practices. To disseminate, or similarly replicate, is to increase understanding of the Nexus concept among a broader base of stakeholders. Scaling up may refer to revising standards and other regulatory frameworks, expanding capacity-building and technologies in a given geographical space, or replicating from one geographic area to another with required adjustments, if needed, as "one size does not fit all".

Some issues to consider when mainstreaming and disseminating a project include the following:

- **Standardize** key elements of the project, such as translating technical standards into local languages
- Understand how the approach fits **system-wide**, not just as a stand-alone project
- **Build capacity and provide training support** (see section 3.4)

Box III.7
Translating standards to promote innovative technologies

Da Nang, Viet Nam, was introduced to vacuum sewer systems as a potential solution to its wastewater problems through the Integrated Resource Management in Asian Cities: The Urban Nexus project. There were no design standards, however, for this technology available in the Vietnamese language. Therefore, GIZ Urban Nexus supported translation of DIN EN 1091 Vacuum Sewerage Systems Outside Buildings (February 1997) and DWA-A 116-1E Special Sewerage Systems from English into Vietnamese, thus making it possible for the city to assess the information and consider installation of this innovative technology.

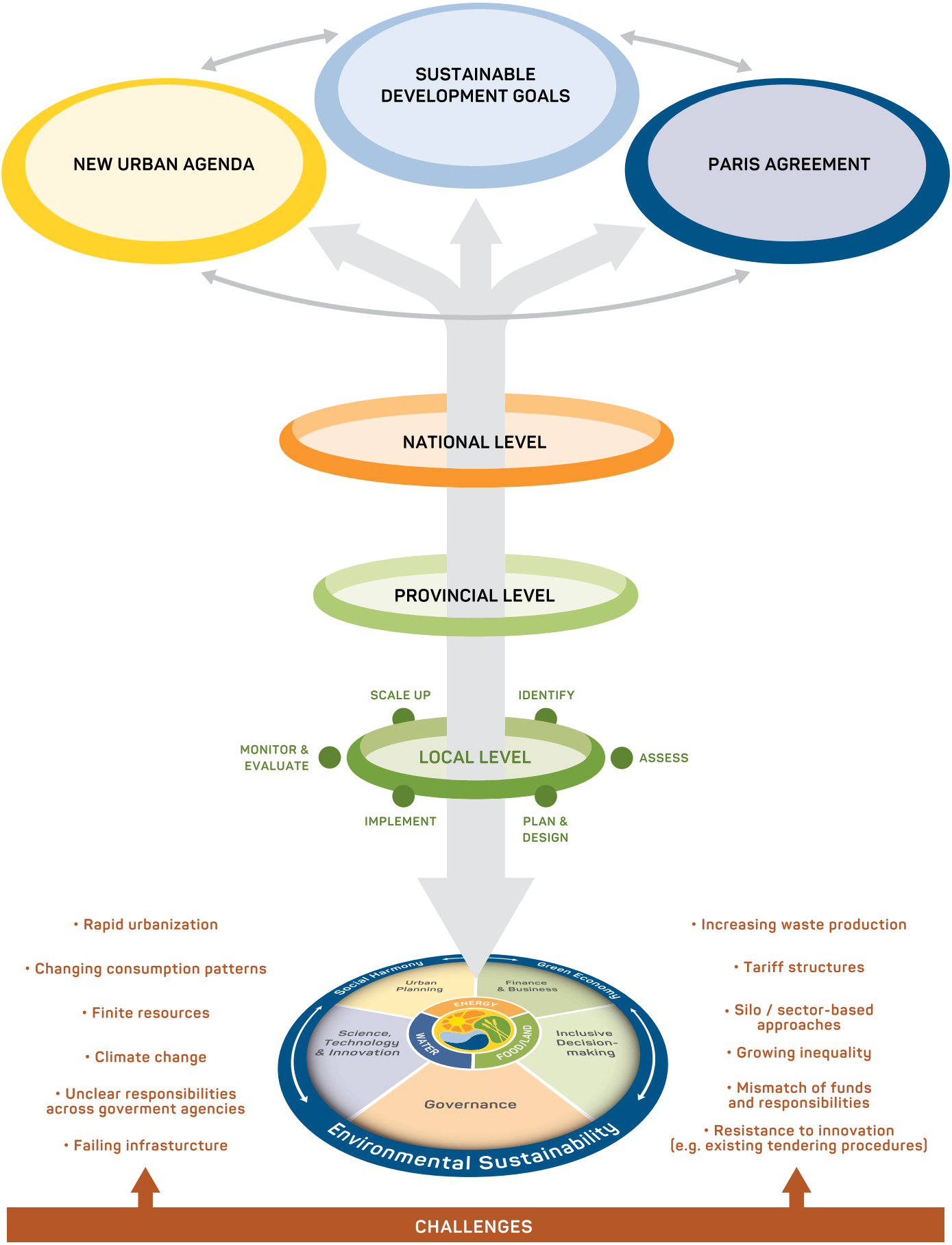
Some guiding questions to consider when mainstreaming and disseminating a project are as follows:

- Have water or energy savings been reached, or has there been a reduction in land requirements?
- How did the target group deal with the new technology?
- Can the staff handle the new technology?
- Has acceptance been reached?
- Is there a need to increase project capacity to meet future demand?
- What aspects of the project could be replicated?
- How can project benefits be shared with other cities?
- Are there sufficient resources available to scale up the project?

3.3 Urban Nexus vortex

As noted in chapter II, the global agendas are universal and interlinked, and the Urban Nexus approach, which examines trade-offs and optimizes synergies, is an ideal entry point to address the many challenges local governments face while contributing to delivery on the global development agendas. The Urban Nexus wheel, introduced in section 3.1, presented five dimensions to consider when applying the Nexus approach, and section 3.2 introduced an Urban Nexus project cycle, with action steps and points for consideration. Figure III.4 introduces the Urban Nexus vortex, which visually illustrates these main elements of the Urban Nexus Guidance Framework.

Figure III.4
Urban Nexus vortex



Source: ESCAP.

3.4 Capacity development

Capacity development is "the process through which individuals, organizations and societies obtain, strengthen and maintain the capabilities to set and achieve their own development objectives over time" (UNDP, 2009). Developing capacity can focus on strengthening different types of skills and abilities, including the following:

- **Functional and operational skills** – such as management of projects, procurement and municipal finance
- **Technical skills** – such as expertise in such sectors as water and sanitation engineering, urban planning, integrated waste management, and civil and transport engineering
- **Behavioural norms** – cultural shifts and changes in attitude among stakeholders, be they to reduce waste generation or to promote better multisectoral programme planning among government organizations (IFC, 2010)

Interventions will depend on which skills or abilities the city intends to strengthen. Assessment tools can help local governments prioritize and optimize investments in capacity development where they are most needed.

Box III.8

Capacity WORKS

Achieving sustainable development is an ongoing process that needs to balance economic development, social justice, environmental integrity and political participation. Finding solutions in social, cultural and political contexts that are continuously changing can be challenging and requires negotiation in order to achieve competing goals. Public, private and civil society engagement at all levels – locally, nationally, regionally and internationally – is needed. Through decades of experience in German international cooperation, GIZ has developed Capacity WORKS,[a] a model for cooperation management. Capacity WORKS is an integral part of GIZ procedures ranging from programme design to implementation and evaluation. Capacity WORKS provides a methodology for successful cooperation management using relevant key questions, the structure of the five success factors (strategy, cooperation, steering structure, processes and learning & innovation) and a toolbox for addressing specific questions.

[a] For further information, see www.giz.de/expertise/html/4620.html.

Capacity development is a continuous, long-term process that may involve the following:

- **Legislation**: Legal stipulations requiring capacity development plans and/or budget allocations for implementation programmes
- **Training programmes**: Regular staff-training programmes or requirements for continued learning among public sector employees
- **Partnerships**: Project partnerships with higher levels of government, public or private organizations, academic institutions and civil society groups
- **External experts**: Consultants from private organizations or academic institutions with sectoral and/or technical expertise
- **Accountability measures**: These may include regular auditing by external organizations, or social accountability through decoupling watchdog groups
- **Information technology**: Incorporating digital technologies that ease administrative burdens, promote greater cooperation between stakeholders and allow for greater oversight and transparency in operations
- **Best practices**: Learning from the experiences and outcomes of initiatives by other cities (SDSN, 2016)

Benefits from capacity development may include more coherent planning and management of Urban Nexus projects, more thorough examination of the interrelationships between Nexus dimensions, better informed policymakers, improved communication with concerned stakeholders and the public, and strengthened ability to conduct needs assessments and identify gaps. These benefits contribute to improved environment and living conditions and more efficient use of natural and financial resources.

Box III.9
Urban Nexus training

The GIZ Urban Nexus project has elaborated a complementary, face-to-face, interactive training programme on the Urban Nexus approach, including training-the-trainer. This type of training is aimed at communicating and anchoring the Urban Nexus planning and management approach in Asian cities and countries. Urban Nexus is thereby understood as an action-oriented guiding principle for integrated resource management considering the interrelations of the Nexus sectors of water, wastewater, energy, food security and solid waste at the local, provincial and national levels. Urban Nexus training takes into account relevant global agendas, such as the 2030 Agenda for Sustainable Development, the New Urban Agenda and the Paris Agreement, and offers dynamic and new interactive formats for participants to learn about and reflect on the relevant issues of the Urban Nexus approach by analysing infrastructure problems of their city or country.

As with this publication, the training is based on knowledge gained and resources produced over the course of the project on Integrated Resource Management in Asian Cities: The Urban Nexus. The main target groups of the Urban Nexus training are government staff (local, provincial and national), training institutes and universities (academia) involved with developing urban infrastructure projects, implementing national and global sustainability strategies and training, in addition to the public sector and academia, and private and civil society entities relevant to implementing the project.

3.5 Conclusion

The scope of dialogue on the water, energy and food/land nexus continues to expand and evolve as Nexus brings together stakeholders to increase the knowledge base, support decision-making and encourage discussion to identify integrated issues and solutions. Recent reports have acknowledged the need for more work to be done, as there are challenges when transforming Nexus theory and ideas into practice.

Some recommendations in moving forward are as follows:

Governance

- Recognize the importance of supportive framework conditions and “windows of opportunity” at all levels of governance. Urban Nexus projects regardless of their size and scope are embedded in regulatory and administrative frameworks. For example, national “silos” in regulation, public procurement etc., can hinder innovative integrated approaches and cross-departmental cooperation at the local level

- Use existing governance structures where possible and improve these structures by creating more coordinating mechanisms but not agencies that again encapsulate themselves. Capacitate existing institutions to think “outside the box”. Improve and systemize inter- and intra-institutional cooperation. For example, creating interministerial task forces and committees, round table discussions or the joint rules of procedure of federal ministries are adequate mechanisms to address Nexus-related issues. Many studies recommend that communication between sectors and government levels could be improved by the creation of dialogue platforms or other inter-agency communication mechanisms

Inclusive decision-making

- Empower cities and enhance citizen engagement. Giving cities a voice and more direct authority through decentralization and taking a participatory approach to promote more inclusive decision-making makes cities more resilient

- Bring the social dimension into the fold. Mechanisms to ensure democratic participation of different sectors of society should be established. Across all stages of a project's life, broad stakeholder participation, including that of women, children, the elderly and persons with disabilities, should be ensured so that their needs and concerns are addressed. This will help foster project ownership and resilience

Science, technology and innovation

- Align the identification and selection of innovative technological solutions to urban development concerns, such as solid waste and wastewater management, with relevant national government regulations and policies and global development agendas

- Build Urban Nexus thinking and behaviours through working with educational institutions, universities, research and training providers. Training and capacity-building, often in partnership with training institutes and/or academe, at all levels of institutions, can help change "business as usual" approaches to urban development and adopt an integrated approach to improve resource efficiency and overall quality

Finance and business

- "Getting fees and tariffs right" is a precondition for private investment, that is, cost-covering and consumption-oriented tariffs are necessary

- Calculate and consider capital expenditures and operating expenses when developing Urban Nexus, decentralized cross-sectoral, infrastructure solutions

- Link cities to financial institutions and support introduction of innovative financial instruments to support Nexus projects. For example, link national development funds or infrastructure financing to reward projects that show an integrated, cross-sectoral approach

- Analyse procurement rules and regulations to make sure they do not impede technological innovations

Urban planning

- Consider introducing Nexus screening of investment projects to ensure that they have been planned in a cross-sectoral manner, which will support more sustainable infrastructure projects. Although urban planning is per se cross-sectoral, cross-sectoral coordination should be enhanced

With much of the projected infrastructure in Asian cities still to be built, the Urban Nexus approach provides an opportunity to create livable, healthy, prosperous and resource-efficient cities, while also contributing to global development agendas. The 2030 Agenda for Sustainable Development requires integrated approaches that cannot be reached by the national level of Government alone. Subnational and local involvement is key, and the Nexus approach at its core involves horizontal and vertical integration. Improved coordination and collaboration that is based on the untapped interdependencies between the water, energy and food/land sectors can result in substantial resource and financial benefits, making the business case for Nexus projects.

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Endnotes

[1] For more information, see www.unescap.org/about.

[2] For further details, see www.un.org/waterforlifedecade/asia.shtml.

[3] General Assembly resolution 66/288, annex.

[4] General Assembly resolution 70/1.

[5] Adopted under the United Nations Framework Convention on Climate Change in FCCC/CP/2015/10/Add.1, decision 1/CP.21.

[6] General Assembly resolution 71/256, annex.

[7] For more information, see www.government.se/speeches/2015/08/speech-by-minister-for-international-development-cooperation-at-world-water-week/.

[8] For details, see www.iea.org/newsroom/news/2018/october/population-without-access-to-electricity-falls-below-1-billion.html.

[9] See *Report of the United Nations Conference on Environment and Development, Rio de Janeiro, 3-14 June 1992*, vol. I, *Resolutions Adopted by the Conference* (United Nations publication, Sales No. E.93.I.8 and corrigendum), resolution 1, annex I, and also Earth Summit, www.un.org/geninfo/bp/enviro.html (accessed on 7 February 2019).

[10] Calculated using 2017 statistics from ESCAP database.

[11] For more information, see www.un.org/waterforlifedecade/asia.shtml.

[12] For more information, see www.ellenmacarthurfoundation.org/circular-economy/overview/concept.

[13] Products that are sold quickly and at a relatively low cost. Examples include non-durable goods, such as packaged foods, beverages, toiletries, over-the-counter drugs and other consumables.

[14] For full remarks, see www.un.org/development/desa/statements/asg/mr-gass/2017/06/keynote-symposium-on-sdgs.html.

[15] For more information, see www.studiocollantin.eu/pdf/UNEP%20Info%20sheet%20-%20EE%20Buildings.pdf.

[16] For the full press release, see www.unfccc.int/news/humans-settlements-cities-and-communities-speed-coordinated-climate-action.

[17] For more information, see www.c40.org/why_cities.

[18] General Assembly resolution 69/313, annex.

[19] Available at www.unescap.org/sites/default/files/E71_13E.pdf.

[20] For further information, see www.unescap.org/urban-nexus.

[21] A barangay is the smallest administrative division in the Philippines and is the native Filipino term for village, district or ward.

[22] In 2014, Naga City enacted Ordinance No. 2014-076, establishing a wastewater management system pursuant to the provisions of the Philippine Clean Water Act (Republic Act No. 9275).

[23] For additional information, see http://icleiseas.org/index.php/2017/06/01/naga-city-gears-up-to-develop-its-30-year-sustainable-urban-development-plan/.

[24] Executive Order No. 004 Series of 2013 was signed by Mayor Arlene Arcillas on 22 August 2013.

[25] For his full remarks, see www.water-energy-food.org/news/kofi-annan-delivering-water-food-and-energy-security-for-all/.

[26] The construction of the wheel was an outcome of an expert group meeting that ESCAP organized in November 2016 to connect the Nexus approach with the concepts of resource efficiency and a circular economy and present how these elements have impacts on the sustainability of cities.

[27] General Assembly resolution 71/256, annex, para. 89.

[28] For more information, see www.thegfcc.org/wordpress/wp-content/uploads/2017/02/2016-Best-Practices-Sustainable-Cities.pdf.

[29] The cycle is adapted from *Operationalizing the Urban NEXUS: Towards Resource-efficient and Integrated Cities and Metropolitan Regions* (BMZ, 2014), adelphi's Urban Nexus Workout (www.adelphi.de/en/project/urban-nexus-workout-%E2%80%93-training-concept-integrated-resource-management-asian-cities) and informal interviews with project partners and stakeholders.

Annex I

Key resource on Nexus frameworks

Organization	Nexus-related events, frameworks, platforms and networks	Year	Resources					Source
			Water	Food	Land	Energy	Others	
United Nations University (UNU)	Food-Energy Nexus Programme (1983) was launched by UNU to fill the research gap that existed on the synergistic solutions to food and energy problems	1983		✓		✓		Sachs and Silk (1990)
World Economic Forum (WEF)	WEF launched a landmark report entitled *Water Security: The Water–Food–Energy Climate Nexus*. (Available at www3.weforum.org/docs/WEF_WI_WaterSecurity_WaterFoodEnergyClimateNexus_2011.pdf.)	2011	✓	✓	✓	✓	Climate	World Economic Forum Water Initiative (2011)
German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety and BMZ	Bonn 2011 Nexus Conference, "The Water, Energy and Food Security Nexus – Solutions for the Green Economy" provided a platform to consider the close interlinkages between water, energy and food security, and the benefits of a Nexus perspective in a multi-stakeholder process	2011	✓	✓	✓	✓		Martin-Nagle and others (2012)
International Atomic Energy Agency (IAEA)	The climate, land, energy and water approach identified land as the basic resource and underlying constraint for examining food. The framework is focused on energy, and conceptualizes energy-water-food nexus interrelations through a quantitative framework which integrates water planning, energy planning and agro-ecological zoning models	2011	✓	✓	✓	✓	Climate	ESCWA (2015)
European Union	The European Development Report, *Confronting Scarcity: Managing Water, Energy and Land for Inclusive and Sustainable Growth*, proposed a framework that broadens the Nexus perspective by explicitly considering competing land uses for agriculture, forest cover, human settlements and infrastructure, and biodiversity; and competing demands in the water sector. (The report is available at https://ecdpm.org/wp-content/uploads/2013/10/ERD-2011-2012-Confronting-Scarcity-Managing-water-energy-land.pdf.)	2012	✓		✓	✓		European Report on Development (2012)
International Centre for Integrated Mountain Development (ICIMOD)	A conceptual framework developed by ICIMOD is centred on ecosystem goods and services which, according to the authors, must be protected and enhanced to ensure their resilience and support of the water, energy and food sectors	2012	✓	✓		✓	Ecosystems	Rasul (2014)

Transatlantic Academy	A collaborative report, entitled *The Global Resource Nexus: The Struggles for Land, Energy, Food, Water, and Minerals*, identified several opportunities, including gains in resource efficiency, the conversion of resource endowments into more sustainable development, greener growth, institution building and engaged cooperation to address security conflicts. (The report is available at www.gmfus.org/file/2614/download.)	2012	✓	✓	✓	✓	Minerals	Andrews-Speed and others (2012)
World Business Council for Sustainable Development (WBCSD)	WBCSD developed a conceptual framework that provides co-optimized solutions for water, energy and food and incorporates the inputs needed for those sectors along the value chain, namely feed and fertilizers	2013	✓	✓		✓	Bio-material, fibre and feed	WBCSD (2014)
United Nations Economic Commission for Europe (ECE)	ECE adopted a conceptual framework that is closely related to ICIMOD	2013	✓	✓		✓	Ecosystems	ECE (2013)
Integrated Resource Management in Asian Cities: The Urban Nexus	BMZ, GIZ, ESCAP and ICLEI – Local Governments for Sustainability work with 12 cities in 7 countries to advance uptake of Nexus concepts	2013	✓		✓	✓	Climate	
United Nations Environment Programme (UNEP)	The UNEP conceptual framework considers opportunities for basin organizations to implement an approach to water governance to support energy and food security, particularly in terms of hydropower and balancing biofuel production with food crop production	2014	✓	✓		✓	Ecosystems	Boelee and others (2014)
University of North Carolina (UNC) at Chapel Hill	The "Nexus 2014: Water, Food, Climate and Energy Conference", held at UNC from 5 to 8 March 2014, brought together stakeholders to focus on the questions of how and why the Nexus approach is, and can be, used on international and local levels	2014	✓	✓		✓	Climate	Water Institute at UNC Website
	Participants in the Conference launched a global academic and practitioners network for the water, energy, food and climate nexus of disciplinary and interdisciplinary experts, practitioners and research thought-leaders tasked with identifying and filling research gaps and needs, compiling and disseminating current water, energy, food and climate (WEFC) knowledge and best practices, and establishing a global clearinghouse of WEFC indicators for the WEFC Nexus Framework.	2014	✓	✓		✓	Climate	
	The Conference adopted the Nexus Declaration, which was delivered to United Nations Secretary-General Ban Ki-moon on 26 March 2014 as an input to the sustainable development goals drafting process; the Declaration outlined the principles of and recommendations for building integrative approaches to what would later become the Sustainable Development Goals and the post-2015 development agenda	2014	✓	✓		✓	Climate	

Global Water System Project (GWSP); German Development Institute (GDI); UNEP; University of Bonn, Center for Development Research; CGIAR Research Program on Water, Land and Ecosystems	The International Conference on Sustainability in the Water–Energy–Food Nexus, held in Bonn on 19 and 20 May 2014, brought together available information, identified knowledge and action gaps, shared lessons on viable instruments and approaches, facilitated networks and contributed to consensus on priorities for appropriate investment and action by different actors and stakeholders for advancing action on the WEF Nexus	2014	✓	✓		✓		Bhaduri and others (2015)
German Federal Ministry of Economic Cooperation Development (BMZ) and the European Union	The Water, Energy & Food Security Resource Platform serves as an independent information and facilitating platform on Nexus work. It is funded by BMZ and the European Union. (It may be accessed at www.water-energy-food.org/nexus-platform-the-water-energy-food-nexus/.)	2012	✓	✓	✓	✓		
Food and Agricultural Organization of the United Nations (FAO)	Earth observations and the water-energy-food nexus workshop adopted a holistic vision of sustainability and explicitly addressed complex interactions and feedback between human and natural systems	2014	✓	✓	✓	✓	Climate	(FAO, 2014)
University of North Carolina (UNC) at Chapel Hill	The conference, “Nexus 2018: Water, Food, Energy, and Climate”, held at the Water Institute at UNC, further developed three new cross-cutting areas, including urban challenges, health-related Nexus issues, and migration and mobility	2018	✓	✓		✓	Climate	Water Institute at UNC Website
ResNexus	The ResNexus conference was held at Wageningen University & Research, in Wageningen, Netherlands, on 7 and 8 November 2018. It brought together academics and practitioners working in government and civil society who deal with the urban water, energy, food and environment nexus worldwide	2018	✓	✓	✓	✓	Climate	

Annex II

Summary of select examples of Nexus tools and methods

Citation	Scale	Method	Methods used	Tool/method availability	Co-benefits	Stated limitations	Data requirements
Villarroel Walker and others (2014)	City	Quantitative	• Multisectoral systems analysis (combines substance flow analysis, metabolic performance metrics and regionalized sensitivity analysis) • Scenario analysis	Analysis framework developed in MATLAB®. Not publicly available.	• Integrated systems approach • Estimates economic benefits • Facilitates decision support	• None stated	Data obtained from publicly available databases from national Governments and international organizations.
Wolfe and others (2016)	Local, regional	Quantitative and qualitative	• Systems informatics • Information analysis • Systems analytics • Decision support systems • Scenario analysis • Transdisciplinary design	Cyberphysical framework for systems informatics, information analysis methods and tools, systems analytics and decision support (proposed).	• Facilitates sharing and integration of interdisciplinary data sets • Support for problem-solving and decision-making • Framework for engaging stakeholders and developing communities-of-practice	• Limited data available at different scales and across a variety of systems	Generally, need better data coverage at various scales and improved data-sharing among researchers and organizations.
Villamayor-Tomas and others (2015)	Local, national	Qualitative	• Institutional Analysis and Development (IAD) framework • Value chain analysis (as “Networks of Action Situations” (NAS))	Approach described and referenced within Villamayor-Tomas and others (2015).	• Value chain analysis identifies input-output and causal relationships • NAS accounts for actors’ decisions • IAD assesses role of institutions	• Focus on provisioning services • Limited evaluation of institutional levels in various collective choice and operational situations • Lacks attention to political and negotiating power among actors	Combination of primary (i.e. semi-structured interviews, focus groups and surveys) and secondary data (i.e. academic literature).

Citation	Scale	Method	Methods used	Tool/method availability	Co-benefits	Stated limitations	Data requirements
Foran (2015)	Regional	Qualitative	• Delphi process • Historical analysis • Critical discourse analysis	References for methods used are provided within Foran (2015).	• Offers social structure and political context to the WEF Nexus	• Limited analysis of system dynamics	Not specified.
Hurford and Harou (2014)	Regional	Quantitative	• Multi-criteria search (optimization) algorithm • Trade-off simulator • Visual analytics • Water management modelling	Interactive River-Aquifer Simulation-2010 (open-source), NSGAII[a] algorithm.	• Investigates how new investments have impact on trade-offs • Visualization assists communication and decision-making • Can analyse large solution sets	• Does not include capital and operational costs or non-water-related benefits • Does not consider uncertainty of future flows • Requires information on ecosystem services and resource use for objective functions	Resource demand data. Flow and abstraction. Revenue and deficit data. Flow alteration. Stakeholders to define metrics and objectives.
Endo and others (2015)	Regional	Quantitative and qualitative	• Questionnaire surveys • Physical models • Benefit-cost analysis • Integrated indices • Optimization management tools • Ontology engineering • Integrated maps	Varies, discussed within Endo and others (2015).	• Synthesizes across spatial and temporal scales • Qualitative methods facilitate inter- and transdisciplinary collaboration and feasibility of cross-sector policies • Quantitative methods estimate impacts of endogenous and exogenous factors, compare costs and benefits, provide thresholds to inform decisions and optimize allocations	• Integrating various spatial and temporal scales • Different methods appropriate for different cases, contexts and stages of assessment	Questionnaires, ontology engineering and integrated maps require data obtained through participatory processes. Benefit-costs analysis, indices and physical models require primary data and measurements. Interdisciplinary teams needed.

Citation	Scale	Method	Methods used	Tool/method availability	Co-benefits	Stated limitations	Data requirements
Karlberg and others (2015)	Regional	Quantitative and qualitative	• Interdisciplinary modelling • Stakeholder mapping • Interviews • Participatory scenario planning and analysis • Strengths, weaknesses, opportunities, threats (SWOT) analysis	WEAP, LEAP, participatory approach with stakeholders and scientists.	• Robust water resources/ biomass and energy/climate modelling modules • "Story and simulation" approach translates qualitative scenarios into quantitative assessment • SWOT analysis facilitates decision-making • Iterative process helps gain stakeholders' support for resultant solutions/policy	• Limited in scope • Does not include qualitative aspects of water, spatio-temporal aspects of hydrologic regime and ecological processes	WEAP, LEAP and participants.
Stucki and Sojamo (2012)	Regional, national	Quantitative and qualitative	• Quantitative indicators • Critical discourse analysis	Approach for this study was described within Stucki and Sojamo (2012).	• Quantitative indicators reduce complexity and allow for comparison • Critical discourse analysis examines global political economy context to identify external drivers	• Linkages between indicators complex without computerized approaches • Data combinations and degrees of certainty vary • Need to address uncertainty	Indicator data were collected from publicly available sources, mostly grey literature. Discourse analysis was conducted on academic and grey literature.
Daher and Mohtar (2015)	National	Quantitative	• Input/output • Systems modelling • Focus groups • Scenario planning	WEF Nexus Tool 2.0.[b] Free, available online with easy registration.	• Offers platform to evaluate scenarios and identify resource allocation strategies • Quantitative and input/output approaches facilitate scenario comparison	• Designed for Qatar • Limited to national scale	National-level percentages of water and energy use, sources, agricultural production and food importation.

Citation	Scale	Method	Methods used	Tool/method availability	Co-benefits	Stated limitations	Data requirements
Halbe and others (2015)	National	Qualitative	• Stakeholder analysis • Participatory model building • Causal loop diagrams • Learning assessment	Methodology described and referenced within Halbe and others (2015).	• Causal loop diagrams (CLDs) are used to collect and compare stakeholder perspectives • Learning assessment fosters knowledge and skill development that facilitates implementation • Participatory model building engages stakeholders to identify strategies and barriers	• Limited to qualitative analysis • Requires substantial simplifications • Difficult to resolve conflicting or redundant information • Challenging to utilize CLD data due to a high number of variables and causal linkages	Stakeholder participation.
Howarth and Monasterolo (2016)	National	Qualitative	• Participatory workshops	Participatory workshops described within Howarth and Monasterolo (2016).	• Identifies stakeholders' concerns to inform Nexus decision-making, collaboration and communication • Engages a diverse group of stakeholders in knowledge production	• Limited sample size and geographic representation of participants	Stakeholder participation.
Howells and others (2013)	National	Quantitative	• Climate, land-use, energy and water integrated model (modules include WEAP, LEAP and AEZ sector-based quantitative models) • Scenario analysis	Further development by the International Atomic Energy Agency, modules developed by Stockholm Environment Institute, the International Institute for Applied Systems Analysis and FAO.	• Robust quantitative modelling integrates multiple sectors and their interactions using an iterative, module-based approach • Integrates climate scenarios • Investigates interdependencies of and trade-offs among resource systems to inform coherent policymaking • Builds on existing modelling methodologies	• Time-intensive and data-intensive • High model uncertainty	Detailed biophysical data sets and climate scenario data.

Citation	Scale	Method	Methods used	Tool/method availability	Co-benefits	Stated limitations	Data requirements
de Strasser and others (2016)	Transboundary	Quantitative and qualitative	• Questionnaires • Workshops/meeting • Demographic data analysis • Nexus dialogues • Resource flows • Document analysis • Governance analysis • Indicators	Transboundary River Basin Nexus Approach. Six-step methodology available from ECE.	• Proposes policy and technical actions across scales • Involves key economic sectors in decision-making in transboundary contexts • Encourages cross-sectoral dialogue and transboundary cooperation • Identifies stakeholder priorities to develop operational solutions	• Ambiguous definitions • Inconsistent indicators • Does not address financial, social and power issues • Water-centric	National and international statistics, river basin management plans, interviews and questionnaires with experts, existing databases and reports, stakeholder participants.
Guillaume and others (2015)	Transboundary	Quantitative and qualitative	• WaterGAP global water model • Spatiotemporal assessment • Historical analysis	WaterGap Model developed by Universities of Kassel and Frankfurt. Not publicly available.	• Offers five transferable principles to relate case study to global trends • Considers role of subsystems outside of WEF Nexus, e.g. water resources • Engages global-scale data (to increase comparability) along with local data • Engages with global drivers (development, globalization) • Considers the effect of system boundaries and externalities	• Utilizes modelled data versus measurements • Many assumptions in model • Water-centric	Publicly available, monthly water availability and consumption data. Publicly available socioeconomic data. Regional data sets integrated when available.

Citation	Scale	Method	Methods used	Tool/method availability	Co-benefits	Stated limitations	Data requirements
Smajgl and others (2016)	Transboundary	Quantitative and qualitative	• Delphi technique • Participatory processes • Agent-based modelling • Scenario analysis • Qualitative relationship and stochastic approaches • Static comparative analysis • Cause-effect chains • System diagrams	Mixed-method participatory approach, monitoring and evaluation and agent-based modelling described in Smajgl and others (2016).	• Identifies advantages of sectorally balanced, dynamic Nexus approach • Minimizes sector-related biases • Robust characterization of Nexus interactions • Engages experts and stakeholders to address policy needs	• Bias and preconceptions about causal relationships possible	Experiences of local experts.
Soliev and others (2015)	Transboundary	Quantitative and qualitative	• Historical analysis • Institutional analysis	Historical analysis described within Utilizes Williamson's framework of institutional analysis.	• Facilitates understanding in complex institutional and resource environments • Benefit-sharing approach facilitates transboundary cooperation • Historical and institutional approach informs policy by reconciling global objectives with local economic goals • Highlights indirect costs associated with benefits	• None stated	The data were gathered through archival research (e.g. laws, decrees, agreements, declarations).
Yang and others (2016b)	Transboundary	Quantitative	• Hydrologic modelling • Hydroeconomic modelling • Ex post scenario analysis • Decision-scaling framework	BRAHEMO (BRAhmaptura HydroEconomic Model). Climate and land-use change scenarios. Methodology applicable worldwide, if sufficient data are available.	• Assess different drivers of the WEF Nexus • Evaluates development and climate change scenarios • Identifies impact of climate and competing water needs • Coupled approach supports policy-relevant solutions	• Not comprehensive • Simplistic thresholds • Social drivers difficult to estimate • Population growth not modelled • Simplifying assumptions and inherent uncertainty. • Limited applicability due to data requirements	Agricultural, hydropower, domestic water use, groundwater pumping and stream flow data are needed. Climate scenarios and potential water diversions.

Citation	Scale	Method	Methods used	Tool/method availability	Co-benefits	Stated limitations	Data requirements
Ringler and others (2016)	Global	Quantitative	• Global computable general equilibrium model (GLOBE) • IMPACT3 (modular integrated assessment model) • Scenario analysis	Approach is described within. Links GLOBE model with IFPRI's IMPACT v36.	• Facilities a detailed analysis of the effects of WEF shocks • Assesses impact of changes in global fossil fuel prices • Examines climate scenarios • Examines role of pricing and other economic tools for addressing Nexus trade-offs • Assess impacts of direct and indirect shocks to food sector	• Relies on economic models • Mostly quantitative data sources • Limited drivers of change considered	Details about input data and scenarios are included in Appendices within. GTAP 8.1 database utilized to calibrate the GLOBE model. Model was run with the HADGEM2-ES.[c]

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Note: Abbreviations used in the annex: WEAP = Water Evaluation and Planning; LEAP = Long-range Energy Alternatives; and AEZ = Agro-Ecological Zones.

a An epsilon-dominance, non-dominated sorted genetic algorithm II used as a sampling approach.

b Available to members at www.wefnexustool.org/login.php.

c Detailed information on this model is available at https://view.es-doc.org/?renderMethod=name&type=cim.1.software.ModelComponent&name=HadGEM2-ES&project=CMIP5.

Annex III

Urban Nexus events and activities from 2013 to 2019

Type	Name	Month	Year	City	Country	Website link
Regional workshops	International Conference on Integrated Resource Management in Asian Cities: The Urban Nexus	24-26 June	2013	Bangkok	Thailand	www.unescap.org/events/international-conference-integrated-resource-management-asian-cities-urban-nexus
	Regional workshop on Integrated Resource Management in Asian Cities: The Urban Nexus	2-4 December	2013	Bangkok	Thailand	www.unescap.org/events/regional-workshop-integrated-resource-management-asian-cities-urban-nexus-1
	Third regional workshop on Integrated Resource Management in Asian Cities: The Urban Nexus	25-27 December	2014	Da Nang	Viet Nam	www.unescap.org/events/third-regional-workshop-integrated-resource-management-asian-cities-urban-nexus
	Fourth regional workshop on Integrated Resource Management in Asian Cities: The Urban Nexus	5-7 November	2014	Ulaanbaatar	Mongolia	www.unescap.org/events/fourth-regional-workshop-integrated-resource-management-asian-cities-urban-nexus
	Fifth regional workshop on Integrated Resource Management in Asian Cities: The Urban Nexus	17-19 June	2015	Chiang Mai	Thailand	www.unescap.org/events/fifth-regional-workshop-integrated-resource-management-asian-cities-urban-nexus
	Sixth regional workshop on Integrated Resource Management in Asian Cities: The Urban Nexus	22-23 June	2016	Santa Rosa	Philippines	www.unescap.org/events/sixth-regional-workshop-integrated-resource-management-asian-cities-urban-nexus
	Seventh regional workshop on Integrated Resource Management in Asian Cities: The Urban Nexus	19-21 July	2017	Tanjung Pinang	Indonesia	www.unescap.org/events/seventh-regional-workshop-integrated-resource-management-asian-cities-urban-nexus
	Eighth regional workshop on Integrated Resource Management in Asian Cities: The Urban Nexus	14-16 November	2018	Bangkok	Thailand	www.unescap.org/events/eighth-regional-workshop-integrated-resource-management-asian-cities-urban-nexus
	Ninth regional workshop on Integrated Resource Management in Asian Cities: The Urban Nexus	22-23 May	2019	Bangkok	Thailand	www.unescap.org/events/ninth-regional-workshop-integrated-resource-management-asian-cities-urban-nexus
National dialogues	National Dialogue on the Urban Nexus in Thailand	19 March	2015	Bangkok	Thailand	www.unescap.org/events/national-dialogue-urban-nexus-thailand
	National Dialogue on the Urban Nexus in Mongolia	6 April	2015	Ulaanbaatar	Mongolia	www.unescap.org/events/national-dialogue-urban-nexus-mongolia
	National Dialogue on the Urban Nexus in Philippines	28 May	2015	Pasig City	Philippines	www.unescap.org/events/national-dialogue-urban-nexus-philippines
	National Policy Dialogue on Urban Nexus in Indonesia	26 October	2015	Jakarta	Indonesia	www.unescap.org/events/national-policy-dialogue-urban-nexus-indonesia
	Second National Dialogue on the Urban Nexus in Thailand	2 March	2017	Bangkok	Thailand	www.unescap.org/events/second-national-dialogue-urban-nexus-thailand
	Third National Dialogue on the Urban Nexus in Thailand	3 May	2018	Bangkok	Thailand	www.unescap.org/events/third-national-dialogue-urban-nexus-thailand

Global and regional outreach events	Integrated Resource Management in Asian Cities: The Urban Nexus, luncheon side event at the Committee on Environment and Development, third session	29 October	2013	Bangkok	Thailand	www.unescap.org/events/integrated-resource-management-asian-cities-urban-nexus-luncheon-side-event-committee
	Parallel session 1 CITYNET Congress- Integrated Resource Management in Asian Cities: The Urban Nexus	5 November	2013	Seoul	Republic of Korea	www.unescap.org/events/parallel-session-1-citynet-congress-integrated-resource-management-asian-cities-urban-nexus
	Integrated Resource Management in Asian Cities: The Urban Nexus, luncheon session, World Water Day 2014	21 March	2014	Bangkok	Thailand	www.unescap.org/events/integrated-resource-management-asian-cities-urban-nexus-luncheon-session-world-water-day-2014
	Parallel session on “Dissecting the Nexus-Resilience Link: From Planning to Practice”	12 February	2015	Bangkok	Thailand	www.unescap.org/events/parallel-session-dissecting-nexus-resilience-link-planning-practice
	Luncheon side event: Asia-Pacific Forum on Sustainable Development 2015	21 May	2015	Bangkok	Thailand	www.unescap.org/events/luncheon-side-event-asia-pacific-forum-sustainable-development-2015
	Training workshop on Urban Nexus	16 June	2015	Chiang Mai	Thailand	www.unescap.org/events/training-workshop-urban-nexus
	Parallel Session on Urban Nexus at the Sixth Asia-Pacific Urban Forum	19 October	2015	Jakarta	Indonesia	www.unescap.org/events/parallel-session-urban-nexus-apuf-6
	Urban Speakers Corner at the third Preparatory Committee for Habitat III	26 July	2016	Surabaya	Indonesia	www.unescap.org/events/urban-speakers-corner-prepcom-3
	Training workshops on “Energy Plus Buildings”	18 August	2016	Bangkok	Thailand	www.unescap.org/events/training-workshops-%E2%80%9Cenergy-plus-buildings%E2%80%9D-august-2016
	Events on Urban Nexus at Habitat III	19 October	2016	Quito	Ecuador	www.unescap.org/events/one-un-pavilion-event-urban-nexus-habitat-iii
	Expert group meeting on Urban Nexus and implementation of urban- and resource-related global agendas	10-11 November	2016	Bangkok	Thailand	www.unescap.org/events/expert-group-meeting-urban-nexus-and-implementation-urban-and-resource-related-global-agendas
	Luncheon event on the theme “From Planning to Practice: Urban Nexus as a Means of Implementing the 2030 Agenda”	30 November	2016	Bangkok	Thailand	www.unescap.org/events/luncheon-event-planning-practice-urban-nexus-means-implementing-2030-agenda
	Training workshop on “Design Thinking”	10-11 May	2017	Naga City	Philippines	www.unescap.org/events/training-workshop-%E2%80%9Cdesign-thinking%E2%80%9D
	Panel session at CityNet Congress 2017, “Sustainable Solutions for Asian Cities through Innovative and Integrated Resource Management”	6 November	2017	Colombo	Sri Lanka	www.unescap.org/events/panel-session-citynet-congress-2017-sustainable-solutions-asian-cities-through-innovative-and

	Luncheon side event at the ESCAP Sustainable Development Goals Week, “Urban Nexus Experiences: Opportunities for Local Governments to Promote Innovative, Integrated and Inclusive Resource Management to Achieve Global Agendas	30 November	2017	Bangkok	Thailand	www.unescap.org/events/luncheon-side-event-escaps-sdg-week-urban-nexus-experiences-opportunities-local-governments
	Side event at the ninth session of the World Urban Forum: Catalysing the New Urban Agenda by Integrating Resources and Collaborative Governance	8 February	2018	Kuala Lumpur	Malaysia	www.unescap.org/events/wuf9-side-event-catalyzing-new-urban-agenda-integrating-resources-and-collaborative
	Luncheon side event at fifth session of the ESCAP Committee on Environment and Development: “How can the Water-Energy-Food Nexus in Cities Contribute to Mitigating Climate Change?”	22 November	2018	Bangkok	Thailand	www.unescap.org/events/luncheon-side-event-escap-s-fifth-session-committee-environment-and-development-how-can-water
	Policy development workshop on “Applying the Urban Nexus Concept to Implementing Global Agendas”	5-6 March	2019	Bangkok	Thailand	www.unescap.org/events/policy-development-workshop-applying-urban-nexus-concept-implementing-global-agendas

Although researchers and practitioners have studied the water-energy-food/land nexus for some time, the emergence of the Urban Nexus approach has been more recent. In 2013, GIZ was commissioned by the German Federal Ministry for Economic Cooperation and Development to implement the Integrated Resource Management in Asian Cities: The Urban Nexus project in partnership with ESCAP and ICLEI – Local Governments for Sustainability in order to address pressing concerns in cities in the Asia-Pacific region.

The Urban Nexus approach examines the interdependencies between water, energy and food/land and the synergies and competing uses of these resources, requiring a shift from a sectoral to a cross-sectoral, integrated approach. It challenges existing structures, sector policies and procedures to promote the protection and use of water, energy and food/land in a balanced manner, countering traditional silo thinking and divided responsibilities that often result in poorly coordinated investments, increased costs and underutilized infrastructure and facilities.

The Urban Nexus approach is an action-oriented guiding principle within the vision of a circular economy, where waste is viewed as a resource. Multisectoral and multilevel approaches which integrate resources contribute to improved resource efficiency. With many project cities identifying wastewater and solid waste management as their most pressing problems, the Urban Nexus approach emphasizes how wastewater and waste can be converted into sources of energy and useful by-products, such as fertilizer.

As an integrated and holistic concept, the Urban Nexus approach helps break barriers between sectors and stakeholders to take advantage of synergies.