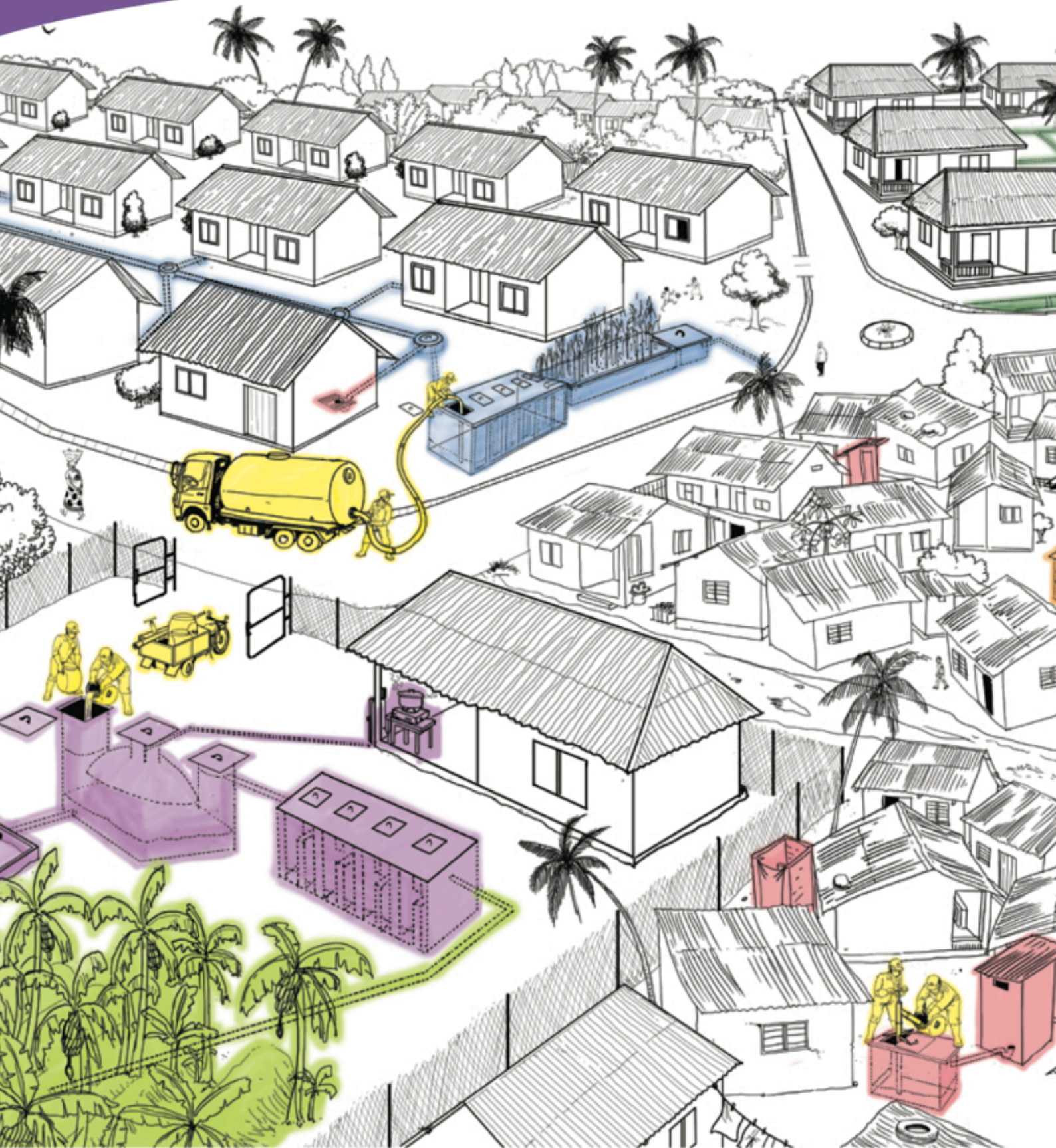
City Sanitation Planning

PART 1

# *Urban environmental sanitation*

## *Integrating decentralised solutions*



# PART 1

## *Urban environmental sanitation*

*Integrating decentralised solutions*

**We welcome any feedback or constructive comments**

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# *About this booklet*

This booklet is the first part of a 3-part City Sanitation Planning package, and provides the rationale for providing alternative environmental sanitation solutions in rapidly growing urban contexts.

The City Sanitation Planning package includes the following interrelated and complementary documents, which focus on the city of Dar es Salaam as a case study.


**PART 1: *Urban environmental sanitation:*** *Integrating decentralised solutions*

**PART 2: *5 step planning guide:*** *Which solutions go where?*

**PART 3: *Catalogue of environmental sanitation options for urban areas***
*Centralised and decentralised*

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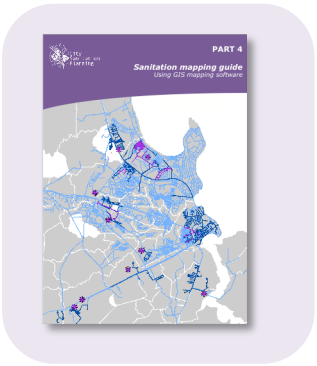



**FUTURE ADDITION**

**PART 4: *Sanitation Mapping Guide:*** *Using GIS mapping software*

# *Setting the scene*

## The need for integrated solutions for environmental sanitation

In many rapidly urbanising cities in the Global South, current "centralised" approaches to sanitation service provision are falling short of the growing needs of the city. In most cases, centralised systems only serve a small percentage of the urban population. As populations continue to grow at unprecedented rates and human settlements expand beyond the scope of centralised networks, the deficiencies of conventional approaches to are becoming increasingly more apparent.

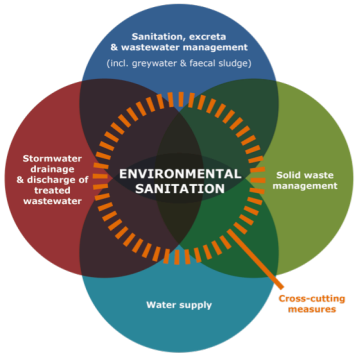
**For this reason, additional solutions are urgently needed to help "fill in the gaps" and provide sufficient coverage to all urban dwellers, in order for cities to mitigate environmental and human health risks.**

In recent decades, decentralised solutions for environmental sanitation have proven to be feasible alternatives and supplements to existing (centralised) systems, in order to improve service provision as well as increase overall coverage.

### Defining environmental sanitation

Environmental sanitation can be understood as a set of activities required to achieve a sanitary physical environment. Based on the *Bellagio Principles for Sustainable Sanitation*, environmental sanitation was developed by a team of WASH experts in 2000 in response to the shortfalls of conventional sanitation policies and practices in meeting the needs of the developing world (WSSCC 2000).

Environmental sanitation goes one step further than the traditional notion of "sanitation" which is limited to the immediate aspects surrounding human excreta and/or the provision of toilets. A holistic approach to achieving a sanitary urban environment considers all aspects related to hygiene, notably those aspects directly linked to human health and quality of life:




- **Sanitation, excreta & wastewater management (including grey water and faecal sludge)**
- **Solid Waste Management (SWM)**
- **Water supply**
- **Storm water & discharge of treated wastewater**
- **Cross-cutting measures**

**NOTE: Understanding environmental sanitation and implementing long-lasting solutions requires a paradigm shift from thinking of "used" water as "waste" water (something to discard) to thinking of it as a valuable resource. The familiar term "wastewater" will be used within this booklet, however it is crucial to acknowledge the value of "used" water, as more than simply "waste" water.**

## Urbanisation & environmental sanitation challenges

> ***"Africa is the fastest urbanising continent on the planet and the demand for water and sanitation is outstripping supply in cities"***
>
> Dr Joan Clos
> Executive Director
> UN-HABITAT 2011

Africa is urbanising faster than any other continent in the world, as the number of people living in cities has more than doubled in the past twenty years. According to "moderate" growth-rate projections, the continent's 2010 urban population of 400 million is expected to triple to an estimated 1.26 billion by 2050[1]. This means that more than 50% of all Africans will live in urban areas by 2035, increasing to 60% by 2050.

Figure 1 shows the growth projections for a number of Africa's major cities. In addition to the rapid growth that occurred prior to 2010, the 2010-2025 projections reveal common patterns that are likely to be seen across Africa, as many cities will double in population by 2025.

As this urban expansion continues, many cities will quickly approach a tipping point in terms of managing unplanned sprawl and ensuring a sanitary environment for all urban citizens. The Sub-Saharan region in particular has the highest proportion of city dwellers in informal settlements in the world[2]. In these areas, infrastructure will be stretched to its limits, with an urgent need for more reliable supplies of electricity and water, and services such as waste management and sanitation. According to UN Habitat's 2010 report on the state of African cities, *"Not a single African government can afford to ignore the on-going rapid urban transition. Cities must become priority areas for public policies"*.

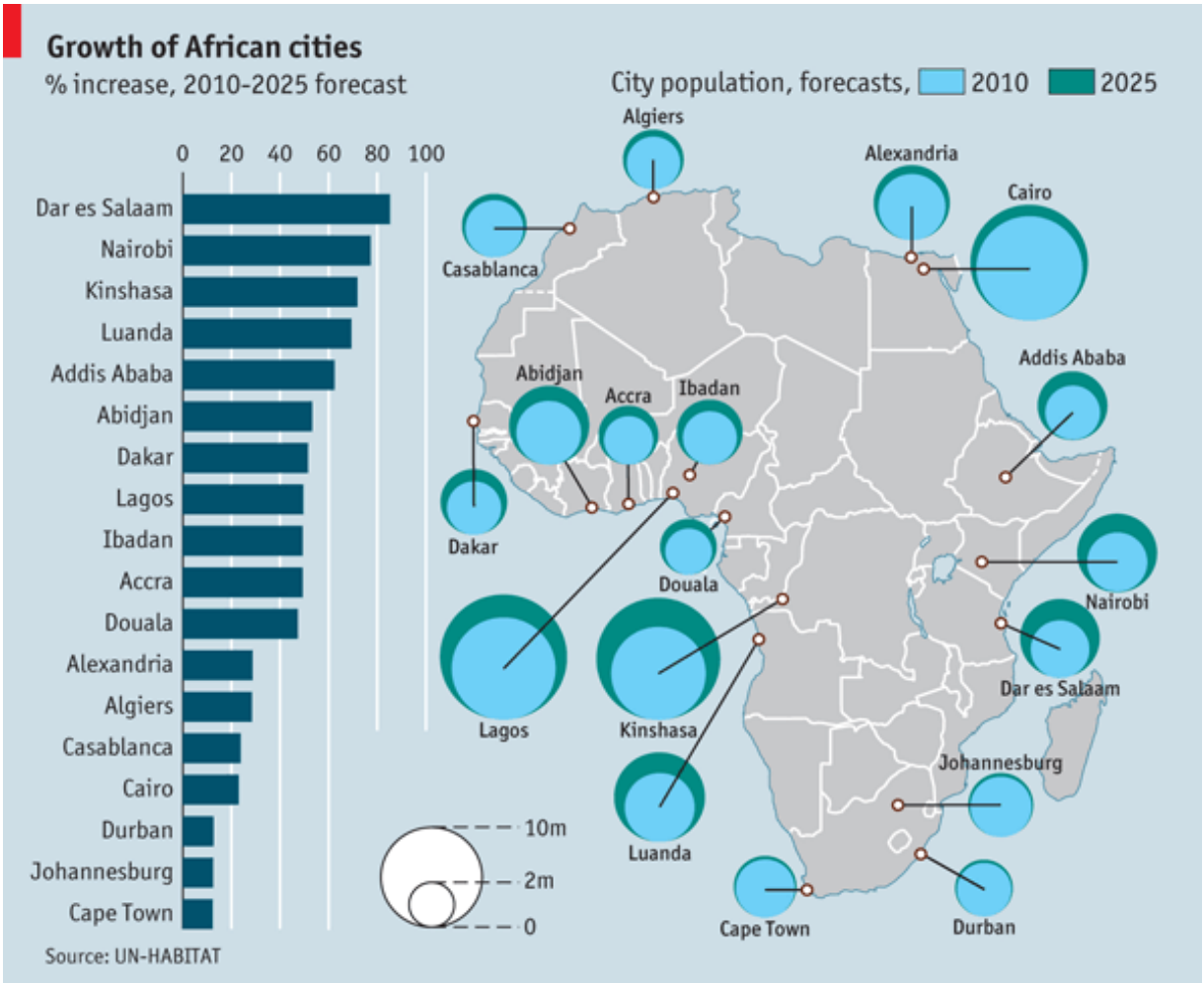



**Figure 1: The growth of African Cities (The Economist 2010)**

[1] UN-HABITAT 2014
[2] The Economist Intelligence Unit and Siemens 2011

# Case study: Dar es Salaam, Tanzania

Dar es Salaam is the largest city in Tanzania, and is considered one of Africa's ten most populous cities. Within East Africa, Dar es Salaam has recently taken over the lead position from Nairobi as the largest city. It is one of the fasted-growing cities in this region, with a projected addition of 226,000 new urban dwellers per year[3], and is ranked the 9th fastest growing urban areas in the world[4].

According to most recent census, the urban population is estimated at 4.36 million[5], although urban population growth is occurring faster than can be quantified. Various sources predict annual population growth rates ranging from 4.39% (NBS CENSUS 2012), 6.63% (UN-HABITAT 2014) to 8% (World Bank 2011). In lieu of an exact growth-rate figure, population will most likely exceed 10 million – reaching megacity status – by 2030[6].

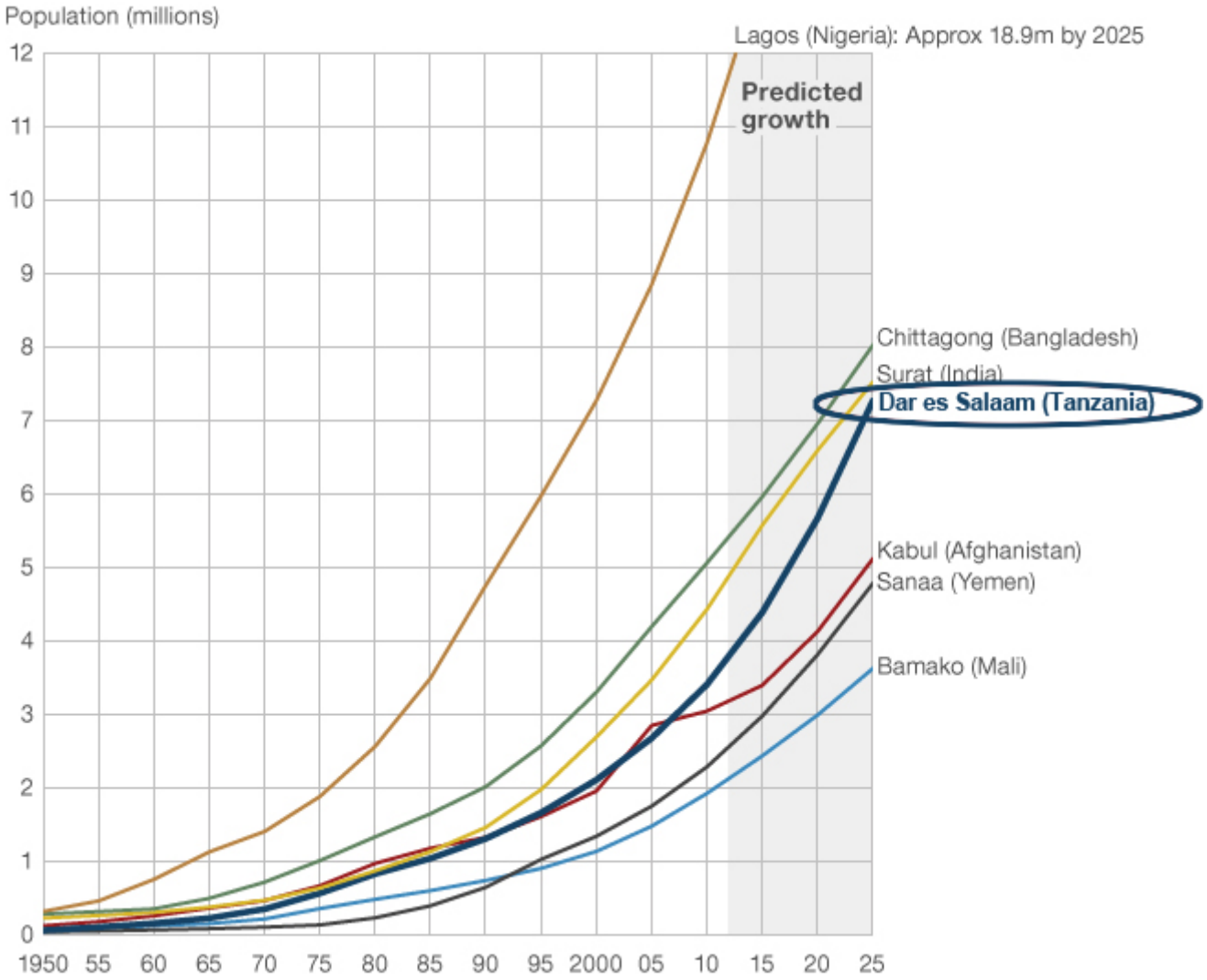



**Figure 2: The world's fastest-growing major cities (Boyle, 2012)**

An analysis of satellite images over the past decade shows extensive urban expansion and densification of the build environment, as shown below.

[3] United Nations 2014
[4] City Mayors Statistics 2007
[5] NBS 2012
[6] UN-HABITAT 2014

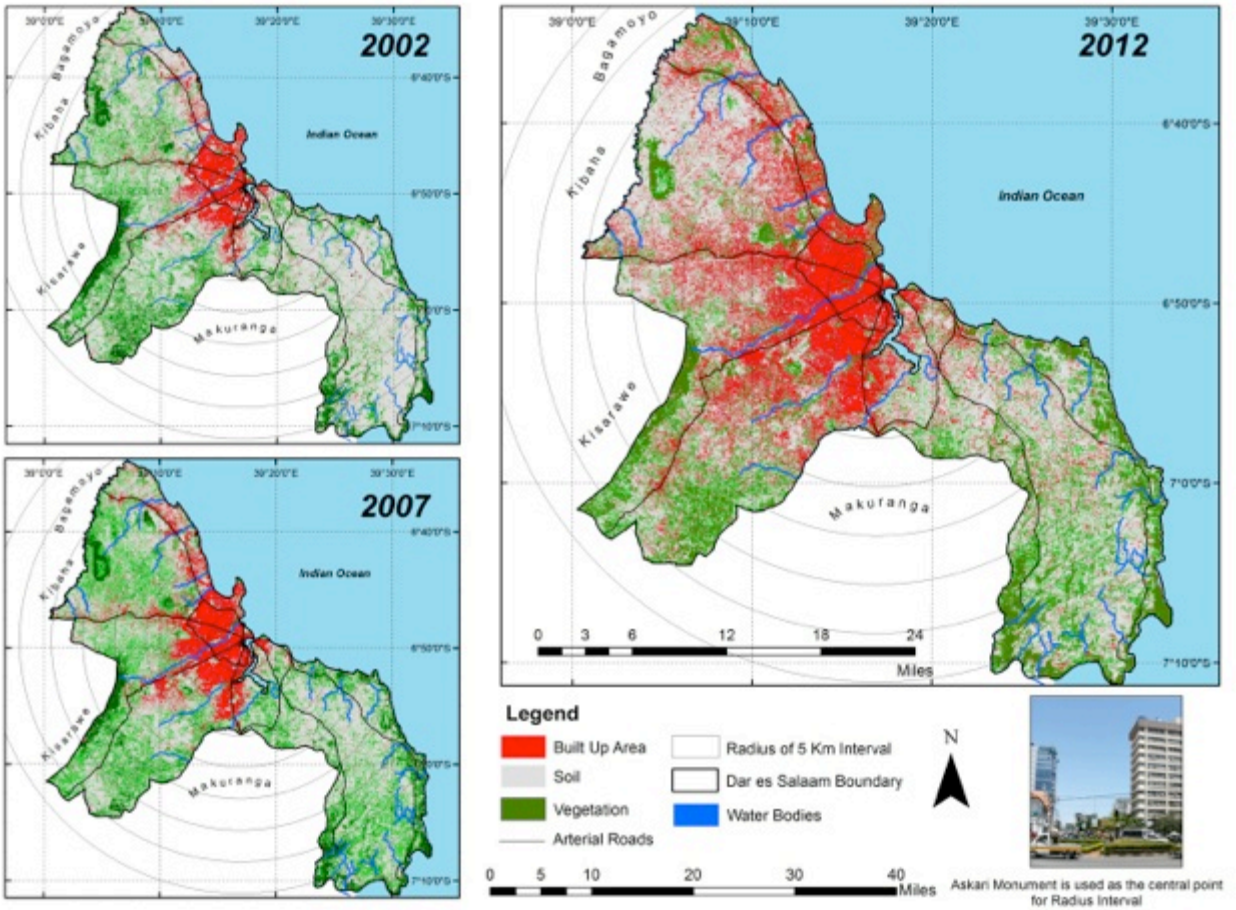



**Figure 3: Mapping the expansion of built-up areas between 2002, 2007 and 2012 (Courtesy of Ardhi University Institute of Human Settlements Studies 2014).**

As the urban population continues to increase, the city cannot afford to ignore the growing demands for water supply along with sewerage, sludge and solid waste generation.

| | 2012 | 2017* | 2022* | 2027* | 2032* |
|---|---|---|---|---|---|
| **Population (millions)**<br>Assuming 4.39% growth rate<br>(NBS CENSUS 2012) | 4.36 | 5.41 | 6.71 | 8.31 | 10.31 |
| **Total water demand (m³/day)**<br>Assuming average 114L/per person/day | 497,000 | 617,000 | 765,000 | 947,000 | 1,175,000 |
| **Total sewage generation (m³/day)**<br>Assuming 85% of water demand | 422,500 | 525,000 | 650,000 | 805,000 | 999,000 |
| **Total solid waste generation (tonnes/day)**<br>Assuming 0.8kg/per person/day<br>(Breeze 2012) | 3,488 | 4,328 | 5,368 | 6,648 | 8,248 |

***** These projections were calculated using fixed rates, assuming that the current economic situation doesn't change. However, development trends suggest that as income levels inevitably rise, as does increasing water consumption and waste generation. Thus, the projections above are likely to be much higher in reality.

Such rapid urbanisation places tremendous strain on the city's capacity to provide sanitation services to all citizens, particularly those in unplanned settlements with little or no access to basic services.

It is estimated that over 70% of the population in Dar es Salaam currently live in such unplanned areas[7]. In these densely populated and sprawling settlements, providing infrastructure has proven to be difficult, due to limited road access, limited available land and hazardous terrain.

[7] UN-HABITAT 2010

# Current environmental sanitation situation in Dar es Salaam

## Sanitation, excreta & wastewater management (including greywater and faecal sludge):

Providing sanitation facilities and wastewater treatment services to all citizens is one of the biggest challenges in Dar es Salaam. Estimates suggest that 10-14% of the population are connected to centralised sewerage networks, while approximately 83% of the urban population use on-site sanitation services[8].

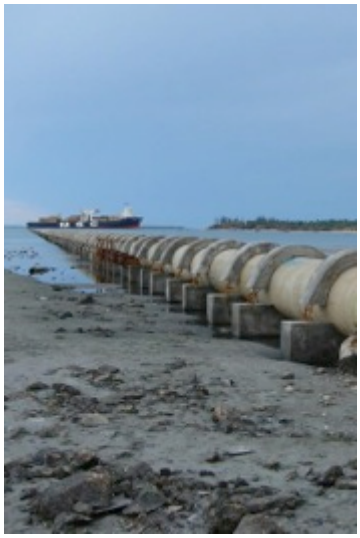
This means that the majority of the population are using on-site sanitation facilities (predominantly unlined pit-latrines and septic tanks), which are often shared between households. Additionally, these facilities are often poorly constructed and unhygienic, with the on-going challenge of wastewater and faecal sludge management.

Faecal sludge and wastewater from pit latrines is either emptied and transported to a treatment facility, dumped into a hole next to the pit, or simply discharged into the street or stormwater drainage channels. This means that the majority of the city's untreated wastewater is being discharged into open water bodies or absorbed into the ground water.

## Solid waste management:

Estimations for solid waste generation are highly variable, however the largest quoted figure suggests that over 1.8million tonnes of waste is generated each year. Due to a shortage in solid-waste management services, over 61% of this domestic waste does not arrive at the final landfill site[9]. This means the majority of solid waste is illegally burned, buried, or dumped into toilets, drainage, rivers, and public spaces.

## Stormwater drainage & discharge of treated wastewater:



Stormwater drainage and treated wastewater disposal options are currently inadequate for the ever-growing volume of wastewater generated. This is a sizeable concern in Dar es Salaam, especially due to high ground water levels, which leave little options for excess wastewater to soak naturally into the ground.

Although some stormwater drainage does exist, options for water discharge or disposal are limited and in many cases non-existent. It is common for water inundation to occur in areas where stormwater drainage does not connect to discharge outlets or disposal options, or where drains are blocked with solid waste. These factors are exacerbated during times of heavy rain.

[8] WaterAID & Share 2013
[9] Moss *et al* 2012

## Water supply:

Approximately 38% of residents in Dar es Salaam have no access to water supply facilities[10]. One of the biggest challenges to centralised water supply is that 50% of the water provided daily by the Dar es Salaam Water and Sewerage Corporation (DAWASCO) is unaccounted for[11], usually due to cut or broken pipes.

Citizens without access to reliable tap stands or the public water supply network use shallow boreholes, privately owned or otherwise. This causes difficulties in terms of the standardisation of user-fees, as well as water quality issues. Boreholes are never tested and although people generally assume the water to be safe, the quality is unknown. Additional environmental conditions such as salt-intrusion, inadequate sewage treatment, sewage leaks from broken or overflowing pipes, as well as effluence from industry, result in ground water contamination which is often too polluted to be considered potable.

# Impacts of inadequate environmental sanitation

Inadequate environmental sanitation causes considerable environmental pollution such as surface and groundwater contamination.

Poor liquid and solid waste management can be extremely harmful to humans and lead to frequent outbreaks of diseases such as cholera, malaria and diarrhoea. In Tanzania, diarrhoea causes 26,500 deaths each year, 90% of which are directly attributed to poor water, sanitation and hygiene[12].

Meanwhile, increased air pollution from the burning of solid waste has been proven to cause irritation and infection of the eyes, skin, lungs and respiratory system, and can even lead to lung cancer.

These health impacts are detrimental to economic growth and inhibit human development prospects. The economic burden of these impacts falls disproportionately on the poorest, as they most likely to suffer from poor sanitation, while also paying a higher price for the negative effects.

# Key challenges in urban areas

Even as infrastructure coverage continues to expand, and public water supply and sewerage expansions are planned for the next 20 years, it is clear that a vast majority of the population will still remain un-served, due to the following centralised and decentralised challenges:

- Rapid unplanned and unregulated urban growth
  - Unregulated growth limits road access for communities
  - Unplanned "squatter" areas have different laws/by-laws and less regulations
- Insufficient water-supply
- Limited sewerage network coverage and insufficient wastewater treatment
- Shortage of service providers for operation and maintenance of wastewater treatment facilities
- Shortage of service providers for faecal sludge management
- Inadequate capacity for solid waste management
- Inadequate storm-water drainage
- Lack of information on solutions
- Unclear priorities
- Challenges of law enforcement and ineffective regulations
- Lack of funding at municipal level
- Lack of capacity at sub-ward

[10] UN-HABITAT 2014
[11] Moss *et al* 2012
[12] Sittoni & Maina 2012

## Looking forward

Increased urban population is a powerful asset for the overall transformation of Tanzania. With a clear vision for the future combined with incremental improvements (E.g. shifting of priorities, effectively combatting corruption, and investments that reach the end user), the sanitation challenges of today can be overcome and all urban citizens can enjoy a sanitary environment.

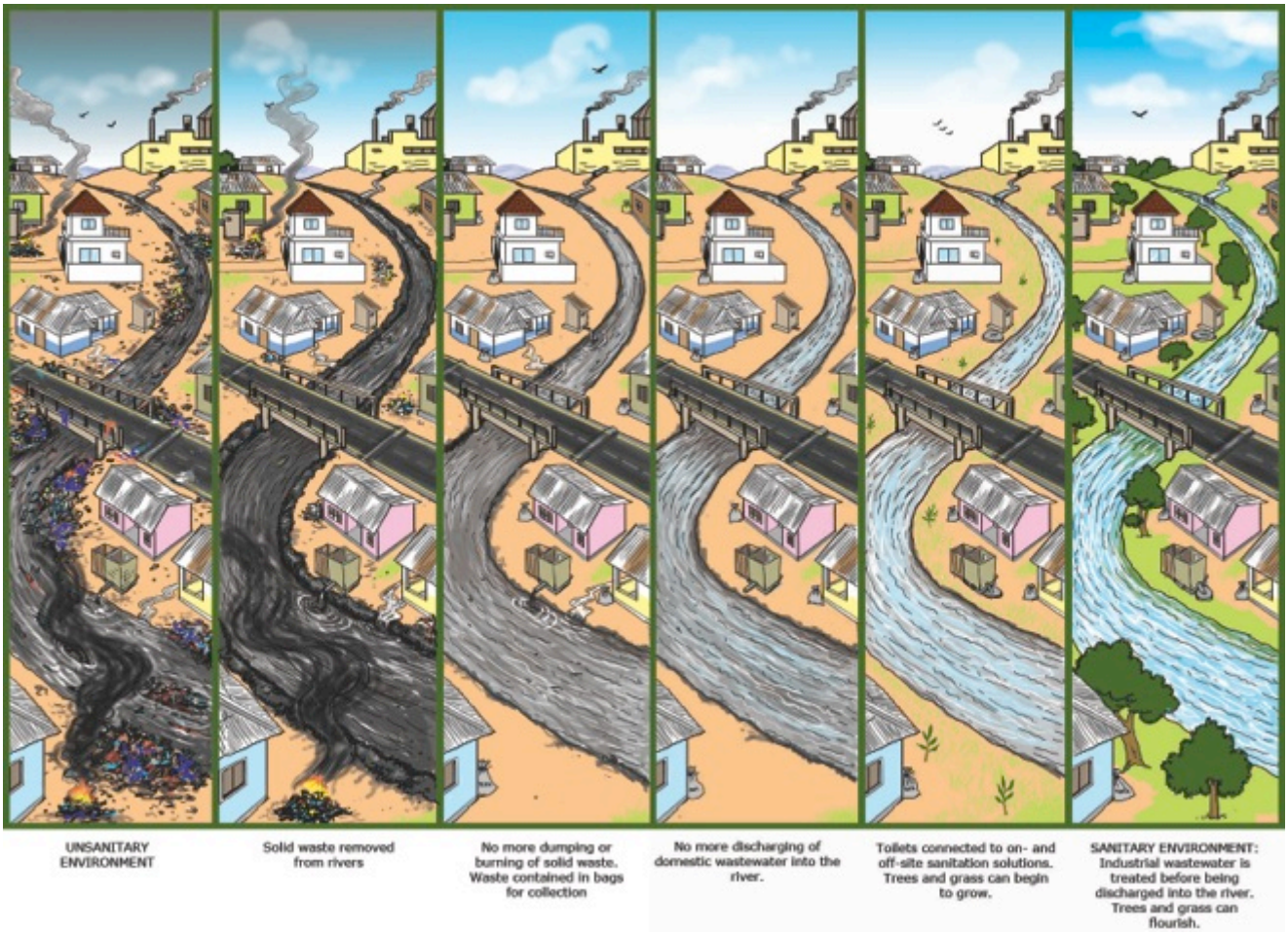



**Figure 4: The transition from an unsanitary environment a sanitary environment**

# *What can be done?*

## Integrating decentralised solutions into urban planning

The challenges associated with rapid urban growth require two parallel courses of action, with a strong policy on the prioritisation of implementation strategies:

- Broad development plans with comprehensive guiding principles and implementation strategies
- Flexible and incremental implementation solutions that provide immediate benefits.

Only then can the city keep up with current and future demands, and provide sanitation service to all citizens – particularly those in unplanned settlements with little or no access to essential services.

## Current coverage by centralised networks

The map in **Error! Reference source not found.** shows the extent of current water-supply and sewerage networks in Dar es Salaam – contrasted against the rapidly expanding built-up areas, which extend far beyond the reach of the centralised networks. Refer to Figure 3 to see the rapid pace of urban growth in Dar es Salaam from 2002 – 2012.

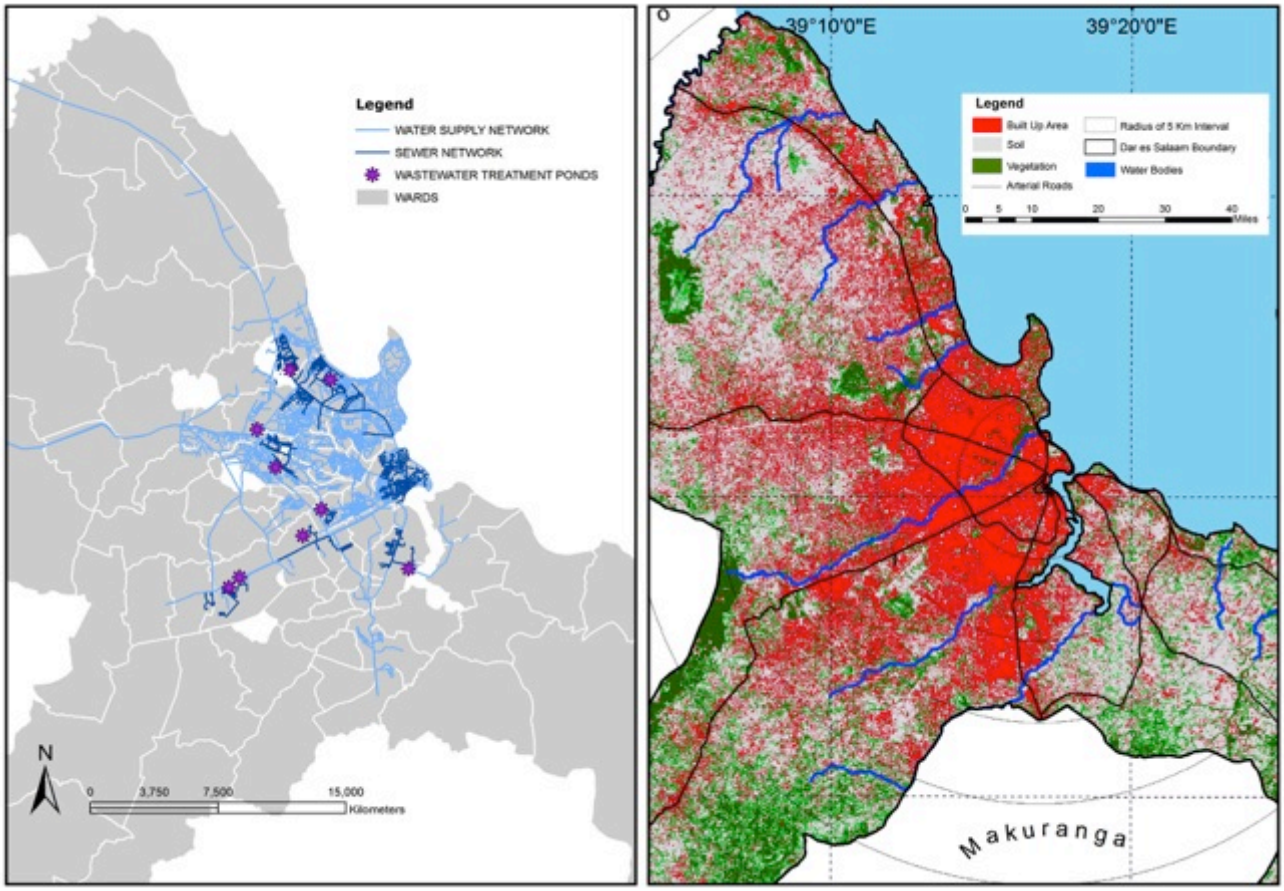



**Figure 5: Map showing the water-supply and sewerage networks (DAWASA 2015);**

**Figure 6: Map showing the built-up areas in 2012 (Courtesy of Ardhi University Institute of Human Settlements Studies 2014).**

When we talk about centralised service provision for water supply and wastewater management, we generally refer to big pipe and sewer networks that transport water from water-treatment plants to the user, and then transport wastewater onwards to technically sophisticated wastewater-treatment plants. While these systems are often considered optimal, in terms of providing a convenient service, they are not always the most appropriate solutions for urban areas in developing countries. Conventional centralised systems, based on Western models, require high capital investment and associated connection rates, as well as on-going operation and maintenance provision.

In Dar es Salaam, the centralised network only serve a small percentage of the population (See Figure 5 and Figure 6) and treatment plants are operating with limited success, due to the shortage of skilled expertise and funding for continuous maintenance and repairs.

This scenario is common with centralised systems throughout the developing world; hence the urgency to break the trend of conventional planning approaches favouring centralised systems, and instead adopt appropriate, decentralised alternatives.

## What are decentralised solutions?

Decentralised systems offer a flexible and sustainable response to environmental sanitation demands in rapidly growing urban and peri-urban communities un-served by centralised public infrastructure. They present an opportunity to manage and treat wastewater and solid waste closer to the source of generation, and can be either stand-alone solutions or they can be integrated into existing centralised service systems.

In order to meet the basic needs of urban citizens, integrated and decentralised sanitation services provide fast solutions and a number of other advantages, such as:

- **Quick implementation**: by facilitating the mobilisation of local financial and in-kind resources
- **Low-cost construction:** using locally available materials and local workforce
- **Low-tech solutions:** requiring little or no outside energy input
- **Localised management of wastewater and solid waste:** no need for heavy infrastructure or mechanisms to transport contents long distances to the point of disposal
- **Simple to operate and maintain by local caretakers:** no need for highly skilled technicians
- **Enhancing capacity building at the community level**
- **Providing local people with income and business opportunities**
- **Adapting to the specific needs of a community, thus optimising community benefits**

## Centralised vs. decentralised systems

In order to proactively plan for future improvements in sanitation coverage, it is important to identify areas where centralised systems and decentralised alternatives have the highest potential for positive impact.

For instance, there are some densely populated, unplanned and inaccessible areas where centralised sewerage networks simply aren't viable without demolishing homes. In such areas, decentralised solutions might be immediately cost-effective, as a result of not having to demolish homes or relocate families. Conversely, in cases where decentralised solutions appear costly, they may present the only feasible option for areas where centralised solutions simply aren't possible.

Although capital costs for decentralised options may initially seem high, these costs must be considered against centralised systems or oxidation ponds, which use much more land (higher costs), and require higher operation and maintenance and energy; costs which will continue to rise in upcoming years. With these factors in mind, decentralised options become much more affordable than centralised systems in the long run. It is also important to note that decentralised options don't require the construction of long sewerage lines and pump stations, instead employing simplified sewerage systems.

Development trends indicate that without immediate attention and suitable interventions in **medium density, low-income areas with no/limited access** (e.g. Msewe), these rapidly growing areas are likely to become high-density urban slums. Once a low-income urban settlement becomes a high-density urban slum with limited access to essential services, the environmental sanitation situation becomes critical. In areas that have already reached a critical level (e.g. Tandale or Ubungo), re-active, emergency solutions are now requirement, which can be both costly and difficult to implement.

Decentralised solutions are therefore prioritised for such areas with **high-density and with no/limited access** to conventional services (regardless of income).

Meanwhile, extending centralised networks to areas with **medium density and low-income** (e.g. Chamazi or Msewe) may present a timely and affordable opportunity – while space is still available – to avoid such scenarios as mentioned above.

**In all areas, decentralised sanitation solutions have the additional potential to be incrementally upgraded, and connect to future centralised network expansions where possible.**

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**BORDA** is specialised in integrated decentralised sanitation solutions in the fields of wastewater, sludge and solid waste management. We advise national and local government to incorporate integrated and decentralised services into legal frameworks and regulations.

The aim is to enhance law enforcement and capacity building, meet quality standards and induce private sector companies and community based enterprises to supply adequate hardware, technologies and services – even to low-income communities.

**More information on suitable environmental sanitation solutions for Dar es Salaam can be found within "CSP Guide PART 3: *Catalogue of environmental sanitation options for urban areas"* which supplements this booklet.**

## Urban NEXUS – Energy, water, food-security & climate protection

The nexus approach recognises that food, water, energy and climate are inextricably linked, and that actions related to any one area must consider the impacts on at least one (if not all) of the other areas. The interdependencies of these sectors are particularly acute in dense, rapidly growing urban areas – as is the urgency for integrated planning, policy and management of vital resources.

In terms of urban sanitation, the NEXUS approach attempts to capitalise on the many synergies (co-benefits) and balance the trade-offs, by linking the essential human needs for sanitation to other essential human needs; namely food and fibre, water, energy and climate protection. More specifically, decentralised solutions promote the integration of energy, water and nutrient recover, while offering the possibility to recover investment and/or running costs. This holistic approach fosters both the protection of the natural environment, while also creating a noticeable benefit for communities and/or system operators.

In order to broaden the influences of the NEXUS approach and promote long-lasting, economically, socially and environmentally sound sanitation coverage, decentralised sanitation solutions need to complement centralised sanitation infrastructure and services. This can be achieved through the integration of decentralised solutions into legal frameworks and urban development plans – notably citywide sanitation plans.

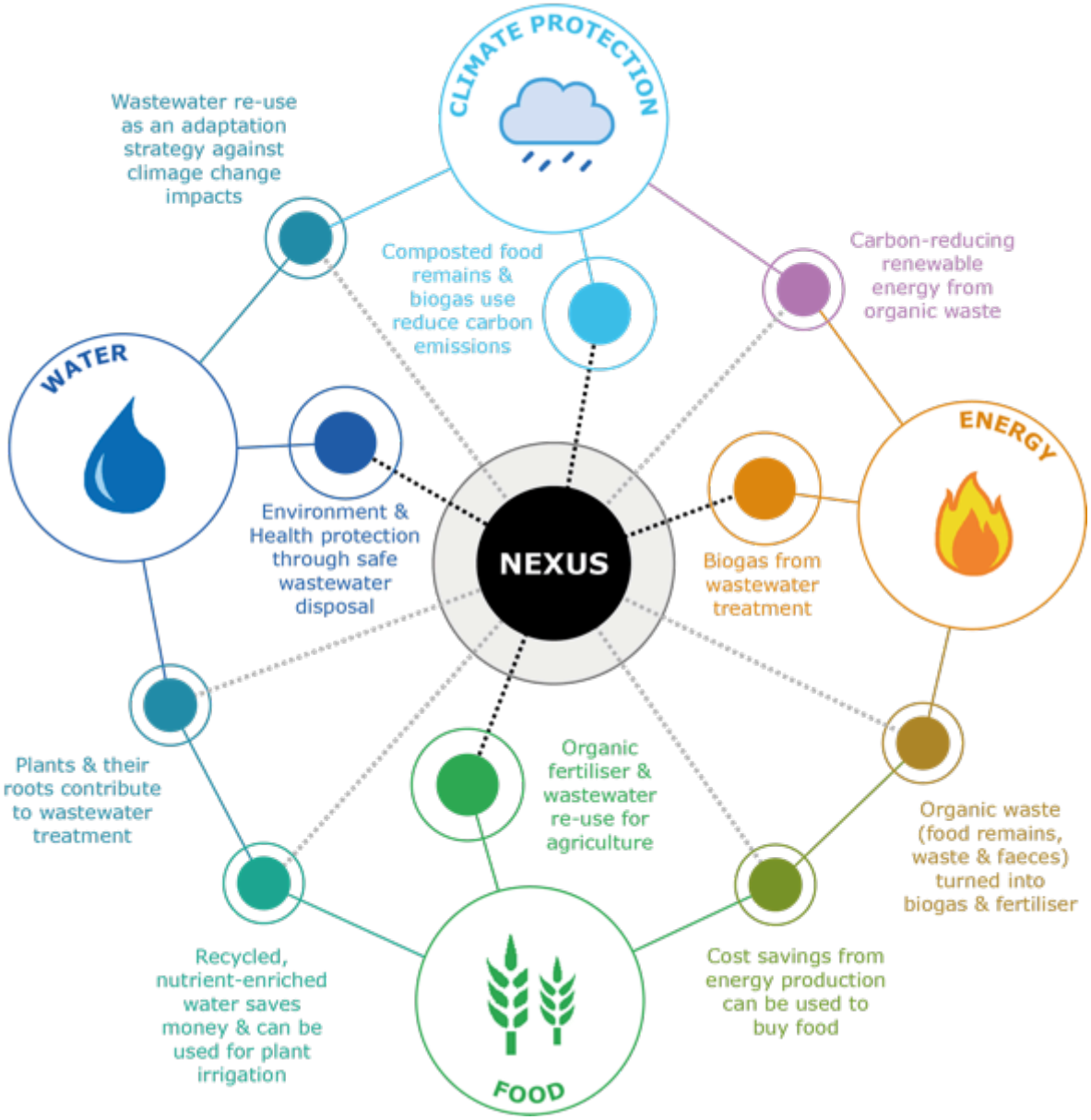


**Figure 7: NEXUS diagram, showing the synergies between energy, water, food-security and climate protection.**

**In addition to broadening coverage, integrating decentralised services into urban planning enables the development of sustainable cities and opportunities to:**

- **Enhance community wellbeing and promote Green Economies**
- **Close water cycles, promote urban water management and protect fresh water resources from overuse and pollution**
- **Encourage urban recycling industries, reduce waste generation and create jobs**
- **Strengthen urban and peri-urban agriculture, particularly food production**






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