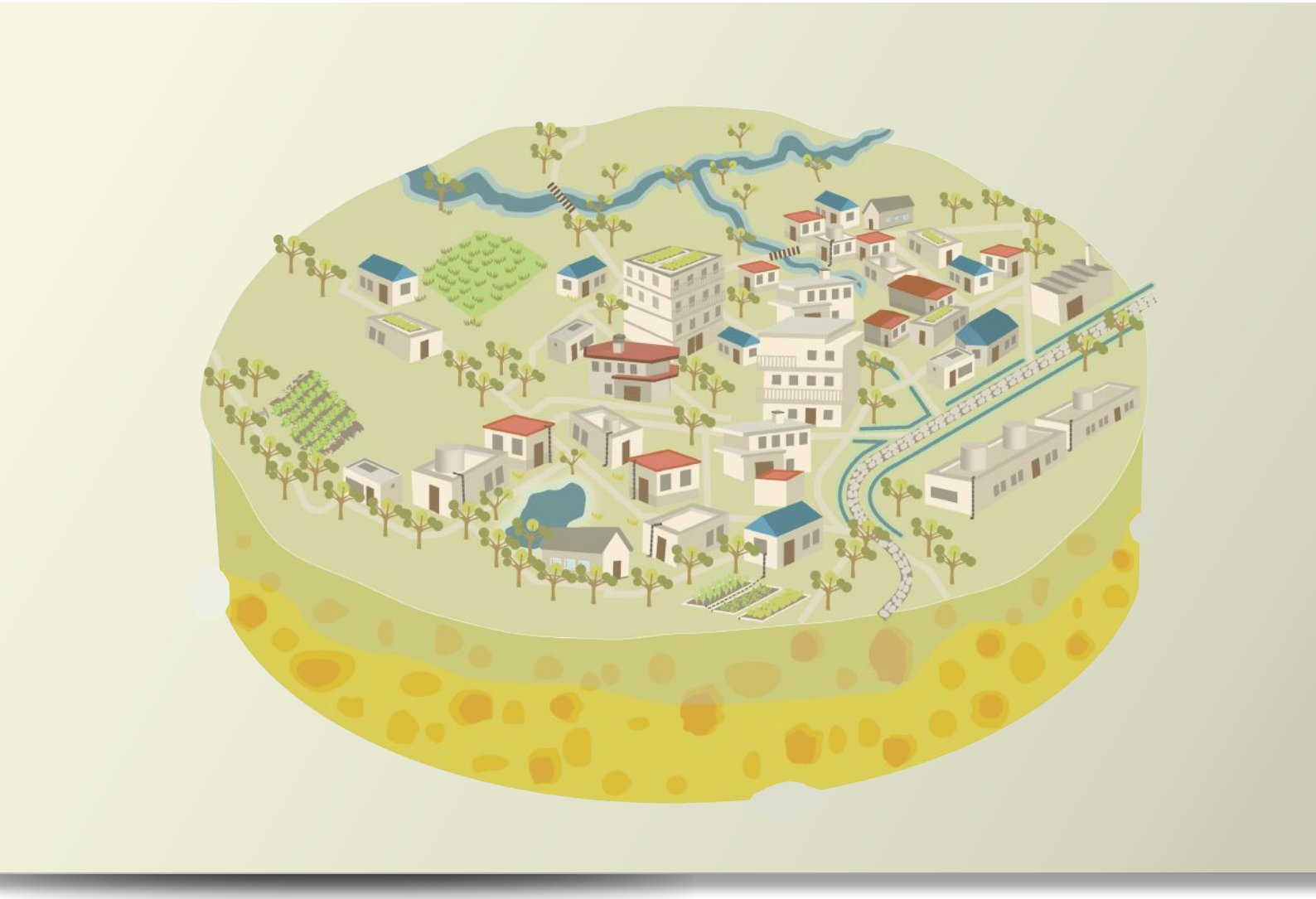
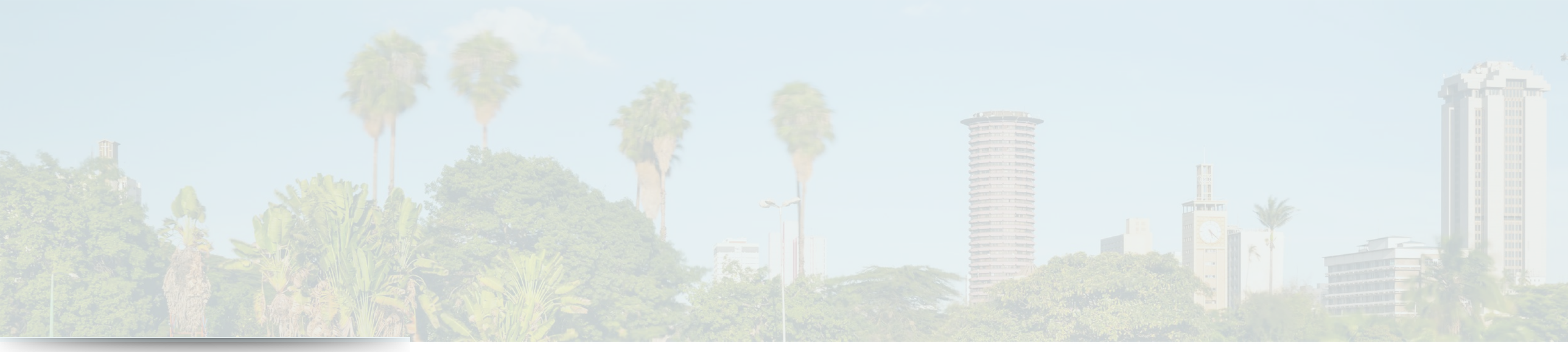
HOW TO CREATE A SPONGE TOWN?

Sponge Town Guideline



Colophon:

This guideline has been prepared by the Sponge Teams of Kajiado and Kwa Vonza, under the ViaWater programme supported by Aqua4All and the Ministry of Foreign Affairs of the Netherlands. From 2016-March 2019 pilots have been implemented in Kajiado and Kwa Vonza. Based upon the experience and learnings from these pilots this guideline is prepared.

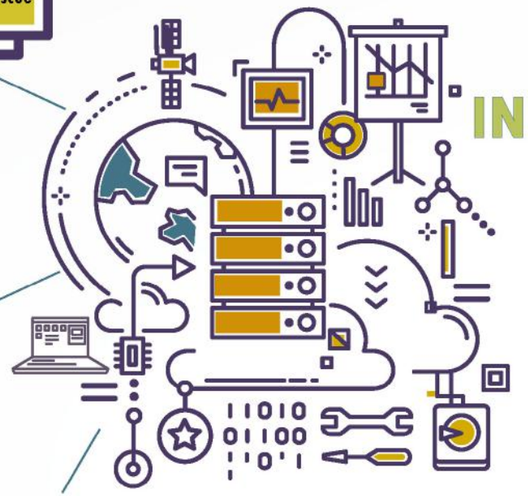


Sponge town to the rescue

Creating a sponge town

Sponge town Planning

INNOVATION



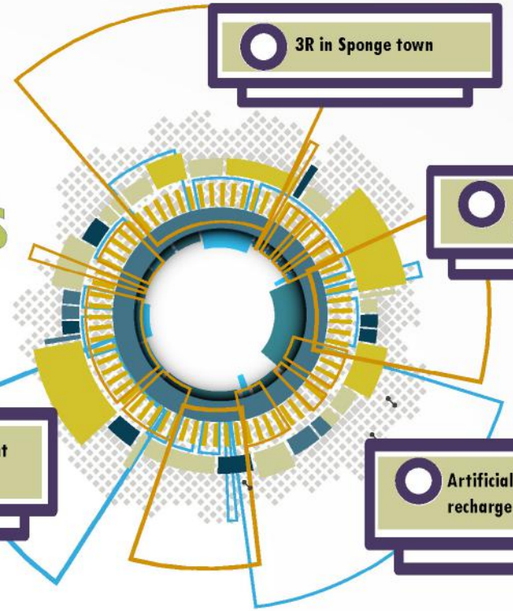
TECHNOLOGIES

3R in Sponge town

Green Infrastructure

Water management techniques

Artificial groundwater recharge



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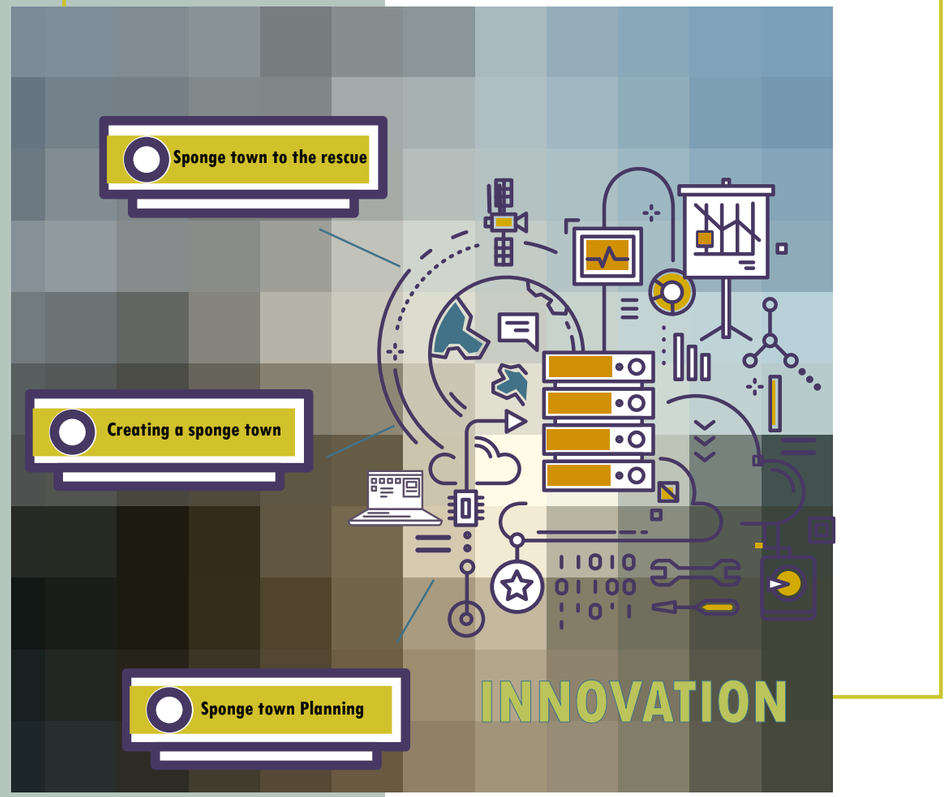


Part 1: INNOVATION

This guide is meant to make small towns more pleasant and healthy to live in. To provide ideas and interventions for water management and regreening of such towns. There are tens of thousands of towns in the world but only very few are 'sponge towns'. Towns with enough water for everyone throughout the year, even though the area around them is arid. Towns with beautiful functional green areas. Towns that buffer floods, not let water flow away, but redistribute the water in times of drought. Towns where the people work on making the town a good place to live. Sponge towns.

In Kenya we have been working to create sponge towns in Kajiado and Kwa Vonza. Two towns that are booming, that trigger new businesses – because all business want to be where it is good to be. Two towns facing big water quality and quantity challenges.

In Kajiado and Kwa Vonza a range of practical measures that combine landscape interventions with water buffering have been implemented. Think of water harvesting, green areas for infiltration and urban farming. All of this by engaging communities, county governments, civil society and business partners. The experiences from the sponge cities of Kajiado and Kwa Vonza are the basis for the guideline you are reading.

In this guideline we describe what it takes for a town to become a Sponge Town. We first explain how a sponge town can come to the rescue and how to read this guideline. Wherever you read 'town' you can also read city, municipality, or market centre.

The guideline is written for everyone who is interested in making her/his town a better place, especially when dealing with water problems. It will give ideas on what steps to take and what changes to make. How to create a buffered town, where are all water is retained, recharged and re-used. A green place where trees and vegetation bring back essential natural functions. A lively place where government, business and citizens are working together. A thriving place with many economic opportunities.

This guideline is meant for you now reading it. You can be working with a county government, a civil society organization or a non-governmental organization, an enterprise or an individual who deals with water management, regreening, urban development and/or spatial planning (See diagram 1 showing the SDG impacts of a Sponge Town).

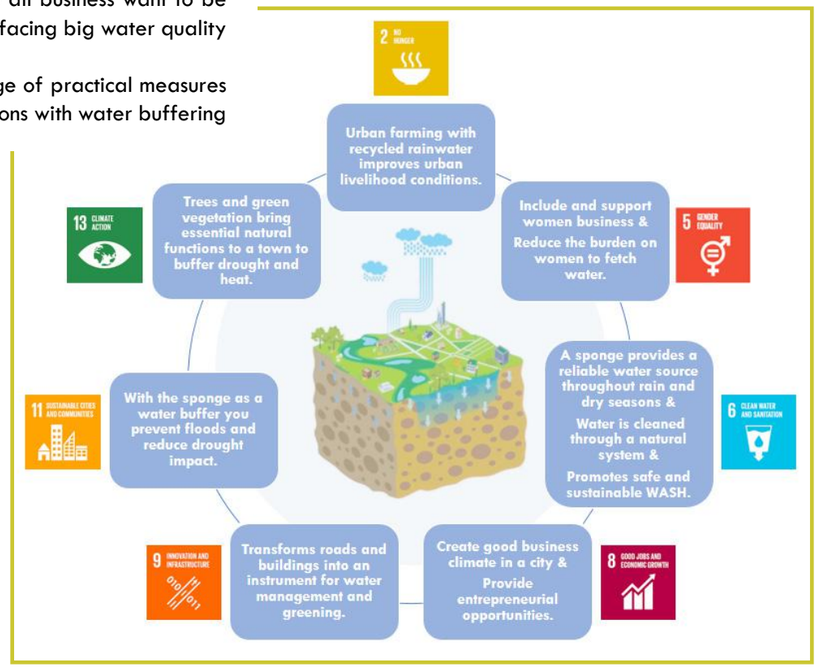


Diagram 1: SDG impacts of a Sponge Town

Info box 1: Background on Kwa Vonza and Kajiado:

First some facts about Kwa Vonza and Kajiado to give you an idea about what kind of towns we are talking about.

Figure 1: KwaVonza (left) and Kajiado (right) from satellite imagery (scales are different)

Some facts:

	Kajiado	Kwa Vonza
County	Kajiado County	Kitui County
Climatic zone	Semi-arid	Semi-arid
Geology at surface	Red, loamy to sandy soils	Red sandy soils
Population (estimate)	14000	4000
Connectivity	Along Nairobi-Arusha highway(A104)	Along Machakos-Kitui road (C109)
Economic activities	Livestock, tourism, trading	Commerce, education and real estate
Trademark	Was decided a municipality in 2018	Designated as University town due to proximity of 2 universities
% of residents connected to piped water supply	Unknown	22% (not-continuous)
Main alternative water sources	Boreholes	Surface water (ponds, rivers, dams), and scoop hole in sandy rivers.

Challenges:
In both towns challenges are faced in adequate urban water management:

- Rainwater runoff (storm water) draining from the increasing number of roofs and roads creates gullies in town and drags rubbish into rivers around town.
- The town lacks a centralized water provision system. Private operators sell from boreholes, sandy rivers or elsewhere. This water is expensive and not always of good quality.
- Infiltration from latrine pits and sceptic tanks in town causes nitrate to seep into the groundwater layers, thereby polluting the groundwater reserves. (Kajiado)
- The central water point connected to a pipe line is not reliable and there are no alternatives. Leading to insufficient water supply while demand is rising. (Kwa Vonza)

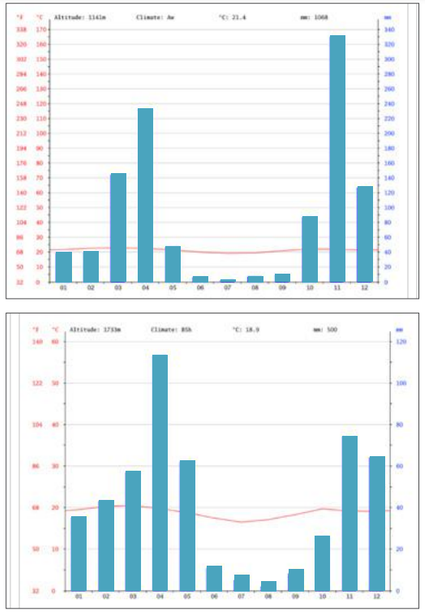


Figure 2: Rainfall characteristics of KwaVonza (up) and Kajiado (down)

1.1 SPONGE TOWN TO THE RESCUE

But first. Why would you want to create a Sponge town? Looking at Kenya, more than 80% of the land is classified as Arid and Semi-Arid Lands (ASALs) and home to around 10 million people. This vast area scores low when it comes to development and economic growth. More than 60% of its inhabitants live in poverty. Water is a key factor for the development of ASALs, which are recurrently hit by drought and the growing effects of climate change and shocks[1].

Kenya is expected to become a predominantly urban country by 2033 with half of its population living in urban centres[2]. Towns all over the country are rapidly growing, which brings along problems common to many booming African cities.

In these ASALs the towns are quickly confronted with big water issues as low and unevenly distributed rainfall results in too little water supply for the increasing demand of the growing population. Worsened by little space in the town for water to be stored and infiltrated into the soil, flood events also pose a constant threat to life and assets. Currently the balance between water infiltration and water demand is often negative; this needs to be restored.

A sponge town makes the best out of two extremes (flood and drought) by means of its buffering function. The Sponge holds water during rains – limiting flood hazards, and releasing it slowly when it is dry – increasing water availability. Offering protection against floods and preventing a water deficit, see diagram 2.

[1] Republic of Kenya, 2005, ASAL National Vision and Strategy, Natural Resource Management 2005-2015

[2] Ngetich, J.K., Opata, G.P., Mulongo, L.S., 2014, Urban Environmental Planning and Development Control of Medium Sized Towns in Kenya. A Case of Eldoret Municipality, Journal of Emerging Trends in Economics and Management Science

A sponge town is innovative and practical, it keeps up with the rising demand of water and the need to protect people and assets. Sponge cities focus on sustainable and functional water management in an urban setting. Cities that can 'hold, clean and drain water in a natural way'. This is done by engaging partners and communities to combine landscape-based and water buffering methods, making their town a nicer place to live. While at the same time improving key water functions to its citizens. A sponge town is green and pleasant to live in. It is no heat island but a place with shadow and good air.

A sponge town focuses on low-cost measures that yield a high impact. Starting from what is there, existing buildings, natural depressions, skilled masons, etc. It combines these resources that are in a town and aims to add value and reduce overall cost. Costs are reduced for two reasons: sponge interventions are cheap compared to conventional water management structures and they increase the life-span of existing structures and assets in town by protecting these from water hazards.

Value is added through improved water functions, healthy living and attractive business climate. In a sponge town the extent of damages caused by water and water scarcity in town decrease, while business opportunities linked to (rain) water use and reuse increase. The revenue streams from water harvesting structures and services, can trigger more businesses to invest in sponge town innovations. The key goals in developing a sponge town are in line with policies for urban development to improve water quality, diversify water supply and the protection against floods.

1.2 HOW TO USE THE SPONGE GUIDELINE?

This guideline is divided into four parts.

You are now reading Part 1 on the innovation, highlighting what a sponge town is all about introducing basic steps and providing a readers' guide.

Part 2 is about getting people involved. It gives an introduction on how to engage, plan and make decisions with other stakeholders.

Part 3 highlights technologies, providing you with a range of measures in water management and green infrastructure that can be implemented when creating a sponge town.

Part 4 is our helpdesk section. Organizations and experts, involved in creating sponge cities introduce themselves. You can approach them for the services they can deliver to help in creating a sponge town.

A sponge town can only really be created when towns with their inhabitants and different expertise's and technologies come together. Parts 2 and 3 of this guideline can best be used as a pick-and-choose menu based on your specific expertise, and the needs and demands for a specific town.

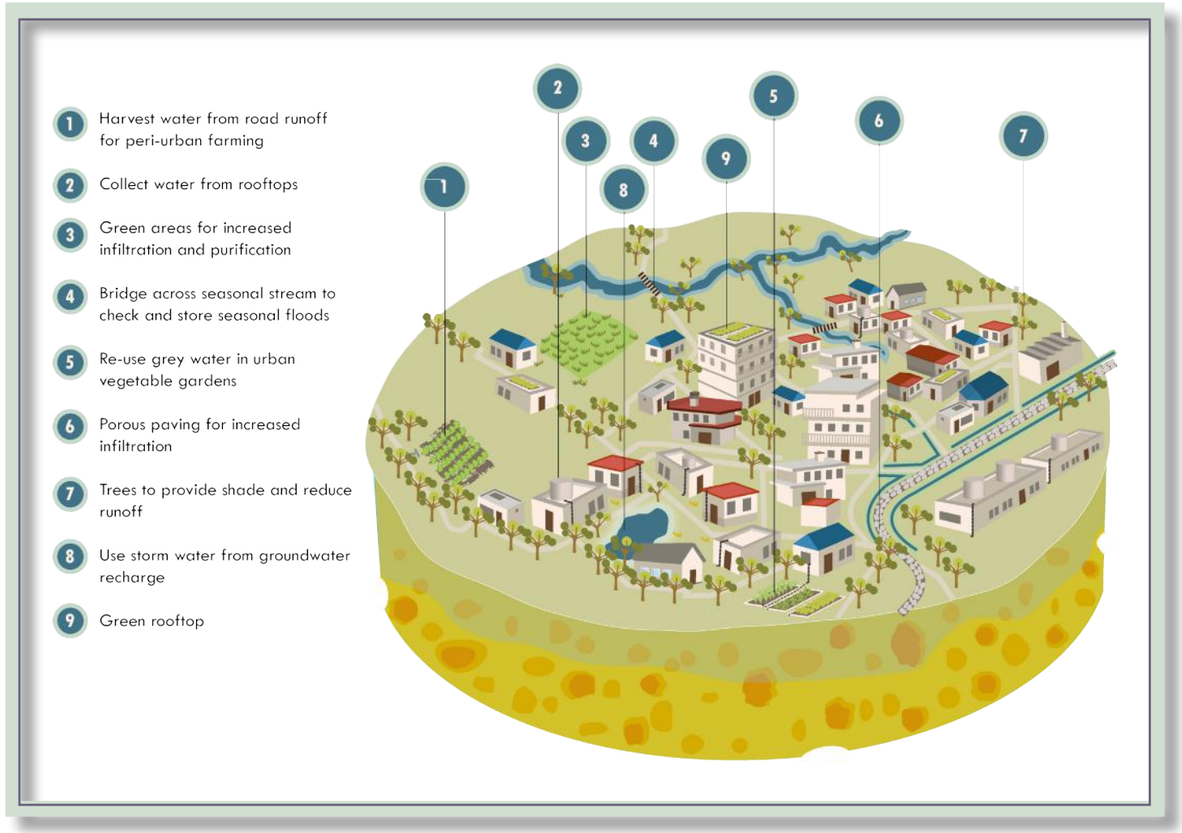
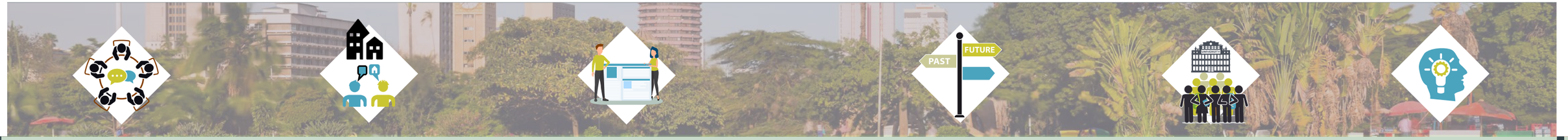


Diagram 2: What does a Sponge town do?

1.3 BASIC STEPS IN CREATING A SPONGE TOWN

To start off with, we share three basic steps for anybody who wants to be involved in a sponge town.

Step 1: Knowing the town's core challenges
It is important to know what are the main issue at hand in your town. Is your town facing water shortage? Do you experience damage caused by floods? Is your town in need of more water retention capacity? What are the water challenges? And what are the important needs of the population? All these questions need to be explored together with your community. Without understanding the issues at stake, it is impossible to come up with a sensible, precise and achievable strategy. It is very important to engage with different people in the town to find out about each other's problems and needs, and how each person can contribute. These are the steps:



1. **Engage with civil society and community groups:** Have discussions about water availability, and related challenges. These discussions can be structured around topics such as flooding, water prices, pollution and water shortage. This engagement not only helps to gather a common understanding, but also brings together the community and helps in building commitment.

2. **Talk and keep talking with town residents:** The people who live in a town, make the town. The people who live in a sponge town, make the sponge town. The residents are the ones who experience the problems. They know very well what is going on and what they want. They will surprise you with out-of-the-box ideas and solutions throughout the entire process and not just being a source of information.

3. **Engage youth and women groups in data collection:** At household level women are the real experts when it comes to water. Their understanding is deeper and their interest is thus higher when engaged in data collection. Youth on the other hand is commonly more creative, seeing issues with a different and more innovative angle. In our pilot in Kwa Vonza both groups came up with valuable insights about the importance of proper urban water management.

4. **Talk about the past, the present and the future:** It is good to talk about the past and the present. It helps understand what has changed and what force is driving a change – how challenges were met in the past and how they are dealt with now. One can make a timeline on the important elements – where people lived, how the economic activities changed, how vegetation developed, how water resources changed. It is also good to talk about the future – what is the better time and what we like to achieve with our dedicated effort and ingenuity. It is also said that if we have no vision of the future, we can never get there. Sharing such a vision gives hope and energy.

5. **Work with local universities:** Students are always keen to find an exciting research subject, they are first users of new technologies and an infinite source of fresh energy.

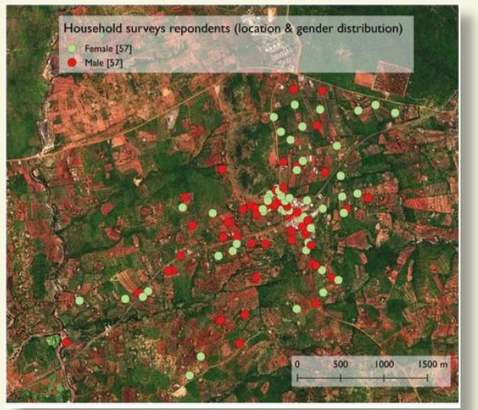
6. **Engage experts:** Some information is rather technical and demands the engagement of experts. When a hydrological study is needed, it is therefore best to work in collaboration with the local water experts, or when needed, engage external experts. The same applies for other technical subjects such as civil engineering, road drainage and sewage disposal.

Step 2: Mapping the problem - gather specific data

Water problems vary as different areas have different problems. As no one size fits all, it is therefore important to map out the findings. By mapping out the problem spots, different types of solutions can quickly be connect to the needs in different areas. Maps can be very simple, and are certainly not dependent on satellite systems or drones. Planners can do (hand drawn) mapping exercises together with the communities in a workshop. Often the people who live in the area know precisely where and what the problems are. This information can be drawn on paper, which informs planners and citizens on where to take what measures. It also provides insights into how one problem can affect another, ensuring that the bigger picture is taken into account.

Toolbox 1: Using kobo collect application

For collecting more data on the specific issues, it is useful to do a survey. An easy way is e-surveying: by using common smartphones it is possible to collect data in a systematic way and with location coordinates attached to every entry. This method of surveying allows easy linking to the mapping exercises and helps in identifying the connections between the different problems. The e-survey can be made in an online dashboard, for example with software from Kobo Toolbox or mWater. The survey-questionnaire

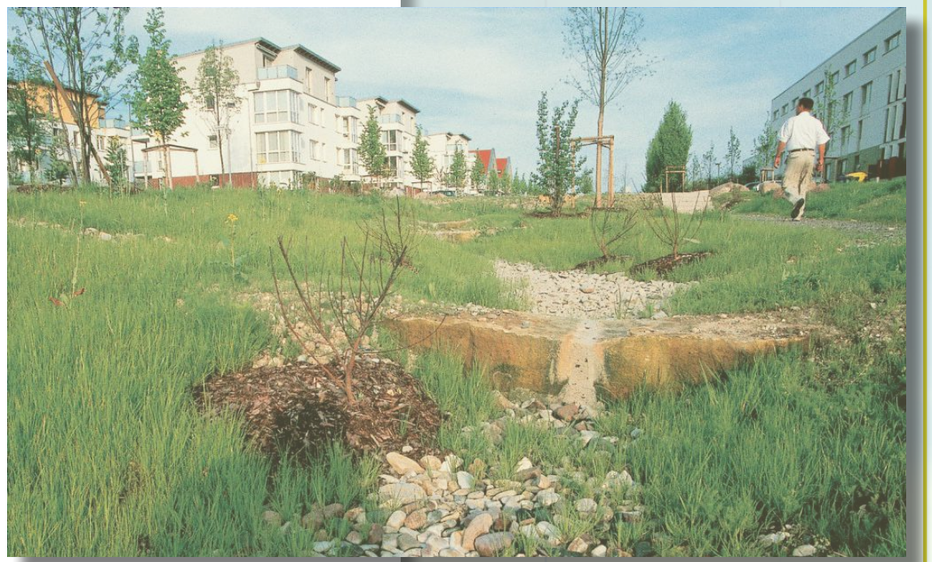


can be downloaded in the app on your smartphone. The surveys can then be done offline, and once the app reconnects with internet it automatically uploads the data to the online platform, from here it can be easily downloaded and analysed. This baseline study is not just about drawing in information, it should really be seen as a first step in working together with community and citizens. All results should be publicly discussed, this can be done at community platforms; through open discussions and playful exercises.

Step 3: What solutions can work?

At this stage we have to get clear what is needed, where and by whom.

The important question is: What are possible measures to solve our identified problems? Do we need a check dam to buffer water that otherwise drains away too fast? Do we need to construct an artificial wetland? Do we need to regulate that all houses have a roof harvesting system? Where to regreen? Do we need to plant trees in market areas to increase soil infiltration capacity and shade? Planting trees along roads and alleys? Where to create mini-parks? The different technical options are explained in Part 3 of this guideline. Based on the problems formulated we can now find suitable solutions. This should be combined with the plan on how to involve the stakeholders in order to clearly identify who does what.



1.4 SPONGE TOWN PLANNING

The challenge of many booming towns is that the growth comes quick and the planning comes late. This challenge is also an opportunity. The necessary drainage systems, infrastructure and water management need to be dealt with – with foresight. It is important to set the right patterns as a nice place will be nice for a long time. Especially in a town we need to prevent that the concrete jungle does not allow water to infiltrate into the soil and cause heat islands, whit hot and suffocating micro-climates.

An urban plan capturing the bigger picture is essential to make sure that the problems are mapped out in the town landscape. In doing so, linking the problems and the solutions at a larger scale, in order to strategize a holistic approach.

Effective implementation of the solutions should start with a clear and practical plan. It can be done by hand or digitally, without fancy software. It is important to bring spatial planners together with water experts and citizen representatives to find feasible solutions. The aim of the plan is to guide the different stakeholders on what measures to take and where.

A typical practical plan for a sponge town should include:

- Measures on handling storm water and harvesting runoff water
- Green areas, trees and other vegetation for natural water infiltration and filtration
- Promotion of green gardening in town
- Supporting measures for rainwater harvesting by citizens and businesses
- Options for innovations, like permeable pavements and bio-swales (table 2)

Spatial plans have many benefits, but also challenges. It can be tedious and difficult to develop them when resources and time are limited. Therefore sponge town plans should be as uncomplicated as possible and integrated within existing plans and programmes. Try to build on what is there and integrate the small-scale interventions step by step eventually reaching scale and big overall impact.

Case-study box 1: involving students in designing sponge plans

Kwa Vonza is lucky to have a large number of students from South Eastern Kenya University (SEKU) and Kenya Water Institute (KEWI). Students were very enthusiastic about the project and keen to participate in project activities. So we put them to work, they studied the town and mapped out water issues. The results were discussed with the citizen platform, so to validate the insights and look for solutions. With approval and ideas from the town representatives the students designed 'sponge neighbourhood plans'. Showing how and where to do storm water management, rainwater harvesting and green spaces management. The plans were again validated by a poll of experts and by the citizen platform.

This form of participatory planning, appeared cost efficient and provided the town planner with plenty of grass root level insights. Lesson learned is that participatory planning initially may be time consuming, however you create a wide support base enabling you to save time in later stages.

Mapping and designing is best done together with the community who know the locations of resources and land uses, which may not be obvious from observation alone. Some important features to be mapped are: 1) Main objects and topography in the landscape such as roads, villages, churches/mosques, big trees and rocks. This will help the community and the practitioner to read the map. 2) Water resources: use different symbols to represent different types, different uses and availability during the year. 3) Water movement: draw all watercourses and gullies and eventual swampy areas. Depict and describe areas where groundwater is at reach with hand-dug wells. Also ask the community to draw how the water is moving over the area. See figure 3 as example.

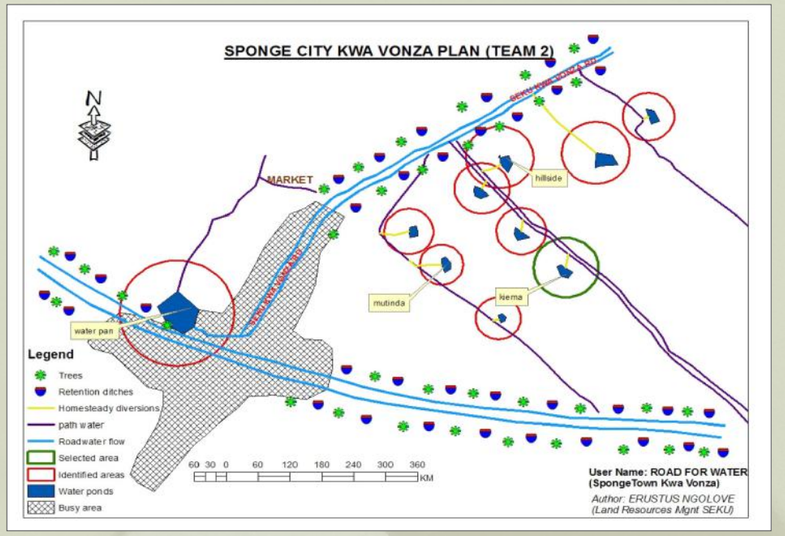


Figure 3: One of the plans designed by a group of students from SEKU and KEWI

Diagram 3: Do's and don'ts

Lessons from the experience of sponge towns Kajiado and KwaVonza:

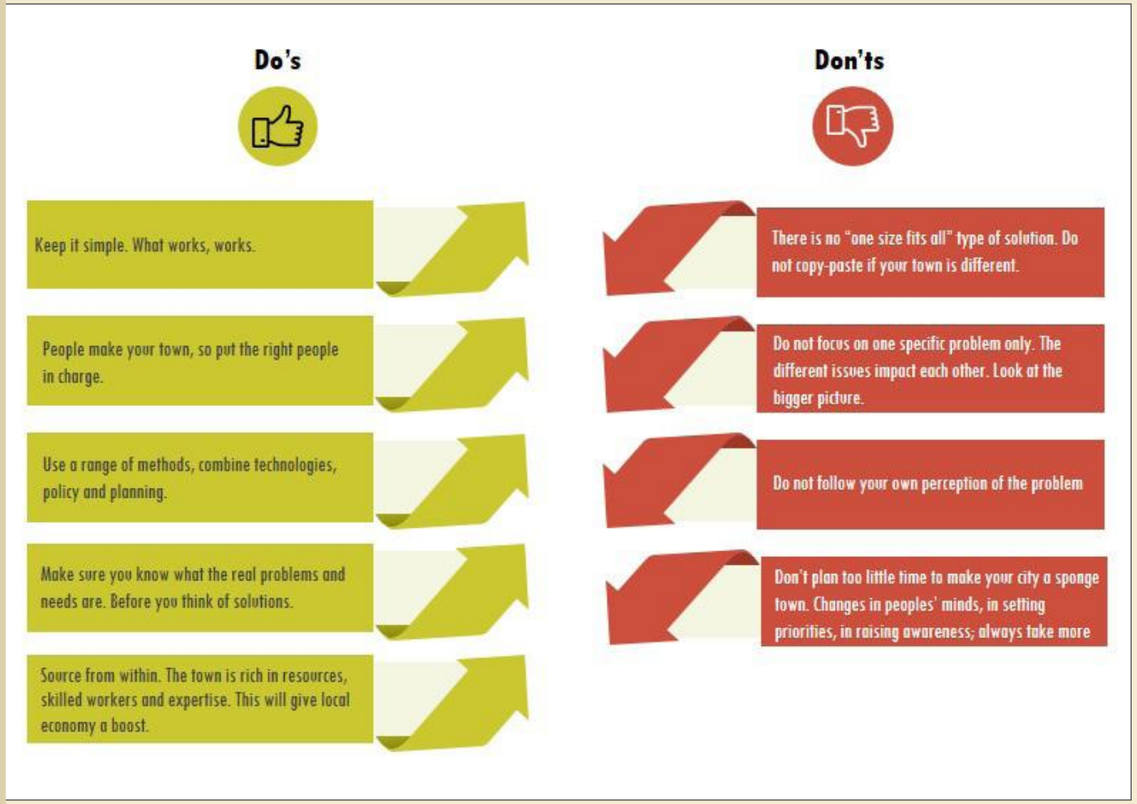


Diagram 4: Explanation of a possible timeline for creating a Sponge town

People

Part 2: PEOPLE

Things work better when they add up. When switching from business as usual to the creation of a sponge town, it is crucial to first set out a level playing field for all those involved around the goal of reconfiguring their town to a sponge town. This working environment will stimulate people to contribute and helps in aligning the roles and responsibilities; involving county governments, civil society, businesses and individual households.
This chapter gives a brief overview of tools and methods to engage with relevant organizations and residents in towns. This toolkit is a living document which provides ideas that follow from practical experience.

2.1 GOVERNANCE

The implementation of sponge towns requires the collaboration of a wide range of stakeholders. The stakeholders range from Ministries and federal institutions to local communities. Stakeholder engagement ensures that individuals, groups and organisations participate in the decision-making and implementation processes of projects or policies that affect them or in which they have an interest.

Governance is key in this aspect. Challenges in urban development include: prior planning with implementation, integration with other sectors and community engagement.

- Keep it simple to enlarge the chance that it can be picked up by people working in different sectors at different levels.
- Even more important; align with existing plans and strategies; take into account government planning, budgeting and reporting cycles (so, at least one year)
- Be clear on what they can expect from you and you from them: support, training, extra payments, involvement, etc.
- Be prepared for corruption at any level at any scale.
- Be prepared for changes in government positions due to elections or (high) turnover.

A few quick tips before kicking it off:

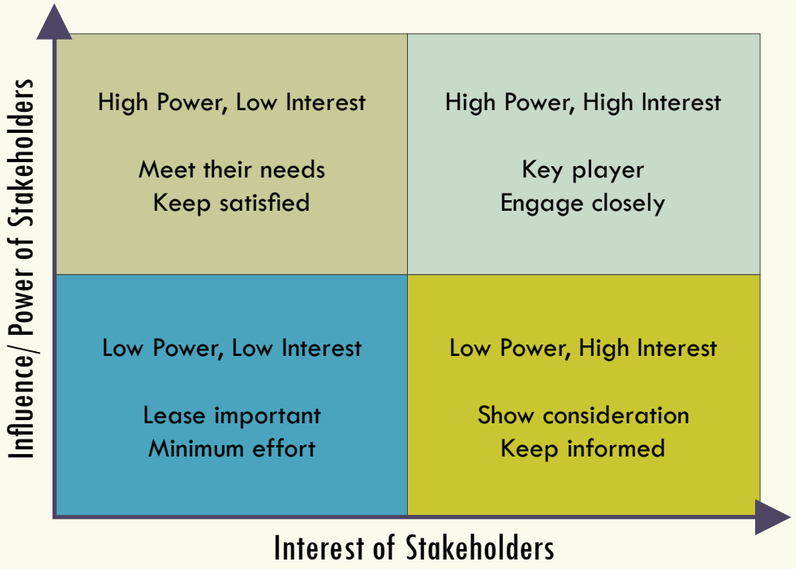
1. Find champions, you have them in every town, they are drivers of change and can motivate and teach fellow residents.
2. Work on implementation early on, many measures can be done quickly and are ‘no-regrets’. They kick-start a change, so do not hesitate.
3. Work on different fronts, engage different people and implement diverse measures, combinations work best.

Our cities and towns host a multitude of people and institutions with different roles, interests and levels of influence. Early and pro-active involvement of the relevant stakeholders in the steps from problem identification, to planning and implementation is key to ensure a successful creation of a sponge town. What we particularly want to achieve is that the different citizens feel their situation will improve and that they can contribute in the process. Stakeholder mapping and identifying roles greatly helps to get a clear insight in the relevant stakeholders and what they can do in the process of creating a sponge town.

Toolbox 2: Stakeholder mapping

1. Identify the stakeholders according to this diagram. Each participant can write relevant stakeholders on a post-it, after which you stick it on a flipchart and discuss. Think outside the box!
2. Use the following questions to help determine whom to engage on a constant basis, who might be resourceful in tackling specific issues (especially, related to rules and regulations) and, who may hamper the process.

a) Who has a strong interest and influence? Ensure clear communication and be clear on the roles and responsibilities.
b) Who has the power to influence and enforce rules? The mapped actors may be rated accordingly. Ensure that their interest is in contributing to the common goal of sponge town.
c) Who has high interest but low influence? How can we stimulate and help these stakeholders to have a higher influence in the process?
d) Who has high influence but low interest? Can these stakeholders negatively affect the process? If so, what measures can we take to keep them happy?
e) Additionally, who are strong influencers in triggering uptake of new interventions? Are there entrepreneurs interested to create a business around the sponge interventions? What are ongoing initiatives that can help the sponge town? Try to bring together good contributions and influential people.



2.2 CITIZENS

Citizens are crucial people to make or break a sponge town. They are a rich pool of ideas and resources and will be very committed when they see developments will benefit them and their town. Citizens will undertake sponge town initiatives themselves – collecting water, regreening, mini-parks, and town-cleaning campaigns. Their local knowledge and connections are important to design a sponge town. Also, what is important to remember is that there are many low-cost and small interventions; but big impact can be made when many people implement these interventions. Example cases are provided of a citizen platform and a co-sharing investment for citizens with roof harvesting systems. In this way citizens can contribute greatly to the process of implementation and can make interventions specifically for their home.

Toolbox 3: Citizen platform

A good opportunity is to work with a citizen platform that has a wide representation of the citizens. It is preferred to work with an existing platform, if this does not exist, get in touch with local administration and leadership to invite representatives to form a new platform. Ensure that the platform is inclusive and that there is active participation of all. The following is important when working with a citizen platform

1. Make sure everyone is involved. This is not always obvious. Ask around with local government, as well as other local channels and informal groups. Ensure there is a good mix between elderly-youth, men-women, business-owners and the different economic activities.
2. Make the workshops interactive, playful and useful. You invite citizens because their opinions and situations matter, ensure that they can speak out. Work with posters, flipcharts, group-work and post-its, to give everybody a chance to share their ideas. Make it as practical as possible. Remember, citizens give up their time to join the workshop, make it worthwhile for them. Do not only take, also give back to the citizens.
3. Frequently engage with the citizen platform in all stages of the project. They are not just a source of information, they are a rich pool of resources for all activities. They may run a business, be a skilled mason or have a kitchen garden. All citizens should be involved not only in thinking about a sponge town, but also making it.

Figure 4: Citizen platform: Group discussions among citizens (left) Practical kitchen garden training (right)

Case-study box 2: Co-financing and cost benefit of roof water harvesting systems for citizens

Market driven solutions are necessary when citizens have enough income and the need for water is a priority. For example, in Kwa Vonza we worked with two hardware retailers for the supply of roof harvesting tanks for a subsidized price to citizens. Through a survey we found that people are willing to invest in roof harvesting systems but were often lacking sufficient resources. At the same time the two retailers saw an opportunity. Together we set up a check-off system to finance water harvesting tanks, 5000L (340 USD) and 10000L (680 USD) tanks. Interested citizens would pay 50% of the tank cost plus entire gutter and slab system and labour costs. 50% of the tank cost was paid by the project. Following this approach we financed more than 45 tanks at less than half the market price. This was direct co-investment from the beneficiaries, and provided good business for local retailers.

When you look at the benefits for citizens, it is clear to see that it is very cost-effective on the long term. Also if we look at non-subsidized tanks. Table 1 shows the price comparisons and the return period of a tank. For both 5000 and 10000 litre tanks you earn back the initial investment in 3 years' time. Looking at a 10 year period, it will save you 1050 USD and 2100 USD respectively.

Table 1 Financial overview of roof water harvesting systems and money savings

Tank volume in Litre	Price tank (including whole system and labour)	Price per 20L jerry can (as currently sold by vendors)	Savings per tank (based on not needing to buy jerry cans)	Money saved per tank per year (based on 3x filling of the tank)	Return period tank investment	Money savings in 10 years (not considering maintenance costs)
5000	44300 KSH (443 USD)	20 KSH (0.2 USD)	5000 KSH (50 USD)	15000 (150 USD)	3 years	105000 KSH (1050 USD)
10000	85400 KSH (854 USD)	20 KSH (0.2USD)	10000 KSH (100 USD)	30000 KSH (300 USD)	2.8 years	210000 KSH (2100 USD)

Tip-box 1: advice on business opportunities in a sponge town

A few recommendations from the experience in Kwa Vonza:

- Make the business case very clear from the start.
- Innovate with the roof harvesting system – can make it more low-cost (for example underground pit, use of bricks and wire mesh for cheap concrete tank). Need to include water household treatment systems to ensure safe quality drinking water at low price, for all types of water supply.
- Groups should assist those members who cannot afford a water tank on their own, with the sole aim of ensuring that all community members have adequate water supply.
- There is need to explore the issue of contracts with more suppliers to improve the uptake of the concept and eventual ownership / access to water resources by as many community members as possible.

2.3 SOCIAL & COMMERCIAL MARKETING

Social and commercial marketing is about getting attention and interest for a new product, or in the case of sponge town, for an innovation. The goal is to either sell your product, your idea or your innovation. It can also be used to initiate citizens to take action and to advice on wise behaviour. Making people aware and trigger them to become involved and do it themselves. The ultimate goal is that people will buy your idea/product, and that they will act upon it.

Diagram 5 explains what marketing can achieve. At the core this has everything to do with branding and making people proud of this new brand.

- Build an identity. A town with an identity is not 'non-descript'. It will attract people and business for good reasons – to be associated with this town and enjoy its amenities. Identity can come from many corners – the special trees, the special food of the town, the (student) population, a special place, a special person.
- Pride. Make the citizen of the town or neighbourhood proud of the beauty and public health of the area where they live.

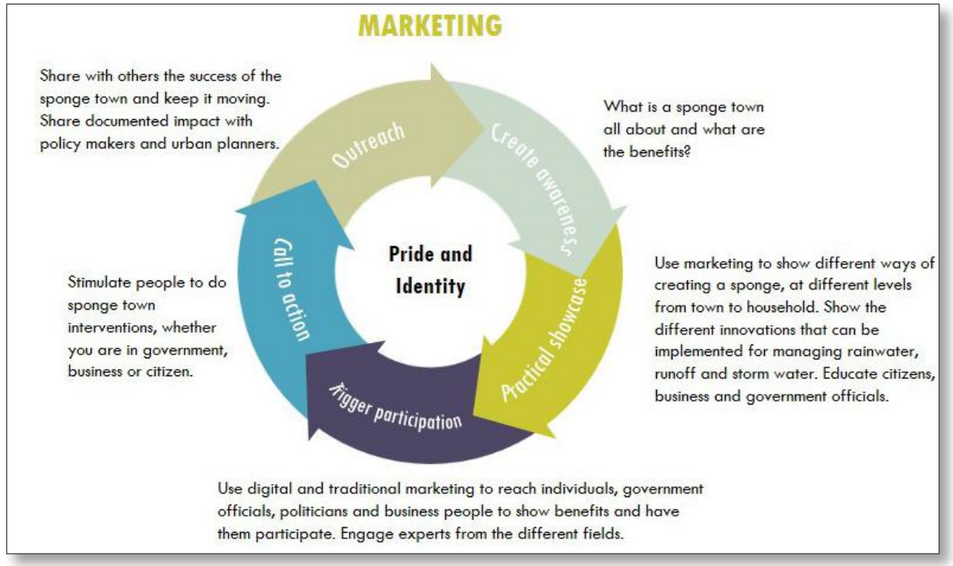


Diagram 5: What can marketing achieve

Toolbox 4: How to do an integrated marketing approach

In order to achieve full results, an integrated marketing approach can be applied. This includes both online and offline marketing tactics. Underneath a suggested stepwise approach with different types of media and marketing to be used can be found. Different tools were successfully used in the pilot projects in Kajiado and Kwa Vonza:

1. Social Media (online presence). The social media presence will be used to share different types of content aimed at educating the target audience about Sponge town. They include Facebook, Twitter and Instagram. For the pilots in Kajiado and Kitui a dedicated Twitter account was created to advertise sponge town related messages and the efforts stimulated by the project (Sponge town Kenya - twitter channel).
2. On-ground Campaigns (Offline Presence) to reach people who are not on social media. This can be done by:
    a. Flyers - distributing flyers about sponge town
    b. Radio and television – share activities and invite people to join
    c. Public forums - inviting members of the general public to forums discussing water conservation, ensure participation of government and business also.
    d. Road shows – engage citizens in outdoor activities in town
    e. Home visits – visit specific homes to apply and train on interventions, which they can spread to their neighbours.
    f. Travelling cinema – a cinema event is organized at public places showing examples from an existing sponge town.
    g. Competitions – organize and promote sponge town interventions through price winning events.

Case-study box 3: Kitchen garden competition

Kwa Vonza Sponge Town project promoted kitchen gardening with rainwater. To promote the activity, we organized a contest open to all citizens. The three best kitchen gardens were to win a rainwater harvesting tank. The initiative was advertised with flyers, radio and through social media. In a very practical workshop participants learned how to grow vegetables at the doorstep of their kitchen by reusing old containers such as buckets, basins, tin cans, plastic bottles, old tyres and barrels. After three months many gardens sprouted around town. The participants, in great majority women, are now excited by the benefits of kitchen gardening and will keep on farming with rainwater.

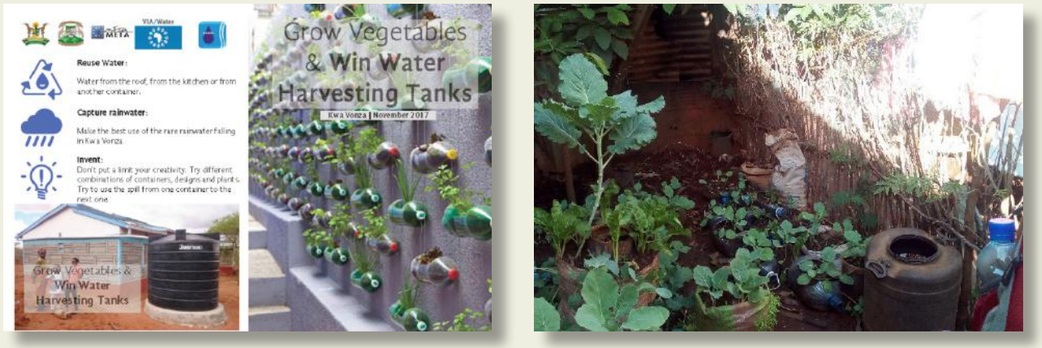
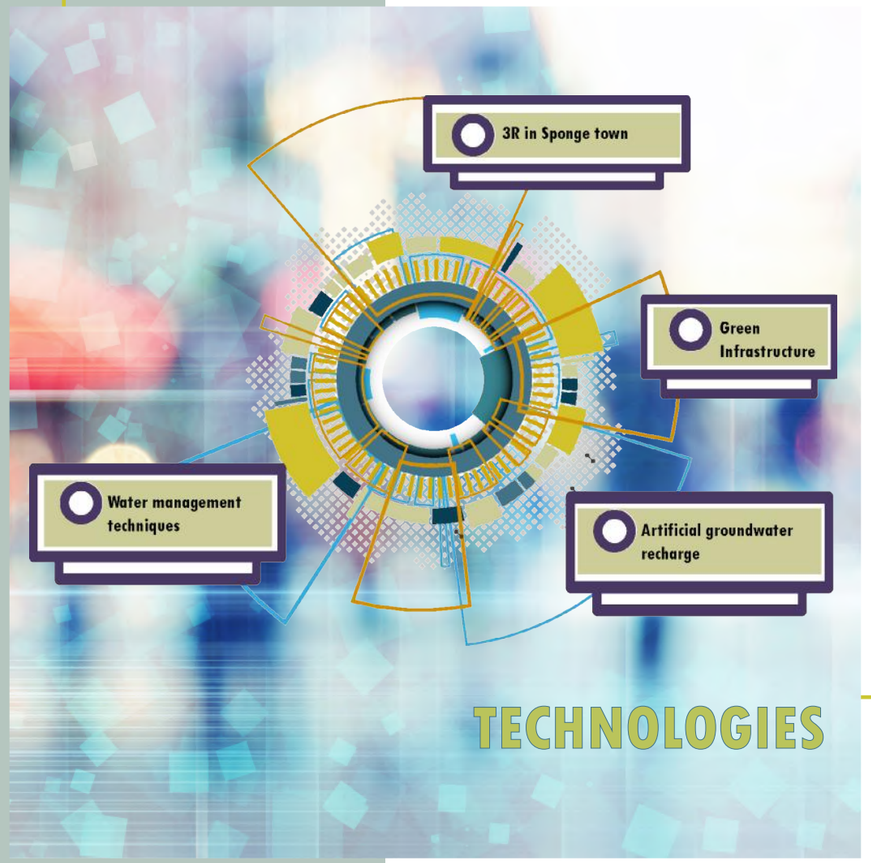


Figure 5: Flyer on kitchen garden competition (left) example kitchen garden (right)

Many people got involved because kitchen gardens are a very cost-effective method, it is basically reusing what you have. The total cost for a kitchen garden is very low. 1000 KES (10 USD) on average of which 50% are one-off investment, and 50% goes to seedlings. Half of the kitchen garden owners make direct income from their kitchen garden by selling vegetables. Others have save money because they do not need to buy vegetables from the market, resulting in a monthly benefit of 2350 KES. The increased fruit/vegetable production, gives a net-return of 300% of implementation costs of kitchen gardens.

Figure 6: "I love Sponge Town" written in a kitchen garden

Technologies



Part 3: THE TECHNOLOGIES

This is the part where we discuss in depth the technologies of water management that build a sponge town. By understanding the dynamics of water, we can plan where and how to retain water and recharge our water sources. This understanding can largely be based on experience and past occurrences of floods and droughts. It can be combined with information from hydrological surveys if needed. Many of the technologies provided are practical and simple, and do not demand in-depth studies. Some other measures are complex and bring about certain risks. These measures (for example managing polluted water, larger ponds) require expert advice.

This part covers three chapters, one is on Retention, Recharge and Reuse (3R) of water, and touches upon hydrology. The second chapter focuses on green infrastructure. The third chapter is on Water, Sanitation and Hygiene (WASH) options in a sponge town. After which a menu of technologies is provided. Different technologies and measures are described on application, benefits and costs. From this menu you can pick and choose what works best for the problems you have identified in your town.

3.1 RETENTION, RECHARGE AND REUSE

Typically, in most parts of ASALs, rain falls for a short period and for the rest of the year there is little or no rainfall. During rainy periods, most of the ASAL regions suffer from high-intensity storms. Such storms trigger runoff and limit infiltration, which is further aggravated by hard/compacted surfaces such as buildings and roads. Such surfaces don't allow water to easily infiltrate. A high proportion of the water instead flows downhill as runoff. The amount of water flowing away from urban areas is commonly more than 80% of the total amount of water received by it. Where is all this water flowing to?

This is exactly the essence of water buffering, integrating these measures in built environment to manage natural recharge and to retain water for longer periods so that it becomes usable during periods of water scarcity. This chapter explains how to operationalize retention, recharge and reuse (3R) for enhanced water resource management in an urban environment.

The abundant water in the rainy season does not have a way to stay in the town. It flushes out of the system very quickly. Thus, leaving it unused is also a hazard to people within the town and downstream. This can lead to specific problems such as: downtown floods, decreasing and seasonally fluctuating groundwater levels, inadequate water supply, dust, and high temperatures. When 3R is smartly planned and implemented, it will build an additional source of water for households. This can greatly relieve the burden on the public water system, and make water supply more reliable.

3R uses many smaller systems that can store and recharge water within the urban landscape.

- Retention keeps water in the area and slows down the outflow. This involves creating barriers which help raise the level of the runoff apart from slowing it down. Additionally, small reservoirs can be created to store the runoff and make it available for reuse.
- Recharge is about optimizing the infiltration of rainfall and runoff water, improving groundwater and soil moisture recharge.
- Reuse makes the now-available water suitable for domestic uses, drinking, production or ecological services. In other words, it is the extended use of retained water. Reuse can include recycling water multiple times.

We will now explain a few topics briefly, on artificial groundwater recharge, road water harvesting, hydrological survey and calculating runoff. A menu of technologies is presented in table 2.

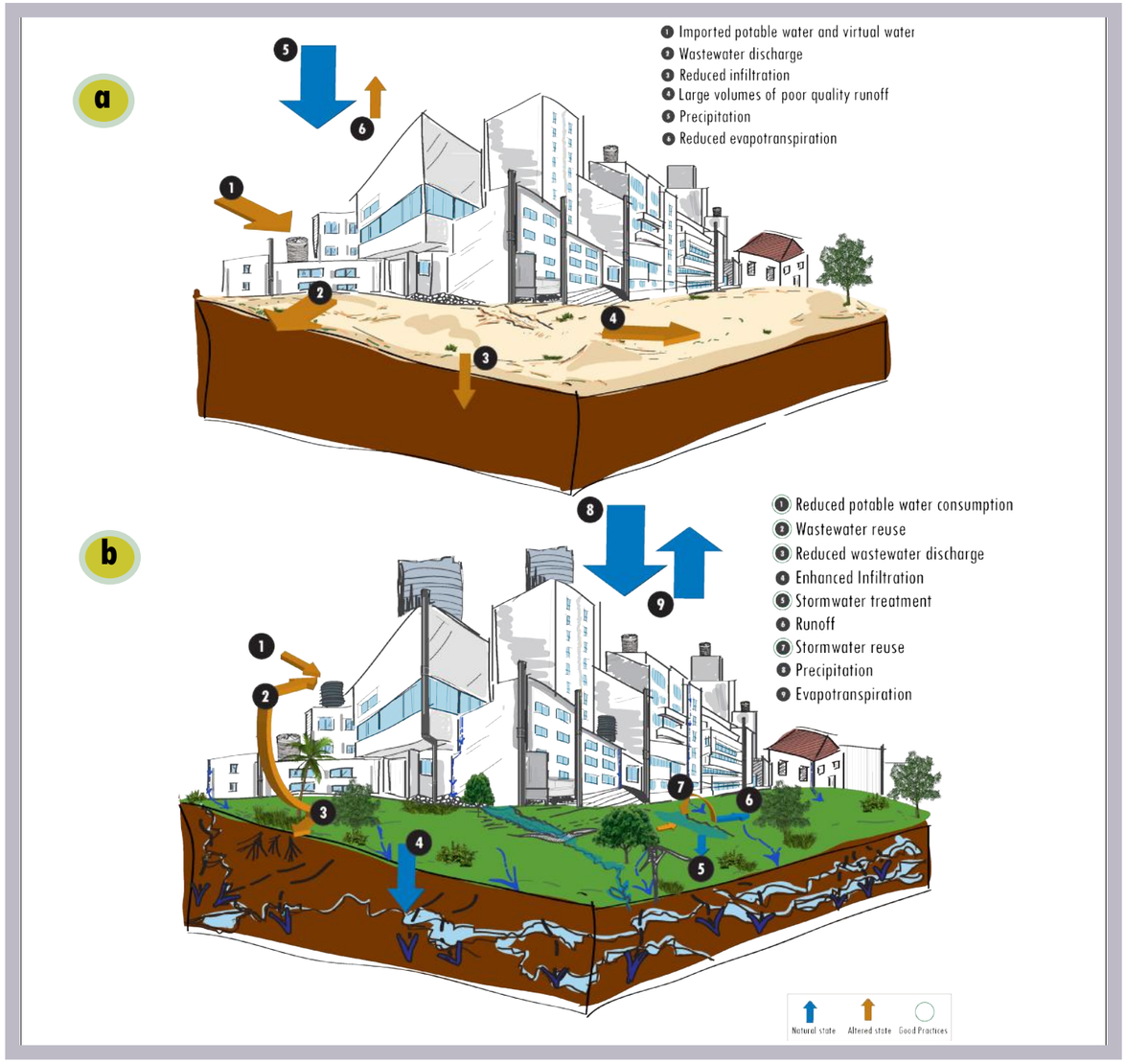


Diagram 6: before (a) and after (b) Sponge City, and the water balance cycle

Artificial groundwater recharge

Artificial groundwater recharge is a method to store water underground in times of water surplus and make it available during the dry period. There are several techniques for using runoff in towns for groundwater recharge. Water can be diverted to percolation ponds, trenches and swales (van Steenbergen et al. 2018). This water can then be extracted through existing or new shallow hand dug wells, tube wells or boreholes. Surface infiltration systems designed for groundwater recharge require permeable soils (sandy loams, sands, gravels) with relatively high infiltration rates. By storing water in aquifers, evaporation losses are reduced (as compared with surface water storage). Moreover, public health risks associated with groundwater are lower compared to surface water.

Especially in towns where groundwater is already used as a resource, increasing infiltration is vital. Aquifers in urban areas are often over-exploited, while the urban surface decreases direct recharge. Moreover, urban areas are susceptible to pollution. When pollution is high but infiltration is low, groundwater sources are bound to suffer from pollution. Building recharge infiltration structures while monitoring pollution is the best way to ensure groundwater sources are resilient, although a deeper understanding of hydrogeology is required to ensure sustainability.

Tip-box 2: Road water harvesting

Water directly harvested from the road should not be used for household purposes directly. There are safe ways in which domestic water can be made available, through groundwater recharge and protecting springs opened by road construction in hilly areas. Here are some recommended practices for using water from roads for households in dry areas.

- Road water harvesting can recharge groundwater. Developing shallow tube wells subsequently serve to source drinking water.
- Protecting and managing springs opened up by road construction can provide a safe and reliable source of water.
- Construction of artificial wetlands or green areas for infiltration, can help to filter and purify the surface runoff from roads before it recharges groundwater.

Figure 7: example of road water harvesting in urban setting, creating infiltration pits and water (recharge) reservoirs

Case-study box 4: Restoring a gully with check-dams

Mwende group consists of 25 members. Amongst other things they do farming together, they grow vegetables and have a tree nursery. The farmland of the group lies below the land owned by Agnes, one of the group members. Besides this land there is a deep gully eroded by road drainage water, coming from a culvert which is the start of the gully. Because this gully is so deep, it was impossible for the group to use this water, instead it quickly flowed away. In this gully a check-dam has been constructed. Within 1 rainy season the gully completely filled up with sediments. Figure 8 (left and right) show the before and after pictures of the check-dam situation. From there an intake was made to direct the water which comes from the culvert and it was diverted into a large storage pond. With the water in this storage pond the women group can easily access irrigation water for their farming activities. This design used a conspicuous amount of concrete, making it very effective and expensive. You can also use designs which are more affordable which can be easier to implement.

Figure 8 Check-dam before (left) and after (right), installation combined with a pond

Toolbox 5: Hydrological survey and example calculation on runoff and recharge

The pictures below show a hydrological survey done in Kajiado based on common satellite imagery. This was combined with on-the-ground information regarding sampling boreholes, gullies, and general flow-direction of road drainage, illustrated in figure 9. This demonstrates how the different issues are interlinked, and serves to inform planners and decision-makers where the different interventions need to take place.

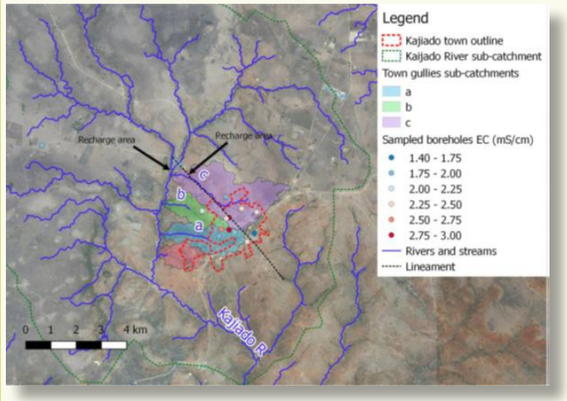


Figure 9 (left): Kajiado Town and its surrounding rivers and streams. The sub-catchments of the gullies draining town (a, b and c) are highlighted, as well as high potential recharge areas outside the urban areas. This figure also shows a large lineament that is possibly a water bearing fracture where groundwater flow is concentrated. Several boreholes were sampled for quality. The electrical conductivity (EC-value) was examined as a measure for salinity (national upper limit EC=2.5 mS/cm).
Figure 9 (right): Satellite image of Kajiado town, with the sub-catchment boundaries of the three gullies (a,b and c) in black; and the general flow-direction of road drainage in red. In blue are shown the gullies that flow towards the Kajiado river. The sub-catchment boundaries are highlighted in black.

Toolbox 6: Effect on runoff and recharge: example calculation

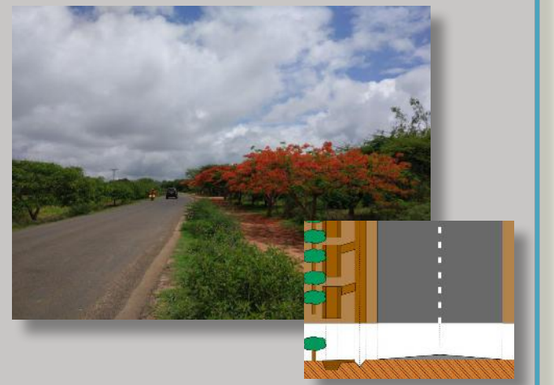
To illustrate the effect of upstream small-scale interventions to augment recharge and reduce runoff, here is a calculation. The sub-catchment area upstream of the SIP is approximately 2 hectares. Typical storm events are 10 mm per day or less (65%). Let's assume the rainfall is concentrated in one hour. The runoff coefficient in urban areas is quite high (50-80% of rainfall contributes to runoff). Assuming a 70% runoff (which is on the high side), this works out to a discharge of 140 m^3/hour at the infiltration site.
If an infiltration trench 100 m^2 and 2 m deep is installed under the gully (for example 100 m long, 1 m wide), 80 m^3 of the runoff can be stored in the trench (assuming a 40% porosity). Additionally, 25 m^3 infiltrates in the first hour. In this case, 70% of the runoff is captured, thereby reducing erosion and downstream flooding. Furthermore, most of the stored water will eventually infiltrate into the deeper groundwater system. This way, most of the precipitation is used for aquifer recharge, whereas currently only a small fraction of total rainfall infiltrates in the upstream areas.

3.2 GREEN INFRASTRUCTURE

Cities have high density of buildings and often lack green vegetation. For water infrastructure, vegetation is very crucial as it gives the water a natural shelter and provides it time to find its way to a storage space in the soil. Trees keep our soils together and also offer shade for reduced heating and evaporation. Reed grasses filter out pollutants. Green roofs with vegetation capture rain water and reduce the amount of runoff. Find some examples and let your creativity go wild.

Tip-box 3: Road side tree planting

Trees have so many benefits besides providing the basis for life, oxygen. Road side tree planting has many co-benefits: shade, shelter, productive asset, reduced soil erosion, improved visibility, wind break, carbon sequestration, beautification and so forth. Furthermore trees can trap dust, a forgotten but major health hazard. In planning road side tree planting one has to consider ownership of road reserve, plans of future road widening, economic value of tree species, shape of tree barrier, root development, road vision, road safety and access to water. Promoting road side tree planting and road side forest can off-set part of the carbon dioxide emissions that come with new roads.



Tip-box 4: Green areas in town

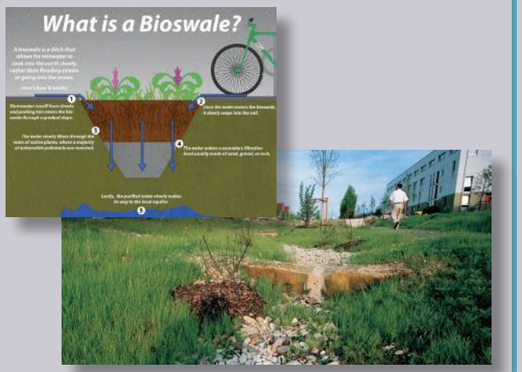
A small community garden is an excellent opportunity to create pocket paradises in your town. Waste lingering in town can be re-used to create a nice place to tuck away and enjoy the greenness around you. At the same time you can grow vegetables as well. A perfect hide-out to escape the urban buzz or to throw a community barbecue.

Tip-box 5: Green roofs and walls

A green roof is a roof which is the ground to green vegetation. Roofs and walls are excellent surfaces to make green. You do not need a flat roof, many types of vegetation can grow vertically and can be used for these purposes. You can even grow vegetables and increase your diet-variety. They are also an excellent way to reduce water flowing down and causing surface erosion around your home.

Tip-box 6: Bio-swales

Swales are shallow channels with gently sloping sides. They are designed to slow down and capture runoff by spreading it horizontally across the landscape. It also filters pollutants and increases rainwater infiltration. It is a measure to do rainwater harvesting and soil conservation and can also be called a contour bund. In arid climates, vegetation along the swale can benefit from the concentration of runoff. An ideal location to plant trees, shrubs and grasses to green your town while retaining water.



Eventually, the aim of Sponge Cities is to make optimal use of environmental resources without harming them, and even sustain and improve them. Retention and recharge of water will help expand coverage of reliable and high quality water supply among town dwellers. Cities will become greener, more resilient, buffered against floods, with different types of vegetation, well-constructed road drainage, more clean and accessible public spaces, and safe sanitation management.

Tip-box 7: Some ideas for WASH interventions

Sponge Town mainly focuses on water harvesting and storage, looking at quantity and quality of water. This touches directly upon water sanitation and hygiene, while it has not been the focus in Sponge Towns. Please get in touch with organisations presented in the helpdesk (Chapter 4) to assist you on this. Some few tips we like to share are:

- Promote innovative and low-cost ways to use solid and liquid waste as a resource and attract business who are doing this. Examples are: Briquettes from solid waste for cooking, manure for fertilization, recycled paper and liquid fertilizer. This requires intensive promotional campaigns. See diagram 7 for examples on waste management solutions
- Promote self-supply at household level through marketing of the products and training of end users. Cost-effective options include rope pumps or shallow tube wells. A tube recharge system can be a useful part of the setup.
- Promote water treatment at household level, for example ceramic, sand, bio or combined filters, for all types of water supply.

3.3 MENU OF WATER MANAGEMENT TECHNIQUES

We provide a menu of techniques which can be combined to implement 3R in cities (the following table 2). The table provides and explains techniques dealing with 3R, water management and green infrastructure. You can pick and choose, based on your local issues, needs and conditions. These techniques form the backbone of the sponge town hardware. The explanations provide an idea regarding the measure to take; we recommend to seek expert advice on the more technical measures. You can refer to the Helpdesk (Part 4) to find out who can help you.

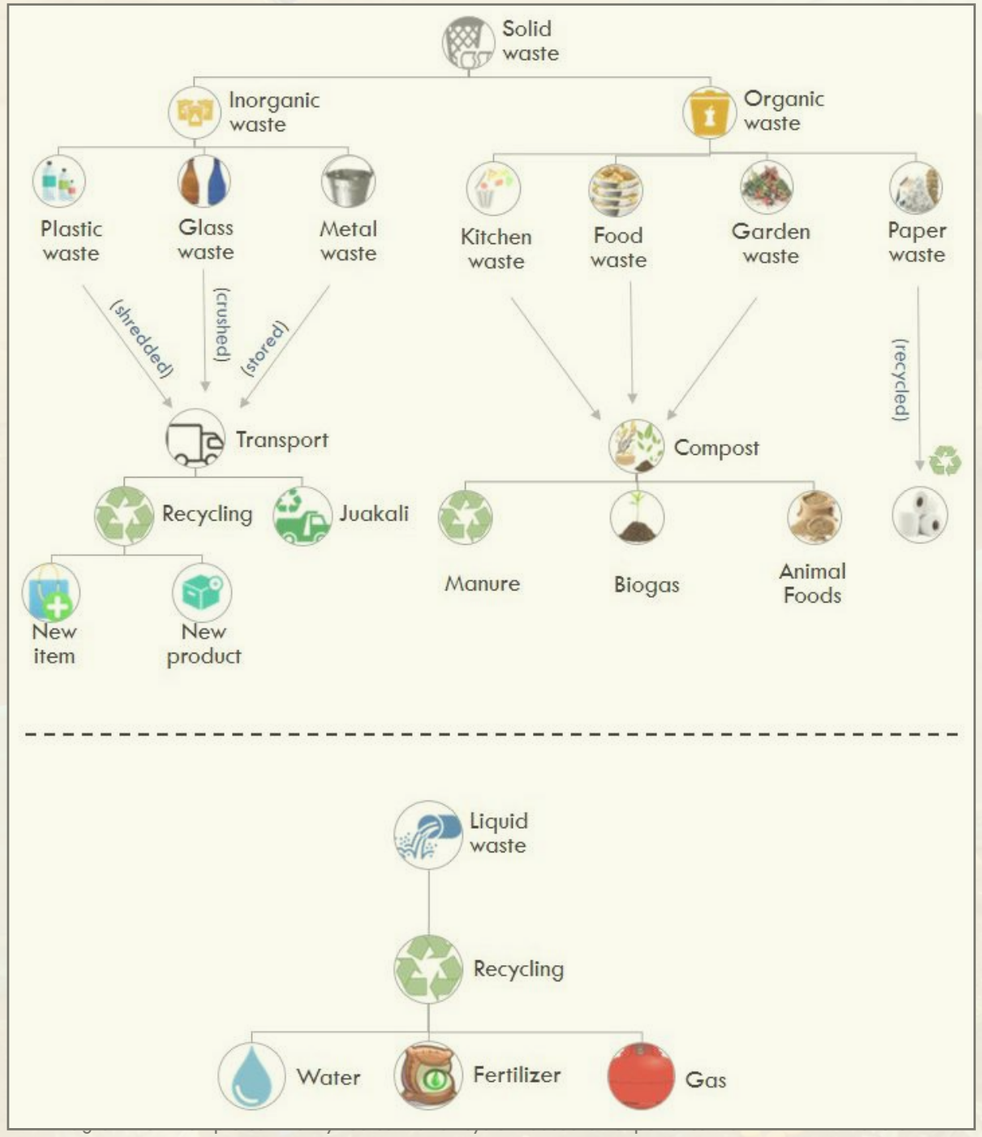


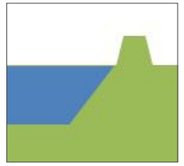
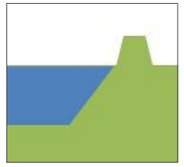
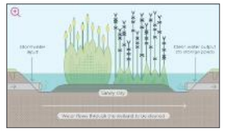
Diagram 7: Waste management solutions

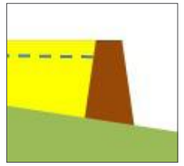
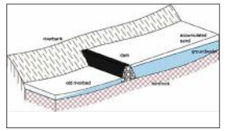
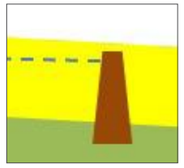
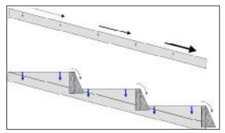
TABLE 2: 3R - WATER HARVESTING/STORAGE INTERVENTIONS

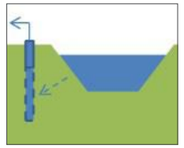
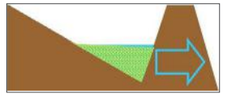
3R Intervention Group	Type of water harvesting	3R Intervention	Quantity	Quality	Suitable for		
					Retention	Recharge	Domestic (re)-use
A	Surface water storage off stream	Valley tanks	💧 - 💧💧	💧	√	O	O
		Water pans or small ponds	💧 - 💧💧	💧	√	O	O
		Green areas for infiltration and recharge	💧 - 💧💧	💧	O	√	X
B	Shallow groundwater storage	Sand dams	💧💧 - 💧💧💧	💧 - 💧💧💧	√	O	√
		Subsurface dams	💧💧 - 💧💧💧	💧 - 💧💧💧	√	O	√
		Road drift	💧💧 - 💧💧💧	💧 - 💧💧💧	O	√	√
		MAR (Managed Aquifer Recharge) / Tube recharge	💧 - 💧💧	💧 - 💧💧	O	√	O
		Riverbank infiltration	💧 - 💧💧	💧💧💧 - 💧💧	O	√	√
C	Runoff reduction measures	Check-dams and gully plugs	💧 - 💧💧	💧💧💧 - 💧💧	O	√	O
		Swales and bunds	💧 - 💧💧	💧 - 💧💧	O	√	X
		Permeable paving	💧 - 💧💧	💧 - 💧💧	O	√	X
D	Hard surface water storage	Rooftop water harvesting	💧	💧💧 - 💧💧💧	√	X	√
		Road water harvesting	💧💧	💧	√	√	X
		Rock catchments	💧 - 💧💧💧	💧	√	X	O
		Underground cisterns	💧 - 💧💧	💧💧 - 💧💧💧	√	O	O

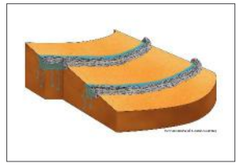
	Retention	Recharge	Domestic (re)-use
√	Good option	Good option	Good option, check water quality
O	Limited amounts or high costs/ only retained as (deep) groundwater	Limited amounts or high costs	Treatment is needed
X	Not viable	Not viable	Not advised, only consider if no other options are viable, treatment is necessary

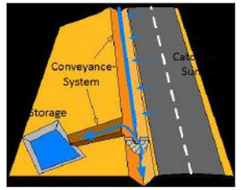
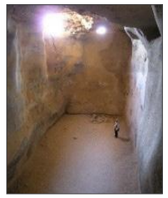
Quantity/quality indication	
💧	Low
💧💧	Medium
💧💧💧	High

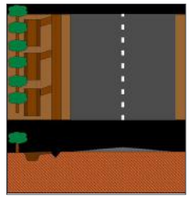
Technique		Indication of usual storage or abstraction capacity	Advantages	Remarks	Technical requirements and special elements of attention	Cost indication
A: OPEN WATER STORAGE						
Valley tanks: Valley tanks are large excavations in depressions or low-laying areas. Water is stored as an open reservoir. The reservoir is constructed off-stream. Water can be diverted with small diversions, such as check-dams.		500 – 5,000 m^3	+ Relatively easy to construct and to implement + A cascade of interventions, whereby the surplus of storage 1 flows into storage 2, increases the efficiency of the volume water stored + Reduce uncontrolled runoff + Strengthen water resources (recharge)	- Limited storage - High evaporation and possible leakage - Sensitive to contamination - Due to lack of filtration only usable for livestock or small-scale agriculture	• Existing depressions or concave and convex shapes in the landscape should be present. These places can be put in use by making reservoirs here • The reservoirs can be excavated to increase storage capacity. They can also be lined to prevent leakage. • Slopes needs to be not too steep, so that storage volumes can be large, and no landslides are caused due to increased soil moisture • Pay special care to water quality, water should not be used for drinking if not previously treated	USD 1 - USD 5/m^3 stored volume
Water pans or small ponds: Excavated water reservoirs, also referred to as ponds, dug-out or valley tanks.		5,000 – 25,000 m^3	+ Strengthen water resources (recharge) + Reduce flash floods + Easy abstraction + Low maintenance + Very local retention, recharge and reuse (3R) of water achievable	- High evaporation and possible leakage - Not reliable in dry areas - Low water quality - Activities in the catchment influence water quality and quantity - Environmental/ health risks (mosquito breeding, etc.)	• Water pans and ponds are very effective in areas with clay soils • Locations with a good natural clay lining are preferable, or lining should be applied. • Assessment of catchment area, calculate runoff characteristics, and determine if the reservoir should be in-stream or off-stream and if a silt trap and by-pass is required.	USD 1 - USD 5/ m^3 stored volume
Green areas for infiltration and recharge: Storm water is retained in green areas with permeable basins that help to recharge shallow groundwater and to buffer peak runoff. This can perfectly be combined with a recreational park with different types of vegetation.		500 – 5,000 m^3	+ Manage uncontrolled runoff + Reduce storm water peaks causing flooding + Strengthen water resources (recharge) + Natural filter for pollutants	- Environmental/health risks (mosquito breeding, etc.) - Activities in the catchment influence water quality and quantity - The area needs to be protected from heavy pollution	• Existing depressions or concave and convex shapes in the landscape should be present. These places can be put in use by making reservoirs here • The reservoirs can be excavated to increase storage capacity. They can also be lined to prevent leakage. • Assessment of catchment area, calculate runoff characteristics, and determine if the reservoir should be in-stream or off-stream and if a silt trap and by-pass is required.	USD 1 - USD 5/m^3 stored volume

Technique		Indication of usual storage or abstraction capacity	Advantages	Remarks	Technical requirements and special elements of attention	Cost indication
B: SHALLOW GROUNDWATER STORAGE						
Sand dams: Dam raised above riverbed, increasing the sand volume, anchored in an impermeable layer, abstraction with hand pump.	 	200 – 5,000 m³	+ Strengthen water resources (recharge) + Reduce flash flood and increase base flow + Natural storage of riverbed utilized and increased + In-ground filtration and protection from evaporation (evaporation losses are very low) + Relative simple abstraction (shallow well) + Low maintenance + Good water quality when surroundings and catchment are protected + Series of sand dams have a higher impact on water volumes stored, restored groundwater levels and re-greening of the landscape	- Limited storage - Solid construction required, dam needs to withstand flash floods - Activities in the catchment influence water quality and quantity - Risk of seepage	• Sand dams are constructed in parts of the river with lower to gentle slopes (ranging between 0 and 10%) • Requires shallow bedrock or clay layer and feasible banks for wing wall • Calculate discharge (peak flow, minimum flow) for design parameters, based on community information and/or catchment characteristics and rainfall data • Water quality of catchment and existing groundwater should be examined, including presence of salty rocks • Start construction at the beginning of the long dry season, when the riverbed has dried (dewatering might still be required) • Ideally the dams is raised in stages during dry seasons to avoid trapping silt and the dam being washed away • Hand pump well should be located next to the river with filters in the storage - water can be accessed during periods of high runoff	USD 1 - USD 5/m³ stored volume (5,000 – 20,000 USD cost estimated for Kenya, June 2018)
Subsurface dams: Dam constructed within the existing riverbed sediment, funded on an impermeable layer, abstraction with hand pump or motorized pump.	 	1,000 – > 50,000 m³	+ Strengthen water resources (recharge) + Natural storage of riverbed utilized + High storage volume to dam size ratio + Does not need to withstand floods + Construction from all kinds of impermeable materials (including clay or plastic sheet) + Can be constructed with community labor + In-ground filtration and protection from evaporation (evaporation losses are very low) + Relative simple abstraction (shallow well) + Low maintenance + Good quality when surroundings and catchment are protected	- Dam wall needs to be founded on an impermeable layer, which can require deep excavation and dewatering - Dam is not visible at the surface (can also be an advantage) - Activities in the catchment influence water quality and quantity	• Subsurface dams are recommended to be constructed in parts of the river with lower slopes (ranging between 0 and 5%) • Site requires impermeable layer under the riverbed for foundation of the dam • Evaluate river flow to determine if the minimum flow is sufficient to annually recharge the sand body behind the dam • Water quality of catchment and existing groundwater should be examined, including presence of salty rocks • Start construction at the beginning of the long dry season • Investigate potential local construction materials such as clay • Hand pump well should be located next to the river with filters in the storage - water can be accessed during periods of high runoff	USD 0.5 - USD 2/ m³ stored volume
Road drift: Low causeway can become a simple way to recharge shallow groundwater when they are built to function as sand dam. It functions in slowing down the flow upstream and building up sand, thereby allowing the water to reach underground storage and cater for recharge.		200 – 5,000 m³	+ Has basically the same functions as a sand dam while it doubles up as a road + Robust structure that acts as a water spreader, reducing the risk of flooding + Low-cost option to enable traffic to pass almost year-round	- Limited storage - Solid construction required, dam needs to withstand flash floods - Activities in the catchment influence water quality and quantity - Risk of seepage	• The principles are similar to a sand dam, only a drift does not need to be tied to the rock bed. • Roads authority need to approve the design to ensure road safety	330 – 1240 USD/m

Technique		Indication of usual storage or abstraction capacity	Advantages	Remarks	Technical requirements and special elements of attention	Cost indication
MAR (Managed Aquifer Recharge) or Tube recharge: Via MAR or Tube recharge water can be retained and infiltrated via small to medium scale infiltration systems.		1,000 – 20,000 m^3 (daily infiltration rate around rain events: 2 – 300 m^3/day)	+ Strengthens aquifer recharge with rainwater + Very local retention, recharge and reuse (3R) of water achievable + Provides a constant freshwater source during the dry season, from the same well or in another well downstream + Sandy aquifers generally have a good reactivity	- Infiltration rate depending on size of retaining structure and the infiltration capacity - Recharge is only possible if an aquifer with a clay layer on top is present	• In case the aquifer is saline, the more saline the aquifer is, the less water can be infiltrated • Quality of the abstracted water depends on the quality of the infiltrated water, the reactivity of the aquifer, the travel time of the infiltrated water and the chance of infiltration of polluted water in between infiltration and abstraction • Infiltrated water needs to be pre-treated to prevent clogging of the infiltration wells. • Good water quality monitoring is necessary to know the quality of the abstracted water	USD 0.5 - USD 5/ m^3 stored volume
Riverbank infiltration: Water abstraction from wells next to a river or other surface water body. Water is induced to infiltrate into the riverbank which provides natural filtration. Infiltration can be increased by floodwater spreading, infiltration ponds		2 – 20 m^3/h per borehole/ well related to the infiltration point	+ Strengthen water resources (recharge) + Low evaporation losses + Riverbank sediments provide natural filtration + Relative easy abstraction – can supply urban area + Low maintenance	- Only feasible near perennial surface water bodies or water bodies with sufficient underground storage - favorable hydrogeological conditions required	• Evaluate river flow or water body to determine if the capacity is sufficient • Explore options for increasing the storage and infiltration capacity, including, dams, floodwater spreading, infiltration ponds and well infiltration. • Site requires permeable formation that is hydrological connected to the surface water body	USD 0.5 - USD 2/m^3 abstracted
C: RUNOFF REDUCTION MEASURES						
Check-dams and gully plugs: Check dams and gully plugs are small to large scale permeable barriers made of stone, rocks or boulders. They create steps in otherwise too steep waterways and gullies. Water slows down, erosion risk is tamed and water gets the time to recharge adjacent land and aquifers.		200 – 5,000 m^3	+ Strengthen water resources (recharge) + Run-off and erosion reduction in steep waterways and gullies + Reduce frequent flooding and waterlogging + Large check dams (30m wide, 350m upstream) can provide a constant steam or base-flow all year-round + Can reduce surface run-off/flow by around 100.000 times	- Limited storage - Stored surface water is sensitive to contamination - If no sediment is present, lack of filtration makes water only usable for livestock or small-scale agriculture	• Check dams and gully plugs are recommended to be constructed in parts of the river with gentle to steep slopes (> 5 - 10%) • They can be built with stone-filled gabions, dry masonry work, cement or simply with branches or farm residues. • Small dams are ideal for water retention far upstream in the catchment, because they are porous, they can increase the base flow of a river. • Check dams can be very similar to sand dams, but are porous • Check dams can only be made if stones / rocks / boulders are available • Check dams are most effective when combined with sand and/or subsurface dams	USD 0.5 - USD 2/ m^3 stored volume

Technique		Indication of usual storage or abstraction capacity	Advantages	Remarks	Technical requirements and special elements of attention	Cost indication
Swales and bunds: Are small excavations and earthen/ stone barriers placed to capture runoff and augment water infiltration in the soil. Better suited for private land.		100 – 2,000 m^3	+ Reduce uncontrolled runoff + Strengthen water resources (recharge) + Increase infiltration capacity of the soil + When coupled with tree planting they reduce the risk of seedlings drying out.	- Limited storage - Stored surface water is sensitive to contamination	• Need to be laid out accurately along contour lines; • After simple training everybody can implement it; • Avoid free cattle movement around the structures;	USD 0.5 - USD 1/ m^3 stored volume
Permeable paving: Permeable paving with cobble stones decreases peak runoff and increases infiltration. It is an excellent form of temporary employment for youth.		50% of rainfall/m^2 road surface	+ Reduce uncontrolled runoff + Strengthen water resources (recharge) + It is an excellent form of temporary employment for youth.	- Labour intensive – requires trained teams	• Feasible on secondary roads • Stones must be sourced locally	Variable, depending on labour costs
D: HARD SURFACE WATER STORAGE:						
Rooftop water harvesting: Intercepts rainwater from hard roof surface whereinafter it is conveyed to a storage tank via a system of gutters.	 	5 – 200 m^3	+ Up to 80% runoff can be harvested + Low losses due to evaporation and leakage + Easy abstraction + Water available at household level + Reasonable to high water quality when tank is properly managed	- Relatively expensive per m^3 - Often not sufficient to cover the dry period for all water needs - Sensitive to breakdowns - Deterioration of water quality with time - High temperature of water	• First investigate potential for either surface or groundwater • Calculate storage capacity based on surface volume and rainfall • Depending on amount of rain, roof size and size of the tank, water can be provided to 5 persons for 1 to 3 months • Incorporate 'first flush' provision in the system • Storage tank should be closed to maintain good water quality • Above the ground storage tanks should be at least 50 cm below the lowest point of the roof, so that gutter and pipes can be placed, and water can flow to the tank • In case storage tanks are built in the ground, soil need to be deep enough. Since these rocks can be permeable, lining of the tank is necessary • Consider alternative construction materials like a combination of bricks, wire mesh and cement to save costs.	20 - USD 40/m^3 stored volume

Technique		Indication of usual storage or abstraction capacity	Advantages	Remarks	Technical requirements and special elements of attention	Cost indication
Road water harvesting: Water harvesting or roads to divert and store big volumes of runoff water. Road surface, drainage channels and culverts can be used to redirect water for recharge or productive use. Water can be stored in soaking pits or storage reservoirs. For example in combination with tree planting and additional vegetation.		50% of rainfall/m² road surface	+ Easy abstraction + Reasonable quality when catchment is properly managed + When taken into account with the design of road construction and maintenance itself, road water harvesting usually does not come with extra costs + Manage uncontrolled runoff + Reduce erosion and gully formation along roads + Reduce flooding and waterlogging + Can connect to cisterns and other storage, install filter/silt trap before it enters to control quality	- High evaporation - Often not sufficient to cover the dry period for all water needs - Deterioration of water quality with time - High temperature of water	• Slope steepness: water should be channeled towards storage reservoirs. The slopes should be such that both water logging and erosion are avoided; • Soil depth should >100 cm, and such that gently sloping road-side ditches and a reservoir can be dug; • The less stable the soils and the steeper the slopes, the shorter the stretches should be along which water is accumulated. Water should then be diverted more frequently to smaller reservoirs. • If there are level differences between the road and its surroundings, improved intakes are needed which come with additional costs; • The structures should be developed close to households or communities willing to provide labor during construction and to maintain the structure after implementation. • Consult road authorities to ensure you have the rights to construct near roads and ensure to align with road furniture.	USD 0.5 - USD 2/ m³ stored volume
Rock catchments: Rock catchments are water harvesting systems built at rock outcrops. All rainwater flowing from the rocks in brought into a storage from where it can be used		80% of runoff/m² rock catchment area	+ Up to 80% runoff can be harvested + Due to high runoff coefficient nearly all rainwater in the rock catchment can be harvested + Easy abstraction – suitable for urban supply + Reasonable quality when catchment is properly managed	- High evaporation - Often not sufficient to cover the dry period for all water needs - Deterioration of water quality with time - High temperature of water	• The rock catchment needs to be constructed at locations with bare rock, free of soil and vegetation, without fractures and cracks. This requires assessment into some depth by a specialist with geological expertise. • The reservoir should have a high depth to surface ratio to minimize evaporation losses, especially since no soil is present that can help support the development of an ecosystem • Treatment of the water is necessary if it is used for drinking	5 - USD 20/ m³ stored volume
Underground cisterns: Underground cisterns are rainwater harvesting systems built where large areas of bare rock is present. Water in the cistern remains cool and somewhat protected against contamination since it is stored in the underground.		200 – 2,000 m³	+ Low losses due to evaporation and leakage + Easy abstraction + Water available at household level + Reasonable quality when catchment and tank are properly managed + Darkness and constant relatively low temperature have a positive impact on the water quality	- Amount of water harvested is very much dependent on type catchment connected to the cistern, the amount of rain as well as the runoff coefficient	• First-flush separators can improve the water quality significantly • The softer the rock, the easier the cisterns can be cut out • The ratio catchment versus is important before starting the construction. • Filtration and minimal treatment is necessary if used for drinking	5 - USD 20/ m³ stored volume

Technique		Indication of usual storage or abstraction capacity	Advantages	Remarks	Technical requirements and special elements of attention	Cost indication
E: ADDITIONAL						
Roadside tree planting: Storm water can be diverted to trees, strategically planted along roads. The short trenches capture the water providing moisture to the trees, who eventually will control erosion due to road water.			+ Reduces soil erosion, holds the soil in place + Flood control by slowing down and absorbing road runoff + Removes dust and other pollutants from the air + Trees provide many benefits, also think of providing shade, shelter and beauty + Trees can be nursed and sold by women/ youth groups or local businesses + Trees can trap dust and contribute to clean air, hence decreasing dust related health hazards	- Need to be watered adequately in the early stages of growth – in arid to semi-arid lands this is needed for up to 1 year	• In planning road side tree planting one has to consider ownership of road reserve, plans of future road widening, economic value of tree species, shape of tree barrier, root development, road vision, road safety, access to water. • Trees can be susceptible to termites and other insects – proper management is needed • Fodder trees can be eaten by animals in early stages, protect the trees by fencing it, or prevent animals to roam freely	1 USD per tree
Kitchen Garden: Use rainwater to irrigate small vegetable plots near the homestead. You can also use your roof or a wall to make a vertical garden. Grey water from cooking and bathing can be re-used. With a kitchen garden you optimize your small space in a city home and recycle water.			+ Recycle grey water and use for irrigation for the kitchen garden + Optimize the use of a small homestead area in town + Add greening and provide for your own vegetables		• Initiate the process through a kitchen garden competition • Reuse old materials, from jerrycans, to sacks, from basins to plastic bottles to old tyres • Design a system so that the waste water from bathing and cooking can be directed to the kitchen garden. Build in layers to ensure that water draining from a higher level can go down and still be re-used.	Costs vary per system – often low-cost
Greywater reuse systems: Grey water reuse is a rewarding option for hotels, schools and homes. It is low-cost and it can save a lot on your water bills.			+ Low cost technology + Good to combine with kitchen gardens + Water usage can be reduced	- Water which is very polluted is not suitable to use	• Low cost technologies such as constructed wetlands; with either vertical flow planted filters (requiring pumps for distribution) or horizontal flow planted filters can be used to irrigate greenhouses, gardens and tree crops.	Costs vary per system – often low-cost

Part 4: HELPDESK

The helpdesk presents the organizations involved in the Sponge Teams in Kajiado and Kwa Vonza. You can always reach out to us for our service and expertise.

Organization	Our offer	Keywords	Contact details
SASOL	We are one of the major experts when it comes to development in ASALs. We plan, design and implement a vast variety of water harvesting measures. Based in Kitui, but with a national and international outreach.	Water engineering Sand- and sub-surface dams Water harvesting	www.sasolfoundation.co.ke
MetaMeta	Do you have a town which is often flooded? A home without water half the time? Are you an urban planner without expertise on water recharge? Then we can help you. We combine vast experience of water management with new innovations. Keeping it simple and very useful. Linking up roads with water, 3R with business models, and linking people together.	Water Resources management 3R: Retention, recharge, reuse Horizontal learning	info@metameta.nl www.metameta.nl
Acacia Water	Acacia provides consultancy services on groundwater exploration, integrated water resources management, development plans and water infrastructure design.	Groundwater Hydrology Water resources Water infrastructure design	arjen.oord@acaciawater.com www.acaciawater.com
RAIN (brand of Aidenvironment)	Specializes in sustainable water programs in a development context. RAIN programs focus on the retention, recharge and reuse of water (3R). We aim to motivate and help as many people as possible to apply these methods in a sustainable and effective way, whether the water is for domestic, productive or environmental purposes. Our focus is on making the concept and practice of rainwater harvesting (RWH) familiar to people in areas that lack sufficient and safe water sources.	Rain water harvesting 3R: retention, recharge and reuse	info@rainfoundation.org www.rainfoundation.org
Neighbours Initiative Alliance (NIA)	Working with pastoralist communities in Kenya. NIA has an impressive track record and experience in implementing community anchored programs in Water, Sanitation and Hygiene (WASH), Health and Nutrition, Food Security, Governance and Economic Development.	WASH Health and Nutrition Food security Governance	sjakinda@yahoo.com
AMREF	Amref Health Africa is an international African organisation headquartered in Nairobi. Its mission is to improve the health of people in Africa by partnering with and empowering communities, and strengthening health systems. Amref Health Africa in Kenya has a long track record on providing WASH services in Kajiado County	Health and nutrition WASH	denge.lugayo@gmail.com
Masai Technical Training Institute	The Masai Technical Training College is a tertiary institution based in Kajiado County, Kenya. It is involved in the thinking process on the ways in which urban areas can be adapted using simple infrastructure. It is the leading institution in the county which offers full-time, part-time, distance and online learning.	Urban infrastructure Vocational education	koomemitti@gmail.com


Rain
SASOL
META
South Eastern
Kenya university
ACACIA WATER
NEIGHBOURS
Nia
amref
health africa
VIA Water