NATURE-BASED SOLUTIONS FOR WATER IN THE PERI-URBAN

CASE STUDY: SOUTH AFRICA, GENIUS OF SPACE

Water JPI

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NATWIP

This case study brief is based on the 'NATWiP South Africa Case Study Description' Report written by Dr Alanna Rebelo.

ABSTRACT

The Genius of SPACE (Systems for People's Access to a Clean Environment) was a pilot project aimed to apply nature-based solutions (NBS) to treat and manage wastewater and greywater entering the stormwater system, as well as the management of solid waste while empowering local community members, improving living conditions and promoting social upliftment. Langrug, South Africa, is a relatively recently formed and continuously growing informal settlement (slum), where wastewater and solid waste accumulate in the streets due to lack of service provision, sewerage and surface hardening, leading to localised flooding, disease risk and associated health issues. The Stiebeuel River drains the Langrug Catchment (about 4.37 km2) and enters the Berg River, an important agricultural river for the Western Cape (predominantly winter wheat, vineyards and fruit) entering the sea at the Velddrif Estuary (St Helena Bay), supporting important fisheries. Therefore the eutrophication and pollution of the Berg River causes issues for agriculture downstream, which is particularly important in terms of the stringent growing and import standards of overseas trading partners. The NBS involved installation of 27 greywater disposal points, underground wastewater pipes, permeable paving, grading and pavement construction and 15 tree gardens for water infiltration. Key challenges included complex social and institutional issues, challenges around cooperative governance, communication and integration of efforts between community and local government and budget limitations. Due to these challenges, the NBS pilot was considered a failure by the implementers, and therefore the second phase of the project never realised, which was geared towards generating income and in turn, maintaining service provision. Nevertheless, the community experienced great benefits in terms of ecosystem service provision, social cohesion and health and well-being through this pilot project, and would like it to be reinitiated. Some important lessons can be learnt from this case study to improve success in future applications elsewhere.

PURPOSE OF THE CASE STUDY

The aim of this case study is to evaluate the results of the "Genius of Space" project as a nature-based solution (NBS) that aims to reduce local and downstream pollution impacts in the informal peri-urban area of Langrug and thus focuses on water quality. The study explores results related to the three dimensions of sustainability, namely, social, economic and environmental and aims to take a systematic perspective on water-related NBS, particularly focussing on resilience, adaptation, complexity, and uncertainty for various peri-urban contexts.
Rather than imposing another "rigid external development model" onto Langrug, the Genius of Space project involved local community members in a slow, adaptive process of cooperation, with the aim of designing solutions that the residents of Langrug wanted. Thus, the overreaching aim of the GOS project was environmentally focussed, improving water quality and ecosystem functioning. However, the project aimed to generate several co-benefits including socio-economic opportunities, social development and skills training related to biomimicry and improved health and sanitation. While not all issues were solved, it is said that the Genius of Space project laid the foundations to do so, "assuming the continuation of investment and incremental improvements over time". This case study investigates what the major barriers to successful implementation were, and what policy-context would favour successful implementation.

AREA CHARACTERISATION

Country	South Africa
Municipality	Stellenbosch Muncipality
Province	Western Cape
Town	Langrug & Groendal
Area	4.37km2
GPS coordinates	33°53'17.7"S 19°06'10.8"E

PHYSICAL CONTEXT

Local geography/ topography	Informal settlement situated on a mountain slope near to the town of Franshoek; Cape Fold Group (predominantly sandstone; some shale); Highest elevation: (highest nearby mountain: 1221m, highest point of township: 302m); lowest elevation 268m
Main water courses	Stiebeuel River, a tributary of the Berg River. The Berg River is an important agricultural river in the Western Cape (Ractliffe et al. 2007), is approximately 285 km long from source to sea, with a basin area of approximately 9 000 km2. It has its source in the Drakenstein and Franschhoek mountains, south of Franschhoek.
Main soil types	Soil: Glenrosa and/or Mispah forms (other soils may occur); Geology: Talus gravel and colluvial sand on granite of the Stellenbosch Pluton, Cape Granite Suite and quartzite, conglomerate, slate and phyllite of the Franschhoek Formation, Malmesbury Group.
Precipitation (monthly averages as well as climate change projections)	Mean Precipitation (mm) Annual: 903 mm; Monthly Medians: JAN - 17, FEB - 14, MAR - 30, APR - 59, MAY - 123, JUN - 1, JUL - 137, AUG - 116, SEP - 69, OCT - 50, NOV - 25, DEC - 20 The difference in median precipitation between the driest month and the rainiest month is 133mm. [Data from Cape Farm Mapper ver 2.2.3]
Temperature range	The climate in Franschhoek is warm and temperate. In winter, there is much more rainfall in Franschhoek than in summer. The Köppen-Geiger climate classification is Csb. The average temperature in Franschhoek is 16.4 °C. Minimum 5.6 (July); Max 28.4 (Feb)
Critical infrastructure	The informal settlement (1800 families in 2011) was formed in the 1980s on government land. Community relies on 2 sanitation systems - flush toilets (84% of respondents) and the surrounding vegetation areas/ bush (15.2%). Sanitation services (in the form of community toilet blocks) were provided by the City Council, but vandalism means not all are functional. In 2011, there were 0 individual toilet blocks, 91 community toilet blocks (83 functional; 49 people/toilet); 57 water taps (45 functional; avg 72 people per tap)
Other relevant physical factors	Greywater management, solid waste management & stormwater drainage all a concern in this informal settlement; concerns of human health & downstream pollution impacts.

SOCIO-ECONOMIC CONTEXT

Population	In 2011, ~14500 people in Langrug & Groendal; and 112 on surrounding farms that intersect with the catchment
GPD/capita	N/A
Economic status (i.e. low income, high income)	Very low income
Other relevant socio-economic factors:	Working population are mostly seasonal workers from surrounding farms (mostly wine farms). In 2011, 1021 of the household heads indicated that they have electricity meters in their informal houses (referred to as shacks); however, the remaining population depend on other sources of energy such as paraffin, gas, petroleum. The community has experienced flooding disasters and is also affected by crime and drug abuse. The Langrug settlement is close to the largely wealthy, historical tourist town of Franschhoek, representing a steep gradient of income inequality.

PHYSICAL CONTEXT

The Stiebeuel River runs through the informal settlement of Langrug, draining a small subcatchment of approximately 4.37 km2 (Figure 1) before entering the Berg River. The water of the Stiebeuel River is heavily polluted by sewage, litter and domestic wastewater (Cameron, 2018). This is largely due to dysfunctional or inadequate drainage systems in Langrug, but also the low-cost housing area in Groendal, as well as agricultural effluent (Cameron, 2018). Therefore there are significantly high loads of organic pollution and nutrients in the water which has a severely negative impact on water quality and therefore habitat integrity and species diversity of the river (Cameron, 2018). It also has severe implications for human health, especially for incidence of diarrhoea and pneumonia in children who play in the streets and areas contaminated by wastewater, who do not adopt sufficient hygiene practises (Olsson, 2017).

In terms of local geography, the informal settlement is situated on a mountain slope near the town of Franschhoek. The geology is predominantly composed of sandstones and quartzites of the Cape Supergroup, with alluvium in the valley-bottoms (DWAF, 2008), with Glenrosa and/or Mispah soil forms. The highest elevation is around 1221 mamsl, with the township situated at about 260-300 mamsl. The climate in Franschhoek is warm and temperate (average temperature of

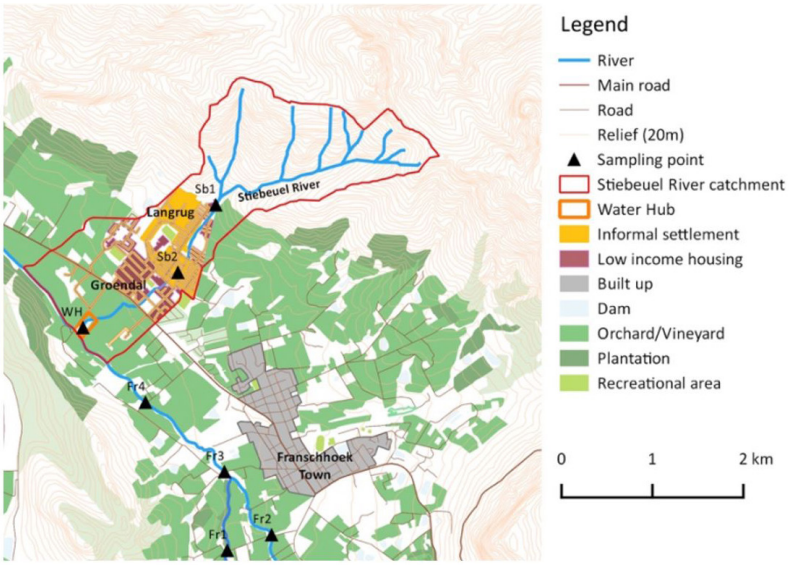

Figure 1. The Stiebeuel River at catchment, Franschhoek (from Cameron 2018).

16.4°C, with a minimum of 5.6°C and maximum of 28.4°C). The area experiences winter rainfall, with mean annual precipitation of around 903 mm. The difference in median precipitation between the driest month and the wettest month is 133 mm

SOCIO-ECONOMIC CONTEXT

The community of Langrug formed illegally on government land in the 1980s, mainly as a haven for migrants from the Eastern Cape looking for job opportunities in the wine industry (factories or farming) (Olsson, 2017; Wolfaardt, 2017). Though the squatting was illegal, Stellenbosch Municipality provided basic community sanitation including toilets and taps (communal flush toilets), while others rely on surrounding vegetation. Due to vandalism, not all public ablution facilities are functional. In 2011, there were no individual toilets, 91 community toilet blocks (83 functional; 49 people/toilet); 57 water taps (45 functional; ~72 people per tap) (GGLN, 2013). Therefore greywater management, solid waste management and stormwater drainage are all a major concern in this informal settlement, like many others in South Africa (Armitage et al., 2007). Research from 2007 found that Langrug lacked community structures that can facilitate 'self-help' solutions to greywater management (Armitage et al., 2007). Though research shows that stormwater and sanitation cannot be separated from greywater management, residents appeared less concerned about greywater as a problem compared to other more pressing concerns (Armitage et al., 2007).

In 2012 the population of greater Langrug (including Groendal) was estimated at 13 000 inhabitants, with 10% of them being children under the age of five years (Olsson, 2017). Langrug itself (composed of suburbs: Zwelitsha, Nkanini and Mandela Park) was estimated at between 16-17 years old, all homes are shacks (informal dwellings constructed by hand with available materials), with about 4088 inhabitants, with 41% female-headed households (Stellenbosch Municipality, 2011). Most people are recent migrants from the Eastern Cape (72%) (ISN, 2011). The economic status of this community is 'very low income' and despite poor water and sanitation services, most households have electricity meters in their homes, while the remaining population rely on paraffin, gas and petrolium. The working population are currently mostly seasonal workers from surrounding farms. The community has experienced flooding disasters (Jiusto & Kenney, 2016) and is affected by crime and drug abuse.

Photo plate: The informal community of Langrug, divided into three suburbs: Zwelitsha, Nkanini and Mandela Park (Source: Genius of Space Info Brochure). Since this map was produced (2015), the settlement has expanded up the mountain and into the area around the dam.

OBJECTIVE OF THE NBS

The Genius of SPACE project aimed to address water quality and quantity (excess) challenges in the Langrug Community, South Africa.
Rather than imposing another "rigid external development model" onto Langrug, the Genius of Space project involved local community members in a slow, adaptive process of cooperation, designing solutions that the residents of Langrug want (Hermanus & Campbell, 2017). While not all issues have been solved, it is said that the Genius of Space project has laid the foundations to do so, *"assuming the continuation of investment and incremental improvements over time"* (Hermanus & Campbell, 2017).

POLICY AND GOVERNANCE CONTEXT

Both local and regional government has been involved in the Genius of Space Project; the Stellenbosch Municipality (local government) and the Department of Environmental and Development Planning (regional - Western Cape Government). In the community, a committee has been established to engage with these stakeholders, called: 'the Langrug Community Projects Committee'. There is a history of governance challenges in this municipality, related to ad hoc, top-down approaches to water-related service provision (Lande & Hendler, 2018). In 2012 a community-led approach was initiated, guided by the 1988 White Paper on Local Government (which includes provision of sustainable services through partnerships between local government, community-based organizations and non-governmental organizations). The partnership consisted of the Stellenbosch Municipality (Informal Settlement Management department; local government) and the Community Organisation Resource Centre (CORC) on behalf of the South African Shack/Slum Dwellers International Alliance. The Langrug Community Projects Committee (LCPC) were the initial intermediary, and the assumption was that community leadership groups would be mobilised and take over the process, however weak community structures meant that this did not happen. A range of projects were initiated, and the partnership then expanded to include the Worcester Polytechnic Institute and University of Cape Town; and the WaSH-UP Intervention Program -which aims to improve water, sanitation and hygiene in the community- (Muniz, 2013; Olsson, 2017) was conceptualised and completed in 2013 and in 2014 an Innovation Centre in the upper section of Langrug began, motivated by lack of sanitation facilities.

In 2015 the partnership MOU ended. Power relations, community leadership divisions and community ownership issues arose, and the WaSH facility & Innovation Centre were vandalised and misused and eventually demolished by the community (Lande & Hendler, 2018). Another issue cited is that benefits of projects did not necessarily filter down to household level (Lande & Hendler, 2018). In 2015 a new initiative started - the Genius of Place project (the focus of this case study) - a collaboration between BiomimicrySA & Informal South (organizations comprising scientists, engineers, architects and innovators that seek designs that use nature-based solutions) and the Western Cape Government's 110% Green Initiative. The Langrug Community Projects Committee was established as the community driver of the project (elected through a general meeting, consisting of community leaders, ward committee members etc). Coordination challenges are well-summarised in the following extract: "Existing local realities of hierarchy, gatekeeping, and powerbrokers have worked against some of the aims of the alliance, which include the building of social capacity" (Lande & Hendler, 2018). Some of the major challenges related to governance include how to change patterns in decision-making; how to build trust, how to sustain engagement and funding through various project cycles and how to mobilise the community (Armitage et al., 2007; Tàbara et al., 2020; Wolfaardt, 2017). Other research argues that this project has been far from transformative, because it relies on the free or cheap labour of unemployed women for successful implementation (Meiring, 2017). In terms of the benefits, only well-connected women are able to access the re-

sources and opportunities provided by community benefactors, excluding many others (Meiring, 2017). There is very little existing policy support for this type of nature-based solution in South Africa.

ACTIONS

The Genius of Space Langrug Community Project proposed a systems-approach to water and waste issues, using methodology that applies nature-based principles to solve water-related challenges. The Genius of Space project implemented three solutions in a pilot project: (1) 27 greywater disposal points to manage greywater run-off and the collection and separation of household solid waste in wheelie bins (compostables, recyclables, non-recyclables), (2) underground wastewater pipes to reduce local flood risk and stormwater management (improved road surface with permeable paving, grading and pavement construction) and (3) 15 tree gardens. Eleven fulltime Langrug locals were employed on the Genius of Space Project to engage with the community around waste and wastewater disposal, as well as to take care of the nature-based solutions. One of these was appointed 'community liaison officer'. Labour (for the installation of the nature-based solutions) was sourced from within the community.

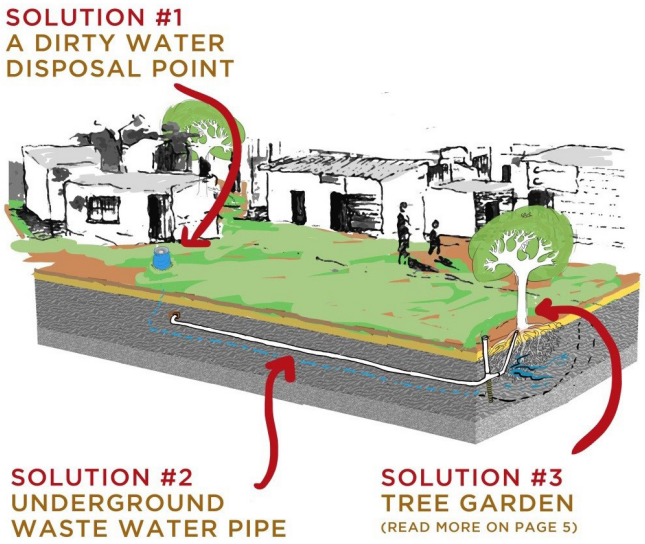

Photo plate: The three solutions proposed by the Genius of Space Langrug Community Project, South Africa (Source: Genius of Space Info Brochure).

The Stiebeuel River flows into the Berg River, which is a critical water supply for farmers downstream. The benefits of this nature-based solution were intended to be local (for the community) by reducing flood and disease risk, and improving the community, but also downstream (improved water quality for agriculture). It should be emphasized that the Langrug community is a site of extensive research, with a focus on participatory action methods which emphasise "participation, collaboration and consensual decision-making with the goal of ensuring long term sustainability of social and technological interventions" (Carden et al., 2008). However, as suggested by the challenges listed in the section on 'governance context', despite its grass-roots approach, many of the Genius of Space initiatives have not continued (DEADP, 2018). Even in 2008, certain risk factors in the community for these types of projects were identified, including: uncertainty about tenure/ownership undermining willingness of inhabitants to take initiative, as well as general unwillingness to take responsibility for service delivery believed to be the municipality's responsibility (Carden et al., 2008).

POTENTIAL (OR ACHIEVED) IMPACTS AND BENEFITS

- Reducing littering and improving wastewater disposal through education while the project was running.
- Improving water quality of the Stiebeuel River by improving greywater disposal (i.e. from the surface of the ground into the wetlands and herb and tree gardens), resulting in the filtering of water.
- Creating potential income generating community projects, such as space for vegetables to be grown in the tree gardens and sold within the community.
- Employment opportunities created indirectly through tourism (i.e. guided walks through the informal settlement).
- Education through communication of the clusters on sustainable waste management methods including waste separation, recycling, upcycling, and composting for food gardens.

- Ownership, by the local community, of the nature-based solutions leading to community-based service provision. This is due to a strong bottom-up focus in the project design and implementation.
- The project was environmentally focussed, improving water quality and ecosystem functioning. However, the project aimed to generate several co-benefits including socio-economic opportunities, social development and skills training related to biomimicry and improved health and sanitation. In addition, the project incorporated collective decision-making processes and infrastructure was community-owned and managed.

Results of the case-study interviews: (in brackets, the % refers to the proportion of agreements by implementers or community members; total n=8 and n=23 respectively)

- Connection to nature improved after the NBS (Community: 61%; Implementers: 50%)
- The NBS changed how the community used nature for recreation (Community: 44%; Implementers: 17%)
- The NBS shaped/changed cultural values and practices (Community: 44%; Implementers: 38%)
- The NBS improved community health and well-being (Community: 70%. Implementers: 75%)
- Access to water for daily use was not felt to improve by either community members or implementers, however water was felt to become more available for other uses (Community: 78%, e.g. vegetable gardens; Implementers: 38%, e.g. washing machines, trees, businesses)
- The NBS improved gender equality (Community: 65%; Implementers: 0%)
- There was no perceived change in crime following the NBS.
- Improved social cohesion (connectedness, sense of community) (Community: 78%)
- In terms of resulting policy, the Genius of Space project assisted implementers in the implementation of another NBS project in Nkanini and Villiersdorp.
- The NBS project played an important role in education: many community members cited being more aware of what happened to wastewater (Community: 83%).
- Implementers felt that the NBS did well in terms of community participation (Implementers: 100%). Community participation was encouraged through the distribution of pamphlets, a community newspaper, people announced meetings in the community with loud-speakers, open days and meetings were held, there was always food and something to drink, door-to-door knocking, with translators, emphasis was placed on building a good understanding of the NBS and questions were encouraged. Implementers wanted as much engagement from the community as possible and a large investment was made into communication.
- Ecosystem services: community perceived increases in provision of most ecosystem services, particularly aesthetic services (65%), food provision (57%), water purification (57%), water regulation (57%) and soil quality maintenance and retention (52%). Implementers particularly agreed that increases were prevalent for aesthetic services (30%), science and education (30%), water purification (26%) and recreation (22%) (Figure 2).
- The NBS project directly created new jobs in the community (Community: 78%) for the duration of that project, resulting in an improvement in household income (Community: 61%). Indirectly, jobs were also created through tourism (Implementers: 63%).

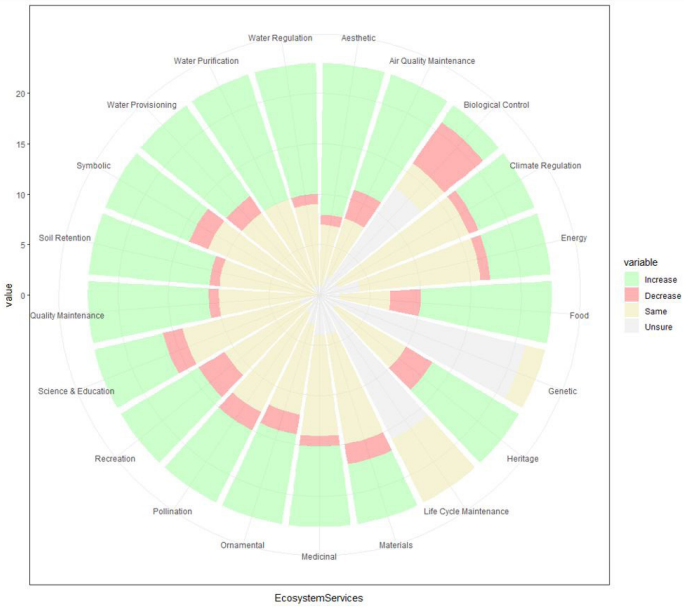

Figure 2. The perceived impact of the Genius of Space NBS on ecosystem services according to community members (n=23).

Constructed permeable paving between Block S and T.

SUSTAINABLE DEVELOPMENT GOALS AND/OR ANY OTHER WATER-RELATED DEVELOPMENT GOALS ADDRESSED

SDG1 -> Job creation for the impoverished.
SDG3 -> A decrease in wastewater accumulation above ground
SGD5 -> Improving gender equality (community perceived an improvement after the NBS)
SGD6 -> Improved sanitation through the NBS (drainage, improving permeability)
SGD8 -> Employment opportunities provided through the NBS
SGD10 -> Improving gender equality (community perceived an improvement after the NBS)
SDG11 -> Installing green infrastructure
SDG14 -> water quality improvements (less litter and sewage entering the river).

LESSONS LEARNT

- Challenges: The greatest challenges for implementation identified by implementers were (in order of importance): the social imbalances, sustainable funding, collaboration (government and society), stakeholder support, rapid urbanisation, and sufficient funding.

Ecological

N/A

Social/governance

- Project management: In terms of how well the project was run, the community rated it as 3.5/5 (1 = very poor; 5 = very good). Implementers felt that the project was well run, it started very well but commitment fizzled out, because the project failed to consider risks and how to mitigate them, and also that it failed to budget for 80% engagement, 20% work (in community work). Overall implementers felt that there was sufficient expertise, knowledge and skills of actors (75%), but one felt that initially this was not the case, and that it was a steep learning curve for all involved.
- Governance: Implementers felt that specific personal values and attributes facilitated the NBS process (75%), for example: being engaging, having empathy and giving support, willingness to be involved in necessary conflict, and to be part of a process. This project implemented a co-create, co-design approach. A lot of investment went into community participation and understanding and ultimately involvement. This required a level of resilience and commitment. The ability to speak to and negotiate with people who are directly affected by the NBS and build trust. The importance of having a champion implementer was raised. The engineers working on the NBS were suggested to have taken a traditional silo approach, and did not engage with the vision of the project.
- Governance: This NBS was an interdisciplinary project (Implementers: 88%); there was a lot of collaboration, especially between the implementers and community members. Although, collaboration was often lacking regarding the municipality. Only one imple-

menter felt that this was not the case (was a bit of silo's, not enough public participation meetings. Would have worked a lot better if e.g. surrounding farmers were involved).

- Power struggles were present in the community but were not thought to be significant by the implementers (i.e. certain individuals with agendas or trying to reach a leadership position, ego's, hidden agendas) (Implementers: 38%).
- There was a lot of effort to incorporate cultural/societal values sufficiently (Implementers: 75%). Cultural/societal values were mainly incorporated via the planting elements and placement of infrastructure.
- Some conflict/tension among actors was noted (Implementers: 50%). There was quite a bit of tension with the community at times in terms of work ethics, contracting, payment. Also level of theft, vandalism and loss of materials. Limited buy-in from municipality (their property) and breakdown in communication at times which led to difficult situations when it came to implementing.

Economic

- Unsustainable funding was the main issue for the project (Implementers: 88%). The second phase of the project never received funding, which is the phase that was supposed to generate income for the community. Government led funding which is very short-term and cyclical and it is punitive, if incapable of spending budget allocated within certain time frame, the opportunity to get a similar budget diminishes. To sustain that investment with various challenges faced, towards the end of project became difficult to plot way forward.
- Community recommendations: Continue with the project and assist other sections of the town as well, Community members involved would not listen to advice/recommendations, Only people from the pilot area were employed in the project, Vandalism led to failure of the pilot project, Train the right people, better communication and understanding and build a trustworthy network, Work together with the community and employ everyone, Assist all sections with water, The community was not consulted initially, budget could have been better used, More taps & cleaner town needed, More job opportunities desired, Clean drains & environment desired, Our voices were not heard, Desire to install toilets and sewerage, Partner with municipality to leverage more funds, Could have implemented new systems and taught youth, They did not work together.

TRANSFERABILITY OF RESULTS

The results of this case study are most useful to practitioners (locally or globally) in that they shed light on the major barriers to successful implementation of green infrastructure types of nature-based solutions in peri-urban areas, and what policy-context would favour successful implementation.

Recommendations:

- Future projects should explicitly consider potential risks and how to mitigate them.
- Future projects should apportion their budget for 80% community/stakeholder engagement, 20% for the physical NBS implementation work. Many projects may not budget for the community/stakeholder, and this engagement can determine the project success.

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Installed greywater disposal point (blue drum).

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WHAT IS NATWIP?

NATWiP is an acronym for a project entitled: Nature-Based Solutions for Water Management in the Peri-Urban: Linking Ecological, Social and Economic Dimensions.

This is an EU-Cooperation project funded under the Water Joint Programming Initiative (JPI) Call 2018 and is led by an international consortium of scientists. The NATWiP team works towards promoting sustainable implementation of nature-based solutions to address water challenges in peri-urban areas.

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