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**DELIVERING WATER, SANITATION AND HYGIENE SERVICES  
IN AN UNCERTAIN ENVIRONMENT**

**Sand dams: harvesting rainwater from sand rivers**

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*Sand dams are a key tool for the restoration of degraded lands and self-supply water technology in dryland regions and thereby addressing poverty, hunger, conflict, climate change and creating green economic growth – all at the same time. The majority of the world's sand dams are found in Kenya. This paper describes what sand dams are, the benefits and impacts they deliver and some different ways they can be applied within development programmes.*

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**Sand dams: a solution for land degradation**

Sand dams are an affordable tool for restoring Earth's degraded lands. By conserving soil and water and creating the time and opportunity for people to further invest in climate smart agriculture, they are a key enabler for people to address poverty, hunger, climate change, conflict and economic stagnation.

Sand dams are applicable to all dryland regions that have seasonal rivers with a sandy sediment. In fact, they are both dependent on, and a solution to, the conditions that exist in drylands under the threat of desertification.

By permanently raising the water table, sand dams increase the capacity of soils to absorb water and enable the growth of trees and plants; improving the quality and stability of soil. This enables further investment in terracing land and planting trees, creating a virtuous cycle of soil and water conservation enabled by both the water stored in sand dams and the time taken to collect it.

Soil and water conservation restores dryland environments, mitigates climate change, reduces erosion and nurtures the environmental services needed for the development of human well-being. In this way, sand dams not only address the effects of land degradation, but also the causes. By retaining water that would otherwise be lost to the ocean and slowing the flow of seasonal rivers, they reduce flooding as well as mitigate the impacts of floods that are highly damaging to drylands.

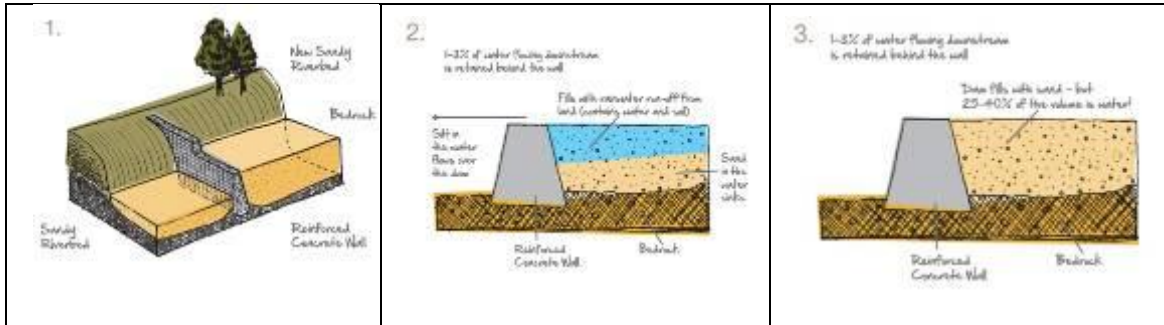
An investment in soil and water conservation towards a land degradation neutral world costs a fraction of the sum of responding to the results of desertification. Key to this approach is the knowledge and availability of affordable, applicable and sustainable technologies that facilitate rainwater harvesting and enable improved land management.

Sand dams are such a technology. As the lowest cost form of rainwater harvesting that last at least 30-50 years and require virtually zero operation and maintenance costs – they are a low-cost sustainable solution that has the potential to transform drylands globally.

**What are sand dams?**

A sand dam is a reinforced concrete wall built across a seasonal riverbed. They are a simple, low cost and low maintenance technology that serves to retain rainwater and recharge groundwater. They can store up to 20 million litres of water and are widely suited to dryland regions of the world.

The soil is made up of silt and sand. The heavier sand sinks behind the dam, whilst the lighter silt washes downstream. Sand accumulates behind the dam until it is full to the spillway. Depending of the particle size, 25-40% of this volume is actually water, trapped in the spaces between grains of sand. Because the water is stored within sand, it is protected from evaporation losses.



While a dam can initially store 20 million litres of water and refill after each rain - the yield of a sand dam can actually be significantly greater than its storage capacity. Sub-surface base flow through the sediment in the riverbed and from the river banks recharges the sand aquifer throughout the year.

A key aspect of a successful sand dam is the protection of land on either side of the dam through the digging of terraces and trenches to reduce soil erosion in the immediate vicinity of the dam. This increases the recharging of the dam and prevents the dam from silting up like open water dams.

Sand dams last at least 30-50 years and require virtually zero operation and maintenance costs – making them a low-cost sustainable solution.

<p>Abstracting water from sand dams. Sand dams permanently raise the water table, making water easily accessible from traditional scoop holes all-year round. Water is available to all members of the local community without any fees to support operation and maintenance of hand pumps.</p>	<p>A pipe built into the sand dam wall and connected to an infiltration gallery provides water ‘on-tap’ close to people’s homes. Often a tank behind the dam allows pumping for irrigation.</p>	<p>A hand pump on a sealed shallow well is connected, to an infiltration gallery buried in the deepest section of the sand aquifer above the dam.</p>

### Different applications of sand dams

Sand dams can be applied in three key contexts: (1) as a method of community led development; (2) as a combined rural water source - rural road crossings over seasonal rivers or (3) within wildlife reserves.

### Community led development

Sand dams are a tested tool for enabling grassroots sustainable development with mutual benefits for environment and human well-being; creating the conditions required for land restoration and empowering people to overcome poverty based on a model of green economic growth. When applied in a community self supply context, sand dams provide a lifetime of clean water for up to 1,000 people in rural dryland areas.

Each sand dam holds between 2-20 million litres of water, protected under sand from evaporation and many water-borne diseases. Sand dams have minimal operations and maintenance cost, unless fitted with a hand-pumped well, and last over 50 years. They are the most cost-effective form of rainwater harvesting in drylands.

Sand dams therefore provide security to rain-fed agriculture: something of a miracle for many people who would otherwise be dependent on the unpredictable rainy seasons associated with drylands.

Communities not only gain a year-round supply of water, but also save between 1.5 and 8 hours a day from the burden of collecting water – creating time to invest in sustainable land management for improved food production and income generation.

With water and time reliably available, communities are now able to invest more in sustainable land management and climate smart agriculture. This is particularly beneficial for women and girls who traditionally shoulder the greatest burden of collecting water.

By digging terraces, establishing tree nurseries and planting trees, communities can create a virtuous cycle of soil and water conservation that restores degraded lands and enables improved farming. Together with techniques such as inter-cropping, crop diversification, zero grazing and establishing seed banks, sand dams enable the production of a year-round and diverse supply of food, even during periods of drought.

The water security that sand dams provide further empowers people to explore opportunities for income generation. Community fish ponds can be established and more, and more diverse, food can be produced; not only improving health, but also enabling surplus crops to be sold at local markets.

In addition, because sand dams store water within sand, it is protected from evaporation. This reduces the concentration of mineral salts in the water and maintains the water's suitability for human, animal and plant consumption.

By increasing the accessibility of water and creating economic opportunity, sand dams are a tool for enabling increased resilience to disaster and reducing natural resource conflict and human environmental and economic migration.

## **Rural road crossings**

In many dryland regions, culvert bridges are traditionally built under small rural roads to allow water to flow underneath during rainy seasons. Culverts, however, are both vulnerable to being washed away and a cause of soil erosion upstream and downstream of them.

Often they are insufficient in size to accommodate water flow or become clogged up with sediment and debris during intense rainy seasons. In this way they cause erosion either by intensifying water velocity through restricted space, and/or forcing the river to break its banks and erode the surrounding land. This also often causes the crossing to be washed away – sometimes making it impassable.

Not only does this erosion of soil degrade lands, it also undermines the stability of rural road systems. Sand dams are a viable alternative to traditional culvert bridges. When a sand dam is built on either side of a crossing (creating what is effectively a river ford and a weir at the same time) a road can be created between them by filling the space with soil and rocks to the level of the spillway. This can then be topped with a concrete or tarmac surface.

While the initial investment is much more than a culvert enabled crossing, sand dams are a more sustainable and cost-effective long term solution. Sand dams last at least 30-50 years and require virtually zero operation and maintenance costs – if not connected to pumping systems.

Sand dams have the key additional advantage of also providing an important source of water. By retaining rain water and permanently increasing the water table, sand dams increase soil water retention, enabling trees and vegetation to grow, improving soil quality and stability and reducing land degradation.

Sand dams used as rural road crossings are not applicable to all crossings. For the lower parts of river catchments where rivers flow for weeks rather than days or hours after each seasonal rain, traditional bridges are still required to maintain transportation links for frequently used roads. However, there are thousands of road crossings over which rivers flow for only a short period and sand dam crossings will still enable access when the river is flowing low.

Therefore, in the mid to higher catchments of seasonal rivers sand dams are an ideal solution, which will act to significantly reduce the flooding of roads and bridges in the lower catchment by reducing the impacts of the flood rains which severely damage dryland environments and reduce access to markets and services, such as health and education. Linking isolated rural communities to markets and services is key to enabling economic growth and improved livelihoods

Poverty is one of the drivers of desertification. Not only do sand dams address the direct causes and effects of desertification, they also create opportunities for poverty alleviation. In drylands, rural roads are vulnerable to erosion and flood damage where they cross seasonal rivers, especially in the face of increasingly extreme weather events. Sand dams offer an improved alternative.

### **Rural road crossings in wildlife reserves**

Wildlife reserves represent large dryland areas in many African countries. Kenya, Tanzania, Namibia, Botswana and South Africa all have significant areas of land reserved for the protection of wildlife and the tourism industry.

The adoption of sand dams as an improved alternative to culverts for rural road crossings over seasonal rivers would enable the restoration of vast areas of land in dryland regions.

Sand dams transform the local ecology, recharging the aquifer above and below the dam, creating a permanent increase in the water table. This in turn allows trees and other vegetation to grow naturally along seasonal riverbanks. The recharged groundwater, improved soil and increased vegetation reduce the loss of biodiversity and the overall degradation of ecosystems.

In this context, they may also offer a mutually beneficial solution for large mammal conservation and the improvement of human livelihoods; acting as a solution for the relief of human-wildlife conflict.

Human-wildlife conflict, in particular the damage that elephants cause to smallholder crops, water supplies, grain stores and houses, undermines rural livelihoods and represents a major challenge to the conservation of elephants in Africa. Because elephants are a keystone species, conserving them also preserves the ecosystem and protects local biodiversity, which forms the foundation of ecosystem services necessary for all human development and well-being.

In addition to representing a significant preserve of biodiversity, wildlife reserves are also a vital economic resource for many countries with dryland regions. Drought and desertification diminishes the ability of the land to support key species and impacts on individual, local and national revenue from tourism.

For example, parts of Tsavo game reserve in Kenya (the largest in Africa) has suffered tremendously from both drought and land degradation – particularly in the last six years. In 2009-10, over 300 hippopotamuses died in Tsavo West Game Reserve – not from thirst (Mzima Springs provides millions of litres of water nearby) but starvation. With sand dam bridges, vegetation would grow naturally around each crossing, significantly increasing vegetation in the park. In Tsavo East the normally perennial Athi/Galana river dried up in 2009 for the first time in living memory. Elephants walked 30-40 km to dig water from sand dams that still had water despite a two year drought.

Sand dams, built as rural road crossings in wildlife reserves, would permanently increase the watertable, enable the growth of the vegetation necessary to support the survival of large mammals during periods of drought. In this way, they would reduce human-wildlife conflict and support the conservation of biodiversity and the sustainability of a valuable economic resource.

### **Conclusion: what is the global potential of sand dams**

40% of the Earth's surface is classed as drylands. Sand dams are applicable to all drylands that have seasonal rivers with sandy sediments and accessible bedrock. Their potential to transform lands and lives is enormous. The key to unlocking their potential is building increased awareness and understanding of sand dams and greater support for dryland farmers and the agencies that work with them to build and manage their own sand dams in order to meet the twin priorities of more food and water.

While sand dams are suited to vast areas of drylands, it is more critical to note that drylands are the home to 80% of the world's poorest and most marginalised people – all 2.3 billion of them. People living in drylands will be some of the worst affected by climate change, desertification, conflict and economic stagnation. With 44% of the world's food produced there, the risks are high – not just for those living there but for the millions of people worldwide who dependent on the resources they provide:

- 40% of the world's land is classified as drylands
- 2.3 billion people live in drylands – one in three of the world population
- 80% of the world's poor rely on dryland resources
- 44% of the world's food is produced in the drylands
- Drylands support 50% of the world's livestock

Source: UNCCD and UNDP

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