DIGITAL DEVELOPMENT DEBATES

CuveWaters: Water and sanitation for arid northern Namibia

Alexia Krug von Nidda und Thomas Kluge, ISOE

Rainwater enables food production, solar energy turns salt water into drinking water and underground tanks store flood water for the dry season: The CuveWaters project in Namibia shows how elaborate technology and clever management can provide water and sanitation even in extremely dry regions.

In this model project, even toilet wastewater is cleaned and re-used – and the sludge serves as fertiliser and for energy production. The project managers are convinced that we need a new way of thinking about how we use our resources. They want to support health, the energy supply and job creation in the region by providing water solutions.

Bringing society, science and technology together

Namibia is the most arid country in southern Africa and is facing severe consequences due to climate change. Its north-central regions in particular are shaped by contrasting extremes such as drought and floods. The area lacks permanent rivers and suffers from seasonal water shortages.

Around one-third of Namibia's population lives in this area. They are strongly dependent on Angola due to the fact that the two main sources of water for the region lie across the border: the upper reaches of the Cuvelai and the Kunene rivers, which feed a long-distance canal and pipeline system.

The Cuvelai-Etosha Basin population, though, doesn't even have access to this pipeline: they rely on saline groundwater. Additional problems are arising from increasing urbanisation, a lack of sanitation facilities and soil degradation.

The international transdisciplinary CuveWaters (2006-2015) research project, sponsored by the German Federal Ministry of Education and Research, chose the Cuvelai-Etosha Basin as its model region. Scientists from different disciplines are working hand in hand with practitioners and local actors to solve this region's water problems. They develop tailor-made solutions in Integrated Water Resources Management (IWRM). New technologies are then adapted to the specific political, social and economic conditions.

Using water from multiple sources

The basic idea of CuveWaters is to obtain water from different sources and then deploy it for different purposes. Desalinated ground water, for example, is particularly clean, while rainwater is of lesser quality. Accordingly, ground water is to be used for drinking and rainwater for gardening or washing. This concept is called multi-resource mix. Its benefits are manifold:

- **Storage and reuse:** In a region with severe water scarcity like the Cuvelai-Etosha Basin, efficient water storage and re-use is essential. Water from all adequate sources such as rainwater or flood water during the wet season should be re-used or stored.
- **Diversification:** Diverse sources safeguard against shortfalls in individual water resources.
- **Flexibility:** The technologies allow for flexible responses to the heterogeneous conditions in the region.

The technologies implemented include pilot plants for rainwater harvesting, groundwater desalination, water sanitation and re-use, and subsurface water storage.

Adapting technologies to local needs

For water management to be sustainable, it is vital to adapt it to local needs – otherwise, technologically sophisticated concepts can easily clash with users' everyday behaviour. This is why CuveWaters applies a demand-responsive approach. The innovative technologies implemented were developed together by German industry and Namibian experts. When the jointly adapted technologies are put into operation at the selected pilot sites, further adjustments are made according to the demands of users and local stakeholders.

Participatory workshops with the communities are another basic element. These help further a better understanding of local living conditions and provide a forum to discuss the new technologies and develop operational, management and ownership strategies. Moreover, the approach focuses on shared monitoring of the technologies. This way the population will really accept and use them.

Rainwater harvesting for gardening and business

Rainwater harvesting is well known all over the world for providing good quality water on a small scale, especially in most developing countries. The water is generally collected from roofs or non-permeable surfaces on the ground. Despite scarce water resources, however, this technology is not well known in northern Namibia.

Multi-resource mix rainwater harvesting is essential for CuveWaters. The water is of fairly good quality and mainly intended for gardening, but can also be used for washing, cooking or watering livestock. The construction of the rainwater harvesting pilot plants and the initial training of local users took place between October 2009 and February 2010 in the village of Epyeshona in the Oshana region.

Three different materials were chosen for the construction of the rainwater tanks for single households: plastic, ferrocement and bricks. These tanks have a storage capacity of 30 cubic meters each. Furthermore, an underground tank with a ground catchment was constructed to collect rainwater for up to six households with a storage capacity of 120 cubic meters.

During the construction phase, up to twelve technicians from the village were trained in tank construction. They learned how to build, operate and maintain the facilities. As rainwater is mainly used for gardening, CuveWaters and the local technicians constructed gardens and water-saving drip irrigation systems for all households with tanks in February and March 2011. An open garden area and greenhouse were constructed at the community ground catchment. This will enable people to use the water wisely, diversify their own diets and generate a small income by selling fruits and vegetables at local markets.

Groundwater desalination through solar power

The project area is devoid of water bodies and groundwater is often saline. In some places the salt content of the groundwater is even three times higher than seawater.

To provide clean and healthy drinking water for the population, CuveWaters installed desalination plants in two villages in the Omusati Region. To date local inhabitants still draw water from hand-dug wells. During the dry period, though, the water becomes saltier due to evaporation and hydraulic links to the saline ground water. And the contamination with algae, faeces and parasites can be tremendous.

Desalination plants are usually built when there is no other option due to their relatively high energy consumption and investment costs. But as there is no infrastructure for conventional energy sources such as oil or gas in the region, the plants installed in Namibia are powered by solar energy. This is also much more ecological, of course. The region is excellent suited for solar energy, as it enjoys solar radiation of more than six kilowatt hours per square meter per day.

In the village of Amarika, a membrane distillation plant from the German Fraunhofer Institute for Solar Energy Systems (ISE) and a chemical-free reverse osmosis plant from the pro|aqua company, also headquartered in Germany, were installed. Each plant can provide up to five cubic meters of drinking water per day. In the village of Akutsima a multi-effect humidification plant from the Terrawater company with a capacity of up to 3.5 cubic meters per day was built. Furthermore, a multi-stage flash plant from Solarinstitute Jülich, Germany, and the "Ingenieurbüro für Energie- und Umwelttechnik" (IBEU) with a capacity of 600 liters of water per day was built.

The plants have been operated and secured by trained local caretakers from the villages since July 2010. A Namibian service provider, Aqua Services & Engineering, checks and maintains the plants regularly.

Subsurface water storage for the dry season

In the Cuvelai-Etosha Basin *oshanas*, very shallow, ephemeral river courses, drain the whole basin from north to south. While the area experiences floods in the summer season from November to April, the whole area can completely dry up during the winter season.

Several attempts have been made in recent years to store the *oshana* water during the winter season using pump storage dams and excavation dams, for instance. But the high rate of evaporation (up to 2,700 millimetres per year) and rapid quality degradation of the stored water have hampered the success of these technologies.

To avoid these disadvantages, subsurface water storage was developed as part of the CuveWaters project. Instead of using open storage reservoirs, the water is stored in an artificial closed subsurface storage reservoir like a tank or a pond. During the rainy season, *oshana* water is pumped in. Its good quality is maintained in the reservoirs so that it can still be used during the dry season.

The advantages of subsurface water storage are:

• Flood water can be stored in areas without suitable perched aquifers.
• The technology is independent of local groundwater and therefore does not interfere with fresh or salt water aquifers.
• The storage reservoirs can be constructed from local or easily accessible materials.

The water provided is of medium quality and intended to be used for small scale gardening. Therefore, gardening infrastructure, such as a drip irrigation system and greenhouses, was constructed next to the storage reservoirs.

Sanitation water and excreta re-use for energy generation

In 2008, 53 % of the population of northern Namibia did not have access to any sanitation facilities. The Namibian National Sanitation Strategy proposes technologies for urban areas, including flush toilets in combination with vacuum technology for the sewage. It is noted that the "benefits of the provision of sanitation are promoted as a public good and include health, environment, energy generation (biogas) and food production (waste water re-use and treated excreta re-use)". CuveWaters takes into account the major recommendations of the Namibian strategy. The concept combines wastewater management with water re-use, fertiliser recovery, energy generation, and a community based approach. Special attention is paid to changing hygiene habits to prevent infections.

The sanitation sub-project is being implemented in Outapi in the Omusati Region together with the town council and Roediger Vacuum as the partner from German industry. Different options for improving sanitation are being put into place in order to ensure the adaptability of the infrastructure to suit an urban setting: sanitary installations in private houses (individual solutions), sanitary facilities for small neighbourhoods in informal settlements (cluster solution), and the concept of a communal sanitation house in a crowded market location (community solution).

Vacuum sewers connect the sanitation facilities to a wastewater treatment plant. This ‘closed system’ was chosen due to the threat of floods in the area. After the removal of solids, wastewater is first treated in in an anaerobic reactor, a process that functions in the absence of oxygen. Afterwards the water is treated aerobically and disinfected before being re-used for agricultural irrigation. The biogas produced from sludge can be used for electricity generation and the processed sludge itself can be utilised as fertiliser.

Connecting these processes is a great opportunity for the urban community to achieve regional development, poverty reduction and job creation. By supporting gardening initiatives, CuveWaters is paving the way for a sustainable improvement to people’s livelihoods.

Conclusion: Changes in water use are best realised at the local level

In the water sector, innovative and adapted solutions are needed, along with a new way of thinking about water. These measures must impact on decisions and actions at every level. Ultimately, changes to water use have to be realised at the local level while keeping in mind the wider context of regional and global interaction in the domain of water management.

CuveWaters seeks sustainable solutions and supports Namibia’s national strategies in the water and sanitation sector. The aim is to improve livelihood security, the regional economy, health conditions and job creation. By doing so, the project contributes to the successful application of Integrated Water Resources Management (IWRM) in Namibia.