From concept to tap

Integrated Water Resources Management in Northern Namibia

CUVE waters integrated water resources management

Publisher:	Institute for Social-Ecological Research (ISOE) GmbH Frankfurt/Main, Germany
Sponsor:	German Federal Ministry of Education and Research
Editors:	Dr. Jenny Eisold, Dr. Corinne Benzing (ISOE)
Design and layout:	Harry Kleespies (ISOE)
Picture credits:	africa©www.fotolia.de (cover), Bernd Meiseberg©www.fotolia.de (4), 2jenn©www.fotolia.de (10), fotoali©www.fotolia.de (20), CuveWaters (5, 7, 11–15, 19, 21–23, 25–26)

| Date: | 2nd Edition, June 2011
Printed on recycled paper |

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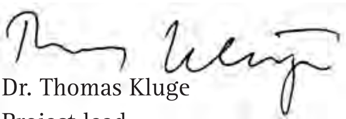
Foreword

Access to clean water is crucial for social welfare, health, economic development, and the preservation of nature. One billion people worldwide lack access to safe drinking water and 2.4 billion are without adequate sanitation. The Millennium Development Goals (MDGs) promote environmental sustainability, global partnership, universal education, child and maternal health, and the end of poverty and hunger. The United Nations want to ensure access to some form of improved water supply and sanitation for an additional 100 million people each year (or 274,000/day) until 2015. CuveWaters, sponsored by the German Federal Ministry of Education and Research, contributes to these goals in Northern Namibia.

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. In doing so, the project contributes to the successful and adapted application of Integrated Water Resources Management (IWRM) in Namibia. High expectations rest on this concept in terms of fulfilling the Millennium Development Goals. IWRM was established in 1992 as a conceptual framework on the basis of the Dublin Principles in order to promote sustainable management of water resources. How this has been picked up by CuveWaters and translated into activities which implicate long-term beneficial effects for Northern Namibia will be presented within this brochure.



Dr. Thomas Kluge
Project lead

Challenges and Solutions

Ecological and societal challenges

Namibia is the most arid country in southern Africa. 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 shortage. Furthermore, the region is especially facing severe consequences of climate change. Around one-third of Namibia's population lives in this area, which is strongly dependent on Angola due to the fact that the two main sources of water for the region lie behind the border: the hydrologically important upper reaches of the Cuvelai, and the Kunene River which feeds a long-distance canal and pipeline system. In the Cuvelai-Etosha Basin, which was selected as the main model region for this research project, parts of the population are unable to benefit from the pipeline water and only have access to saline groundwater. Additional problems arise from increasing urbanisation, a lack of sanitation facilities, and soil degradation. Current water management needs to be adapted to these challenges to bring about improved health conditions and reduce stress for the people and the ecological system.

The model region for CuveWaters, the Cuvelai-Etosha Basin, is located in North Central Namibia adjoining the Angolan border (Source: Steffen Niemann)

Local users participating in a CuveWaters workshop

Bringing together society, science and technology

The international joint research project CuveWaters reflects a transdisciplinary research approach. Scientists from different disciplines work in tandem with practitioners and local actors.

The project develops and implements Integrated Water Resources Management (IWRM) in a form tailored to the Cuvelai-Etosha Basin. The central goal is to strengthen the potential of the region's resources by combining new and adapted technologies in a multi-resource mix for water supply and sanitation. Technical project parts are framed by societal and scientific components. Furthermore, IWRM is embedded in existing processes and adapted to the specific political, social and economic conditions.

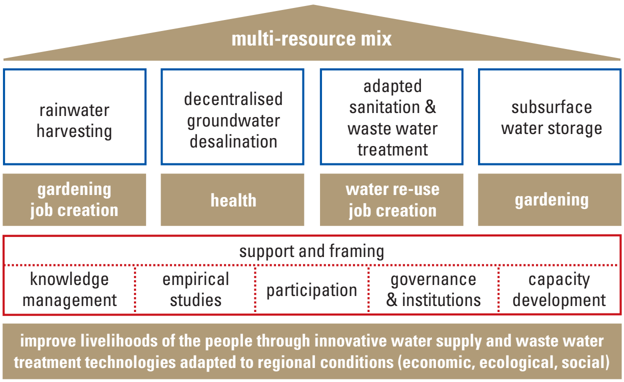


Diagram showing the multi-resource mix as part of Integrated Water Resources Management in CuveWaters

The project is composed of three phases, the first of which was successfully completed in 2009. Close coordination between local decision-makers and actors was established during this stage. Empirical studies were conducted with specific emphasis on combining a qualitative socio-empirical perspective with participatory planning.

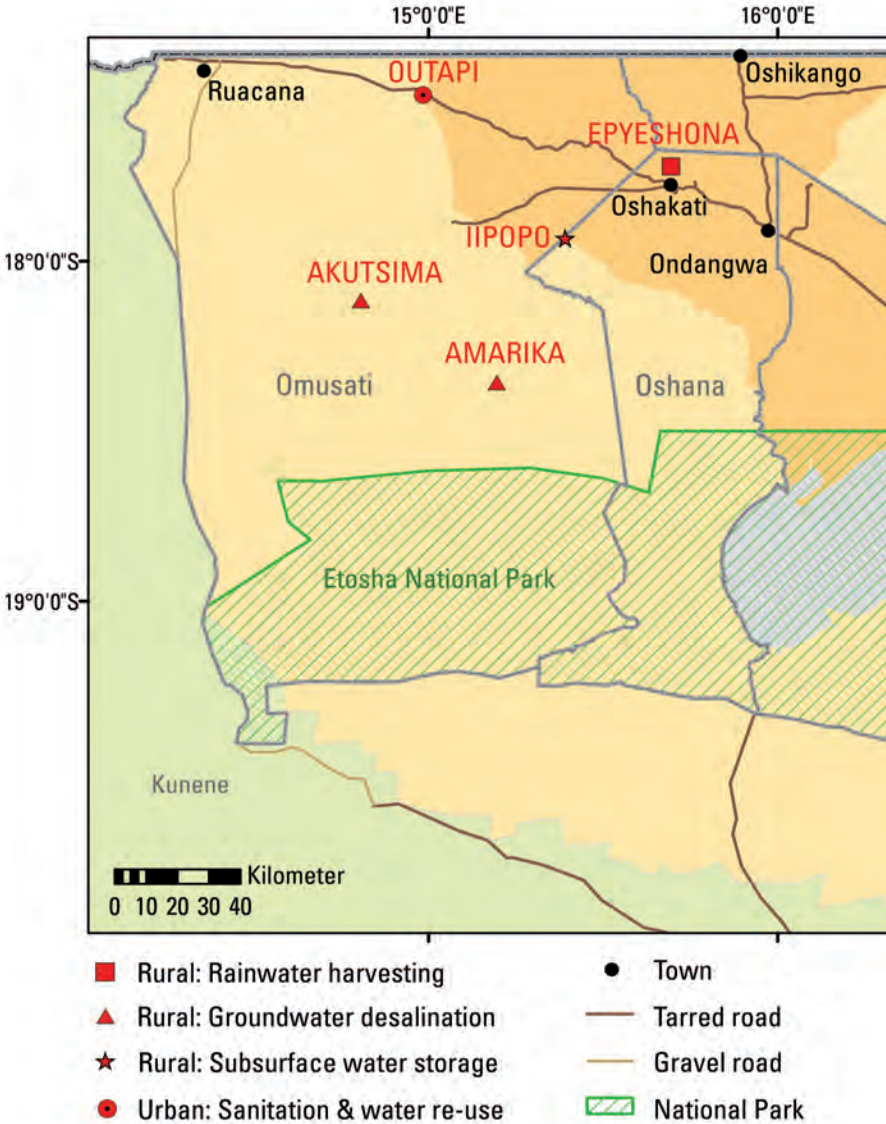
Phase II, the implementation phase, runs until the middle of 2013. Innovative pilot plants are being put in place and their operation monitored in collaboration with the local stakeholders and communities. Parallel to this, capacity development measures such as technical training at local level and scientific projects for young researchers are being conducted. The final Phase III is designed to bring the successful technologies to further sites in Namibia and southern Africa. Furthermore, the support and evaluation of the implemented IWRM concept is continued.

Demand-responsive approach

Technologically sophisticated concepts can easily clash with users' socio-cultural needs and everyday behaviour. Therefore a demand-responsive approach is applied in CuveWaters to develop and implement the new technologies based on informed choices. With this approach, local users in particular but also stakeholders at other levels participate in the implementation process. Basic elements are participatory workshops with the communities to get an understanding of their living conditions and everyday patterns, to discuss the new technologies and to develop operation, management and ownership strategies. In Phase II the approach focuses on shared monitoring of the technologies. The intention is that this approach will lead to ready acceptance and actual use of the technologies in question and hence sustainable resource management.

Village mapping during a stakeholder workshop as part of the demand-responsive approach

CuveWaters implementation sites



Cartography:
J. Röhrig (2010)

Data sources:
NNEP and EEP, MET (2000)

Technologies in a multi-resource mix

Multi-resource mix

The IWRM concept of CuveWaters is based upon a so-called multi-resource mix, which means that water is obtained from different sources and then deployed for different purposes. An example would be water of relatively higher quality for drinking and water of lesser quality for gardening. The implemented technologies include pilot plants for rainwater harvesting, groundwater desalination, sanitation and water re-use, and subsurface water storage.

The benefits of a multi-resource mix are manifold. Firstly, 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 therefore be re-used or stored. Secondly, a multi-resource mix uses diversification to safeguard against shortfalls in single water resources. And thirdly, it allows for flexible responses to the heterogeneous conditions in the region.

To achieve sustainable water resource management it is vital to adapt the multi-resource mix to local conditions and needs. The innovative technologies implemented in CuveWaters were therefore developed together with German industry partners and Namibian experts. While the jointly adapted technologies are put into operation at the selected pilot sites, further adjustments are made to the technology line via the continuous integration of local stakeholders.

Rainwater harvesting

Rainwater harvesting is a technology that is very well known all over the world as a means of providing good quality water on a small scale, especially in most developing countries. Rainwater is generally collected from roofs or on non permeable surfaces on the ground.

Despite scarce water resources rainwater harvesting is not very well known in northern Namibia. As part of the CuveWaters multi-resource mix rainwater harvesting is one of the technologies to be piloted. The harvested water is of fairly good quality and is mainly intended for gardening purposes, 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 (Okatana constituency/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 metres 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 metres.

Trainees from Epyeshona and experts building an underground tank for rainwater harvesting

As part of capacity development measures, technical training was provided to enable technicians from the village to build, operate and maintain the facilities. During the construction phase up to twelve people were trained in tank construction.

The harvested rainwater is intended to be used mainly for gardening purposes. Therefore gardens were constructed together with the previously trained technicians in February and March 2011. All households with rainwater harvesting tanks were equipped with gardens and water saving drip irrigation systems. At the community ground catchment an open garden area and a greenhouse were constructed.

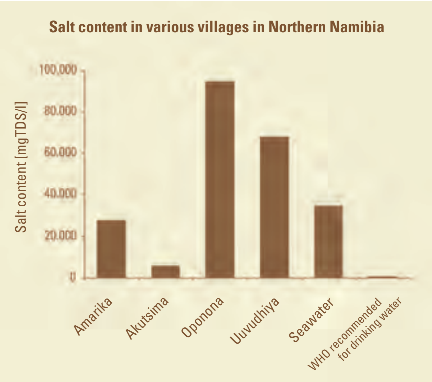
The gardens and the drip irrigation systems are intended to enable the users of the rainwater catchments to use the water wisely, diversify their own diet and generate a small income by selling of fruits and vegetables on local markets such as Okatana and Oshakati.

Greenhouse and gardens in Epyeshona, irrigated by water from a rainwater harvesting tank

Groundwater desalination

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

To provide clean and healthy drinking water for the population, innovative desalination pilot plants have been installed by CuveWaters in two villages in the Omusati Region. To date, local inhabitants took water from hand-dug wells for themselves and their livestock. During the dry period the water becomes saltier due to evaporation and hydraulic connection to the saline ground water. 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. The installed plants are powered by solar energy in the interests of environmental sustainability and in the absence of an infrastructure for conventional energy sources such as oil or gas. The region is most suitable for solar energy plants, enjoying solar radiation of more than six kilowatt hours per square metre per day.

In the village of Amarika a membrane distillation plant from the Fraunhofer Institute for Solar Energy Systems (ISE, Freiburg, Germany) and a chemical-free reverse osmosis plant from the company pro|aqua (Mainz, Germany) were installed. Each plant can provide up to 5 cubic metres of drinking water per day. In the

village of Akutsima a multi-effect humidification plant from the company Terrawater (Kiel, Germany) with a capacity of up to 3.5 cubic metres per day was built. Furthermore a multi-stage flash plant from the Solarinstitute Jülich and "Ingenieurbüro für Energie- und Umwelttechnik" (IBEU, Jülich, Germany) with a capacity of 600 litres of water per day is constructed.

In October 2010 the plants were officially inaugurated by Honorable Deputy Minister Petrus Iilonga.

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 maintain the plants regularly.

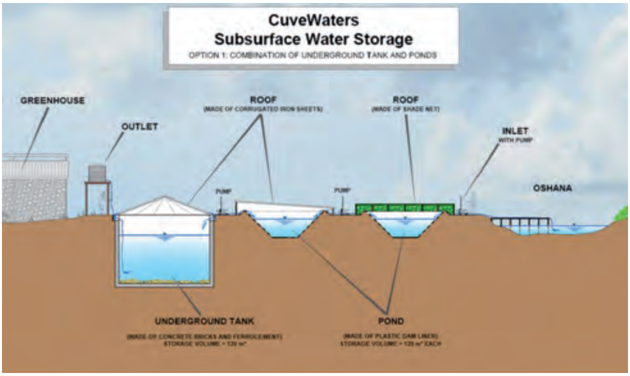
Left: People from Akutsima drinking tap water produced by a desalination plant.
Top: Solardriven desalination plants in Amarika

Subsurface water storage

The Cuvelai-Etosha Basin is characterised by a system of so called Oshanas. These are very shallow, ephemeral river courses which drain the whole basin from north to south. While in the summer season (November to April) the area is experiencing floods it can happen that the whole area dries up in the winter season.

Several attempts have been made in recent years to store the Oshana water into the winter season, for example via pump storage dams and excavation dams. Major problems afflicting all these technologies are the high rate of evaporation in central-northern Namibia (up to 2700 millimetres per year) and rapid quality degradation of the water stored.

The technology of subsurface water storage was developed within the project CuveWaters to avoid these disadvantages. Instead of storing the water in open storage reservoirs the water is stored in an artificial closed subsurface storage reservoir (tank or pond). Oshana water will be taken using pumps during rainy season when Oshana water quality is good, remains in good quality in the storage reservoirs and can then be used during dry season.



Plan of pilot plant for the technology of subsurface water storage. Oshana flood-water is pumped into tanks and ponds during rainy season and can then be used in the dry season (Source: Christoph Treskatis)

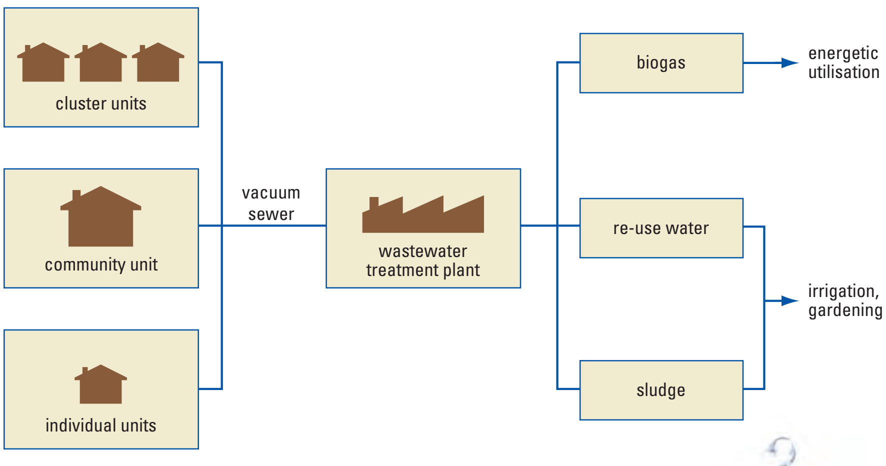
The advantages of the technology are:

- Subsurface Water Storage is considered for storage of flood water in areas without suitable perched aquifers
- Subsurface Water Storage is independent of local groundwater and therefore does not interfere fresh or salt water aquifers
- The elements of Subsurface Water Storage are supposed to be constructed from local or easy accessible materials

The provided water will be of medium quality and is intended to be used for small scale gardening. Therefore gardening infrastructure like a drip irrigation system and a greenhouses will be constructed next to the storage reservoirs. The users will then be able to diversify their diet by gardening and to generate a small income by selling of fruits and vegetables.

Sanitation and water re-use

In 2008 53 per cent of the population 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 "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 altering hygiene behaviour to prevent infections.



Scheme of the sanitation and water re-use concept

The sub-project is implemented in Outapi, together with the Town Council and Roediger Vacuum as the German industry partner. Different options for improving sanitation are being put in place in order to ensure the adaptability of infrastructure to urban transformations: 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 an anaerobic reactor (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.

Typical Namibian market

Connecting these processes is a great opportunity for the urban community to acquire new options for regional development, poverty reduction and job creation. With its support of gardening initiatives, CuveWaters is paving the way for a sustainable improvement to people's livelihood.

Scientific components & societal processes

Involvement and active decision

The project works with a transdisciplinary research approach based on the integration of science, technology and society. This approach is reflected in the project structure: the scientific components *Concept development* and *Empirical studies* are closely interlocked with the integrative societal components *Participation, Good governance & institutionalisation, Capacity development* and *Knowledge management*. These processes constitute the basis for adapted problem-solving, as they promote social embedding of technologies and active involvement of institutional players and the local population. Knowledge from social and natural sciences and engineering is linked with the everyday practical know-how of the players involved. Hence, the results of the scientific components are not only scientifically relevant but contribute directly to the solution of practical problems. Management and transfer of knowledge support implementation of the project and are important factors in guaranteeing its sustainability.

Paulina and Simon from Epyeshona measuring the rainfall for monitoring

Integrative societal components

Good governance & institutionalisation deals with the institutional consolidation of the IWRM process by supporting legal and institutional structures. This sub-project involves stakeholder analysis and the review of existing plans and schemes as well as key institutions, policy documents or legal instruments. Such analyses provide strong back-up for the incorporation of CuveWaters into current regional planning activities.

Participation ensures that various groups of players (such as users, practitioners, administration, political bodies) are included in the process at a local, regional and national level. To this end, demand-responsive approaches are employed throughout all stages of the project. Decisions on issues such as suitable sites, implementation or legal rights are taken in cooperation with the user groups and stakeholders. Workshops addressing participants, users or stakeholders represent an integral part of this research approach.

Capacity development aims at transferring knowledge at all levels. Technical know-how relating to aspects such as installation and maintenance is conveyed to the users. This essential part of the project enables the local residents to autonomously maintain and operate the facilities. The exchange of ideas is encouraged along with an exchange with scientific bodies for mutual learning and securing of the scientific context.

Festus checking the desalination plant

Scientific components

Concept development serves the scientific underpinning of ongoing work. Scientific as well as practical insights are generated. Tools are developed to support processes of planning and decision-making. Furthermore, a social-ecological impact assessment of the CuveWaters IWRM approach is conducted. The project and its results are under constant scrutiny in the light of the international scientific debate on IWRM concepts.

Empirical studies generate valid and fundamental data on the project. In Phase I scientists primarily gathered data on developing scenarios and potentials – for example in the domains usage schemes, ecology or water supply. In Phase II the operation of the pilot plants under regional on-site conditions is evaluated. To this end a specific monitoring programme is developed for every site. The results will subsequently be analysed from socio-economical and socio-cultural perspectives.

Knowledge management provides tools to allow appraisal of future decisions and their consequences. Besides publications and conference participation, the requisite dissemination of key results has been achieved via events directed at the general public and provision of appropriate information material (e. g. internet presence www.cuvewaters.net).

Albertina collecting data in the Omusati Region

Benefits

By improving water supply and sanitation, CuveWaters helps secure the livelihoods of the local people in a sustainable manner and supports Namibia's efforts to reduce poverty, adapt to climate change and prevent crisis. The project is part of the country's path towards the enforcement of Integrated Water Resources Management (IWRM) and Water Demand Management strategies, both of which are essential for social well-being, economic development and environmental health as stated in Namibia's Vision 2030.

The CuveWaters' conceptual approach comprises the development and implementation of technological components in the form of a multi-resource mix. Acceptance and proper adaptation of this mix is addressed by a participatory approach in all phases, ensuring sustainability beyond the duration of the project. Capacity development strategies furthermore provide people with the technical know-how required to use and maintain the technologies or engage in gardening activities. Agricultural production is an important additional benefit covered by CuveWaters as it is a successful element for income generation and a healthy lifestyle.

With its multi-resource mix, CuveWaters aims to increase the efficiency of water use, create buffering mechanisms against water shortage and thus enhance the potential to adapt to climate change. Four technology lines are part of the multi-resource mix: rainwater harvesting, groundwater desalination, sanitation and water re-use, and subsurface water storage. This is strongly related to the so-called 3R concept with its strategies for water re-use, recharge, and retention. In Northern Namibia, the 3R concept remains untapped as yet, but is capable of unlocking considerable potential for improving the quality and availability of water.

'Re-use' in this context means understanding waste water as a resource, not only for re-use of the mere water content but also for gaining energy and using the nutrients in the waste water for plant production. Water re-use means a considerable reduction in the amount of resource being used.

'Recharge' in this project is represented by the subsurface water storage of flood water. Water availability will be increased significantly by avoiding evaporation, a major factor under the prevailing climatic conditions.

'Retention' refers to rainwater harvesting from ground and roof catchments. Combined with gardening it improves the population's welfare in terms of job creation and food security. For the regional conditions this form of water harvesting is promising, particularly as it has not played a substantial role in the Namibian water sector so far.

The implementation of small-scale desalination of groundwater completes the multi-resource mix with regard to increased water security in remote rural areas. The desalination strategy pursued in CuveWaters duly provides drinking water for parts of the population who previously lacked access.

CuveWaters thus contributes to the achievement of the Millennium Development Goals by bringing about benefits to social, ecological and economic aspects. Secure access to clean drinking water and sanitation facilities is a vital element in the quest to improve and secure livelihood.

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