

Biotechnology for Africa's sustainable water supply

The paper introduces the WATERBIOTECH project „Biotechnology for Africa's sustainable water supply“ and its midterm progress.



Authors: Sana Arousse, Gerhard Schories

Abstract

Water scarcity, climate change, particular geographic characteristics and limited economic resources have led to a restricted range of choices affordable for African countries to deal particularly with the water issue, as major topic. Polluted water treatment before use has been their almost unique solution to deal with a growing water scarcity. The treatment of water and elimination of pollutants, mainly dissolved organic pollutants, nitrogen and phosphorous compounds, pathogenic organisms, xenobiotics and heavy metals, although itself presents significant challenges, is crucial for environmental considerations and human health. However, most regions in developing countries cannot afford the costs of advanced and specialized treatment systems. WATERBIOTECH presents biotechnology as a useful tool for delivering improved products and processes having the possibility to manage the wastewater economically and effectively around the world.

Introduction / project background

In order to achieve its main objective of presenting efficient and cost effective biotechnological techniques for wastewater treatment, WATERBIOTECH investigated the African water sector based on several influent and tightly linked factors, mainly: climate change, agriculture and food security, and the economic issues.

Climate and water availability in Africa

Water availability and quality, climate, and food security are elements ineluctably linked and with respective influences, hindering human health everywhere and are exceptionally critical in Africa. Africa's water resources are limited, mainly depending on climate factors, essentially rainfalls and weather (temperature, humidity, etc).

Even the existing and available quantities of water, are generally subject of low quality hindering people's health and negatively impacting on agriculture. This is of nature to accentuate the environment, health and food stability, in a continent where's registered the highest growth rates of population. In fact, water distribution in major parts of Africa, tightly depends on the climate variable and consequently is characterized by complex patterns and opposite models changing from quasi important rainfalls over the equatorial zone to an extreme aridity in the Sahara. Western Africa and central Africa have significantly greater precipitation than northern Africa, the Horn of Africa and southern Africa. Africa's extreme variability of rainfall is reflected in an uneven distribution of surface and groundwater resources, from areas of severe aridity with limited freshwater resources like the

Key messages:

- WATERBIOTECH is a coordination and support action (Contract No. 265972-KBBE; duration: 1.08.2011 – 31.01.2013) funded within the Africa call of the EU 7th Framework Programme
- The aim and scope of the project is to promote biotechnology as useful, efficient and cost effective technique adaptable to African specific conditions and resources for water - wastewater treatment and reuse particularly for agriculture
- WATERBIOTECH has 17 partners (8 European, 8 African and 1 from Middle East)
- Countries involved:
 - 6 European countries (Austria, France, Germany, Italy, Spain, United Kingdom)
 - 8 African and Arab countries (Algeria, Burkina Faso, Egypt, Ghana, Morocco, Senegal, Tunisia, and Saudi Arabia)
- Initiating and coordinating organization: ttz Bremerhaven (Germany)
- Project website: <http://www.waterbiotech.eu/>

Sahara and Kalahari deserts in the northern and southern parts, to the tropical belt of mid- Africa with abundant freshwater resources. Northern Africa is the most water-stressed sub-region, with less than 1 percent of the renewable water resources of the continent for an area equivalent to 19 percent of Africa. Freshwater availability will become an even more important issue in the coming decades, for the western Maghreb countries (Morocco, Algeria and Tunisia) where climate change scenarios predict a rise in temperature of between 2° and 4°C this century, accompanied by a reduction in rainfall of up to 20 per cent and increased evapo-transpiration. The driest country is Egypt with 51 mm/year on average, followed closely by Libya (56 mm/year) and Algeria (89 mm/year). The rainfalls are also impacting on the groundwater quantities, from which many African countries are tightly depending. Africa is considering as having the lowest total water supply coverage of any region in the world, with only 62% of the population having access to improved water supply. Indeed, compared to the other continents, Africa's share of global freshwater resources is only about 9%, unequally distributed across the whole continent. These freshwater resources are distributed unevenly across Africa, with western Africa and central Africa having significantly greater precipitation than northern Africa, the Horn of Africa and southern Africa. Most areas receive either too much rain or too little. In parts of the west coast, for example, annual rainfall averages more than 250 cm. The rainfalls are also impacting on the groundwater quantities, from which a lot of African countries are tightly depending. Actually, Africa's freshwater resources average 4050 km³/year, providing in the year 2000 an average of about 5000 m³ per capita/year, is significantly less than the world average of 7000 m³ per capita/year (according to UNEP). At least 13 countries suffered water stress or scarcity in 1990 and the number is projected to double by 2025. The spatial distribution of both surface water and groundwater is uneven, while groundwater is a major source of water in the region, accounting for 15 percent of Africa's total resources. Groundwater is used for domestic and agricultural consumption in many areas, particularly in arid sub-regions where surface water resources are limited. However, areas heavily dependent on groundwater reserves are also at risk of water shortages, as water is extracted far more rapidly than it is recharged. This is the case for Algeria and Libya respectively depending at 60 and 95 percent on groundwater as first source of fresh water.

Water availability, agriculture and food security in Africa

The productivity of agricultural, forestry and fisheries systems depends significantly on the availability of freshwater resources for irrigation and fresh water supply. By seriously affecting crop productivity and food production, in addition to being a necessity in food preparation processes, water plays a critical crucial role in food security. Currently, huge losses due to crop failures arising from droughts are being experienced

more frequently than ever before in Africa where one billion people are still undernourished (according to FAO). In sub-Saharan Africa, one of three people - or 236 million (according to FAO) - are chronically hungry, the highest proportion of undernourished people in the total world population. Socio-economic pressures over the next several decades will lead to increased competition between irrigation needs and demand from non-agricultural sectors, potentially reducing the availability and quality of water resources for food. At the same time, during this century, climate change may further reduce water availability for global food production, as a result of projected mean changes in temperature and precipitation regimes, as well as due to projected increases in the frequency of extreme events, such as droughts and flooding. Indeed, the recent IPCC Fourth Assessment Report (IPCC, 2001) indicates that climate change will have significant impact on crop production and water management systems in coming decades, seriously hindering the irrigated agriculture, which represents the bulk of the demand for water in these countries, and which is also usually the first sector affected by water shortage and increased scarcity, inducing a decreased capacity to maintain per capita food production while meeting water needs for domestic, industrial and environmental purposes. In order to sustain their needs, these countries need to focus on the efficient use and management of all water sources.

Water and its economic dimension

The availability and access to freshwater is an important determinant of patterns of economic growth and social development. Freshwater is a necessary input for industry and mining, hydropower generation, tourism, subsistence and commercial agriculture, fisheries and livestock production, and tourism. In Africa, most people live in rural areas and are heavily dependent on agriculture for their livelihoods. The economy is also the major stressor of the environment; for instance, production in the industrial and agricultural sectors contributes to pollution of the air and water and the generation of solid and hazardous wastes. Consumption activities lead to the production of solid waste and create demand for wastewater treatment services. In Africa, the economic development and the water situation are critically linked and both reversely impacted. Most of industries in Africa are polluting without treatment options, mainly because of a lack in financial resources or awareness of availability of affordable technical solutions. The focus in these countries is mainly on building industries and enhancing the economy, while ignoring at a large extent the environmental and ecologic aspect. In the very recent few years, African governments, especially in the northern countries, started begging attention to the water issue; however, no significant actions are taken yet, mainly due to the expensive technologies and knowledge transfer in the water treatment sector.

WATERBIOTECH concept and structure

Biotechnology applied in the treatment of polluted water resources can play an important role in addressing the challenge of water scarcity in developing countries. Biotechnological wastewater treatment methods are governed by aerobic and/or anaerobic micro-organisms or plants which can detoxify dissolved contaminants in water. This allows society to reclaim their resource value. However, many applications of biotechnology have not yet delivered practical solutions or are not widely used due mainly to the lack of information about the potentials and benefits of these technologies as well as the lack of dissemination of solutions adapted to local conditions. WATERBIOTECH is an initiative that will contribute to cope with water scarcity in Africa by providing access to relevant stakeholders in Western, Eastern and Northern Africa to knowhow in biotechnologies, good practices and management solutions adapted to their local conditions for the sustainable management of polluted water resources. The targeted countries of the present Coordination Action will be Algeria, Burkina Faso, Egypt, Ghana, Libya, Morocco, Senegal, and Tunisia. The idea is to disseminate best practices jointly with all the requirements and the strategy necessary for the implementation of selected biotechnologies specifically assigned to local regions within the targeted countries, getting inspired from time to time, from former projects carried on the field. Relevant actors that will benefit from this action will be farmers, providers of sewage treatment services, authorities and decision makers, specialized scientific community, local communities, and general public who live in water stressed areas. The integrated approach of WATERBIOTECH takes into consideration that different aspects influence the availability to water resources and only a holistic vision can provide effective solutions to enhance water management in African countries. Environmental and health concerns, as well as socio-economic aspects such as households income, water consume patterns, irrigation methods or interests in water resources of different stakeholders must be taken into account in the proposal of solutions. For that reason, WATERBIOTECH will provide solutions based on a deep analysis of the current situation in the targeted countries, and cost-benefit analyses developed during the project considering the specific requirements of local regions. WATERBIOTECH outputs will enhance the decision making process by providing guidelines and materials that support stakeholders to implement cost-effective and sustainable solutions adapted to the reality in their regions. These outputs will:

- Provide recommended biotechnologies adapted to specific local conditions
- Make available an investment decision tool based on cost-benefit analyses of biotechnological best practices
- Facilitate the exchange of information between biotechnology providers and end users in order to

enhance market opportunities in biotechnology and their operation services

- Train relevant stakeholders in technical and non-technical aspects required for the implementation of recommended biotechnologies
- Raise awareness on the necessity of sustainable and environmentally sound technologies for development
- Show examples of good practices in demonstrative activities of implemented technologies.

The project is structured in a way that all partners contribute promptly based on their knowledge and expertise within a particular task. All efforts are conjugated to ensure a complete partnership with a specific knowledge transfer via innovative schemes and methodologies. The exchange of expertise between European and Arab-African countries (partners) is of nature to promote the development and uptake of innovative and adapted methods, highlighting and focusing on the role of biotechnology in water treatment. The exchange of experiences and know-how will be very fruitful for WATERBIOTECH.

The project approach is not only technical oriented, but is widely based on training, knowledge transfer, awareness and involvement rising of the whole addressed community members, which is of nature to enhance the process of water resources management. More precisely, the project conceive a research co-ordination platform formed by an expert network to define, organize and manage common initiatives and to co-ordinate, assess and guide suitable research activities, of biotechnological methods adapted to the socio-economic and environmental conditions of the targeted developing countries for the treatment of polluted water before use, for agricultural, industrial and domestic activities. The contribution of each of the parties will be integral to the enforcement of the project, with a process of external consulting and participation through panel discussions and workshops with all relevant interested, will be thereby developed. Locally, regular consultations with different sectors and participatory processes in training the local interest groups will be held during the last half of the project period through national and international workshops.

Project progress

WATERBIOTECH's was launched in August 2011 and its activities effectively started after the kick off meeting held in Tunis, Tunisia in September 2011. Actually, the project already went through its first half period time marked by the organization of the WATERBIOTECH first international conference held in October 2012 in Cairo, Egypt. The midterm stated on the steady progress towards the project objectives for which all fixed milestones have been reached on time with no hindering delays. In fact, the project subdivided into several work packages,

presents a clear overview of the activities performed and the other still to be. The activities were initiated by WP1 within which a geographic segmentation of Africa based on the regional water availability as key differentiator factor have been completed. This led to a classification of the targeted countries within homogeneous regions in order to provide adapted solutions in subsequent work packages. Each region has been assigned with a regional representative within the consortium. These targeted regions have been then characterized with regards to legal and institutional, socio-environmental and economical aspects. Moreover, the work package team assessed the general obstacles potentially hindering any innovative technological implementation in the targeted regions, taking into account technological and non technological obstacles. These activities have been followed by the activities of WP2 where an evaluation of existing water treatment biotechnological practices within the targeted countries has been performed. This evaluation from both a socio-economic and an environmental perspective has been based on questionnaires applied across the targeted countries by the respective national African partners. As a result of the evaluation, best practices within the targeted countries have been identified. In parallel with this task, technical and non-technical requirements for the implementation of innovative water treatment biotechnologies in the specific targeted regions identified in WP1 have been defined. Cost-benefit analyses of the investments to implement selected best practices have been as well developed under this work package in order to assess costs of implementing biotechnological practices previously selected against the total expected benefits.

The work at this stage (Month 15 of the project's period) is enhanced with the third work package already started with an identification and assessment of potential innovative biotechnologies for the sustainable water management in the targeted countries. Taking into account the most applicable innovative biotechnologies as well as the best existing practices identified, this work package team will assign to each of the targeted regions identified in WP1 suitable practices and biotechnologies adapted to their characteristics. The cost-benefit analyses developed under WP2 will be extended to the biotechnologies selected in WP3.

A database of biotechnology suppliers for WW treatment has been elaborated identifying the regional suppliers, who can allow the concrete implementation of water treatment biotechnologies. This database will be part of the guideline for the implementation's process of the biotechnologies for water treatment to be developed. The dissemination activities are accompanying all project's steps and phases. Demonstration and training workshops to be organized at month 24, 26 and 29, respectively corresponding to July, September and December 2013, will be the main outcomes of the

technology transfer work package (WP4) followed by the final WATERBIOTECH's international conference to be held in Marrakech, Morocco in January 2014.

Conclusion

The technical part of the project will focus on promoting the role of biotechnology in water treatment practices in Africa. A deep assessment on water treatment biotechnologies and their adaptability to the African situation will be performed during the project. Innovative water treatment biotechnologies such as activated sludge systems including membrane bioreactors and sequencing batch reactors, trickling filter systems, rotating contactors or constructed wetlands as well as conventional methods such as stabilization ponds will be evaluated in order to provide adapted solutions to specific selected regions based on previous analyses of the socio-economic and environmental situation of the targeted countries. Special attention is paid – apart from purification performance - to decentralised installations considering energy efficiency and energy supply by renewable energy sources. The regional approach of WATERBIOTECH intends to cover the lack of know how in regions that face water scarcity consequences, but also to guide latest research achievements in biotechnology to solve local problems. Innovation is a key source of competitive advantages, a multiplier of economic activity, employment and development. Investments in human capital cannot only foster the creation of innovation but also, and most importantly in rural areas, the assimilation of innovation that is often produced elsewhere. For that reason, capacity building on biotechnology is an essential factor in WATERBIOTECH initiative. Strengthening local capacities will be on focus during the project workshops, in which guidelines and recommendations developed under the project activities will be presented to decision makers and other relevant stakeholders. The achievement of the project results will contribute to a better understanding of the African requirements for promoting research and innovation and how these aspects can boost the economical situation of the continent and therefore improve the living conditions of their inhabitants.

References

IPCC (2001): Climate change: Impacts, Adaptation and Vulnerability, Cambridge

Names: Sana Arousse

Organisation: ttz Bremerhaven, Germany

eMail: sarousse@ttz-bremerhaven.de

Names: Gerhard Schories

Organisation: ttz Bremerhaven, Germany

eMail: gschories@ttz-bremerhaven.de