Biotechnology and environment
Water - source of life?!

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SYNOPSIS
Water is a limited resource in our world and many companies consider it a borderless product. Water is essential for life. Many people, especially children in less developed countries, suffer from water-borne diseases. In the middle-ages there were serious problems in Europe due to the lack of waste and wastewater treatment. People in Great Britain were the first to protest against this situation. New technologies such as the biological treatment of wastewater spread to other countries. Today, there is a high demand for water in many regions and the amount of wastewater is growing fast, just like the population and the industry. To avoid problems, adapted and effective wastewater treatment is necessary. The presentation shows research projects and global cooperation on this topic.

**Water: a limited but essential resource**

Within a global perspective, water is a limited resource. Even in countries regarded as rich in water, such as Brazil, for example, there are regional shortages. Particularly in less developed countries or in poor regions, there are seasonal or continuous problems with water shortage or its poor quality. The result is high child mortality and a threat to society, as is the case in many African countries.

Based on the present situation, we can state the following:\(^1\)

- 40% of the world population is suffering from the shortage of water;
- the demand for clean water will double in the next 20 years;
- in 2025, in 45 states of the world, 1.4 billion people will have to live with less than 1000 m\(^3\) water per capita per year.

In African countries, in special, deserts will increase. In developing areas, the demand for water will be higher due to industrial development. Rivers and oceans will receive higher amounts of untreated wastewater and the water resources for drinking purposes will be limited.

According to the World Health Organization (WHO), 3.4 million people die every year as a result of water-related diseases. Water is the leading cause of diseases and death in the world. This year 2008, is the Year of Sanitation. The International Community\(^2,3\) has committed to cut the number of persons who have no access to water treatment or sanitary facilities by half till 2015. If the present rate is maintained, this aim will be reached in African countries not earlier than 2076.

**Water supply and sewage systems in historical context**

In order to illustrate our discussion, we can make a brief historical digression to show that the highly developed cultures of ancient Babylonia, Egypt, and Rome were amazingly aware of the dangers of impure water. They already had drainage systems. The need to separate fresh water and sewage was obvious to ancient Romans, but this was somehow forgotten during the European middle-ages, leading to the outbreak of a number of epidemics that infected a significant part of the population and contributed to its decimation. A canal system was developed to take away the garbage from the cities. In this system, water was used to transport and dissolve the garbage. However, the problem was not solved, but rather transferred. The rivers became extremely unclean, blackened, and smelly.

Ultimately, the population in Great Britain protested against the officials’ inaction. The press alerted the population to the irregularities.

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\(^3\) *UN Millennium Declaration* of 2000.
As a consequence, cities began to introduce sewage treatment systems in Europe. Seen through a historical lens, these systems were developed step by step, and have now reached a high standard. The aim of sanitation is to prevent risks for humans as well as for the environment.

Water in the focus of international business by multinational companies

While districts are focused in building local water and wastewater networks, companies are more and more interested in water resources, which have become a global business as shown in Tables 1 and 2.¹

Table 1: The most important multinational companies in the water sector

<table>
<thead>
<tr>
<th>Name of MNC</th>
<th>Home country</th>
<th>Subsidiaries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vivendi Universal</td>
<td>France</td>
<td>Vivendi Environment/Veolia + 69 subsidiaries</td>
</tr>
<tr>
<td>Suez (Lyonnaise des Eaux)</td>
<td>France</td>
<td>Ondeo/United Water resources + 68 subsidiaries</td>
</tr>
<tr>
<td>RWE/Thames</td>
<td>Germany</td>
<td>Thames Water/American water Works + 7 subsidiaries</td>
</tr>
<tr>
<td>United Utilities</td>
<td>United Kingdom</td>
<td>24 subsidiaries in partnership with Bechtel</td>
</tr>
<tr>
<td>Bechtel Group</td>
<td>USA</td>
<td>6 subsidiaries</td>
</tr>
<tr>
<td>Biwater</td>
<td>United Kingdom</td>
<td>In cooperation with Africa and Americas</td>
</tr>
<tr>
<td>Gelsenwasser (E.ON)</td>
<td>Germany</td>
<td>In cooperation with Hungary, Poland, Czech Republic</td>
</tr>
<tr>
<td>Aqua Mundo</td>
<td>Germany</td>
<td></td>
</tr>
</tbody>
</table>

Table 2: Market for the multinational companies in the water business

<table>
<thead>
<tr>
<th>Name of MNC</th>
<th>Number of costumers / Financial profit in the water business</th>
<th>Business sectors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vivendi Universal</td>
<td>110 million people in more than 100 countries / 12.2 billion dollars with water resources</td>
<td>Water, wastewater, energy, transportation, services</td>
</tr>
<tr>
<td>Suez (Lyonnaise des Eaux)</td>
<td>115 million people in 130 countries / 9 billion dollars with water resources</td>
<td>Water, waste management, electricity, natural gas, television, broadband distribution</td>
</tr>
<tr>
<td>RWE/Thames</td>
<td>70 million people / 1.5 billion dollars</td>
<td>Water and wastewater services</td>
</tr>
<tr>
<td>United Utilities</td>
<td>2.9 million people, 1.7 billion dollars</td>
<td>Water-related services, electricity, telecommunications</td>
</tr>
<tr>
<td>Bechtel Group</td>
<td>134 million dollars</td>
<td>Engineering, construction, water services, energy, telecommunications</td>
</tr>
<tr>
<td>Biwater</td>
<td></td>
<td>Water, wastewater infrastructure</td>
</tr>
<tr>
<td>Gelsenwasser (E.ON)</td>
<td>195 million euros</td>
<td>Management of water supply</td>
</tr>
<tr>
<td>Aqua Mundo</td>
<td></td>
<td>Water, wastewater management systems</td>
</tr>
</tbody>
</table>

The wastewater treatment as a biotechnological process

In Germany, wastewater treatment is normally a combination of mechanical, biological, and chemical processes. An essential step in the biological treatment is the degradation of organic substances by microorganisms (picture 1) similar to natural activities.

Aerobic or anaerobic organisms are key players in the destruction of organic materials. (In aerobic processes, bacteria use oxygen to grow; in anaerobic ones they grow without oxygen.) Based on this, there are two different ways of treating wastewater. Bacteria are able to produce a broad range of enzymes to solve particles and use them as nutrients. Whereas in Germany the majority of plants are operated with aerobic sludge systems, anaerobic ones are widespread in other regions such as Brazil. Anyway, in both cases it is necessary to separate bacteria from water through sedimentation (pictures 2 and 3) or filtration.

Decentralized water management as a new option for sustainable management of water resources

The Fraunhofer Institute IGB has started a research project on decentralized wastewater management in Germany and within this project it built a small but very modern and effective plant for 100 persons (see pictures 4 and 5). The project, funded by the German Government and developed in cooperation with several companies, is located in a residential neighborhood. It is closed, odorless, and its effluents are much better than those from comparable plants.

Sustainable management - from sewage to production

Sewage can be seen from different viewpoints and not simply as a dirty stream that one should dispose of as quickly as possible. That is just one side of things. I want to show that although conventional procedures are very meaningful and protect people from health problems, we must understand that sewage also contains numerous resources.

In the sewage system, water is a solvent for inorganic salts and organic compounds. Water is also seen as a means to transport all types of waste, from human to those brought into the sewer canals by natural events like rain or floods. Because water is a limited resource, there are good reasons to pursue recycling strategies not only in baren areas of the earth but everywhere.

From the beginning and still today, the goal is to eliminate the undesirable content from impure water and to keep dangerous material away from human beings. This must remain an uppermost goal. However, substances can be recovered from sewage and used as fertilizers for food production, reentering the food chain where they are once again used and excreted. Through anaerobic processes and the production of available substances, lasting energy sources can be found, which is something very interesting in our current context, when we are attempting to reduce carbon emissions. With modern procedures, the cycles can continue and water may be reused.

Benefits of decentralized systems

Rainwater flows in urban areas because of the many sealed surfaces – cement and pavement. It flows rapidly to the rivers, unused and in great quantities, where it causes floods. Such process is related to the shortage of water resources in the affected areas. Precipitation is no longer absorbed by the ground. It flows away unused and cannot be...
used later as groundwater. The collection and the local use of rainwater is highly beneficial.

Decentralized water management offers the following advantages:

- the treatment of wastewater close to the user;
- short distances between the source of wastewater and the treatment plant;
- cost reduction for pipes;
- biogas, energy, and fertilizer production (depending on the amount);
- noiseless and odorless closed systems, even within big buildings;
- water reuse;
- accommodation to different scales of plants;
- adaptable to different regions and demands.

Worldwide learning through cooperation

Problems and demands are different worldwide. However, human needs do not essentially differ from culture to culture so that worldwide learning from and with one another is important to finding lasting solutions both regionally and globally.

This was the motivation, more than 10 years ago, for the beginning of a cooperative project between the Methodist University of Piracicaba (UNIMEP) (picture 6), in Brazil, and the Fraunhofer Institute for Interfacial Engineering and Biotechnology, in Germany (picture 7).

How did the cooperation come about?

The partnership between the Brazilian Methodist Church and the Evangelical Methodist Church (EMK) in Germany was the starting point. As a member of the EMK, I came in contact with UNIMEP through several visits. I was impressed by UNIMEP's work and its strong fight for social issues and by how it put research results into practice.
practice, acting as a multiplier. Thus came the idea of establishing a professional relationship. Professor Almir de Souza Maia and the institute-leader of the Fraunhofer IGB, Professor Herwig Brunner, started discussions. We tried to identify possible areas for cooperation. Thankfully, Professor Klaus Schuetzer supported the process of developing a plan of cooperation so that a staff exchange became possible. For cooperation to work, people must get to know one another, learn to communicate on different levels and be ready to work together.

From the beginning, “water” was the foreground topic. The project was given an impulse when Prof. Amos Nascimento, from the international office of UNIMEP, took on the project and we could apply for German research funding for an interesting project in Piracicaba. With its German partners, UNIMEP established a work team and a research project that we named “H₂O”. Common projects, regular workshops and seminars were organized on this basis. Both partners developed new cooperative relations with communities and companies, which will hopefully lead to improving public welfare and furthering cooperative ventures.

**German-Brazilian research-project for decentralized water management**

Semi-decentralized systems have the advantage of working locally, of being managed according to their sizes and positions and thus having a high degree of adaptability. They can also show meaningful results according to the realities of the place, the weather conditions, the cultural surroundings, the population demands, and so on. The ministry for research and education of the Federal Republic of Germany approved a research grant for the Fraunhofer IGB to undertake a cooperative project with Brazil in order to explore the conditions for semi-
decentralized water management in the region of Piracicaba and to develop adaptable solutions for the area.

The topic of the common project was: “Decentralized water and wastewater treatment related to the production of energy and the sanitary condition for the region of Piracicaba (Sao Paulo).”

Piracicaba (picture 8) is located in the southwestern part of Brazil in the most developed region of the country with a very strong industrial base and a highly productive agricultural industry. Its population, which reaches 320,000 inhabitants, has grown and met the need for increased labor force. There are several educational institutes and universities in the region, playing an important role in the total development of the area.

The region is fertile, which means there is a huge demand for water not only because of the population density but also because of the industrial and agricultural needs. As a result, the accumulation of wastewater is high, causing considerable problems in the ecological scope, as it happens in so many other regions of the world, and often leading to protests that result in political action. Limited financial resources and inefficient use of funds push the existing system to its limits.

The Fraunhofer IGB research-project was done in cooperation with UNIMEP, along with local facilities and German industrial partners who already had experience in Brazil. The purpose of the project was to find decentralized solutions for a long-term water management plan. Aspects of innovative solutions from highly effective sewage cleaning systems that had shown very good results in closed systems in small areas were taken into account. When possible and economically feasible, the production of nutrients or fertilizers from the sewage stream
was considered. The removal of organic wastes through an anaerobic process resulted in the reduction in volume, on the one hand, and the production of energy from heat and biogas on the other.

**Conclusion**

Technologies adapted to the country’s condition, culture, and climate must be developed. This requires fair and sustainable cooperation between people around the world to improve the situation for the present and future generations (picture 9).

![Picture 9: Brazilian students having fun](image)

**The global condition of water resources and the Methodist responsibility**

A plausible question to be asked is whether the water condition in different parts of the world should be a concern for the Methodist churches and facilities and a challenge to active participation or whether it should be solved at the political level.

In my view, the responsibility for individuals and social group to eliminate abuses and develop better living conditions goes along with the central theme of the Gospel’s announcement and the making of disciples. In the Methodist churches this has led to a remarkable commitment by society that is well founded in the Methodist theology.

In addition to his very extensive sermon activity, John Wesley worked in the pastoral care, recognized social abuses, and spoke about and fought for change. To a large degree, Wesley was concerned with education and wrote an impressive number of books for groups of
people that had little information and were disregarded by most of society as ill-suited for information or education. The fact that the Methodist education is recognized in several countries today is a positive consequence of such initiatives.

The issues of our time involve both individuals and society and have become more complex worldwide. They have to do with the survival of people and the responsibility for our natural resources. Complex questions require interdisciplinary solutions as well as international exchange, so that we can learn from one another and find regionally and/or locally adaptable solutions. Appropriate advances are reached only through research based on the actual field of application and anchored on the multiplying effects of learning.

In my view, there is a special meaning for us as members of the Methodist Church and in the sense of our connections. Our task should be to recognize abuses that lead to world discrimination, loss of dignity, and even death. From this, improvements can be made in the quality of life for numerous people, including those who live in the few developed countries of this world. An important prerequisite is dialogue on different levels in order to make changes and agree on common practices. One alternative could be the promotion of change in the cities where we live. It is possible to show the dangers of bad water quality, or present model projects at church facilities, universities or schools of how water can be saved and reused; how rainwater can be used and sewage cleaned or recycled.

Another possible task is to inform people and to shape children and high school education worldwide so that these basic and future-oriented questions are put into lesson plans and practical applications are made accessible.

It is essential that we develop suitable measures that take regional needs and realities into account and that are based on research projects that can be concretely implemented. All this leads to know-how, to the strengthening of international cooperation, and to the education of a new generation with knowledge applicable to a society shaped by a sustainable economy and concerned with the welfare of the individuals and the support of people in overwhelming conditions.