P8

IMPETUS BENIN

Bacterial and Viral Contamination of Drinking Water Sources in the Upper Ouémé Catchment

J. Verheyen (1), A. Uesbeck (2), T. El-Fahem (3), F. Mazou (2), T. Klein (6), A. Fink (5), J. Rissland (7), R. Baginski (2), H. Pfister (1), M. Krönke (2)

1 Institute of Virology, University of Cologne, 2 Institute of Medical Microbiology, Immunology and Hygiene, University of Cologne, 3 Institute of Geology, University of Bonn, 5 Institute of Geophysics and Meteorology, University of Cologne, 6 Institute of Social & Cultural Anthropology, University of Cologne, 7 lögd, Landesinstitut für den Öffentlichen Gesundheitsdienst NRW

Aims:

- Create a **database of drinking water sources** in the upper Ouémé catchment.
- Establish methods for detection of **bacterial and viral contamination** and to evaluate water quality in Benin.
- **Analyse factors** influencing the bacterial and viral water quality.
- **Support stakeholders in** construction and restoration of drinking water sources.
- Estimate drinking water quality in different **future scenarios** based on changing conditions.

Bacterial water quality

Waterborne pathogen bacteria as *E. coli*, *Salmonella* ssp., *Shigella* sp., *Vibrio cholerae* and others are isolated from water samples by cultivation on special **selective nutrient media** in the IMPETUS laboratory in Parakou.
Positive samples are differentiated by **serological, biochemical and genetic methods** at the Institute of Medical Microbiology, Immunology and Hygiene in Cologne

Bacteriologic analysis of water samples show following **results:**

Water source	Contamination
Wells, marigots	70 % contaminated by *E. coli* or other coliform bacteria 8 % contaminated by Salmonellae
Pumps	1 Pump contaminated by coliform bacteria

Noticeable contaminations by non-typhoid **Salmonellae could be observed in 8 % of open drinking water sources**. These Salmonellae which may be responsible for **enteric fevers, gastroenteritis and septicaemia** are found to be rarely known serotypes in Germany.
A hitherto **unknown serotype** with the antigen formula 1,42:l,w:z35 could also be isolated and will be designated **<Salmonella Parakou>**. Salmonellae serve as indicator organism for the evaluation of epidemiologic data.

Comparison of *Salmonella*-Serotypes in Germany and Benin

Serotypes the most frequent in Germany (RKI, Berlin)	Serotypes isolated in Benin
S. Enteritidis (68,3 %)	S. Give (9,5 %)
S. Typhimurium (23,8 %)	S. Muenster (6,3 %)
S. Infantis (1,1 %)	S. Rostock (4,7 %)
S. Bovis-morbificans (0,6%)	S. Virchow (4,7 %)
S. Virchow (0,5 %)	...52 other rare Serotypes (< 3%) and one new serotype

Water sources found to be unacceptably contaminated were subject of **disinfection by application of chlorine dioxide-solutions**. A few days after successful disinfection most wells exhibit new bacterial contaminations.
It can be suggested, that these organisms are passed from the ground into well water via **"puisettes"** (bucket), which are used to scoop water and not stored properly after usage. This seems to be **one main source for bacterial contamination** of water.

Plastic buckets ("Puisettes") used to scoop water from wells

Cooperations

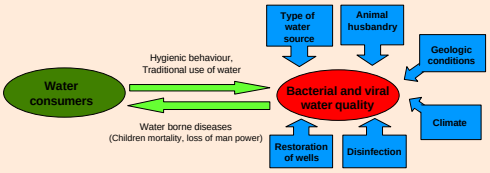
The Swiss organisation **HELVETAS** performs restorations of defective water wells and pumps. Large village wells are deepened if possible and finally pumps are installed on the top to avoid usage of "puisettes" and to close the system hermetically. In cooperation bacterial analyses of water samples before and after intervention of Helvetas are carried out in the IMPETUS-Laboratory at Parakou by our team to monitor the **hygienic improvements**.

Epidemical studies are underway with the university of Parakou to determine the burden of viral diarrheic diseases in children (rota- and adenoviruses). The results could be used as response indicators after the improvement of hygienical conditions.

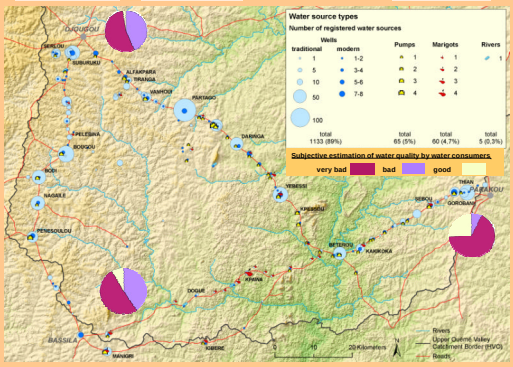
Background

The quality of drinking water is significant for health in both developing and developed countries worldwide. Water quality can have major impact on health, both through outbreaks of waterborne disease and by contributing to the background rates of disease. About **2 million people die every year due to diarrhoeal diseases**, most of them are children less than 5 years of age. [http://www.who.int/topics/water]

Factors influencing and being influenced by water quality



Traditional well | Modern well | "Marigot" | Pump



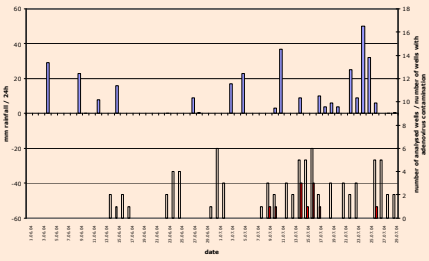
Viral water quality

10l of water are filtrated in the IMPETUS laboratory in Benin with a special designed suitcase and were analysed in Cologne. The validation of this method showed that water samples spiked with 1ml of reference Adenovirus suspension corresponding to the concentration of virus shed by symptomatic patients, tested positive.

Viral contamination of drinking water sources:
8,8% Adenoviruses
1,5% Rotaviruses
0,5% Enteroviruses

The comparison of positive and negative tested samples in three villages with the amount of rainfall suggested the need of moderate rainfall in the days before the sample is taken for viral contamination (Tab. below).

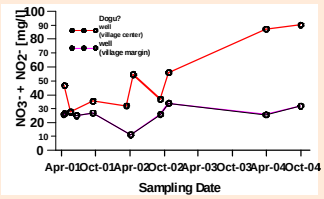
Adenovirus contamination in Gorobani-Thian-Tourou correlated to the amount of rainfall in June-July 2004



The amount of rainfall (blue columns) was analysed in comparison with the number of analysed water wells (grey columns) and adenovirus positive wells (red columns).

Physico-chemical analysis of drinking water

In contrast to public village wells and house wells which are usually dugged into the saprolite, boreholes for pumps are drilled into the underlying crystalline rocks where prospected fractures assure sufficient water supply.
All over the upper Ouémé catchment the groundwater table fluctuates during the year from a depth of 2m below ground in the rainy season to 15m below ground at the end of the dry season.
The physico-chemical quality of groundwater from wells and pumped boreholes is generally acceptable with the exception of **widespread nitrate contamination**. Low horizontal hydraulic conductivity of the saprolite layers prevents flow of nitrate or other contaminants along long distances. Thus well contamination must take place directly above the well or is due to **surface and interflow carrying nitrogen deposits** from the soil zones into the wells and pumps.
The figure shows increasing concentrations of the nitrogen components in the rainy season for several years at two wells in Dogué. The fractures are draining the saprolite layers above them. Wide range transport of nitrates in the fracture network affecting boreholes of pumps might occur but is not proven yet.



Applications:

- A **database of drinking water sources** in the triangle of the cities Bassila, Djougou and Parakou is created and used to coordinate sample collections in different seasonal settings and to plan further interventions.
- **Methods** for detection of bacterial and viral contamination in drinking water **are established** to analyse drinking water quality.
- **Capacity building** through education of Beninese lab technicians.
- Monthly analysis of the drinking water reservoir of Parakou in consultation with the local **SONEB.**
- **Support of decision making for restoration of defect wells** in cooperation with the Swiss project **HELVETAS**: after publication of the above mentioned data, HELVETAS mainly restoring defective wells so far is now converting them into pumps by central insertion of a drill stem and coverage of the upper opening to prevent further contamination.
- Bacterial analysis of restored and disinfected water sources will also be performed in cooperation with the local **"Service de l´Hydraulique"** and the **"Service de l´Hygiène", Parakou.**
- The alteration of bacterial and viral water contamination will be used as **response indicator**.
- **Viral water** contamination seems to be directed by water flow after an appropriate amount of rainfall stressed by the results of physicochemical analysis.

Universität zu Köln
MWF NRW.
Bundesministerium für Bildung und Forschung
universitätbonn