INVESTIGATIONS WATER MANAGEMENT AND WATER QUALITY IN PICOS/ PIAUÍ AND TAUÁ /CEARÁ WITHIN THE BILATERAL WAVES PROGRAM IN NORTHEAST BRAZIL

Susanne Voerkelius[1], Gerold Heinrichs[1], Margarita M. López Gil[2] & Ligia Alves dos Santos Semrau[3]

Abstract - The knowledge on water management, -quality and supply is an essential basis for the evaluation of the potential of regional / national development. Within the project WAVES the investigations of the water quality were performed in surface and ground waters as well as in drinking water supplying systems in urban and rural areas of different municipalities in the region of Picos (Piauí) and Tauá (Ceará). The results show that on principal in the region of Picos the hydrochemical quality does not impose any restriction for the agricultural and drinkingwater use. In Tauá, due to geological conditions part of the water sources can not be used because of the high salt content. The hygienic quality in most of the analyzed samples did not met the requirements of the standards for drinking water. The quality is strongly influenced by different handling caused by the structural differences of the municipalities. In urban areas with water supplying companies the water is chlorinated almost on a routine basis and microbiologically safe, yet containing high concentrations of chlorinated hydrocarbons if surface water is used. The correlation of the results of water quality and structural differences of the municipalities as well as the geological conditions can be used for an up-scaling of the results for those groups in the program WAVES working on a larger scale.

Keywords - Northeast Brazil, Water Quality, Water Management Structure

[1] Hydroisotop GmbH, Woelkestr. 9, 85301 Schweitenkirchen, Germany, hydroisotop@t-online.de
[2] Depart. de Hídrometeorologia, SEEAB, CEP 64002-150 Teresina-Piauí-Brazil, lopez_margot@hotmail.com
[3] Univers. Federal do Ceara / Depart. de Hidráulice e Ambiental, 60451-970, Fortaleza-Ceará, cariri@ufc.br

INTRODUCTION

The program WAVES (Water Availability, Vulnerability of Ecosystems and Society in Northeastern Brazil) intends to create a basis for the development of sustainable landuse strategies in a semiarid region in the Northeast of Brazil. In order to understand the interrelations between water availability, ecosystems and human systems in a semiarid region different groups are working on interdisciplinary basis. The investigation area are the states Ceará and Piauí in the Northeast of Brazil. Social and economic activities relay heavily on the supply and quality of freshwater. The holistic management of freshwater as a finite and vulnerable source is of paramount importance especially in the Northeast of Brazil, where water availability is restricted (Forster M., et al. 1996). Within the project WAVES our working group studies exemplarily in two focus regions Picos (Piauí) and Tauá (Ceará) the actual water quality, water supply and water structure. Only a few data on water quality were available, so that own measurements were performed. Within the project there is a challenge for the estimation of water quality not only in the areas of the focus regions but also on larger scale. Within the project for lager scales data cannot be obtained by sample analyses. The analyses of the water structure should help to identify the impacts on the water quality. It is the aim to find a correlation between water quality and structural data. In the case of correlation knowledge of the water quality can be obtained by acquisition of structural data and by the knowledge of the geology. An up-scaling of the data is possible.

WATER QUALITY INVESTIGATIONS

In the focus areas water pollution is caused by sewage, garbage and agriculture. Industrial waste water is by it's quantity playing a minor role. For the description of hydrochemical quality of ground- and surface waters the main anions and cations, N-components and physico-chemical parameter (pH, conductivity) were used. In some cases pesticides were analyzed. Disinfected waters were analyzed on the content of chlorinated hydrocarbons. For microbiological analysis of coliform bacteria and Escherichia coli on our field trips we used Colilert[®], an EPA-approved test of IDEXX Laboratories (Edberg and Smith, 1994). The main problem for microbiological measurements in the Northeast is how to transport samples for microbiological analysis quickly. It is a far easier way of getting reliable results due to short transport times by using the Colilert[®] test that can be applied even if no laboratory is available.

Water source: The geological conditions are decisive for the use of ground or surface water. In Piauí most of the area is sedimentary with the possibility of groundwater use. The

crystalline bases in Ceará is the reason for construction of many dams and for surface water use (Fig. 1). The focus regions Picos and Tauá are representative of this conditions. In most cases the water quality of surface water is worse because of the lacking protection of sediments against contaminants. In the investigation areas up to now predominantly the microbiological property, the content of organic substances and of halogenated hydrocarbons are responsible for the deterioration of the surface water quality (cf. drinking water quality). Due to the geological conditions and the high evaporation in Tauá surface and ground waters partly can not be used because of high salt contents.

Drinking-water quality: In the region of Picos in an area of about 3000 km^2 samples of about 50 sites have been investigated. The existing hydrochemical quality does not impose any restriction for use following international drinking water standards. In the region of Tauá first investigations showed that due to natural conditions many ground water wells but also one of the 4 dams cannot be used directly because of high mineralization. In the periods of aridity due to water scarceness also this salty water is used after a costintensive desalinization. The hygienic quality characterized by the content of coliform bacteria and E. coli was analyzed in ground- and surface waters as well as in water supplying systems. The surface water investigations were performed at all dams in the focus regions, three drinking water springs and five locations at the Rio Guaribas. Following the WHO guidelines the waters general were of bad quality due to high contents of coliform bacterias and some contents of E. coli. In the Picos area surface waters are only used by a minority of people in detached locations, but in any case the water quality is bad. Ground water, that's area´s most common source in Picos for public or private consumption is protected against contaminants by layers of sediments and none of it's samples showed any Coliforms or E. coli. Despite this we analyzed in some deep wells low, but detectable, concentrations of nitrate. This we consider as an indicator for a starting contamination of the deeper ground water resource, which partly is affected by a high exploitation rate. So far, the results of some water samples we analyzed showed that pesticides could not be detected.

Water quality in the water supplying systems: In urban areas with a centralized water supply by companies e.g. AGESPISA (PI) or CAGECE (CE) the water is usually chlorinated on a routine basis and is microbiologically safe (e.g. Tauá). In Picos even ground water of good quality is chlorinated to prevent the risk of contamination in the supplying net. However, in parts of the water supplying net and especially at the end of the net, we found a slight but persistent microbiological contamination and no free chlorine. Central water services in rural areas, which use clean ground water (Cana Brava) perform

only periodical disinfecting of the net, show also a slight but persistent contamination by coliform bacteria. In rural areas (e.g. Angical, south of Picos), ground waters we proved, were found to be severely contaminated by coliform and E. coli on delivery to the consumers via water supply stations (chafariz). None of the samples at these sites we analyzed met the requirements of drinking water. Disinfecting of waters is a precondition for a safe drinking water supply. A severe disadvantages of water-disinfection by chlorine is the secondary formation of halogenated hydrocarbons in those waters, which show high contents of organic substances. Such conditions can be expected in surface waters. Samples from Jaicos and Tauá, but also from the capitals Teresina (PI) and Fortaleza (CE) were analyzed on chlorinated hydrocarbons (Fig. 3). They all show elevated concentrations. The Picos water supply uses ground water low in organic carbon. Here we only found traces of chlorinated hydrocarbons. In all cases an anthropogenic source for the chlorinated hydrocarbons can be excluded. The measured contents reach up to 200 µg/L, especially Trihalogenmethan significantly above the international guideline value being set at 30 µg/L for Trihalogenmethan.

Water quality for agricultural use: For the region of Picos the quality of irrigation water was defined by the US-Sodium-Adsorption-Ratio-Index (Rehm, J., 1990). The diagram (Fig. 4) gives a direct indication of the salinity and alkalinity hazards. In general the mineralization and the SAR-Index of ground- and surface waters is relatively low and most water sources are suitable for irrigation. Only one water-sample in the municipality of Sussuapara shows a SAR-value greater than 20. The continued use of this water could lead to serious sodium hazards. Where used on sensitive crops this water may be detrimental because of sodium phytotoxicity.

STRUCTURAL ANALYSIS OF LOCAL DRINKING WATER SUPPLIES

For those groups of the program WAVES, which are working on a larger scale, it is important to get estimations about water quality on local and as well on larger scales. For "scaling up" our data, we made a structural analyses of the water supplying systems by means of `expert interviews´ with water supplying companies, local authorities and medical services as well as interviews with local water users. The main items of the questionnaire are: source of water, supplying system, water treatment, water demand, water costs, supplying problems, water born diseases and waste water treatment. In addition we collected data and maps from existing water supplying systems. Our investigations were able to prove the expected interdependence of water supplying structure and hygienic quality of tap water (Fig.2) in the Picos area. As a result of the correlation of

microbiological investigations with structural data, the following "valuation criteria" were elaborated: ownership of the supplying system, number of inhabitants, technical installations within the supplying system, quality of water exploitation devices, water-treatment devices and prices for water.

CONCLUSION

In the region of Picos the main problem with respect to water quality is the bad hygienic property. We can describe a definitive dependence between the water supplying structure and the hygienic quality of the tap water. We want to point out, that the hygienic problems can be improved by changes in handling the water-supply: covering of open wells or open water tanks, installation of metal water taps, disinfecting of taps, periodical cleaning of water tanks and pipes, perhaps using of different tanks for drinking water and water for other purposes. Nevertheless the aim remains to construct supplying nets with regular attendance and control of water quality.

Without any doubt, the disinfecting of both, surface and ground water, is primary requirement for a safe and healthy drinking water supply. Microbiological quality of the water has first priority. But the high concentrations of chlorinated hydrocarbons found are cancerogenic. A reduction of their level should be a second aim of water treatment. If possible the use of ground water is to be favored.

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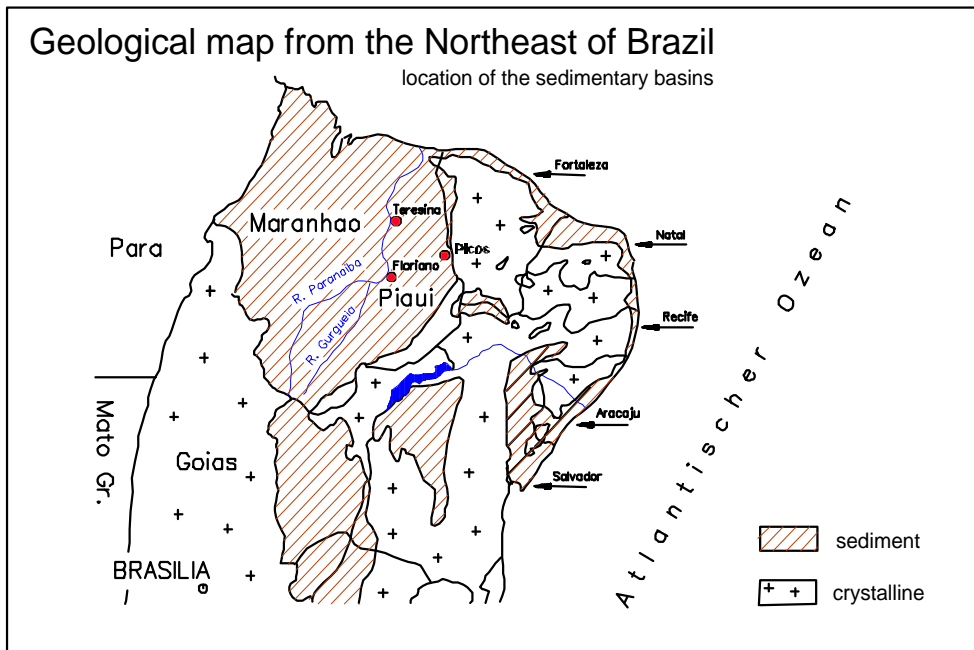
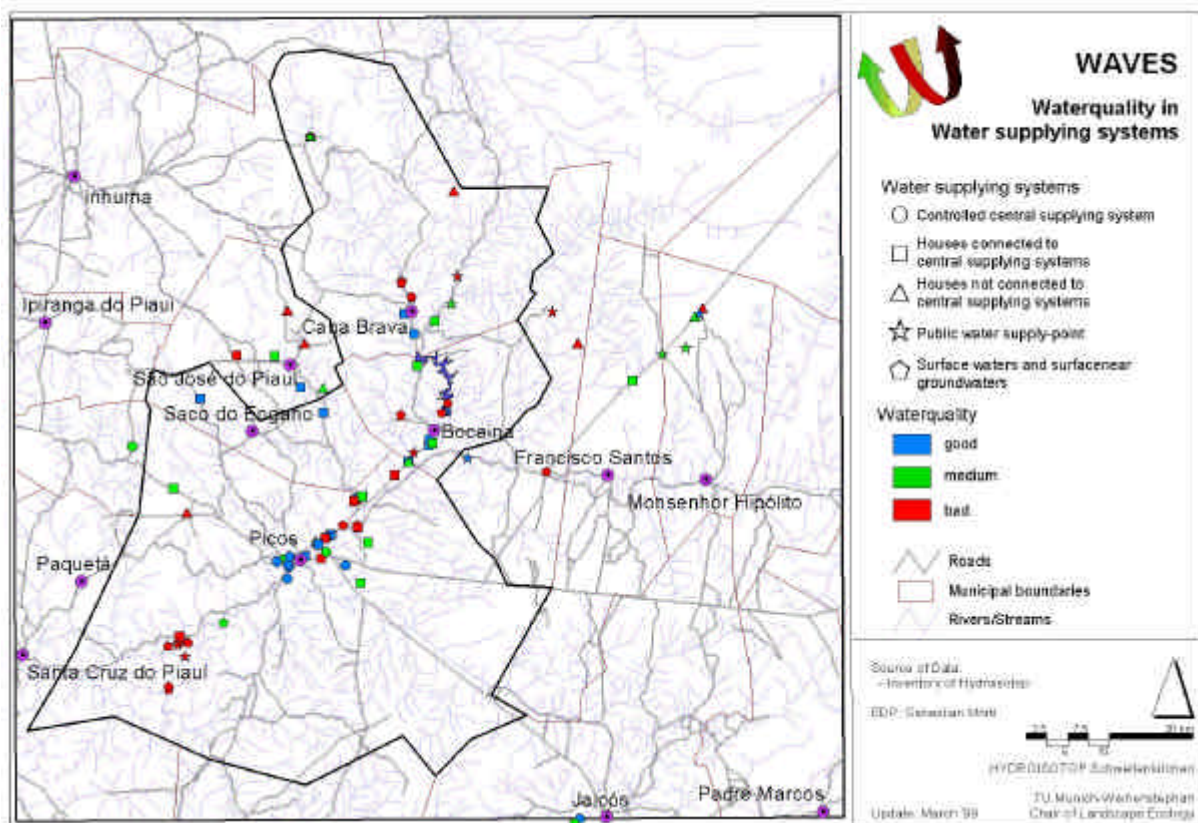**Fig.1**:Geology of the Northeast of Brazil

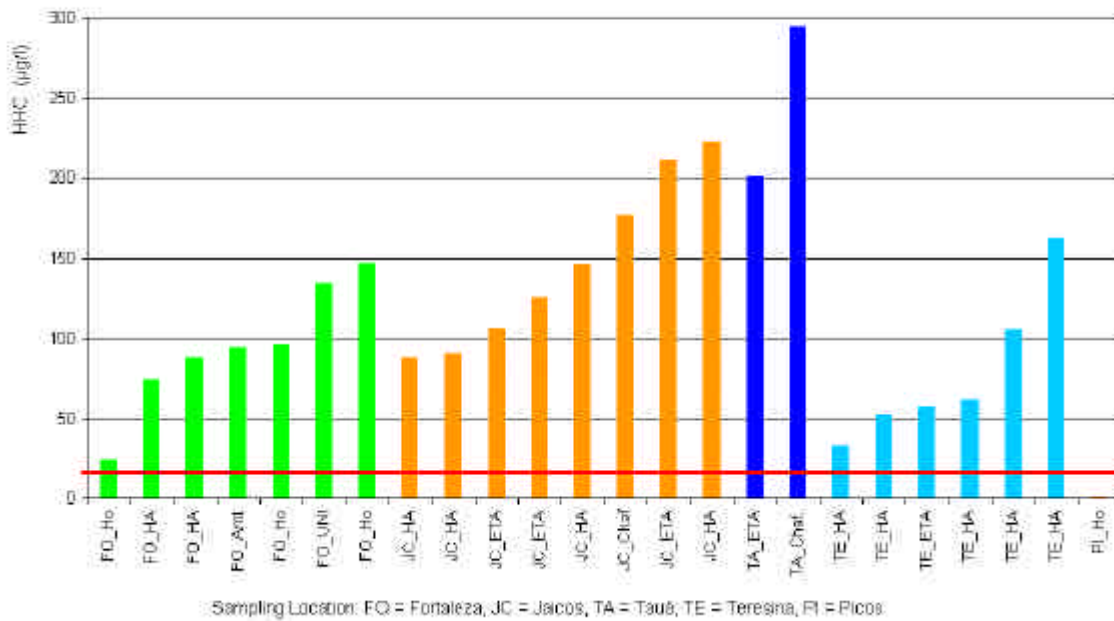**Fig. 2**: Drinking water quality in different supplying systems

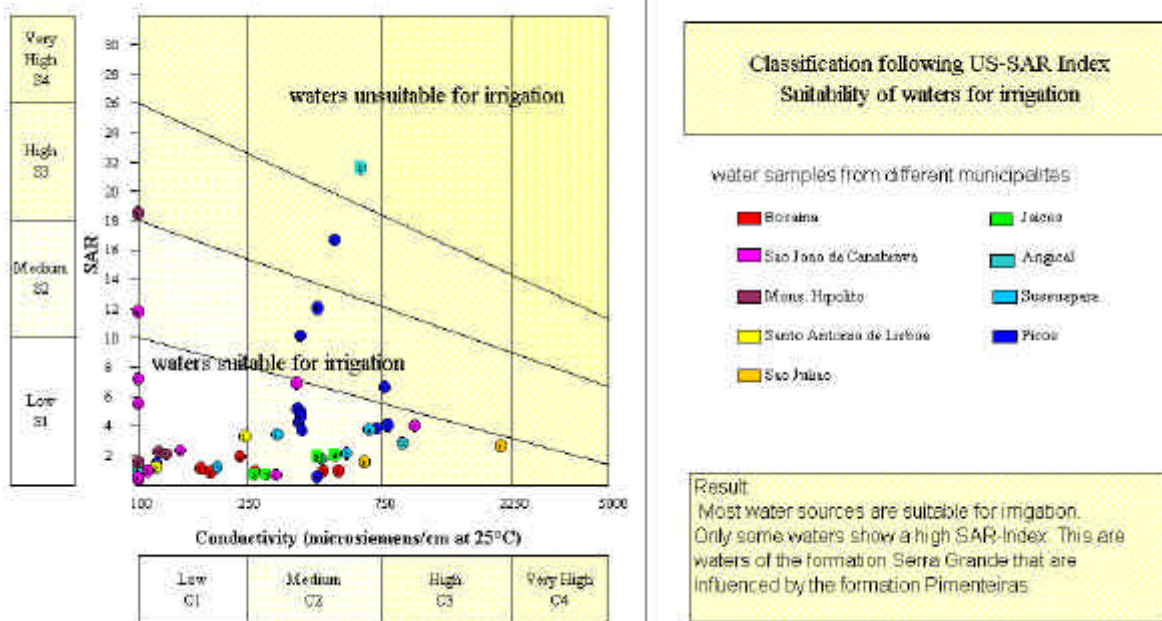**Fig. 3**: Halogenated Hydrocarbons in drinking water of the Northeast of Brazil

Fig. 4 : Quality of water for irrigation use in the focus region Picos