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Nitrate contamination in peri-urban Maputo (Mozambique)

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Abstract

Groundwater recovered from shallow wells and boreholes is at present the main water supply source in the peri-urban zones of Maputo city. The waste water drainage and sanitation is done through local systems such as pitlatrines and in the best cases septic tanks.

In almost all shallow wells and locally in some of the boreholes very high nitrate concentrations (till 500 mg/l) are measured. This paper contains a brief description of the situation and following evaluation of the groundwater pollution by nitrates. Finally some ideas about possibilities to improve the sanitary conditions and water supply of the population are discussed.

Introduction

The capital of Mozambique, Maputo, has in recent years been confronted with a strong growth in population. At this moment the city lodges about 1.2 million inhabitants of whom almost 80 % live in the peri-urban zones of the city. The density of the population in the peripherical quarters often exceeds 150 hab/ha. Generally the peri-urban zones are deprived of canalized systems for both water supply and waste water drainage.

The population uses local systems such as pitlatrines and in the best cases septic tanks for sanitation. The relative small quantities of waste water dispersed per household would in fact not support a canalized system [6]. The principal water source is groundwater recovered from predominately unprotected shallow wells and some deeper boreholes which provide water to small standpost systems. In many cases the supplied water shows nitrate concentrations that surpass the WHO limit (45mg/l).
This precarious situation seriously worries all involved authorities.

Nitrate contamination

The shallow wells withdraw water from a phreatic aquifer which is composed of dune sands of a fine texture. The hydraulic permeability of these eolic deposits ranges from 2 to 4 m/d.

Analyses of water samples from the shallow wells generally show high nitrate concentrations (till 500 mg/l) and the presence of bacteria. The highest contamination is found in the areas with high population densities and relatively small distances between the water source and the waste water deposal. In fact there seems to exist a linear relation between the nitrate content and the population density. This derived relation shows that for population densities exceeding 50 inhabitants/ha the WHO limit will be surpassed (Fig 1).

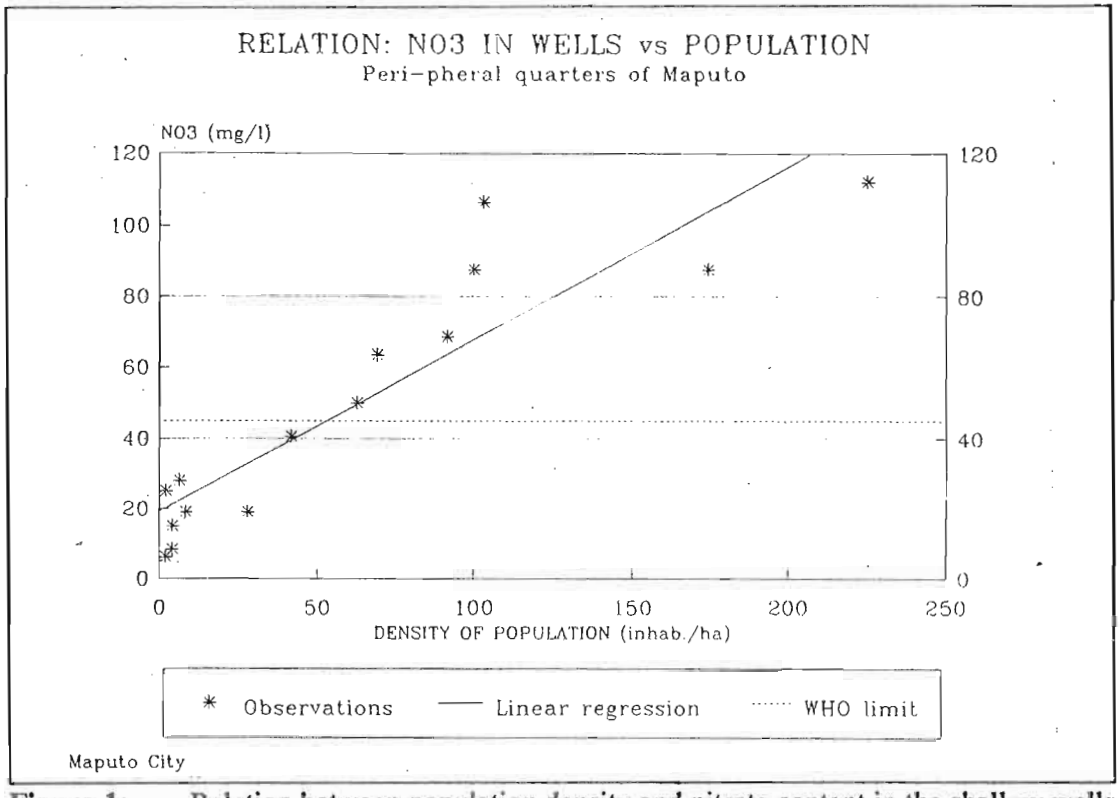

Figure 1: Relation between population density and nitrate content in the shallow wells

Although there exist an official limit of 30 m for the minimal distance between a well and a latrine, the virtual absence of a effective planning in the peri-urban zones and the fact that almost every household has its own well and latrine make it difficult to obey this rule, hence sometimes the distance is less than 2 m. Often the wells also have a bacteriological contamination partly as a result of direct introduction through incorrect operation.

Clayey-sandy deposits at a depth of 35m form the base of the phreatic aquifer and overlay a marine calcareous sandstone of Mio-Pliocene age. These deposits are intensively explored by boreholes with yields that can exceed 10m^3/h. Locally the water from the boreholes also has high nitrate contents (till 300 mg/l) that surpass the WHO limit (Fig 2).

Despite the fact that the contamination appears to be concentrated in two distinct zones the distribution is hard to explain. In the same zone boreholes which show very high nitrate levels can occur at short distances (500 m) of a borehole with hardly any nitrate content. The nitrate level can also vary significantly and irregularly in time. This seems to indicate rather a local than a regional pollution. Observations taken in one and the same borehole during one day show a likely relation with the pumping regime (Fig 3). Immediately after connection of the pump the highest level is measured. The Nitrate concentration reduces gradually during the day. Short circuiting, due to the absence of a proper seal, could be the explanation.

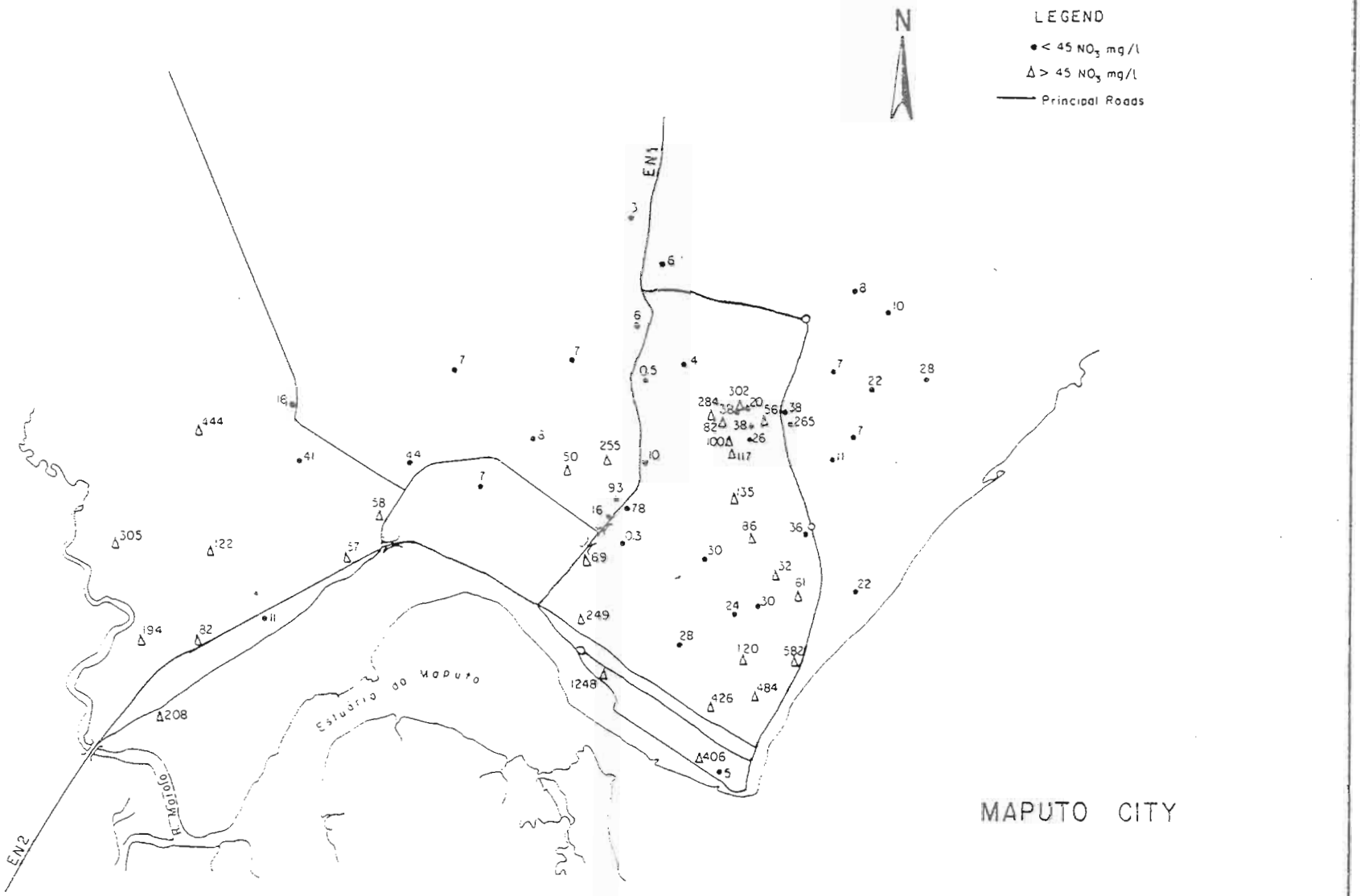

FIG. 2 : NITRATE CONCENTRATION [mg/l]
(Well Samples)

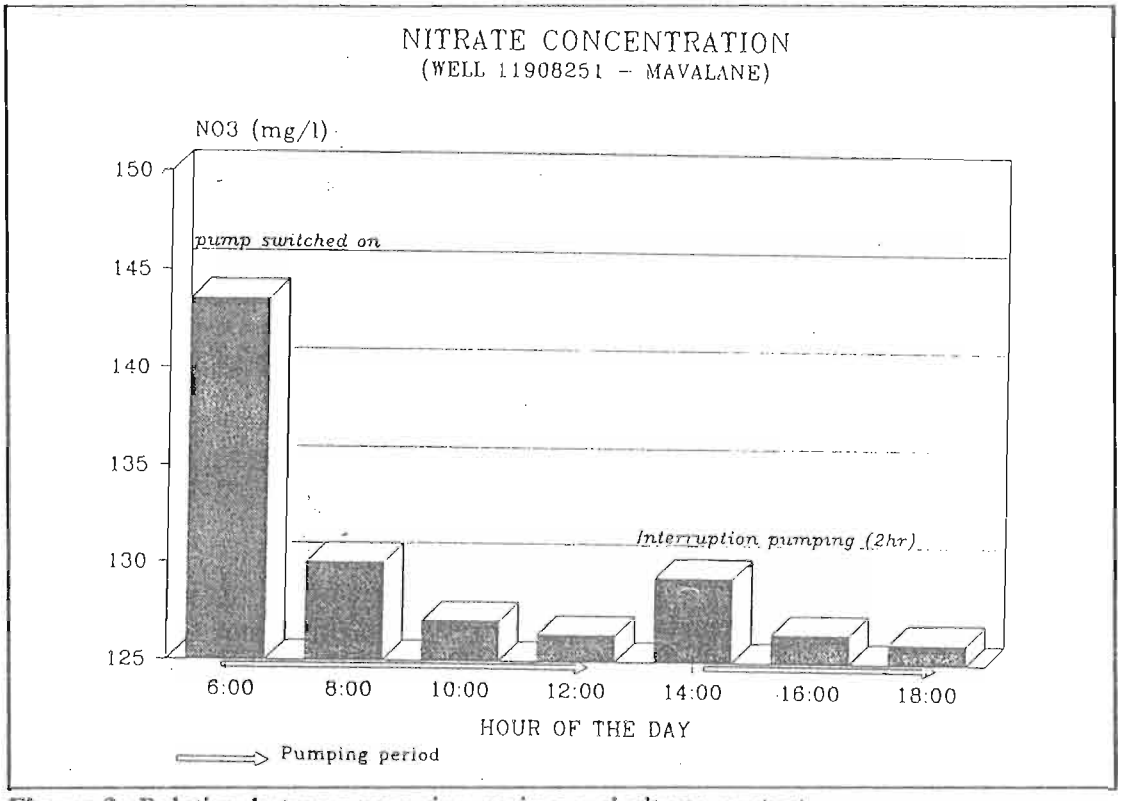

Figure 3: Relation between pumping regime and nitrate content

The residence time of the water in the deep aquifer is estimated to be at least some decades. This would mean the water infiltrated before the expansion of the city and should have had sufficient time for the removal of the nitrate through desnitrification. Desnitrification is the natural biochemical process whereby organic material or pyrite is oxidized with nitrate after stronger oxidizers already have been used. The relatively low content of organic material, specially in the dune sands but also in the deeper aquifer, might possibly have prevented the desnitrification process from running well.

Concluding considerations

Until the present moment, the local Health Services claim to have never observed cases of obits related with water pollution by nitrate, but a systematic search was never executed. At the same time the international discussion about maximum nitrate levels acceptable for human health is still far from reaching a conclusion [7].

Although the nitrate contamination is still not understood entirely, the obvious solution seems to be to change either the sanitary system or the water supply source and preferably both. Preliminary estimations prove that substituting the water source by more expensive, purified water from the Umbeluzi river, which is already supplying the urban center, would be the least expensive solution. Nevertheless even this solution will be, considering the economical situation in Mozambique, extremely hard to implement and only render effects on the middle and long term. But to prevent future generations of facing even worse problems action should be taken now.

The critical situation in developing coun-

tries, such as Mozambique, forces often in these cases to adopt the short term, economically inexpensive solutions, without tackling the fundamental problems. Regarding the water supply, very rightly, priority is given to sanitary education and simple technical methods to protect the water from direct and bacteriological pollution. The same holds for the low cost sanitation by pitlatrines. Unfortunately these efforts, although very important for public health, hardly effect the nitrate contamination. Therefore it is feared that in the near future nitrate rich water will remain to be the principal water source in the peri-urban zones.

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