

Origin of Nitrate in Shallow Groundwater in Teungku Dilaweung, Aceh Province, Indonesia

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Introduction

On 26th December 2004 a tsunami wave damaged hundreds of wells along the eastern coast of Sumatra. In September 2005 German Agro Action (GAA) started cleaning and rehabilitating almost 300 dug wells in this region. Water samples taken by GAA were analysed in the hydro-geochemical laboratory of the Federal Institute for Geosciences and Natural Resources (BGR) in Hannover, Germany.

Fifteen percent of the water samples from dug wells exceed the national guideline value for nitrate. Almost all of these wells are located in one of the three villages Cot, Teungku Dilaweung and Blang Raya in the sub-district Muaratinga, north-west of Sigli.

In March 2007, the Bureau of Mining and Energy (DISTAMBEN) and BGR started a joint field campaign in the village Teungku Dilaweung to find out the source of the high nitrate concentration. Within this investigation further 25 dug wells were tested. The concentrations of nitrate range from < 0.1 to 241 mg/L. Fourteen of the 25 tested wells tap water with nitrate concentration above the guideline value of 50 mg/L. The lowest concentrations of nitrate are found in dug wells upstream of the village and the highest in the centre of the village.

Sources of Nitrate

Possible sources of nitrate in shallow groundwater in this region are:



Excessive application of fertilizer in agriculture



Inadequate disposal of human excreta



Livestock farming

Herein groundwater contamination from field fertilizer is ruled out as high nitrate concentrations are found in the centre of the village, while nitrate concentrations in agricultural environments are low. Analyses of ¹⁵N and ¹⁸O isotopes also point on septic waste as the source of nitrate.

Effluent from latrines is directly infiltrated into the groundwater via soakaways, thus causing a major hazard to the quality of shallow groundwater. Livestock farming, especially poultry is likely to represent a further source for contamination.

Influence of topography

Along the eastern coast of Sumatra poor sanitation is prevailing, thus causing a major risk of groundwater contamination. High nitrate concentration in shallow groundwater in contrast only occurs in Teungku Dilaweung and the two surrounding villages. Other constituents like phosphate show also elevated concentrations, but no clear distribution pattern.



The reason for this is probably found in the topography. The centre of Teungku Dilaweung is located in a narrow local basin. The hydrologic barrier between the village and the hinterland has wide influence on the groundwater balance. Nitrate accumulates in groundwater, because it is not diluted by an adequate amount of fresh water.

The special topographical setup in Teungku Dilaweung is similar to the neighbouring villages Cot and Blang Raya.

In contrast to the above described morphology, most of the settlements along the eastern coast of Sumatra are located in flat areas.

It is supposed that nitrate influx into shallow groundwater along the whole inhabited coast is more or less in the same range as in the study area, but nitrate concentration is reduced particularly by dilution with fresh water.

There is a considerable influence of the geomorphologic and hydrogeologic setup on the concentration of undesired constituents in groundwater. On this basis it is proposed to have a close view on hydrogeology and geomorphology when implementing sanitation programmes.

Legend

