Developing a GIS- and QRA-based Hazard-Analysis-Critical-Control-Point-System (HACCP) for drinking water abstraction

- with regard to new and modified hazards to drinking water supply –

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Sponsored by the Scholarship Programme of the German Federal Environmental Foundation
DBU
Deutsche Bundesstiftung Umwelt

1. Background

In recent years the concern of water quality for human purpose re-increased, in particular in respect of microbiological parameters. Outbreaks of waterborne diseases continue to occur in both developed and developing countries (WHO 2002). Different reasons are discussed, whereas among the most important aspects are climate change and emerging pathogens (Fig. 1).

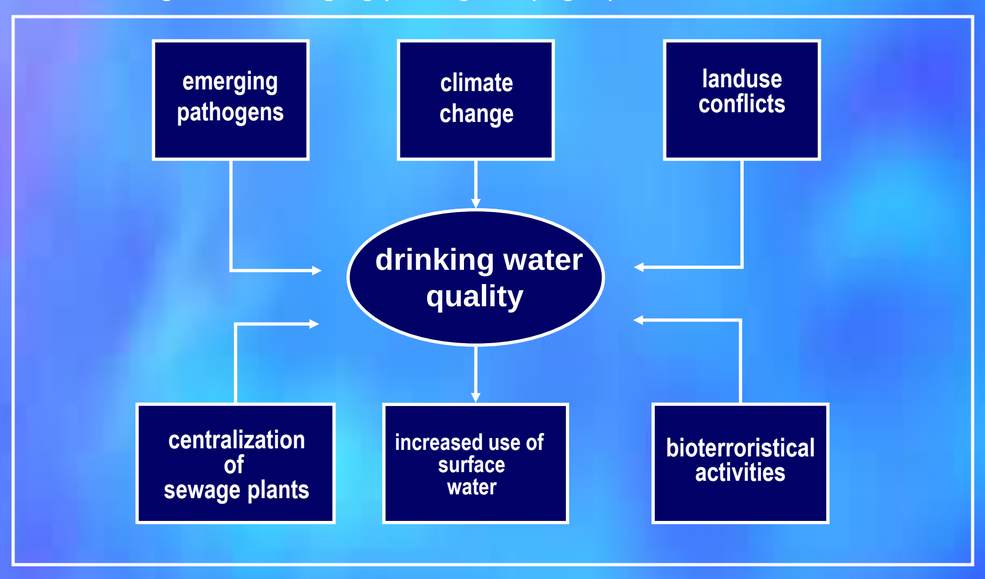

Fig. 1: Assessment of new risk factors for drinking water abstraction

2. Combining HACCP and QRA

Against this background of hazards, new possibilities of quality assurance and quality management are needed: a process oriented concept for risk and surveillance management, that meets new legal requirements.

The conceptual framework is the Hazard-Analysis-Critical-Control-Point System (HACCP), which comprises the identification of hazards concerning product quality and determination of so called critical control points (CCP). A CCP "is a step or procedure at which control can be applied and is essential to prevent or eliminate a hazard" (Codex Alimentarius 1997) (Fig. 2). The World Health Organization (WHO) implemented the HACCP principles in the Water Safety Plan, a strategy for control and monitoring of drinking-water quality (WHO 2002).

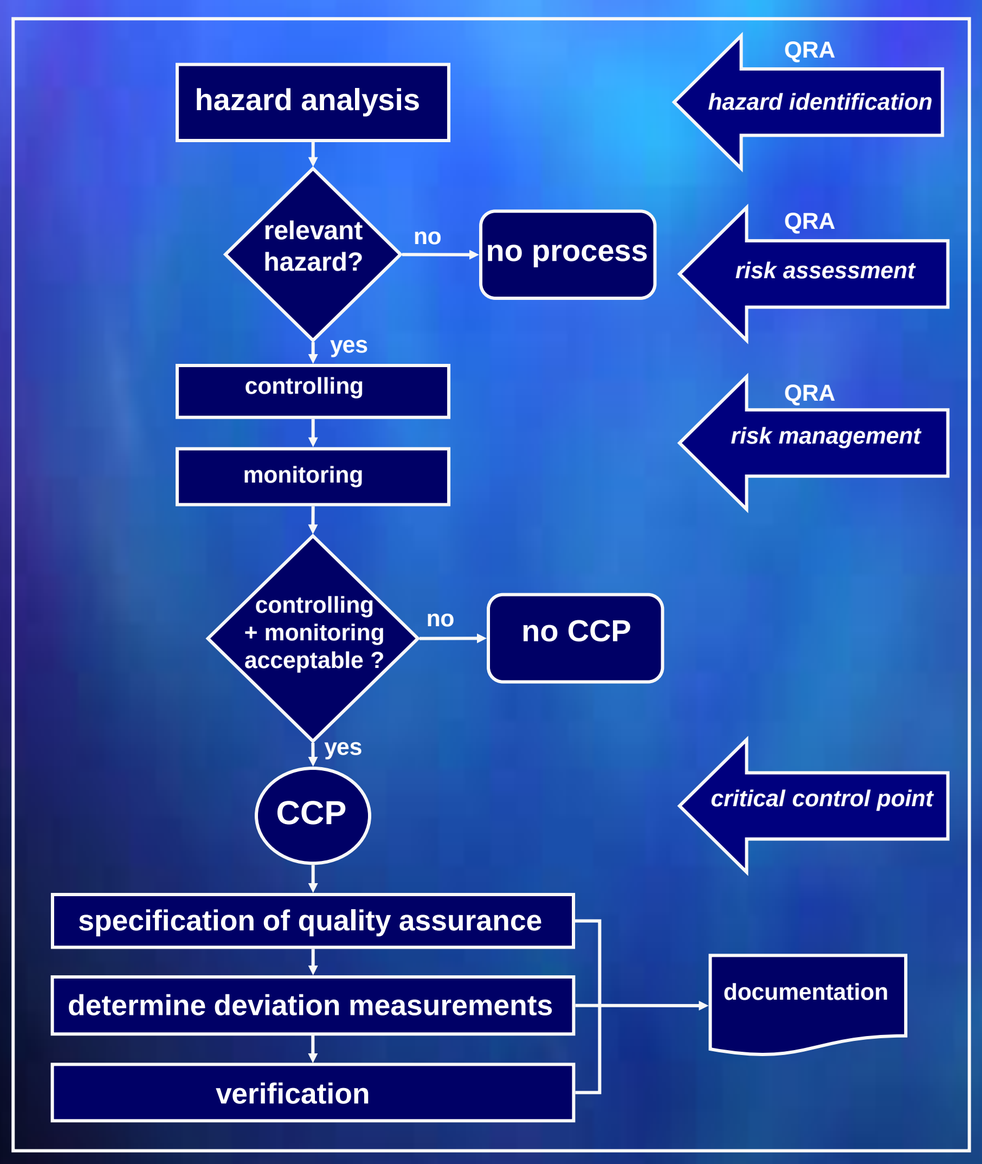

Fig. 2: Decision tree of HACCP (after Untermann 1996)

Catchment management and source water protection provide the first barrier for the protection of water quality. Once the potential hazards and their causes have been identified, the level of risk associated with each hazard must be estimated so that priorities for risk management can be defined (NHMRC 2002). Thus the establishment of critical control points and the specification of critical limits in this project focus on the process of ground water abstraction in the catchment area and is based on the Quantitative Risk Assessment (QRA).

3. Combining HACCP and GIS

The characterisation of the catchment area comprises the collection of geo-ecological data, the analysis of raw water quality and the survey of potential hazards. The data management is conducted with the use of Geographical Information Systems (GIS). Such a GIS-supported HACCP-Concept is implemented for a catchment of ground water abstraction in Germany (Fig. 3+4).

Municipality of Niederkassel:

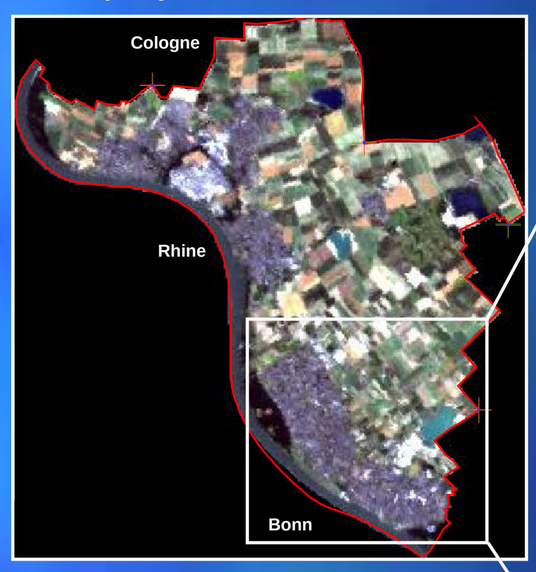

Fig. 3: Landsat ETM +, 30 meters resolution, real-colour-composite

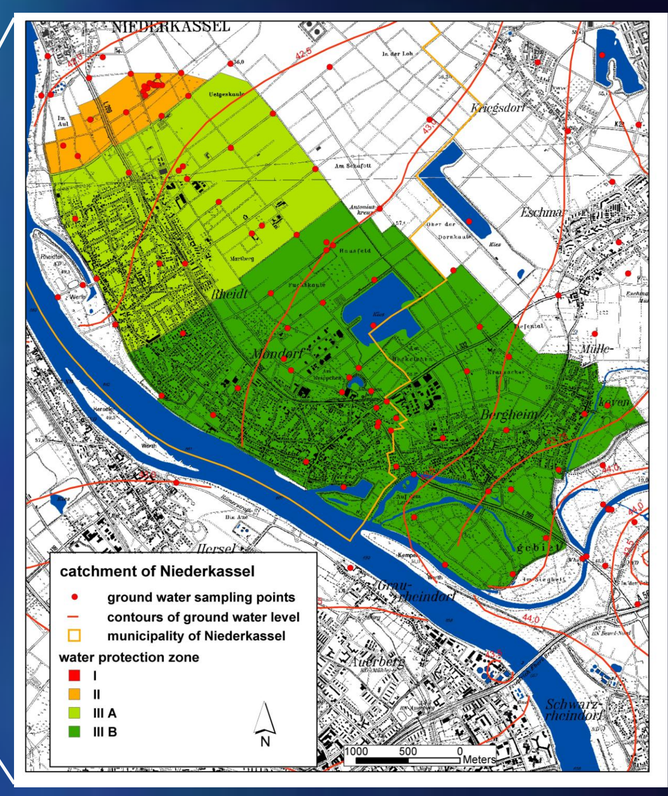

Fig. 4: Water protection zone in the catchment of Niederkassel

Spatial analysis methods, in particular interpolation techniques, emphasise the investigation of the catchment area predicting unknown values for sample input point locations.

Spline interpolation is used to minimise overall surface curvature, resulting in a smooth surface (Fig. 5).
This method is best suitable for gently varying surfaces, such as elevation, water table heights or pollution concentrations (McCoy, Johnston 2002).

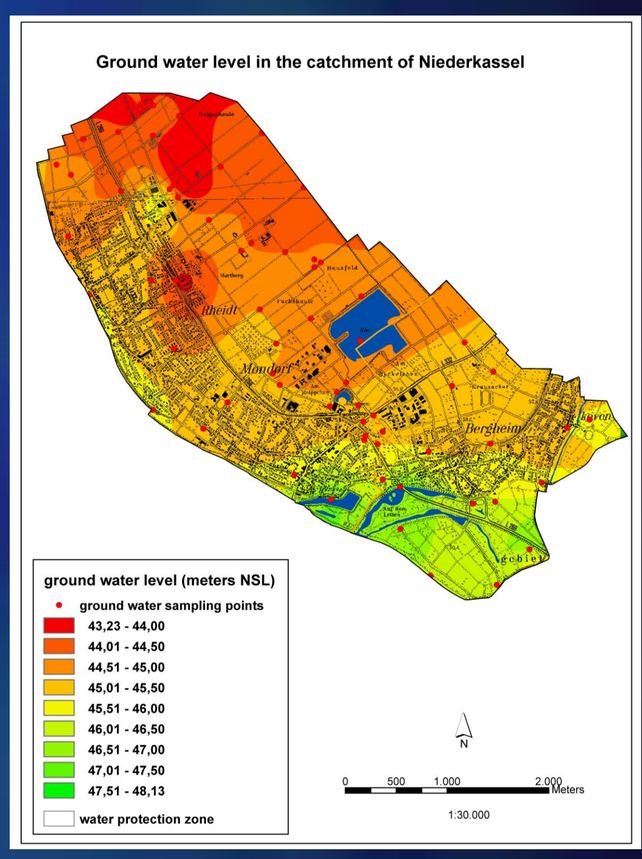

Fig. 5: Ground water level in the catchment of Niederkassel

4. Aim and products

The implementation of a GIS-supported HACCP for drinking water abstraction contains:

- the identification of local actors
- a detailed analysis of geo-ecological characterisation of the ground water catchment area (hydrogeological conditions, agricultural activities...)
- the identification of potential microbiological, physical and chemical hazards from point sources (leakage, sewage discharge points, horticulture, industry...) that are associated with the water abstraction process
- the collection of raw water analysis over long time series
- the complete design of a GIS for drinking water abstraction
- the identification of critical control points (CCP) and QRA-based determination of critical limits regarding to HACCP

Due to the investigations of this project, important substantial conclusions, concerning the relevance of new potential hazards for drinking water abstraction in Germany are expected. The development of an adapted HACCP-system for a concrete drinking water abstraction will allow important insights for its applicability in Germany and initiates the German perspective of the world-wide discussion of HACCP for drinking water supply.

References:
FAO/ WHO (1997): Codex Alimentarius. Rome
McCoy, J. et al. (2002): Using ArcGIS spatial analyst. Working draft
National Health and Medical Research Council (NHMRC) (2002): Framework for management of drinking water quality. Canberra
World Health Organization (WHO) (2002): Water Safety Plans. Working draft

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