

KORA: Natural Attenuation for Contaminated Site Management

BMBF Funding Priority KORA: Natural Retention and Degradation Processes to Reduce Contaminants in Groundwater and Soil

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KORA's aim has been to investigate retention and degradation processes, leading to a reduction of contaminants in ground water and soil. It conducted 74 research projects (€32.7m) at 23 model sites. Results have enabled the development of methods to facilitate the evaluation and bespoke use in risk assessments and remediation of contaminated sites.

KORA projects are organised into eight Thematic Networks (TN) covering a range of typical industrial pollutants and broader aspects. These have provided technical guidelines about the potential for natural retention and degradation of pollutants at different locations to be assessed. Each of the six guidelines had three sections;

- 1) An introduction and description of the model sites and adopted methods;
- 2) The fundamentals of natural attenuation (NA) processes for typical pollutants and
- 3) Site-specific requirements for monitored NA (MNA) application and subsequent site management.

The TN 1 guideline dealt with aliphatic petroleum hydrocarbons, BTEX, and MTBE. It focused on quantitative assessment and the predictions such as contaminant type and clean-up at big sites (refineries, airports). The main tasks of TN1 included method development, the establishment of contaminant degradation rates, modelling reliability and evaluating the viability of the operations. The TN2 guideline dealt with NA at sites contaminated with tar oil (e.g. gas works, coking plants). It discussed natural conditions (e.g. physical, chemical and biological) that permit tar oil degradation, NA time-frames, and applied findings to other sites to assess future NA viability.

The TN3 guideline dealt with the NA of

sites contaminated by chlorinated solvents. Solvent plumes were characterised by complex degradation processes and long plume lengths. The TN4 guideline dealt with NA of soil and groundwater beneath landfills and former waste disposal sites and evaluated the conditions under which NA occurs and outlined subsequent measurement and control methods.

TN8 focused on evaluating wider aspects (e.g. prognosis, social acceptance), applying them into a practical context. This was achieved by raising specific questions such as, 'which factors influence social acceptance?', 'how can NA processes be evaluated both economically and ecologically if, for example, long-term monitoring needs to be considered?'



Key of contaminated sites:

- TN1: Mineral oils
- TN2: Tar, tar oils (PAH)
- ▲ TN3: Chlorinated solvents
- ▲ TN4: Landfill - typical
- ◆ TN5: Explosives
- TN6: Heavy metals, pest.

Map of Germany illustrating the location of contaminated sites studied by KORA project. Sites are contaminated with the compounds as described above, each of which are dealt with a thematic network (1-6). NA of sites is described in the recommendation handbook: 'Natural Attenuation for Contaminated Site Management'.

The TN5 guideline reviewed NA processes for explosive compounds (nitro-aromatic) and development and standardisation of equipment and methods required. It also supported decision-making during risk assessments and aftercare, defined handling instructions and principle remedial measures. The TN6 guidelines dealt with minimizing contaminated effluents from spoil heaps from the strip mining lignite industry and fate of pesticides in industrially polluted river sediments. It described the methods to evaluate NA processes in such materials and characterisation of the pollutant retention capacity.

TNs 7 and 8 provided chapters for a "recommendations handbook". TN7 detailed evaluation, prognosis, modelling and process control tasks. These are essential for the success of the investigations. TN7 also included the development of an information and simulation system. This system took account of the time variability of groundwater flow conditions and subsequent effect on plume spatial development. It included a numerical simulation tool of reactive transport of contaminants.

The recommendation handbook 'Natural Attenuation for Contaminated Site Management' contains the methods that were developed, tested and utilised in KORA, and the technical guidelines that will aid implementation of NA processes for *in situ* management of contaminated land. The handbook explains a four-step approach for MNA. This includes modelling and forecasting, NA assessment, monitoring requirement and the investigation of MNA. The handbook also includes key information such as the surrounding legal framework, the fundamental importance of economic evaluation, and the practicalities of risk communication and acceptance. It provides a reference for the management of contaminated sites and serves as a link to technical guidelines.

For further information and to order any copies of the KORA recommendation handbook please visit:

www.natural-attenuation.de

