

gaiac – research institute for ecosystem analysis and assessment: a small and medium enterprise working hand in hand with RWTH Aachen University

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Received: 27 June 2010 / Accepted: 30 June 2010 / Published online: 23 July 2010
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1 Introduction

gaiac was founded in 2003 as a research institute affiliated to the RWTH Aachen University with a research focus on the effects of anthropogenic influences on aquatic and terrestrial biocoenoses.

gaiac as a small and medium enterprise (SME) operates in close cooperation with the Institute for Environmental Research at Aachen University which provides the chairman and further members of the board of the association. The members of the board are:

- Prof. Dr. Andreas Schäffer (chair)
- Prof. Dr. Hans Toni Ratte (vice chair)
- Dr. Martina Roß-Nickoll
- Prof. Dr. Henner Hollert
- Dr. Monika Hammers-Wirtz (managing director)

The registered association gaiac is supported by a research advisory committee composed of experts from academia, industry and different authorities. Currently we have 14 employees, corresponding to seven full-time equivalents.

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Fig. 1 Outdoor mesocosm facility at the Research Institute gaiac in Aachen (photo by Peter Winandy)

gaiac research activities (Fig. 1) include

- ecological and ecotoxicological lab and field investigations
 - ecological modelling
 - development of environmental decision support systems
- The institute is involved in many joint research projects (supported, e. g., by BMBF, UBA, EU) and offers R&D services to industrial partners, different authorities and water associations.

Combining experimental research in the fields of “aquatic ecology”, “terrestrial ecology” and “ecotoxicology” with the development and application of corresponding models is a unique strength of the institute. This is carried out in a truly inter-disciplinary research environment by collaboration with several faculties at RWTH Aachen University and external institutes.

Scientific expertise is regularly introduced in lectures and training courses at RWTH Aachen University and in supervising master and Ph.D. students in ecological and ecotoxicological topics.

2 Ecotoxicology

gaiac offers experimental investigations and the development of mathematical models to assess the impact of industrial chemicals and complex environmental samples on aquatic and terrestrial organisms, populations and communities. Together with our main partners Harlan Laboratories Ltd. and Fraunhofer IME, studies can be performed in accordance with good laboratory practice (GLP).

The institute's competence in the field of ecotoxicology is based on longstanding experience of aquatic higher tier studies and the comprehensive knowledge of the scientific staff in aquatic and terrestrial ecology.

gaiac carries out ecotoxicological studies with a main emphasis on:

- Aquatic outdoor mesocosm studies
- Aquatic indoor microcosm studies
- Higher tier studies with invertebrates such as population studies and bioassays combined with mesocosm studies
- Terrestrial outdoor model ecosystem studies (TME) including soil mesofauna
- Determination of terrestrial invertebrates from experimental field studies
- Ecotoxicological biotests, e.g. *Daphnia*, algae and fish egg assay
- Mechanism-specific bioanalytical methods, e.g. for mutagenic and endocrine potentials
- Statistical analysis of complex datasets using univariate and multivariate methods

3 Aquatic ecology

Comprehensive taxonomic and ecological expertise in planktonic organisms, macroinvertebrates and macrophytes enables gaiac to offer a broad variety of limnological investigations of standing and flowing water bodies:

- Plankton ecology and food chain analysis
- Biocoenotic investigations (e.g. benthic macroinvertebrates)
- Biological monitoring and determination of water quality indices in accordance with the EU Water Framework Directive
- Development and use of complex mathematical simulation models for the analysis and optimisation of water maintenance and water management

4 Terrestrial ecology

Research is focused on the investigation of biocoenoses at the landscape level in order to refine existing testing and assessment methods and to optimise concepts of need-oriented use. Many years of experience in this field ensure that results can directly be applied in planning practice for decision-making.

gaiac offers the following services:

- Expert reports and taxonomic expertise (e.g. *Carabidae*, *Araneae*, *Collembola*, *Oribatida*) on terrestrial communities (e.g. for landscape management planning and for the assessment of environmental impacts and compatibilities in accordance with the Habitats Directive)
- GIS-based analyses of landscape datasets
- Statistical analysis of complex datasets using multivariate methods

5 Mathematical modelling and numeric simulation

Computerised mechanistic simulation models are playing an increasingly important role as decision support systems in environmental risk analysis and landscape management. The essential advantage of numeric simulation models is the consideration of different scenarios, which are too expensive or protracted to be studied experimentally. Furthermore, simulation models as an explanatory aid will improve our understanding of the functionality of the systems under examination. Expertise from several disciplines can be brought together and gaps in knowledge can be identified. gaiac has longstanding experience in the development of mathematical models for ecosystem management and risk assessment of pesticides.

The following models are currently available:

- Individual-based population models for the water flea *Daphnia magna* (IDamP) and the phantom midge *Chaoborus crystallinus*
- models predicting bioaccumulation in the food chain
- a complex lake model (StoLaM) for water management
- a coupled model linking the lake model (StoLaM) with the individual-based population model for *Daphnia magna* (IDamP) which is used in environmental risk assessment of pesticides
- a vegetation succession model for grassland used in land use management
- ecologically based Decision Support Systems (DSS) for flood protection and land use management

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