

European Commission, Directorate General for Environment

Final Report

Training Course “Bioremediation of waste from marine pollution”

03 - 07 November 2002 in Bremen, Germany

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The following lecturers provided valuable contributions which were essential for this course:
Dipl.-Biol. Karlo van Bernem from the GKSS, Institute for Coastal Research, Geesthacht, Germany

Dr. Gustav A. Henke (Umweltschutz Nord GmbH & Co., Ganderkesee, Germany)

Dipl.-Ing. Bernhard Knollmann (Bezirksregierung Lüneburg, Germany)

Dr. Stéphane Le Floch (CEDRE, Brest, France)

Dr. Sarah MacNaughton (AEA Technology Plc, UK)

Dr. Lars Stemmler (BLG Consult GmbH)

Dr. Johanna Wesnig (Max-Planck-Institute Marine Microbiology, Bremen, Germany)

Dr. Martin Wittmaier (Institute for Recycling and Environmental Protection- Institut für Kreislaufwirtschaft, Bremen, Germany)

Dr. Christopher Wooldridge (Cardiff University, Cardiff Marine Institute, UK)

Dr. Hilke Würdemann (Universität Karlsruhe, Institute of Aquatic Environmental Engineering, Germany)

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Last but not least we would like to thank the participants for their enthusiasm and dedication to contribute to the course.

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1. Objectives

The course "Bioremediation of Waste from Marine Pollution", performed in Bremen, 03 – 07 November 2002, was one course in a series of related training activities in the field of accidental marine pollution co-funded by the European Commission's General Directorate Environment.

The overall objectives for this course were:

- To foster co-operation between the member countries in the field of combating accidental marine pollution and treatment of resulting wastes;
- To enhance information exchange between professionals inside the European Union and to evaluate experiences gained in this context;
- To further develop the practical and professional knowledge of personnel from local, regional and government authorities dealing with the issues under question.

Additionally to this overall objectives specific objectives were set for this specific course on "Bioremediation of Waste from Marine Pollution". It was aimed for that the participants would obtain the following information and experience from the course:

1. Detailed information on the actual techniques used in the area of bioremediation of oily and other wastes;
2. In depth knowledge gained from practical examples and case studies;
3. Detailed understanding of the costs, benefits, duration and constraints of different techniques;
4. Development of Guidelines for use of the techniques.

2. Performance of the course

2.1. Overall Performance

The course on "Bioremediation of Waste from Marine Pollution" was executed by the Institut für Kreislaufwirtschaft GmbH (Institute for Recycling and Environmental Protection) in cooperation with the BLG Consult GmbH in Bremen in November 2002. Sixteen participants from 12 Maritime Member States participated the course (see figure 1).

The course was carried out according to the timetable given in the course folder which has been prepared for the participants (see Annex 1). The course is described in detail in the course folder. The folder consists of the following:

- course programme
- list of lecturers
- biographies or CV's of lecturers
- list of participants
- abstracts (in English and French) and papers of the lectures
- Information on the simulation exercise
- additional information material and brochures which were handed out by the lecturers and participants during the course.

Annex 2 lists the content of the course folder including all additional papers.

The event started on Sunday Morning, 03.11.02 in a conference room of the Hotel Westfalia in Bremen. After an address of welcome by the Director of the Institut für Kreislaufwirtschaft GmbH, Dr. Wittmaier, and by Capt. Brünings from the BLG Consult GmbH, the week plan was introduced by the Course Director, Dipl.-Ing. Findeisen.

The participants were offered the opportunity to introduce themselves to the group and to present their background and experience (see Annex 3: list of delegates). As this was notified in advance the participants had prepared short presentations. Some used the chance to use visual aids.

To conclude the day a guided City Walk through the old City Centre of Bremen and a Welcome dinner in the evening were organised which served to acclimatise and for the group to get to know each other.

On Monday Morning the opening of the course was done by Mr. Voss from the Central Command for Maritime Emergencies (CCME) Germany. He gave an introduction on the German strategy for spill response and on the tasks of the Management Committee on Marine Pollution.

One of the main features of the course were lectures by national and international experts to provide the necessary theoretical background upon various aspects of Bioremediation (see Chapter 2.2). In addition a number of opportunities were offered to the participants for own contributions and exchange of ideas and experiences (see Chapter 2.3). Thirdly an excursion

to a company was arranged which is involved in the bioremediation of contaminated soils and sediments (see Chapter 2.4).

At the end of the week the participants were asked to evaluate the course. Two evaluation sheets were filled in, one prepared by the organisers focusing on the content of the course, and one used by the EC DG Environment for evaluation of all related training courses, focusing on the overall arrangements (Chapter 3.2).

Finally every participant was handed a personal certificate which certified their participation of the training course (Annex 4).

Apart from the formal opportunities arranged during the lectures and exercises the organisers provided additional possibilities for the participants and the lecturers of the respective day to communicate and exchange views and ideas. All meals during the week were pre-organised and taken together, either on the premises of the University of applied Sciences, in restaurants or in the hotel. Additionally one to two half hour breaks per day were planned in the schedule to leave ample time for discussions within the group and/or with the lecturers.



Figure 1: The participants from the course “Bioremediation of Waste from Marine Pollution”.

From left to right: Vincent Hayes (IRE), Stephen Verity (IRE), Stefan Heitefuss (GER), Maria do Pilar Pestana da Silva (P), Roberto Giangreco (I), Marina Penna (I), Bernhard Knollmann (Lecturer- District Administration Luneburg, Germany), Camilla Della Torre (I), Gloria Lopez Gamallo (E), Susanne Findeisen (Course Director), Maria Anousaki (GR), Jamie Storrie (UK), Konstantinos Korizis (GR), Inge van der Felde (NL), Stéphane Le Floc (F), Peter van den Dries (B), Carsten Rasmussen (DK)

2.2. Lectures

To fulfil the *objectives 1-3* lectures were given by a number of national and international experts.

The course started with an introduction to the topic bioremediation and marine pollution by Dipl.-Biol. Karl-Heinz van Bernem from the GKSS-Research Centre, Institute for Coastal Research, Geesthacht, Germany. He stressed the importance of sensitivity studies of coastal areas as a prerequisite for in-situ bioremediation techniques and presented sensitivity mapping of the mud flats of the German North Sea as an example.

After that Dr. Johanna Wesnigk from the Max Planck Institute for Marine Microbiology gave a talk on constraints to biological degradation in the marine environment. It included the sources of pollutants, its fate, behaviour and effects and the limits of natural occurring bioremediation (see figure 2).



figure 2: Dr. Johanna Wesnigk, talking on the sources of marine pollution and their fate.

Dr. Hilke Würdemann introduced bioremediation techniques available to deal with marine pollution. She explained the framework conditions and requirements needed, the different methods ranging from natural attenuation to in-situ and ex-situ bioremediation (on-site and off-site options). Dr. Würdemann concluded with the applicability of bioremediation in the marine environment.

Dr. Henke from Umweltschutz Nord, a company involved in bioremediation of soils and sediments, presented practical experiences and economic aspects of bioremediation from a commercial organisation point of view. Her could demonstrate that it is possible to biologically treat a variety of different contaminations. However costs and time needed for treatment must be looked at when considering biological options.



figure 3: Dr. Henke, giving a talk on biological treatment technologies carried out by the company Umweltschutz Nord and economic aspects.

Dr. Lars Stemmler, from BLG Consult, presented legal aspects in the framework of treatment of marine waste and marine bioremediation.

A number of case studies on experiences with bioremediation, their challenges and results were presented in detail during the one-week course. Dr. Knollmann from the District Authority of Lüneburg presented a case study on landfarming of oil contaminated clay which was the option chosen after a collision of two freighters in an ecological sensitive area of the German river Elbe.

Dr. Sarah MacNaughton from the English Organisation AEA Technology Plc gave a talk on bioremediation of contaminated shorelines focussing mainly on the methodology and results of treatments done after the Sea Empress incident and the Exxon Valdez incident.

Dr. Martin Wittmaier presented lab-, pilot- and field studies of ex-situ bioremediation of TBT-contaminated harbour sediment which have been carried out by the Institute for Recycling and Environmental Protection. Although TBT is not introduced into the marine environment

by accidents, it is a chronic and very toxic pollutant most countries are confronted with. He presented the way to approach the problem of sediment contamination and how to find scientific correct and economic viable treatment options which can be adopted to other pollutants as well.

Finally Dr. Le Floch from CEDRE, France, who was also nominated as a participant, presented a case study on the ERIKA-incident. Although bioremediation was not the treatment option chosen in the ERIKA-incident, this example illustrated the methodology to assess the potential of bioremediation in a particular situation.

2.3. Contribution by the participants

Apart from the introductory round at the beginning of the course, the participants were asked to contribute actively at various occasions. After each lecturer the participants used the chance for discussion within the group and with the lecturing experts. In addition all participants were actively involved in the following discussion sessions and exercise.

Discussion about the guidelines on marine bioremediation, developed by Cadiz University and the Spanish Association of Fishing Cities AECIPE

Originally the *forth objective* of this course was to develop guidelines on marine bioremediation. However this was already done by the Cadiz University and the Spanish Association of Fishing Cities AECIPE. Within the framework of the three-year-rolling plan of the EC they have jointly carried out the workshop on "marine bioremediation technologies" in July 2002 to develop guidelines and a screening matrix. As a consequence the organisers decided, with the approval of the Commission, that it is more effective to use the results of the workshop and not to start a parallel activity to develop guidelines. At first, Dr. Hilke Würdemann presented the guidelines to the participants. The guidelines were then discussed by the participants and the present lecturers/ experts. The results of the evaluation are made available to the authors of the guidelines.

The participants found that the use of bioremediation depends on various factors and must be decided for each situation and by the help of experts. It is a very complex and challenging tasks, especially as there are not much practical experiences with in-situ marine bioremediation yet. Generally a lot of information is needed which cannot be given in this guidelines like this.

However the group agreed that the guidelines represent an adequate tool which can be used for a first evaluation at the preplanning stage whether or not bioremediation can be further considered as a treatment options. Also the guidelines give a good overview on the criteria which need to be considered. Thus they can be useful for training purposes. In this context the guidelines of the U.S. Environmental Protection Agency on marine bioremediation were mentioned as a good example which summarise information available in the form of a literature review.

Suggestions made by the participants for improvement of the guidelines include:

- the addition of other response or treatment options, to give a broader overview,
- the addition of a list of experts (who has experiences with bioremediation),
- the consideration of low energy coast (Mediterranean coast),
- the improvement/ further specification of the screening matrix.

Discussion about the use of bioremediation in EU-Member states

There was a session offered for open exchange concerning Bioremediation. The participants used the chance to discuss the use of bioremediation in their countries. It became clear, that there are great differences in the application and experiences with marine bioremediation (in-situ and ex-situ) in Europe. Only some countries have experiences with in-situ bioremediation, in particular with marine bioremediation. The legal situation gives different frameworks for considering bioremediation in practice. Also the extent and objectives of research in this field varies. Some countries are on the way to develop national guidelines for the application of marine bioremediation. In summary the participants could expand their view on bioremediation and realised the chance for the countries to profit from the experience of others.

Simulation Exercise 'OPERATION BREMEN' (BioRemediation for Effective Management of Environment and Nature)

Dr. Wesnigk and Dr. Wooldridge formulated and moderated a practical exercise for the participants. The exercise was set in the context that an incident had occurred, salvage operations and emergency / contingency plans were in operation, and a command and control team had been set up to deal with the strategic response. As part of national response plan, a team had been specifically tasked to consider the options for bioremediation as part of short- and longer-term response. It also had been asked to provide a statement of Intent in the form of a structured press release paper to give information to the concerned public.

The exercise was designed as an integral component of the course and to be an important step in the progression of learning through knowledge, understanding and synthesis. The participants should further their skills in integrating the factors that feed into the decision-making process concerning the options for applying bioremediation. The objectives of the exercise were:

- to provide realistic scenarios within which participants can recommend appropriate options for applying bioremediation techniques, considering both in-situ and ex-situ approaches,
- to encourage a multidisciplinary, team-based approach to the implementation of selected response options,
- to demonstrate the significance of science-based evidence and the quality of information required in developing management plans,

- to provide the opportunity for participants to develop further their confidence and competence in applying the guidelines and screening procedures available.

The exercise was divided into four different scenarios: 1: Milford Haven (UK), 2: Limenas Porou (Greece), 3: Wadden Sea (Germany) and 4. Ballydehob (Ireland). Therefore the participants were split into groups of three or four, with different nationalities, professional backgrounds and levels of experience, so that each group could deal effectively with one scenario. A team leader was designated for each group. The Course Instructors Dr. Wooldridge and Johanna Wesnigk represented the liaison officers, and were available to answer questions related to the operational scenarios.

The groups were provided with:

- description of the exercise, its rules and objectives
- situation report of the declared incidents
- checklists on aspects /criteria which should be considered
- Nautical charts and for the effected coastlines for each scenario
- Guidelines on marine bioremediation and screening matrix
 - o Environmental Technologies Research Group Faculty of Marine and Environmental Science, Cadiz University, Spain and AECIPE, Cadiz, Spain (2002) "Guidelines: Marine Bioremediation Technologies, Screening Matrix and Reference Guide, Draft. Version III", July 2002
 - o International Maritime Organisation IMO (2001): "Draft Guidance Document for Decision Making and Implementation of Bioremediation in Marine Oil Spill" Submitted by France, 14 Dec. 2001
 - o U.S. Environmental Protection Agency (EPA) (2001): "Guidelines for the Bioremediation of marine shorelines and freshwater wetlands". September 2001
- Impact Reference System – Effect of Oil in the Marine Environment: Impact of Hydrocarbons on Fauna and Flora (European Commission).

The description of the exercise, the scenarios, the checklists on aspects to consider during the exercise and the results of the groups (in the form of overhead slides, etc.) can be found in Annex 5 a-c.

All groups were working very actively and dedicated and presented the results afterwards to the other participants (figures 4 and 5). On completion of the exercise after three hours, participants were able to:

- recommend the most appropriate options for the application of bioremediation techniques based on best practice guidelines,
- describe the criteria used in the decision-making process and identify the advantages and disadvantages of the techniques that they have recommended,
- appreciate the range of environmental, technical, regulatory, and economic considerations involved in bioremediation of wastes,
- understand the significance of time, environmental characteristics and coastal dynamics in applying bioremediation techniques.

The Course Instructors compiled a list of the major recommendations which was used as points for discussion so that the whole group could benefit from the experience and recommendations made for each different scenario. Furthermore moderators and participants used the material from the simulation presentations to debate the major issues arising from spill incidents and the potential application of bioremediation options. The following aspects were mentioned from the groups to be relevant in reference to marine bioremediation (in brackets: Number of times mentioned from the working groups):

- Monitoring (3)
- Field- and laboratory work (3)
- Details of (3)
 - o Chemicals
 - o biota
- Exposure (2)
- land use /sea use (2)
- Contingency and response (2)
- Investigation (1)
- Test-experiment (1)
- Access for tourism; Access for Scientists (1)
- Tidal range (1)
- Sediment size (1)
- Beach replenishment (1)
- Time (1)
 - o For biological process
 - o For recovery
 - o Seasons to consider
- consideration designations (1)
- Lack of detailed information (1)
- Logistics (1)
- Safety vs. environment (1)
- Do something ↔ do nothing (1)

The exercise itself was deemed successful in harnessing the talents and professional experience of the participants and complementing the information provided during the course itself. In conclusion, it may be suggested that the simulation provided a vivid insight into the challenges of identifying relevant criteria which need to be considered in marine bioremediation and the problems on decision-making whilst working in an international forum within strict time limits (admittedly, no substitute for the 'real thing', but a useful exercise!).



figure 4: Group 2 and Dr. Wooldridge discuss the potential use of bioremediation for a specific site at Limenas Porou, Greece.



figure 5: Group 3 presents their recommendations on the use of bioremediation in the Wadden Sea.

Final round-the-table discussion and summary

The exercise functioned as a synthesis of the major considerations and facilitated a final group discussion and summary of the training outcomes. Reflecting the wide background and range of experiences of the group, the training effect ranged from "learnt about a completely new topic", "got more information on the topic", "changed the opinion", "got more realistic ideas" to "opinion was mainly confirmed".

The participants concluded by summarising vital aspects of marine bioremediation:

- bioremediation is one option among others; its application should be considered as a polishing step after the first clean-up (it is not an emergency technique!),
- insitu bioremediation can only be used in small "niches" as there are many restrictions; it should be considered carefully,
- in most European countries marine insitu bioremediation is applicable probably only to a very limited extent, in some countries it will not be applicable at all,
- ex-situ bioremediation has a larger potential in Europe, especially when stricter regulations on landfill-sites come into force in the future,
- monitoring is essential,
- working together inter-disciplinary is an important prerequisite for successful bioremediation (scientists, engineers, planners, authorities, etc.),
- a lot of information is needed for deciding on bioremediation options (e.g. sensitivity of coastline/ beach); this should be taken into account in national contingency plans,
- there is not a lot experience on marine bioremediation, much more research needed.

2.4. Visit of Waste Treatment and Bioremediation Companies

A site-visit to the company Umweltschutz Nord GmbH & Co. KG was organised on an afternoon (figure 6). Umweltschutz Nord GmbH & Co. is a leading company for bioremediation of contaminated soil in Germany. Dr. Killer explained the biological treatment of soils and sediments which is contaminated by oil, other hydrocarbons or chemical substances. The treatment is carried out in large treatment halls (figure 7). The principle of bioremediation involves the optimisation of the conditions for the microorganisms which degrade the pollutants. The soil is piled to "windrows" and is intermittently mechanically mixed to provide aeration for the microorganisms and to homogenise conditions throughout the windrows. Biofilters absorb emissions and the final product of the bioremediation, CO₂. Another treatment option for highly contaminated material was explained: the thermal treatment plant (figure 8). The treatment principle bases on desorption and catalytic oxidation at high temperatures. Dr. Killer explained the advantages of the treatment options and the conditions under which they are applied.



figure 6: Site visit at Umweltschutz Nord.
Background: right: a large pile of treated soil, left: thermal treatment plant.



figure 7: A treatment hall for treating contaminated soil in windrows.

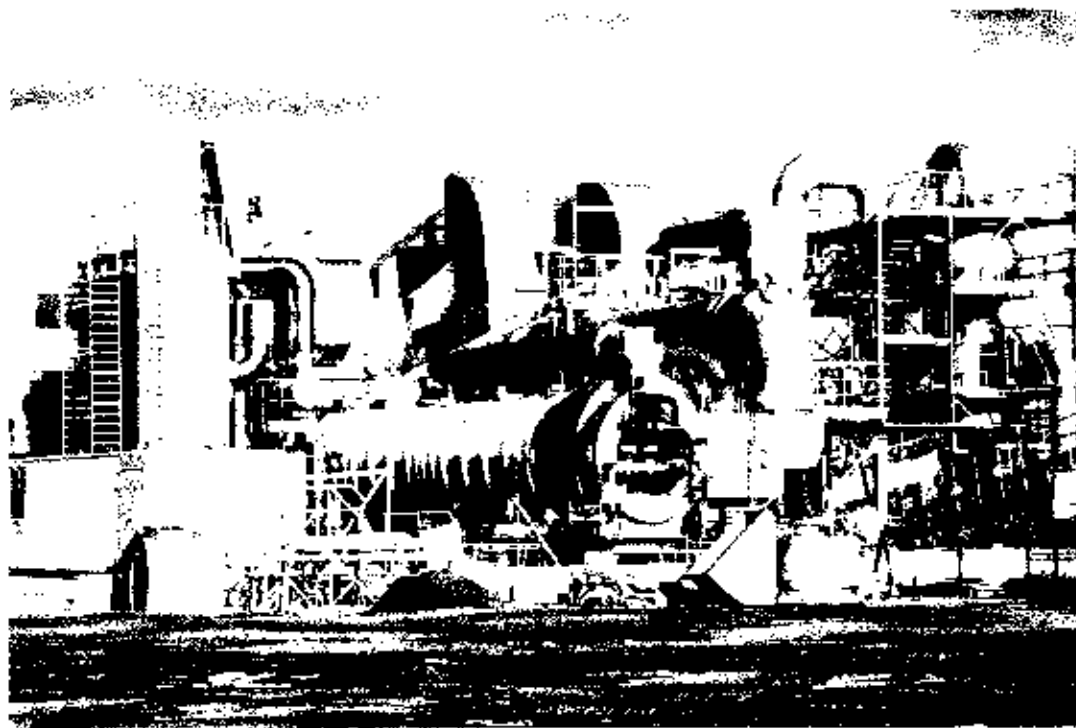


figure 8: The thermal treatment plant for highly contaminated soil of Umweltschutz Nord GmbH & Co.

3. Results and Conclusion

3.1 Evaluation of the course

The participants were asked to evaluate the course according to an own evaluation sheet from the organisers and the DG Environment's course evaluation sheet (Annex 6 a). The scale of the organisers evaluation ranged from "good", "adequate" to "poor". The scale of the DG Environment evaluation was different with every question, using 4 or 5 grades. For detailed results please see Annex 6 b, c.

Objectives

All participants felt that the objectives of the event were met well or completely (EC Questionnaire, Question 1). One participant did not give his/her evaluation.

Own Objectives

The evaluation shows also that the own objectives of the participants were similar to those set for the course. 15 participants felt that their own objectives for the course were met well or completely (EC Questionnaire, Question 2). Again 1 participants did not give his/her evaluation. Please see Annex 6 b for the own objectives for the training stated by the participants.

Content

The content was considered relevant (13 times) or even very relevant for their jobs (3 times) (EC Questionnaire, Qu. 3a). According to the EC Questionnaire, the level of content was about right for most participants (14 times) (EC Questionnaire, Qu. 3c). Only 2 participant found that the level was too advanced.

The content of each lecture was evaluated on the IKrW Evaluation sheet. The content of the topics altogether received mainly the best mark "good" (12 times) (IKrW Qu. A).

The majority of the participants found that the content of 8 out of 10 lectures deserved "good" (here: best mark). Two got mainly "adequate". The excursion was mainly regarded as "good" (11 times)

Format

The amount of topics covered was about right (15 times) (EC Questionnaire, Qu. 3b). Only one person found that too much was covered. Reflecting this, 15 persons found the length of the event about right, one person found the course too long (EC Questionnaire, Qu. 3d).

The majority of the participants evaluated the skills of the speakers to be very good (7 lecturers) or good (2 lecturers) (EC Questionnaire, Qu. 4). According to the IKrW Questionnaire (Qu. C) all delegates summarised that the quality of the lecturers deserved the highest mark. In addition almost all participants thought that their performance and methodology used was very good (EC Questionnaire, Qu. 5; IKrW Questionnaire, Qu. B).

Organisation

The seminar organisation and administration received the best mark (IKrW Questionnaire, Qu. E) from 14 out of 16 participants and this was repeated several times in the "own comments" section.

Overall

According to the EC questionnaire (Qu. 6) the overall event was found to be very good (11 times) or good (5 times). Everybody would recommend this type of event.

4 Conclusion

Finally it can be said that everything went very well from the organisational point of view due to the pleasant atmosphere in the Bremen University of applied Sciences, and due to the interest, openness and the lively contributions of all participants.

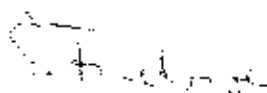
The participants used the time intensively for discussions and professional exchange during the sessions especially dedicated for discussions, the lectures, the group work and the breaks. The joint meals gave extra time for that which was received well.

The participants were actively involved in the discussions, the evaluations of the guidelines on bioremediation and in the simulation exercise. Although there was a wide range of objectives and expectations from the participants the course has been received well. Reflecting the wide background of the group, the training effect ranged from "my opinion was mainly confirmed" to "I changed the opinion" and "I learnt about topic which was completely new for me".

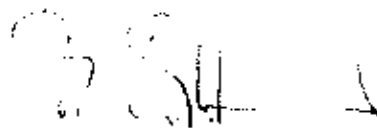
The group agreed that marine bioremediation, in particular insitu techniques, will represent a niche technology for Europe due to many restrictions and criteria which have to be considered. It became clear that further research has to be done on this complex topic as experiences are limited. However the group was very interested in potential applications for bioremediation (insitu AND exsitu), which can represent an environmentally and economically sustainable option for marine contamination.

Bremen, May 2003

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