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Modeling of spills dispersion in transboundary waters

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1. Basis for operational modelling of hazardous substances transportation

Legal framework

- European Water Directive (Art. 11 (3) l)

Each member state behaves with care,
So that for every unit of river area....
There is a programme of preventive measures
Every preventive measures programme contains **"basic preventive measures" ....**
Basic preventive measures ... contain.....
All necessary measures...
(in case of unexpected pollution)...
In order to give an early warning...
In order to reduce the risk

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1. A basis for operational modelling of hazardous substances transportation

Application of Art. 11 (3) of the European Water directive

- International alert and alarm plan for Rhine

The task of the alert and alarm plan is ...
passing on the notification about pollution with substances which are a hazard to water
… warning sent to appropriate authorities ... using a Rhine alarm model (a downstream flow time model)
in order for the goals to

- counteract the hazard
- state the reasons
- identify the perpetrator,
- take steps to repair the damages
- tame measures to avoid and reduce damages in the future,
- Avoid the results of damages

could be reached.

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1. A basis for operational modelling of hazardous substances transportation

Application of Art. 11 (3) of the European Water directive

- International alert and alarm plan for Elbe

The task of the alert and alarm plan is ...
passing on the notification about pollution with substances which are a hazard to water
… warning sent to appropriate authorities ... using a Rhine alarm model (a downstream flow time model)
in order for the goals to

- counteract the hazard
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could be reached.
... In order to make the reports more precise, the calculations for the Elbe alarm model have been used ...

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1. A basis for operational modelling of hazardous substances transportation

Organisational framework/ reporting paths

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1. A basis for operational modelling of hazardous substances transportation

Water situation on the Elbe

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2. Operational modelling of flowing waters drainage paths

- requirements
  - a simple model (user friendly)
  - working with a PC
  - short duration (quasi immediate results)
- Implementation ► ALAMO
  - single-dimension numerical model
  - empirical formulation of dispersion and transverse crossing
- requirement
  - dispersion and transverse crossing values calibration
- Tracer methods experiments

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3. Physical grounds for modelling

Efficient processes in:

- **The mainstream**
  - advection
  - diffusion/ dispersion
  - distribution
  - moving out of / moving into
- Tranquil water zone
  - distribution
  - moving out of / moving into

Numerical usage:
Extended Taylor Model
1,5 – dimensional model

- **Calibration necessary**

Introducing a substance and time shift during substance introduction

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4. Tracer methods experiments for model calibration

- Test review
- Instruments available
- results

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4. Tracer methods experiments for model calibration

Test review: Instruments available; results
Tracer introduction: in a variety of spots along the Elbe;
under varying outlet conditions Q with MNQ < Q < MHQ

Date	Location of tracer introduction	station [km]	Number per tracer [kg]	Outlet Q [mł/s]	MNQ [mł/s]	MHQ [mł/s]	reference
29/11/99	Němčice	-249.2	2.0	16	12	309	Dostál et al.
02/05/05	Němčice	-249.2	8.0	52	12	309	
26/04/99	Mělník	-104.8	24.0	255	76	1324	Dostál et al.
30/11/97	Ústí	-37.0	12.1	130	91	1430	Dostál et al.
15/07/97	Schmilka	4.1	33.5	330	102	1480	Hanisch et al.
29/03/01	Schmilka	4.1	75.8	912	102	1480	Hanisch et al.
06/10/04	Mauken	184.5	20.0	136	114	1380	
11/10/99	Elster	200.4	26.0	160	130	1490	Hanisch et al.
27/10/98	Elster	200.4	26.4	265	130	1490	Hanisch et al.

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4. Tracer methods experiments for model calibration

- Test review
- Instruments available
- results

per SRG tracer adjusted fluorometers
measurement In the mainstream
measurement In tranquil water zone

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4. Tracer experiments for model calibration

Time sequencing during tracer measured concentration
In the Elbe (outflow Q=150 m3/s)
Results assessment from the viewpoint of:
Duration
Start of tracer passage
Max. tracer passage
End of tracer passage
Max. concentration of tracer cloud
In the mainstream
In tranquil water zone

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5. Calibration and model usage

accident report

- perpetrator and location
- type of harmful substance
- time and quantity

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5. Calibration and model usage

- Report of Current outflow situation
- Outflow water level and water curve

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5. Calibration and model usage

calculation of hazardous substances transportation

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5. Calibration and model usage

Presentation of results

- animation of hazardous substances transportation along the river
- presentation of hazardous substances transportation on the map
- hygrograms of hazardous substances concentration
- max. concentration
- time of occurrence
- warning report
- separating concentration following the time frame provided beforehand

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5. Model calibration

Model versus measurement - review

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5. Model calibration

Model versus measurement – partial processes observation
Advection; Dispersion; Transverse crossing

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5. Calibration and model usage

Presentation of results

- animation of hazardous substances transportation along the river
- presentation of hazardous substances transportation on the map
- hygrograms of hazardous substances concentration
- max. concentration

- time of occurrence
- warning report
- separating concentration following the time frame provided beforehand

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6. Model verification

Using the model in case of hazardous substances accident

- water pollution
  - substance: Cyanide
  - location: Nymburk
  - date: 09.01.2006
  - concentration.: >500 µg/l
  - quantity: > 100 kg
  - perpetrator: LZ Draslovka
  - the first warning: 16.01.2006
- Problem
  - lack of precise information on introduction

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7. Summary

- EU Water Directive requires early warning measures in case of water pollution
  - a need for operational modelling of hazardous substances
- **The model available for the Elbe is an operational model embracing a number of countries:**
  - **ALAMO** - gives the duration and max. concentration of hazardous substances cloud
- ALAMO is part of IKSE, the Elbe alert and warning plan
- ALAMO is based on Taylor markings, extended onto tranquil water zones
- Data needed to calculate transportation, ex. The Elbe outflows, can be downloaded form the Internet

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Thank you very much for your attention

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