
BIOMATH
 Department of Applied Mathematics,
 Biometrics and Process Control

**Probabilistic Environmental Risk
 Assessment Framework
 for chemical substances**

Peter A. Vanrolleghem
 Frederik Verdonck, J. Jaworska, C. Janssen

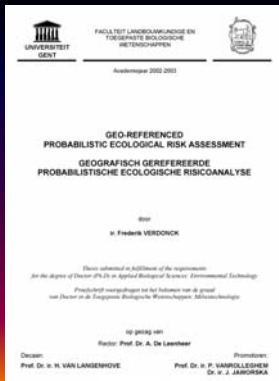
Lund, Sweden, November 28 2003

RUG-Biomath, Coupure 653, 9000 Gent, Belgium (e-mail frederik.verdonck@rug.ac.be)


**Ph.D. of
 Frederik Verdonck**

"Geo-referenced
 Probabilistic Ecological
 Risk Assessment"

[http://biomath.ugent.be/
 publications/download/
 verdonckfrederik_phd.pdf](http://biomath.ugent.be/publications/download/verdonckfrederik_phd.pdf)




F. Verdonck

BIOMATH 

Outline

- Introduction
- Probabilistic ecological risk assessment
 - General framework
 - Variability & uncertainty characterisation
 - Variability & uncertainty propagation
 - Communicating probabilistic risk and its uncertainty
- Reducing spatial variability
- Case study
- The Future: Reducing temporal variability
- Conclusions


F. Verdonck

BIOMATH 

Ecological risk assessment

Exposure Analysis


Models
(Monitoring)




Environmental
Concentration

Effect Analysis

Toxicity tests
(Models)




No Effect
Concentration

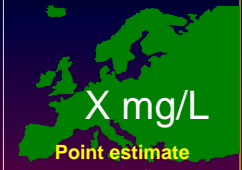


PEC NOEC

F. Verdonck

BIOMATH 

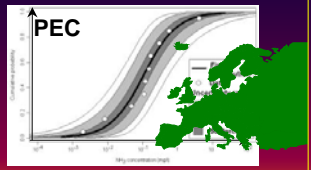
Include variability & uncertainty



X mg/L

Point estimate

Probabilistic approach




PEC

spatial + temporal + other
variability & uncertainty

Make more realistic

F. Verdonck

BIOMATH 

Introduction


- Current risk analysis approaches are:
 - not so realistic & transparant
 - don't stimulate further research
 - don't distinguish between uncertainty and variability

>> **Use of probabilistic approaches**

- No 'standard' probabilistic framework
- Still several (statistical) issues
- Communication issues

>> **Development of probabilistic framework
 + visualisation of risks (communication)**

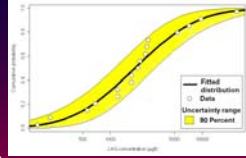
F. Verdonck

BIOMATH 

Variability <=> uncertainty

Variability:

- true heterogeneity
- not reducible through further measurements
- e.g. temporal/spatial variations of river flow



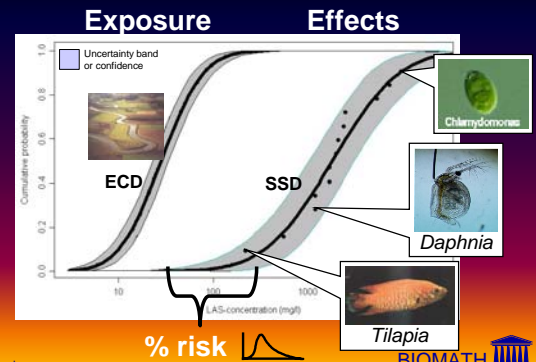
Uncertainty (= epistemic unc.):

- ignorance, partial knowledge
- partly reducible through further measurements
- e.g. sampling or measurement error

F. Verdonck

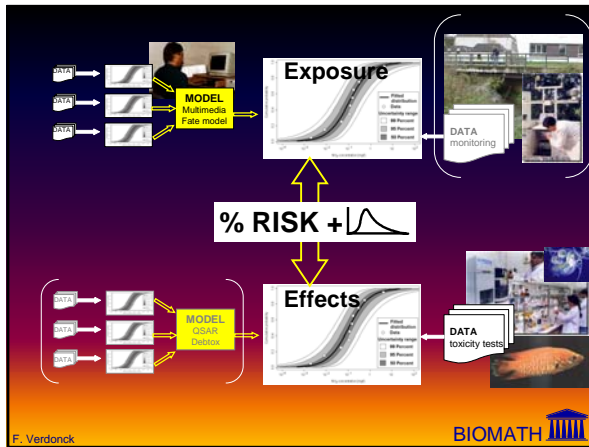
BIOMATH

Probabilistic risk assessment



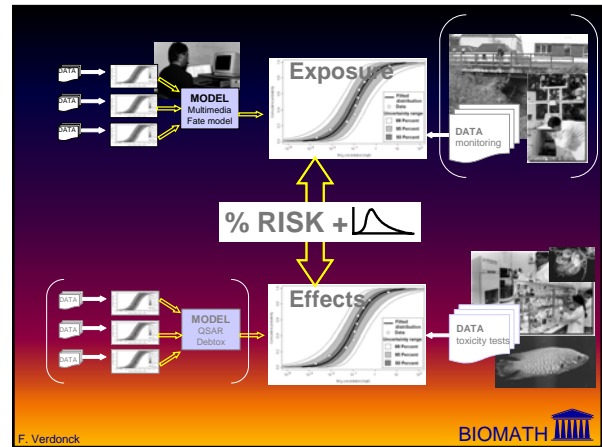
F. Verdonck

BIOMATH



F. Verdonck

BIOMATH



F. Verdonck

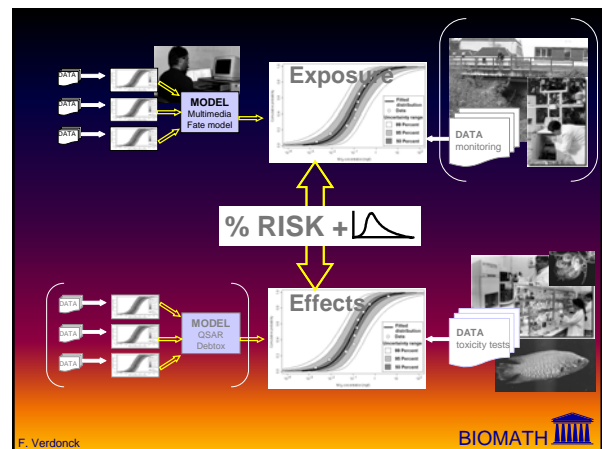
BIOMATH

Characterising & propagation

- Characterising variability & uncertainty
 - Maximum likelihood method
 - Bayesian approaches
 - Bootstrapping
 - ...

F. Verdonck

BIOMATH



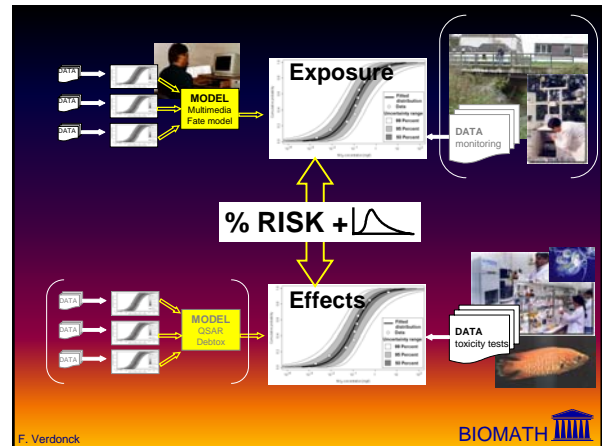
F. Verdonck

BIOMATH

Characterising & propagation

- Characterising variability & uncertainty
 - Maximum likelihood method
 - Bayesian approaches
 - Bootstrapping
 - ...
- Propagating variability & uncertainty through models
 - Monte Carlo
 - 1st order / 1 dimensional
 - 2nd order / 2 dimensional
 - ...

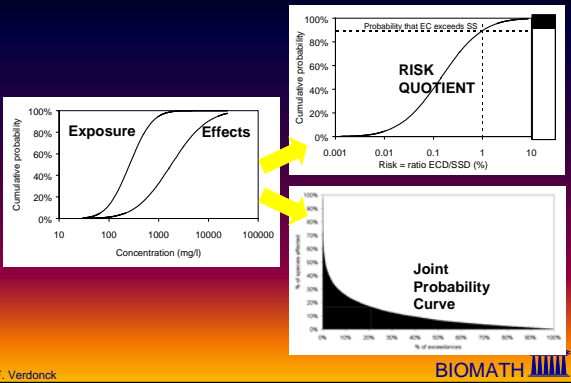
F. Verdonck



F. Verdonck



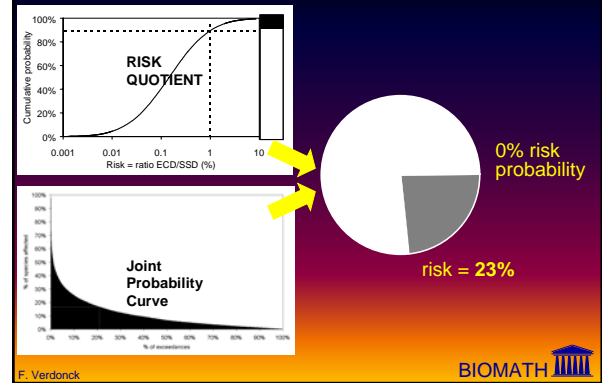
1D Risk calculation



F. Verdonck



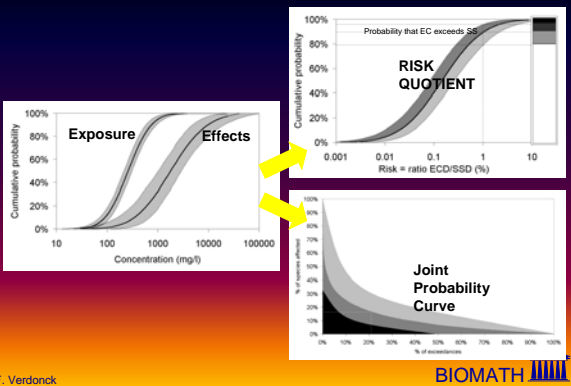
Risk visualisation



F. Verdonck



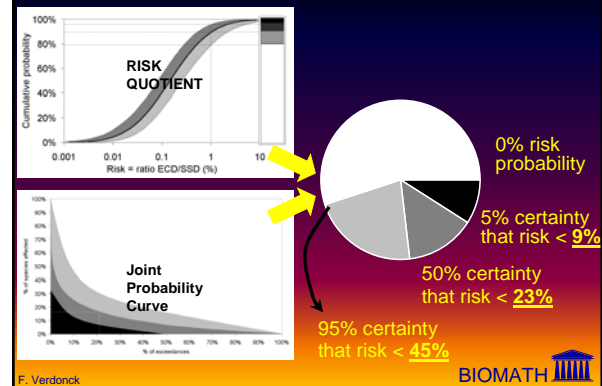
2D Risk calculation



F. Verdonck

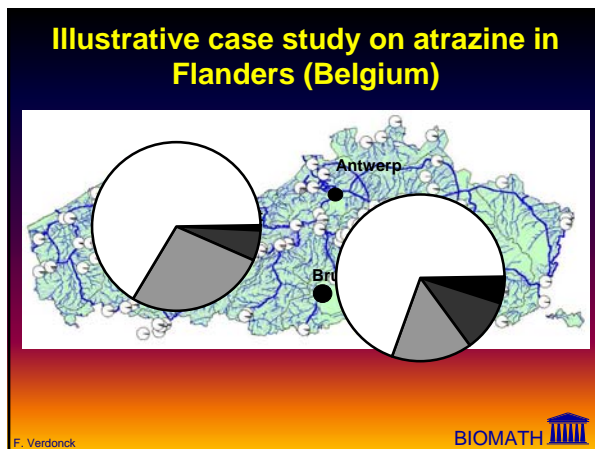
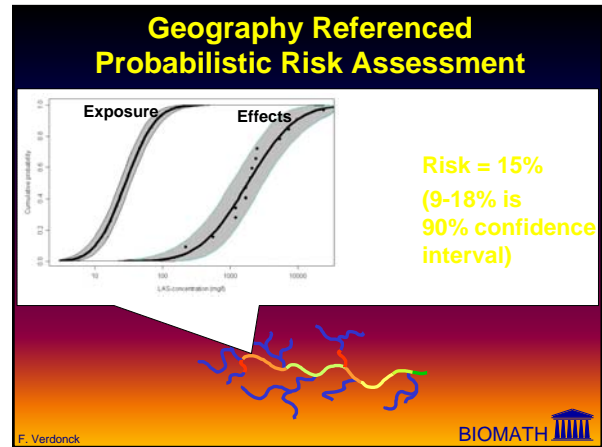
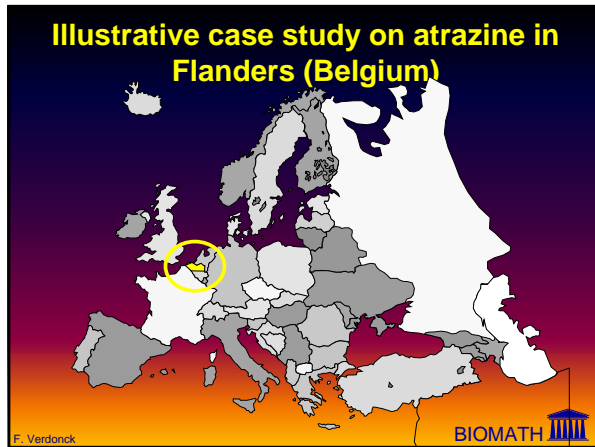
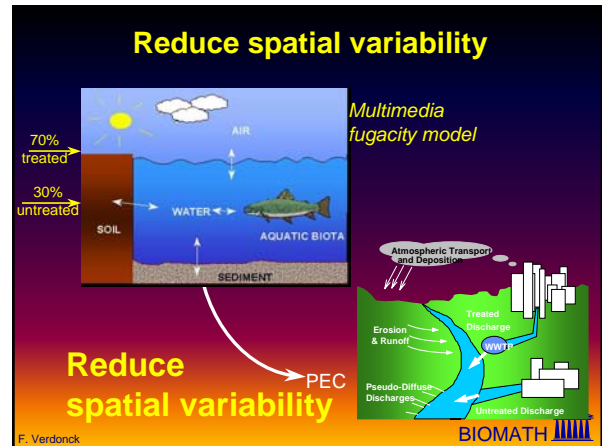
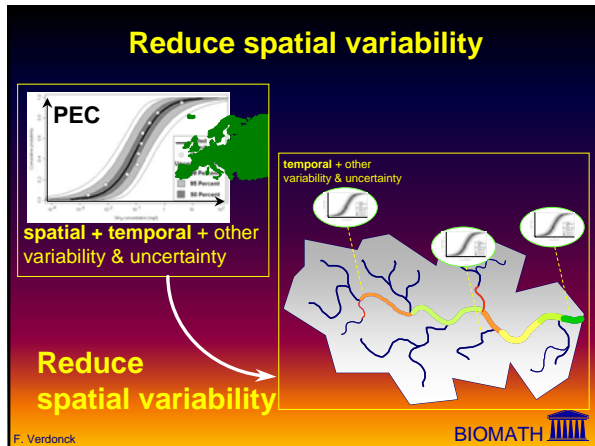


Risk visualisation



F. Verdonck





- ### Conclusions
- A probabilistic risk assessment framework is developed and improved
 - The outcome of the methodology is a percentage risk with uncertainty interval
 - Probabilistic risk assessment improves Decision Support because it is more realistic
 - Pie chart proposed as communication tool for decision makers
- F. Verdonck BIOMATH