Environmental risk assessment in connection with offshore studies

How ERA is used toward offshore activity, differences between issues related to sediment and produced water; methodologies and models practiced in ERA for offshore activities

RF-Akvamiljø
Mekjarvik 12
4070 Randaberg
http://www.rf.no

Contact person:
Dr. Odd Ketil Andersen
Head of Research
Tel.: +47 51 87 50 50
E-mail: oka@rf.no

Hazard assessment - tool:
CHARM

CHARM

Chemical Hazard Assessment and Risk Management

Weighs properties of the chemical product:

Acute toxicity

(marine algae, zooplankton, sediment reworker, fish test data)

Biodegradability

(O_2 consumption or CO_2 evolution tests)

Bioaccumulation potential

(Octanol/water partitioning)

Discharge characteristics

(amounts, dilution factor etc.)

HAZARD quotient

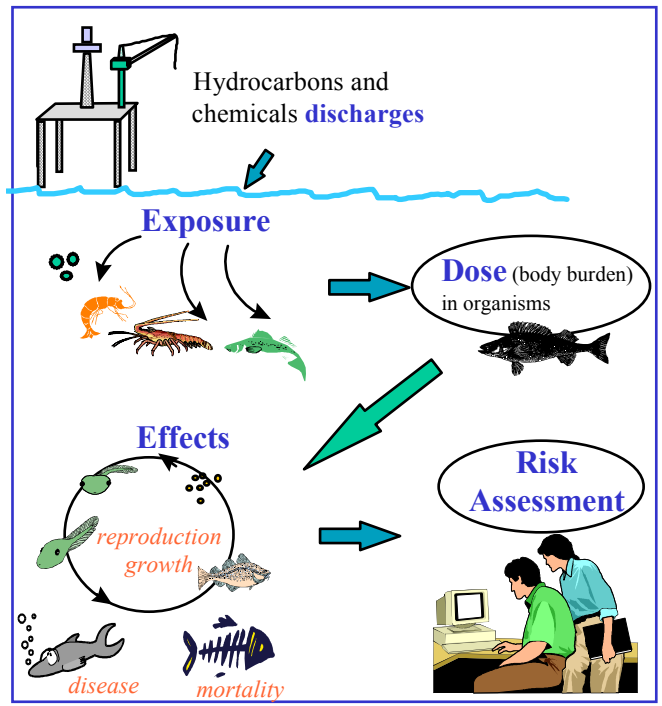
Chemical RANKING

Environmental Risk Assessment - tool
DREAM

DREAM

Dose related Risk and Effect Assessment Model

- Links together:
  - discharges (multi sources)
  - physical/chemical fates of discharges
  - biological uptake
  - biological long term effects
  - expressions of risk



Effluent Discharge

FATE

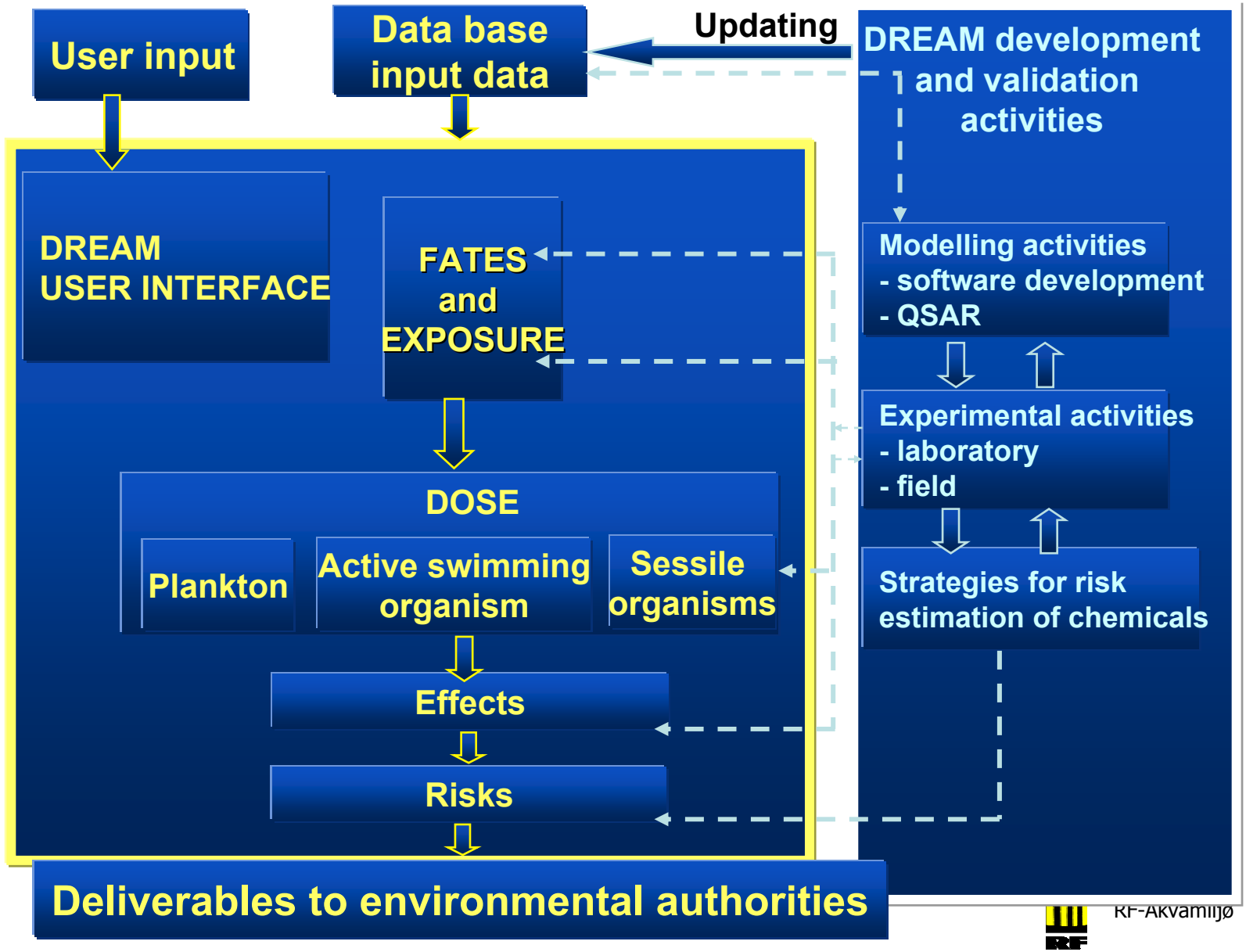
DOSE

EFFECT

RISK

Model

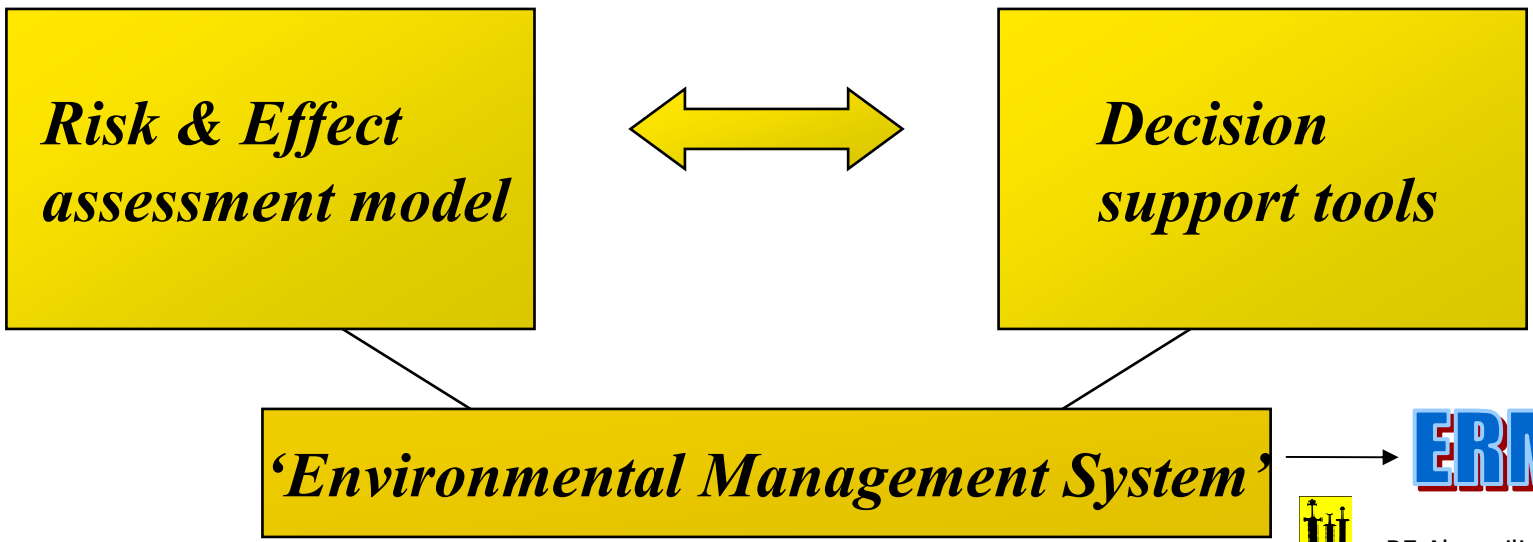
Experiments & Analyses



DREAM proposed follow-up

- *Different purpose tools*

...important to remember that a model is only one of several tools in a decision process... (SFT)



DREAM – EIF Produced water

- A Decision support tool made for the zero discharge plans for the North Sea

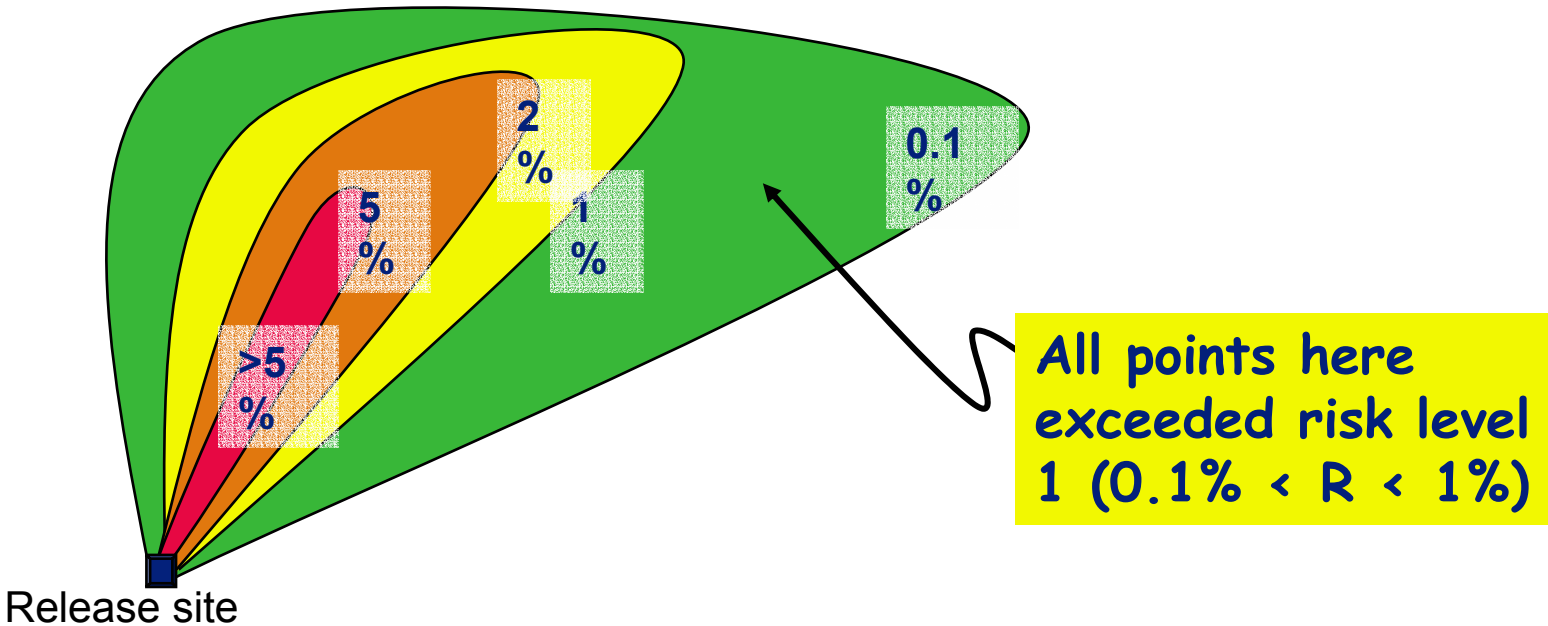
- EIF based on PEC:PNEC
  - PEC = Predicted Environmental Concentration
  - PNEC = Predicted No Effect Concentration

- PEC calculation based on DREAM
  - DISCHARGE and FATE
  - Imported to an Excel spreadsheet (EIF sheet) for weighing

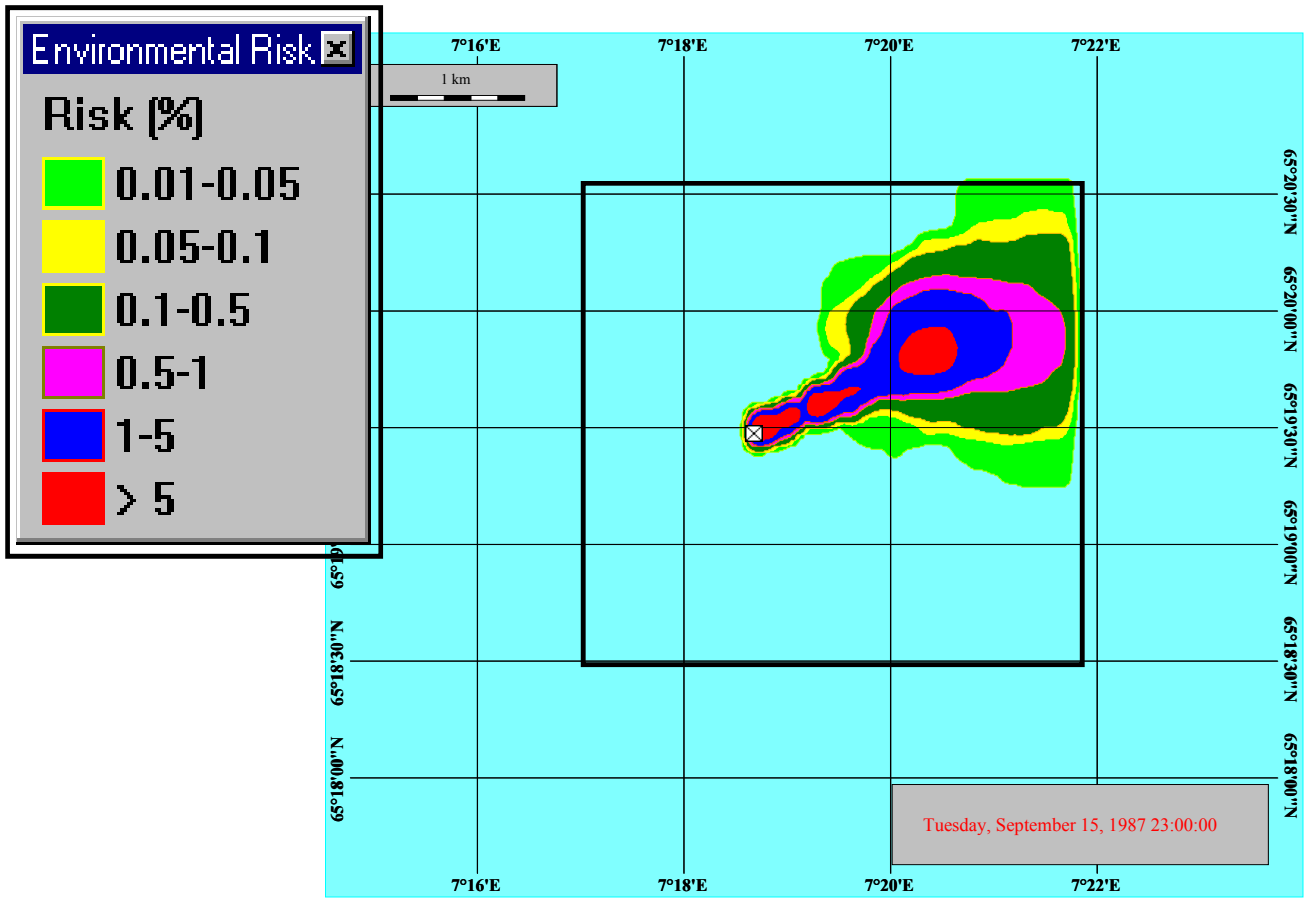
Proposed PEC/PNEC Risk Measures for DREAM

Water volumes exceeding selected risk ranges:

- time-averaged or maximum risk fields
- exposure-variable PNEC analysis (TNO)



Snapshot of total risk from produced water from a single platform



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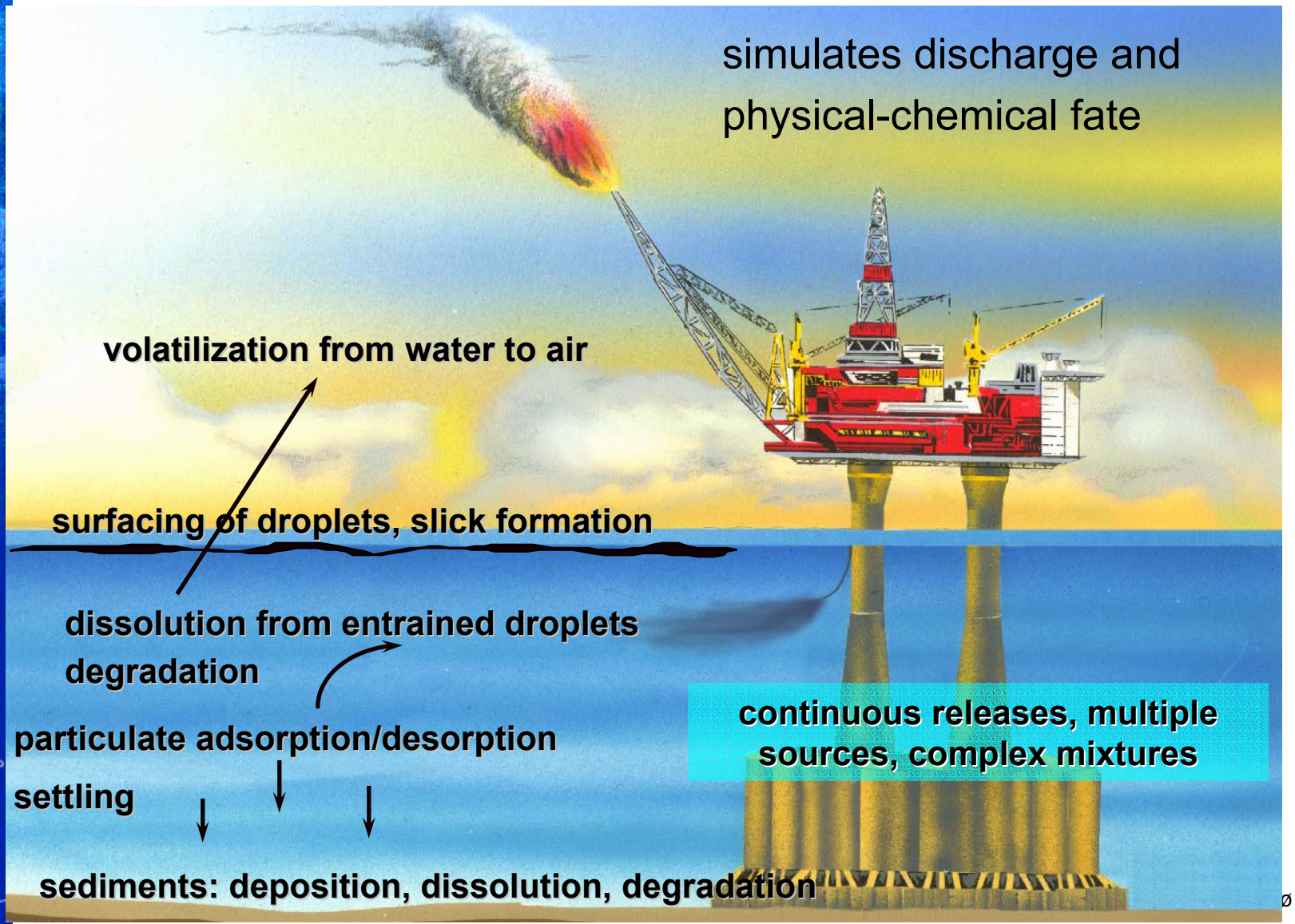
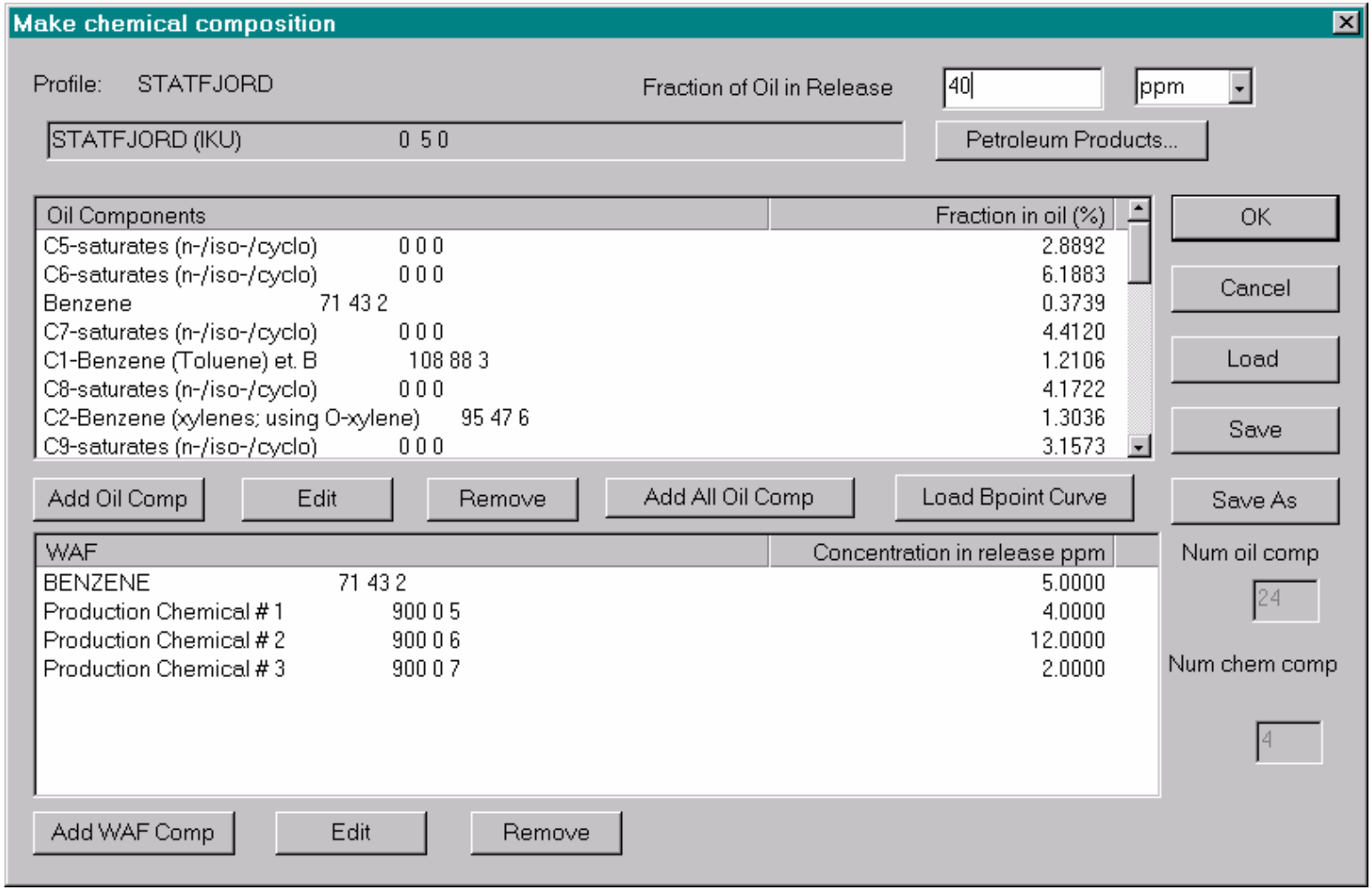
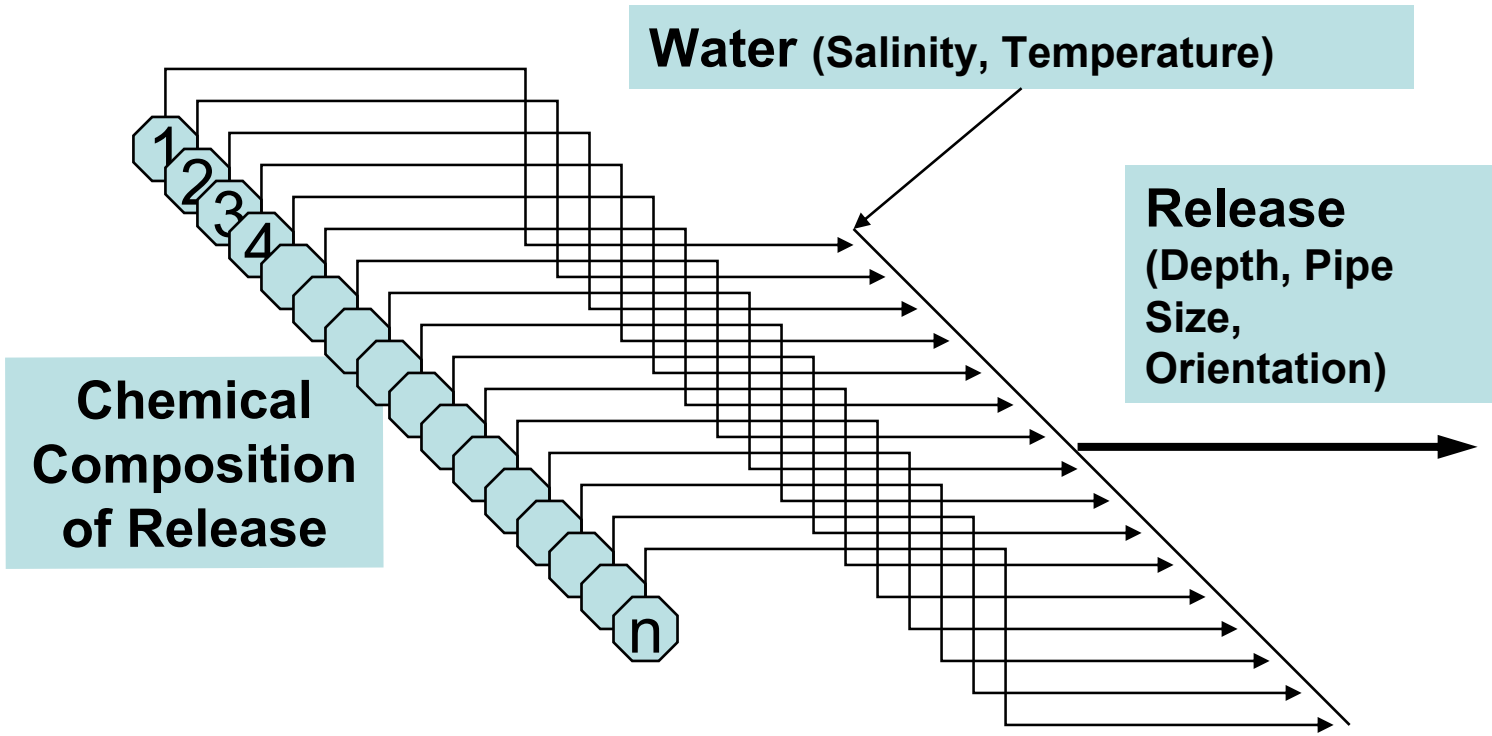
Prediction of environmental concentration (PEC)
using DREAM



User-Specification of Release

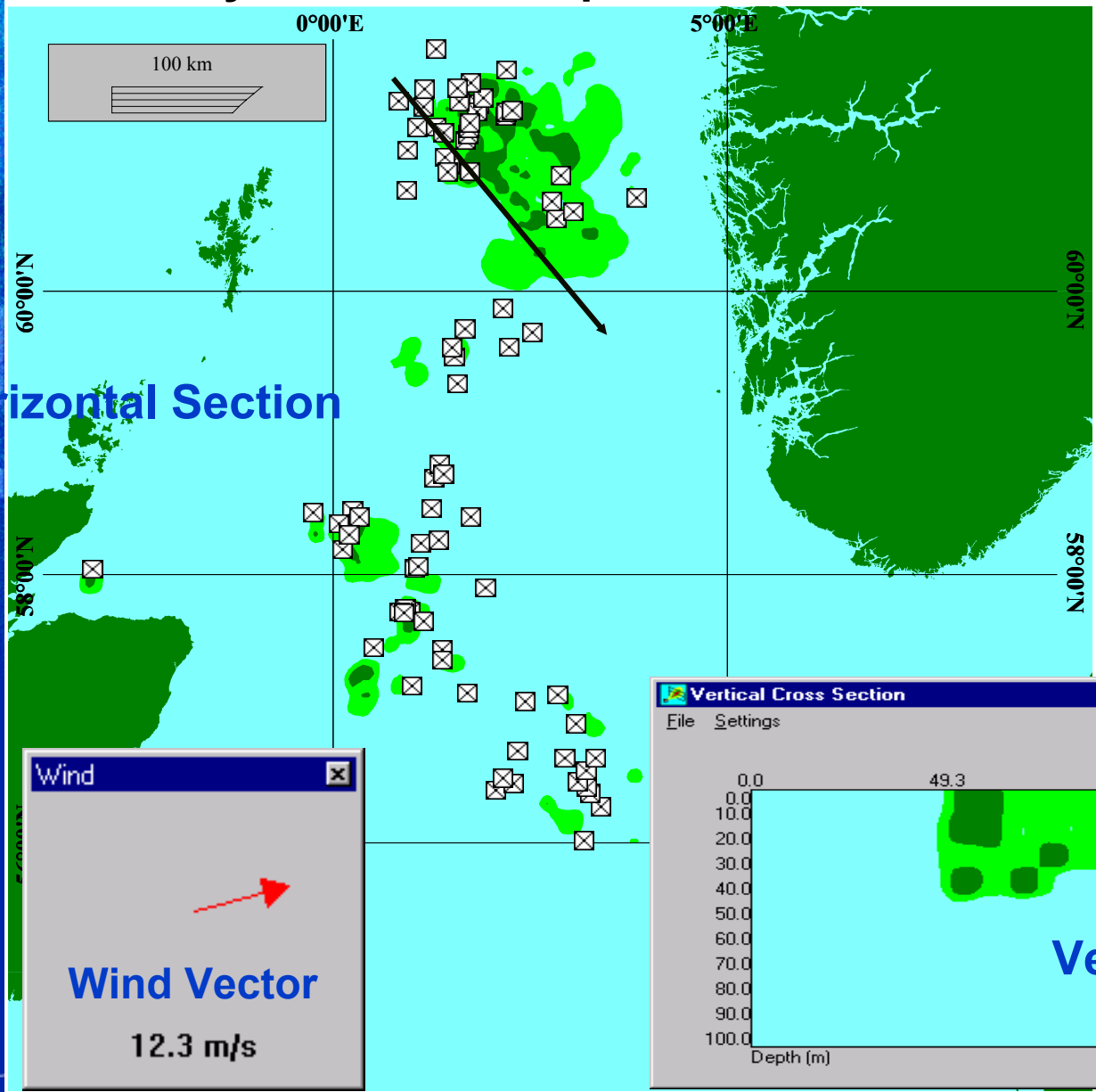


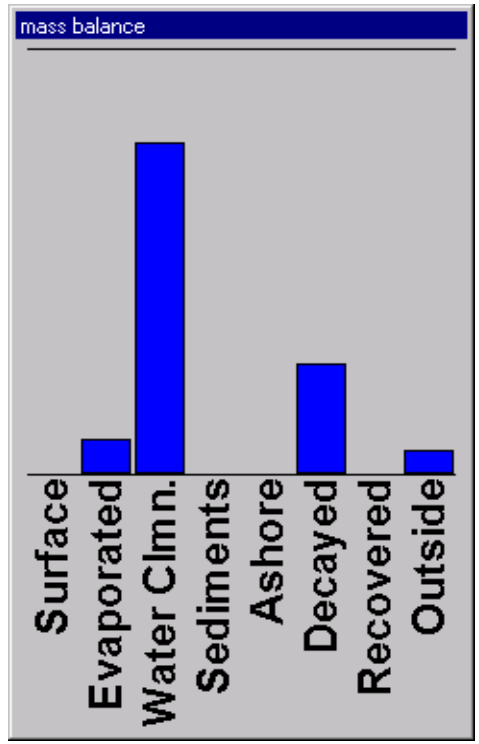
Release of Complex Mixtures

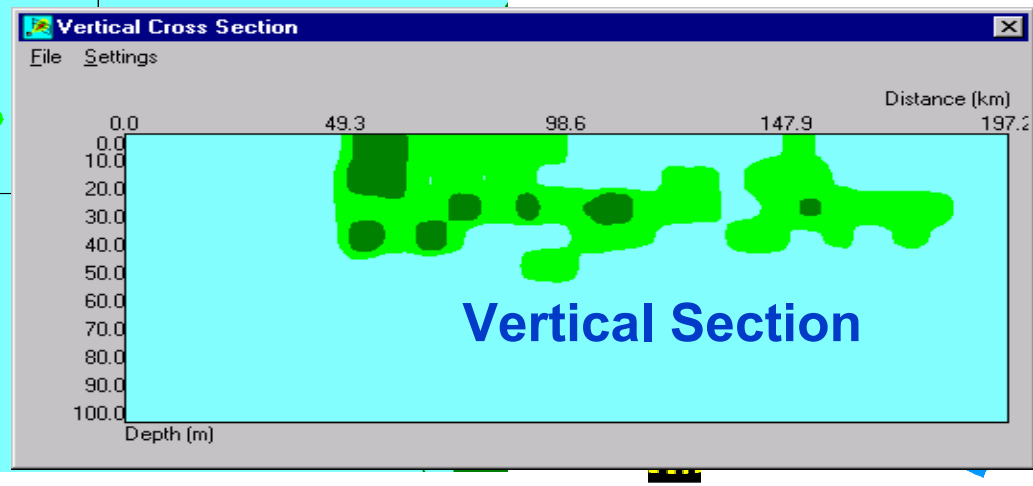


DREAM fate simulation:

hydrocarbons in produced water from 95 platforms







EIF output –
Table & PIE chart

- Spreadsheet weighting - Table output

Scenario X

MEMW 1.2beta	Standard input	**13.5 m dd**	Scenario specific input	**Simulated EIF**	**101**
		(dd= discharge depth)			Chemical specific input

	Dishcharge tonn/day		Conc. ppm		PNEC ppb					
Component group	Simulated	New	Basis	New	Basis	New	Contr. to risk	Contr. EIF	Weight	Weighed contr.
Total	24273	24273					%			
BTEX			6,2	6,2	17	17	3,64	3,6764	1	3,68
Naphthalenes			0,741	0,741	2,1	2,1	8,5	8,585	1	8,59
2-3 ring PAH			0,03162	0,03162	0,15	0,15	16,77	16,9377	1	16,94
4-ring+ PAH			0,00038	0,00038	0,05	0,05	0,45	0,4545	2	0,91
Phenol C0-C3			2,3583	2,3583	10	10	4,54	4,5854	1	4,59
Phenol C4-C5			0,01	0,01	0,36	0,36	1,36	1,3736	1	1,37
Phenol C6-C9			0,0026	0,0026	0,04	0,04	5,03	5,0803	2	10,16
Alifates			16	16	40,4	40,4	33,7	34,037	2	68,07
Cu			0,000526	0,00053	0,02	0,02	1,64	1,6564	1	1,66
Hg			0,000035	3,5E-05	0,008	0,008	0,27	0,2727	1	0,27
EC-6165A			0,428	0,428	426	426	0,05	0,0505	1	0,05
KI-384			0,068	0,068	63	63	0,04	0,0404	1	0,04
FX-2099			0,0023	0,0023	18,3	18,3	0	0	1	0,00
PI-795			0,00113	0,00113	37	37	0	0	2	0,00
EC-9242ASiFl			0,000765	0,00077	30700	30700	0	0	2	0,00
EC-6191A			0,374426	0,37443	10	10	2,92	2,9492	1	2,95
Grid size: 100x100km								**Adjusted EIF**		**119**

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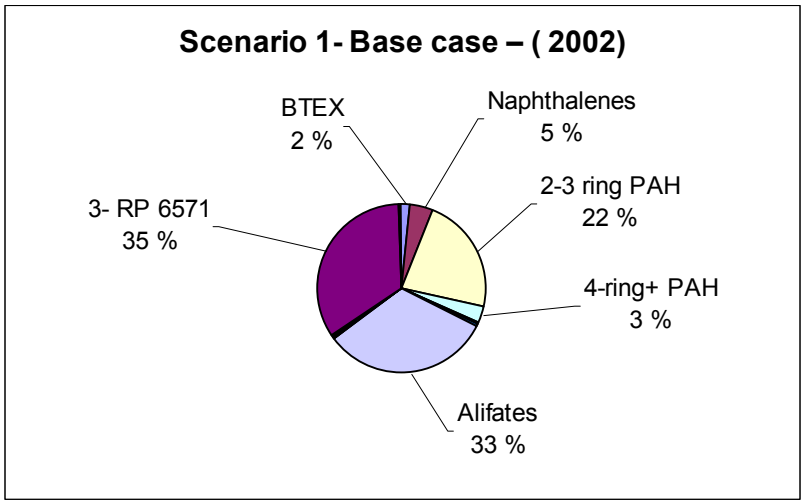
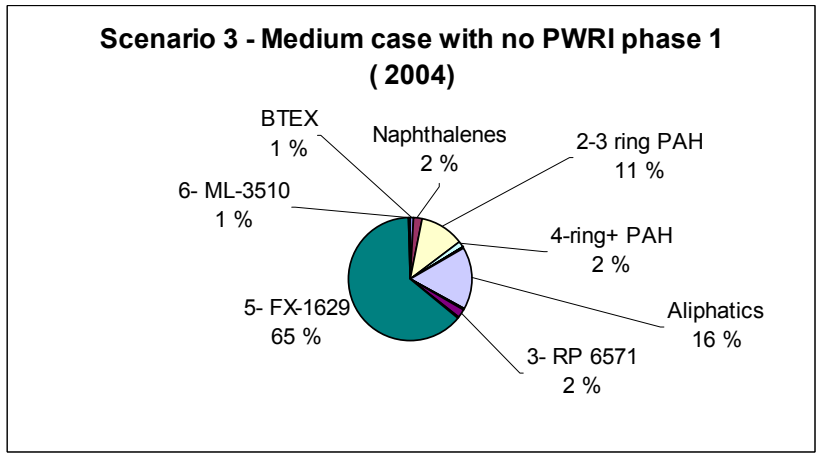
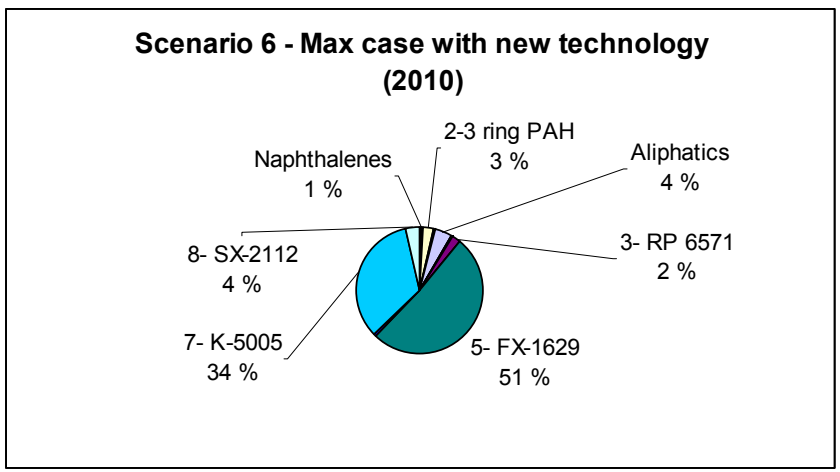
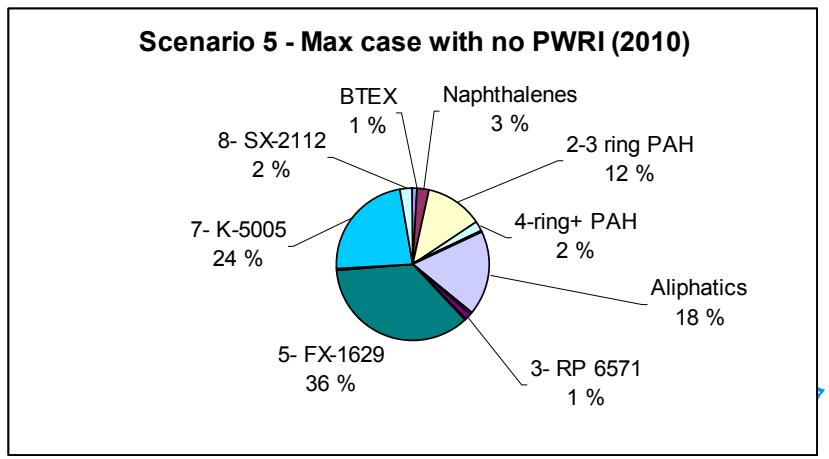
EIF output –
Table & PIE chart

PIE chart examples:
Contributions to risk from different PW components for scenarios at a North Sea oil field









PROTEUS

- **Pollution Offshore Risk Technical EvalUation System**

  Predicts the physical dispersion, chemical interactions and ecotoxicological risk for discharges during exploration, production and decommissioning

- **Exploration Drilling**
  - unique database to generate suitable cuttings size distributions
    - based on drilling plans.
  - simulates complete drilling operation
    - multiple sections
    - different mud systems
    - workover delays
    - bulk or continuous discharges of material
- **Decommissioning**
  - disturbance of existing piles during the decommissioning process
    - detailed hydrodynamic information to simulate re-distribution of mud/cuttings following intervention or removal operations
- **Produced Water Discharges**
  - dynamic, buoyancy and passive mixing phase of produced waters discharged into seawater

DREAM – EIF Drilling Discharges
under development (ERMS project)

- DD - EIF water column
  - New definition of discharge chemicals; + particles
  - Merging 'DREAM - EIF Produced Water' & 'ParTrack' models

- DD - EIF sediment
  - Merging as above + new features
  - Other disturbances (than chemical stress)
    - Oxygen depletion
    - Burial
    - Change in grain size

Example of Risk model procedure in DD- EIF Sediment:

From exposure to risk (grain size)

- Calculate change in median grain size
- Compare change in grain size with maximum allowable change in grain size (threshold)
- Calculate % risk using SSD for grain size

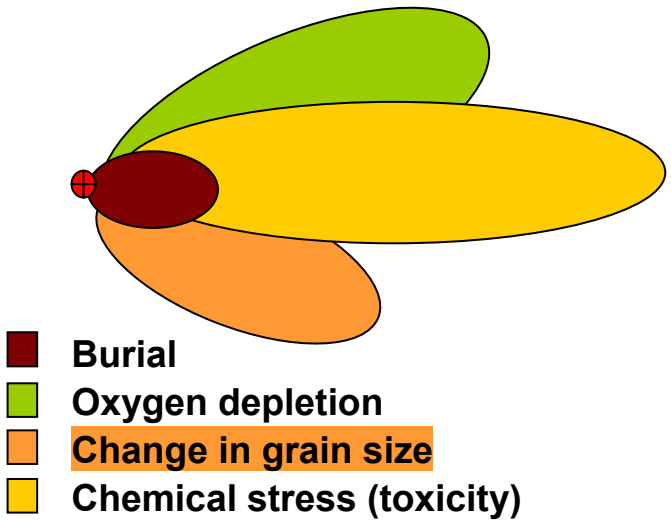
- Result:
  Sediment Area with certain risk value caused by altered grain size

Example of Risk model procedure in DD- EIF Sediment:

Integration of risks / surfaces with risks (under development)

- Alternative 1:
  Risk value per sediment area of all four disturbances

- Show sediment surface area where PEC/PNEC > 1 for:
  - Burial
  - Oxygen depletion
  - Change in grain size
  - Chemical stress (toxicity)

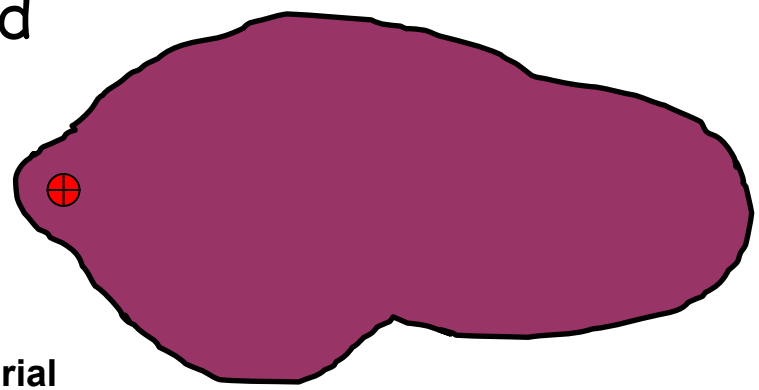


Example of Risk model procedure in DD- EIF Sediment:

Integration of risks / surfaces with risks (under development)

- Alternative 2:
  Integrate risks areas of the four disturbances
  - Assume Additivity, or
  - Using weight factors

- Show area with an integrated risk value of > 5%

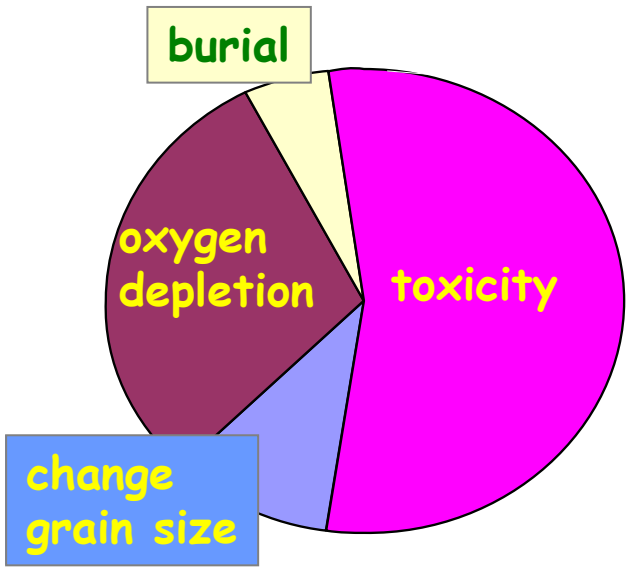


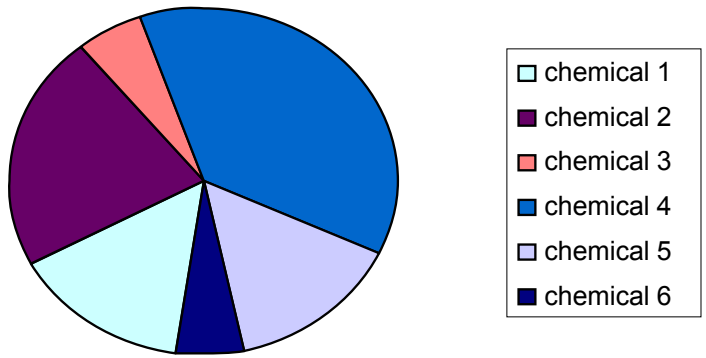
INTEGRATED RISK > 5%

Burial
Oxygen depletion
Change in grain size
Chemical stress (toxicity)

EIF Sediment =
area with integrated risk > 5%
(under development)

- Based on PEC/PNEC approach





EIF = 500 m²

How to combine EIF_{water} and $EIF_{sediment}$

(under development)

- Unit of EIF water = m^3

  PW:

  - Maximum value during the simulation time

  DD:

  - Will be present only few days
  - Will quickly decrease to zero after discharge stops

- Unit of EIF sediment = m^2
  - Will increase during discharge
  - Will slowly decrease after discharge, time scale in months

Summary

...important to remember that a model is only one of several tools in a decision process... (SFT)

- Different tools are being developed for different assessment purposes
- We have here shown
  - CHARM (Hazard ranking of chemicals)
  - DREAM (Risk and Effect assessment of PW)
  - DREAM – EIF (Decision support for PW based on Risk indication
  - PROTEUS (Risk predictions for DD, PW & Decommissioning)
  - DREAM – EIF DD (Decision support for DD based on risk indication; = ERMS)
    - DREAM – EIF DD Water
    - DREAM – EIF DD Sediment
- Next we will see how EIF are being used for North Sea operations