STUDIECENTRUM VOOR KERNENERGIE
CENTRE D'ETUDE DE L'ENERGIE NUCLEAIRE

Impact of hypothetical radioactive releases in the Belgian inland rivers-sea continuum

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Deleersnijder E., Lambrechts J., Sweeck L. Vives I Batlle J.

Problem description

- The Nuclear power plant in Scheldt Estuary (Belgium)

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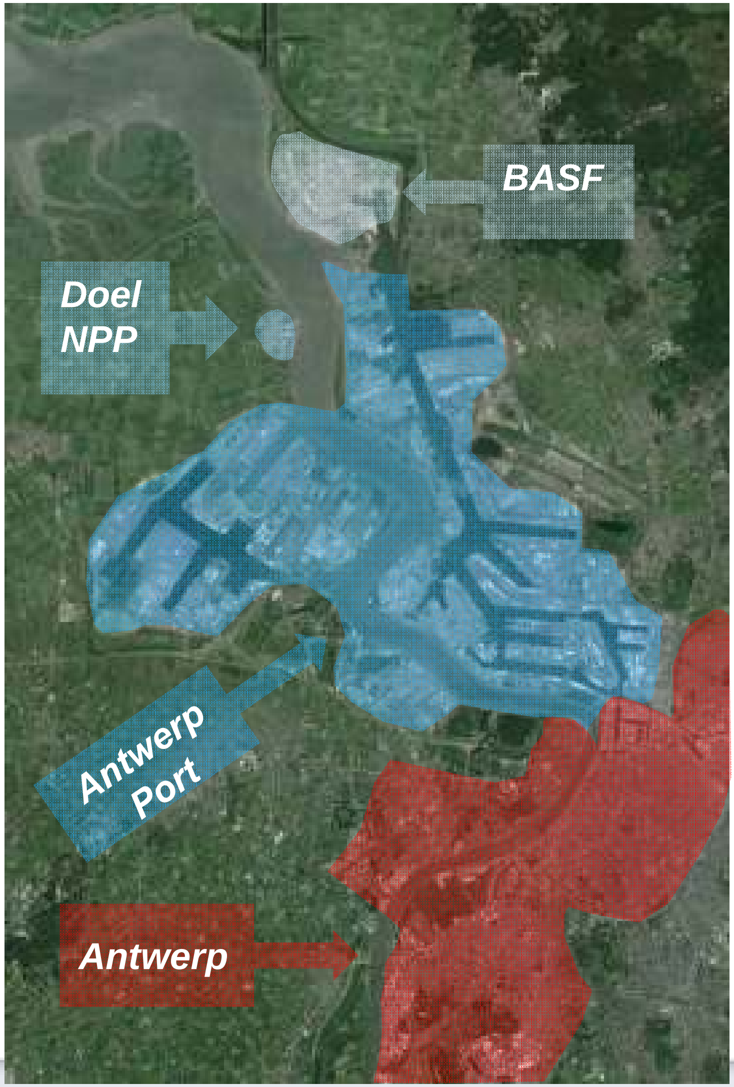
The Scheldt Estuary is one of the largest European estuaries and internationally **Important nature area. Entrance to the port of Antwerp**

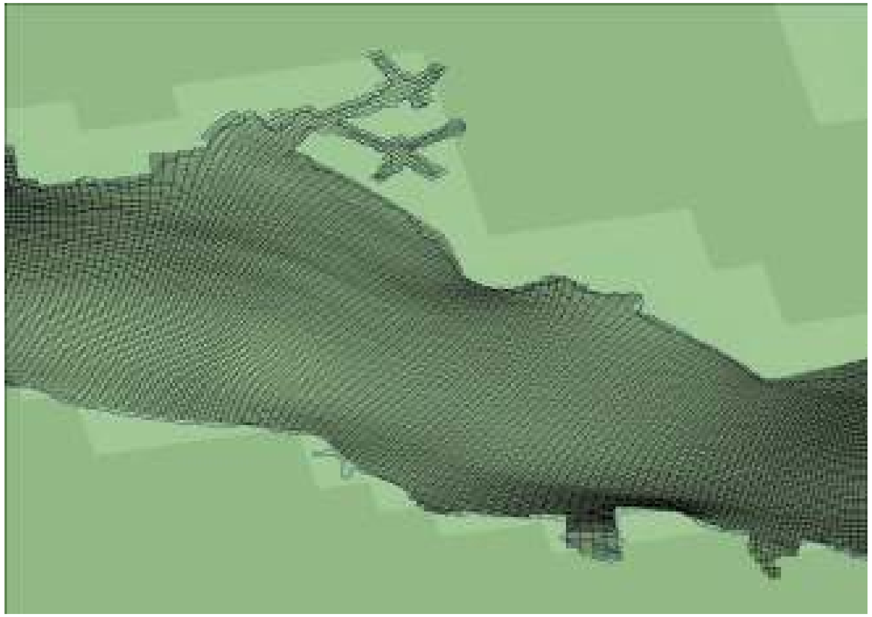


Objectives of the research

- Development of estuarine model for the simulation of the fate and transport of radioactive effluents as consequence of accidental releases
- Scenario definition based on the predictions of source term of NOODPLAN –Belgium
- Definition of possible release moments in order to include the influence of the tides in the transport
- Multiple partition coefficient scenario definition
- Estimation of the radiation dose rates to the aquatic biota

Model selection

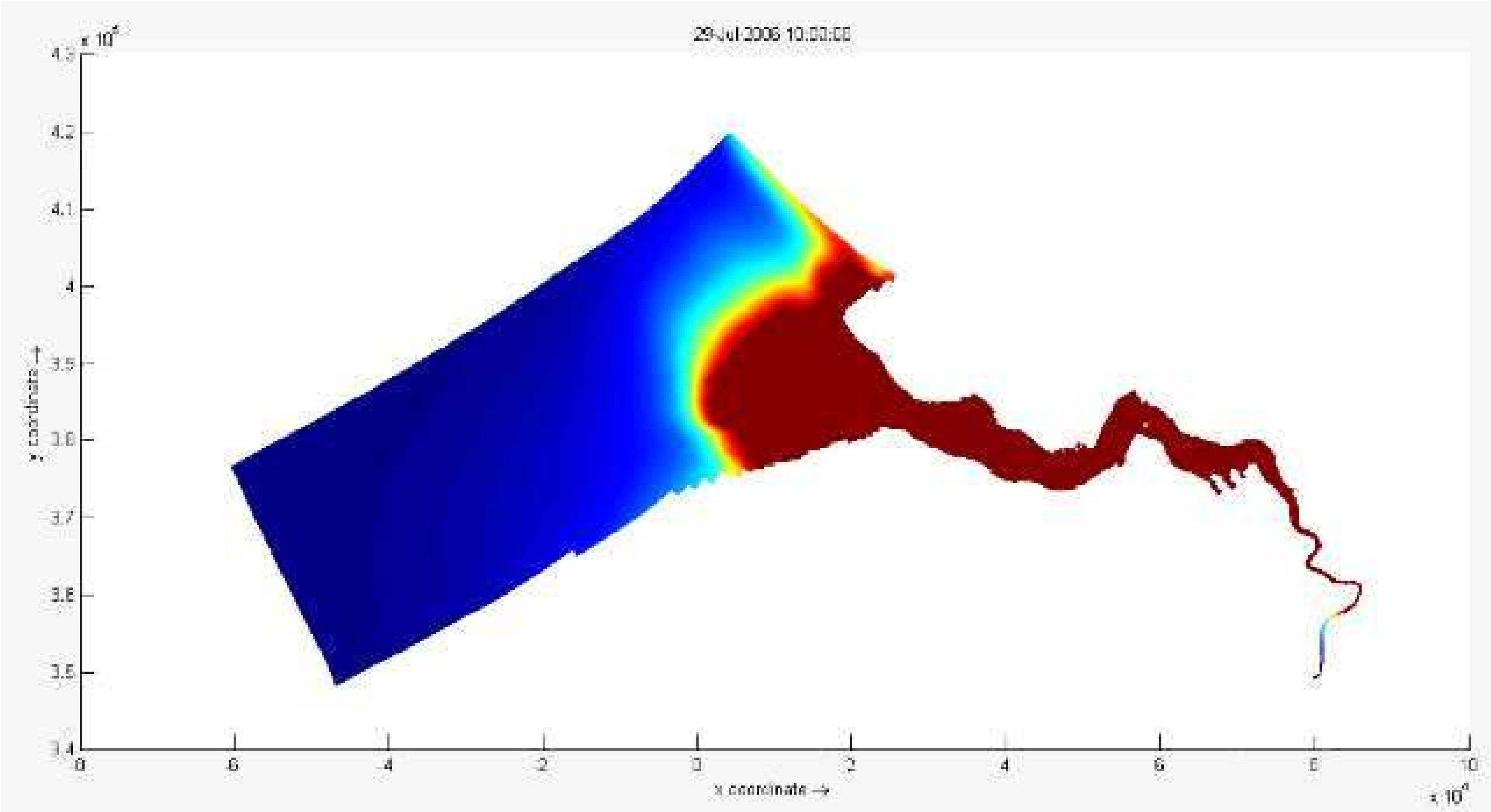
- Boundary conditions problem
- Computation time problem
- Integration of the River-Estuary-Coastal systems (1D-2D) systems



Structured grid: Limits the extension of the model due to large number of cells (around 500 000 cells)

Model selection

- Boundary conditions problem



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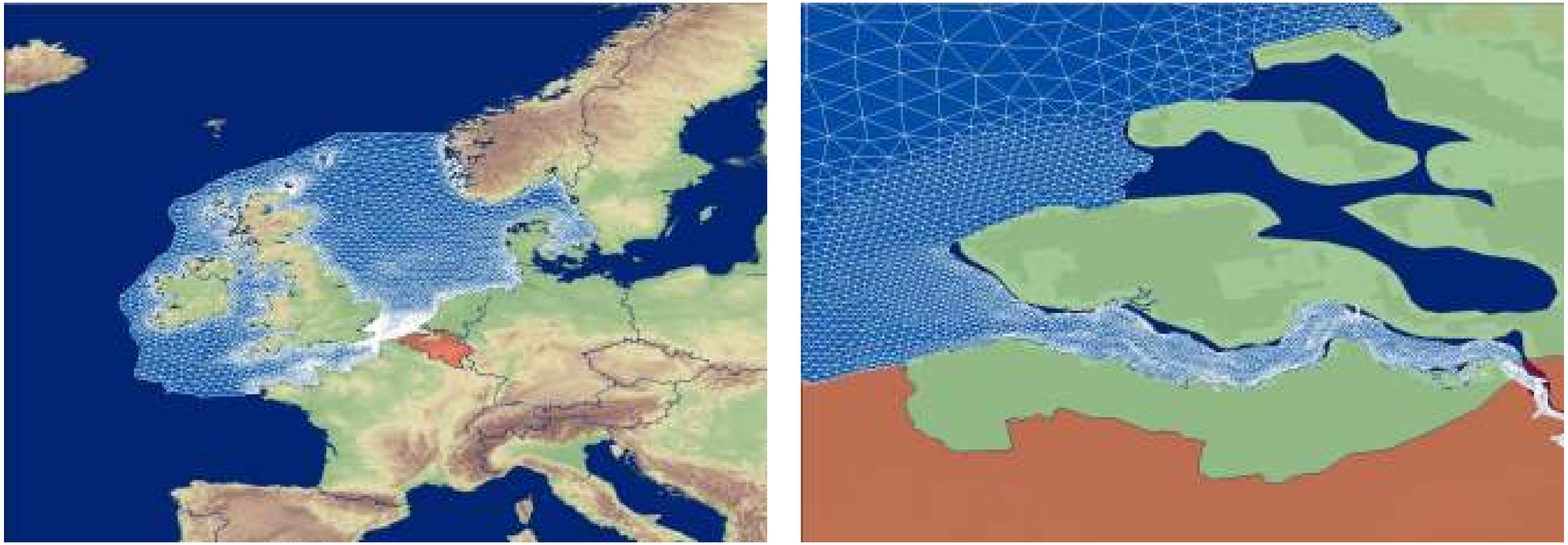
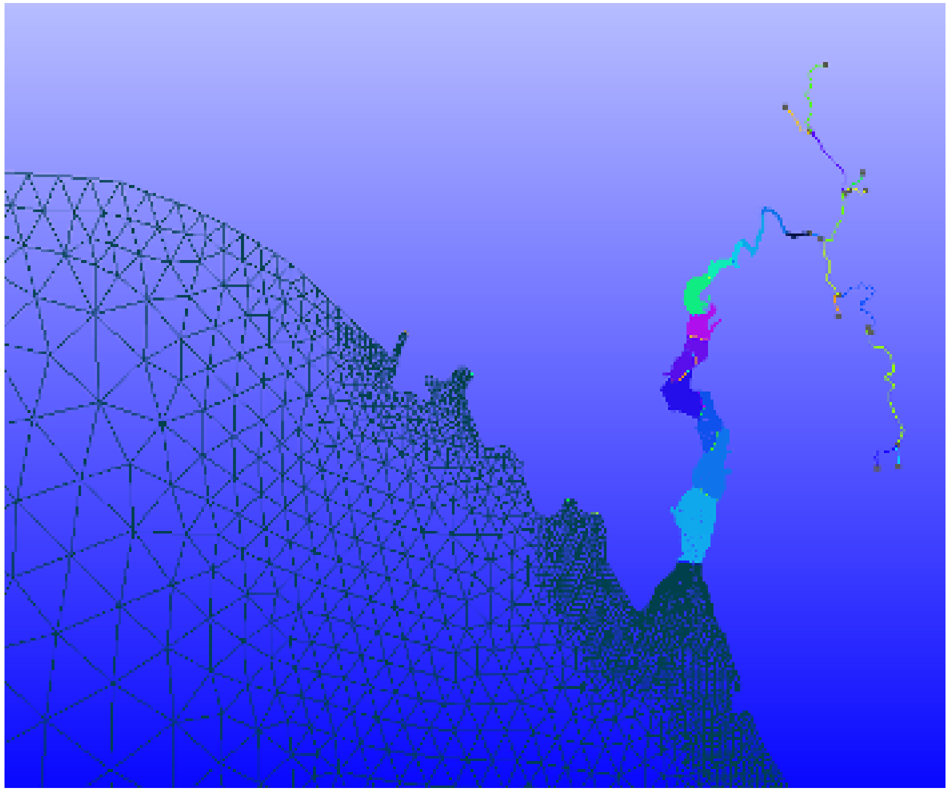
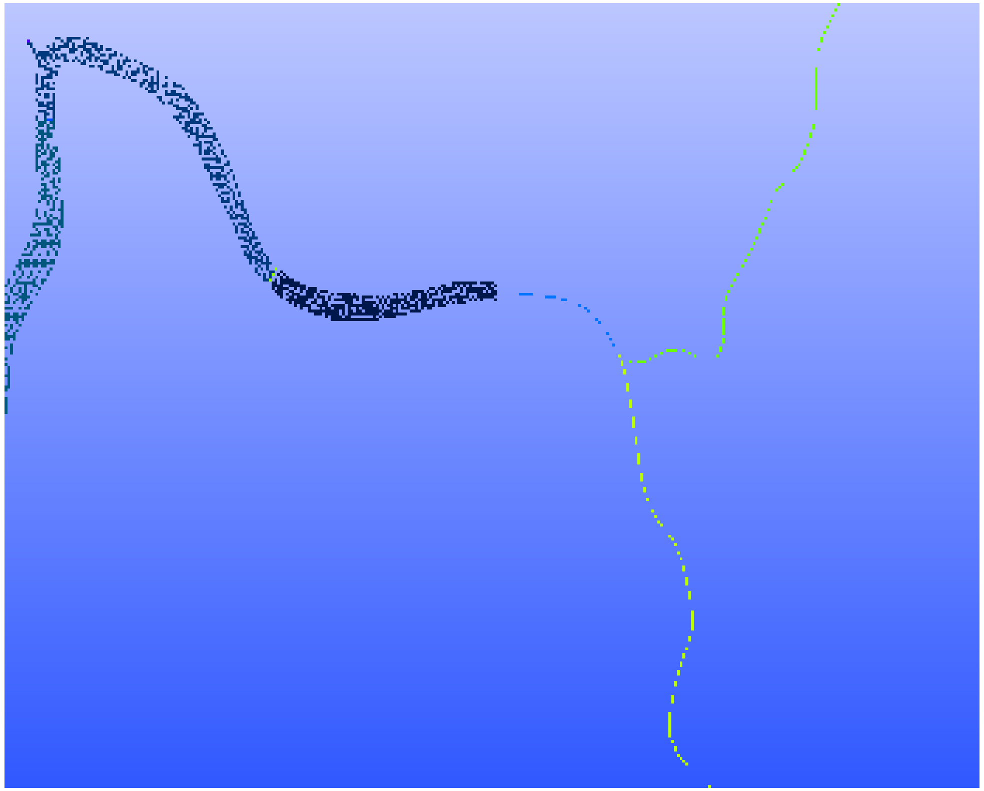


Unstructured grid: Allows to extend model without loss of detail (around 30 000 cells)

Model selection

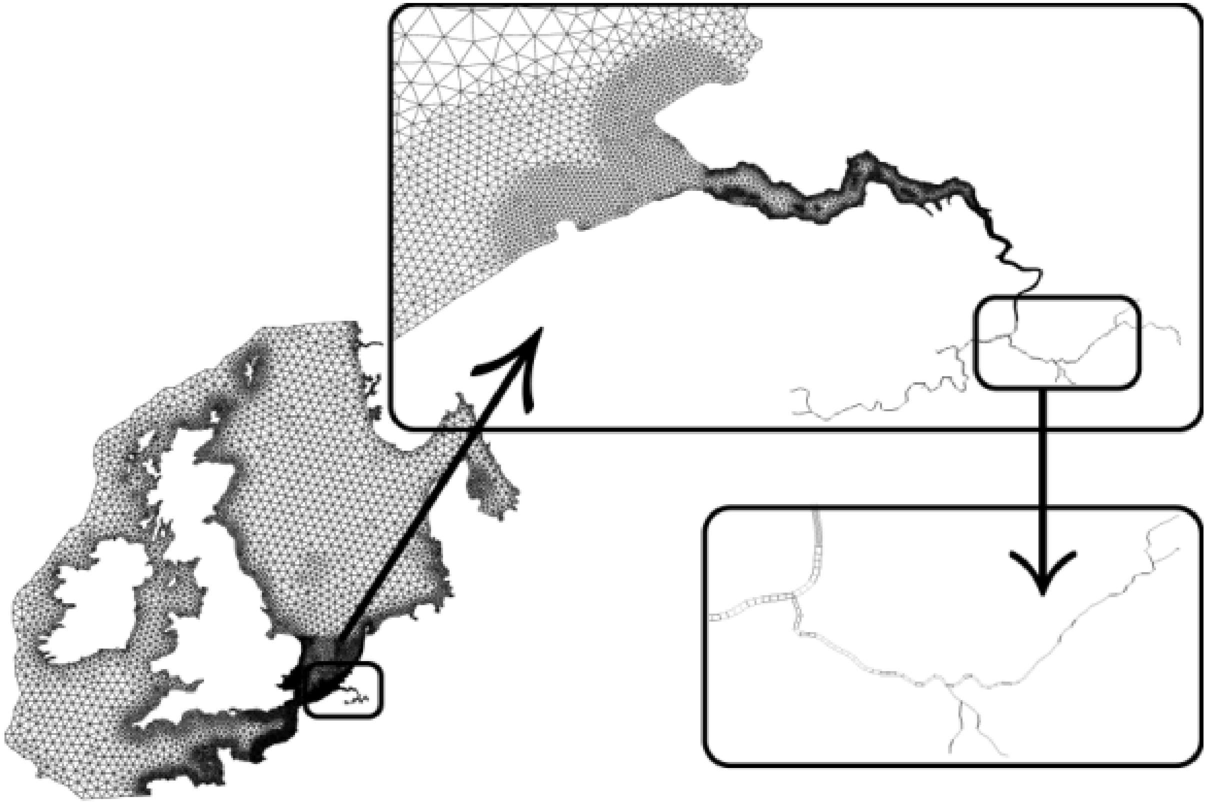
- Integration of the River-Estuary-Coastal systems (1D-2D) systems





Model selection

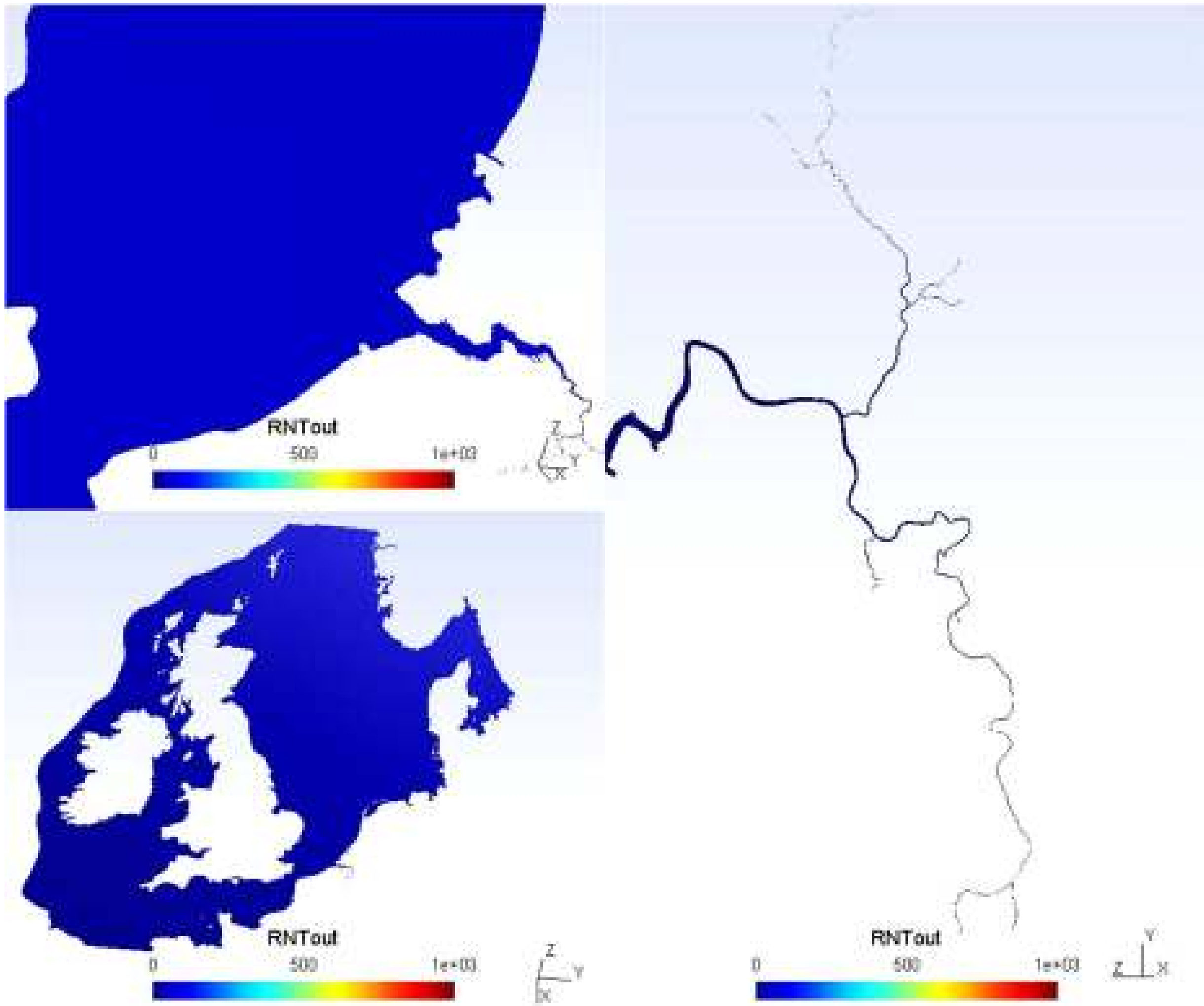
- SLIM model



Second-generation Louvain-la-Neuve Ice-ocean Model (SLIM)

Second-generation Louvain-la-Neuve Ice-ocean Model (SLIM)
Institute of Mechanics, Materials and Civil Engineering (IMMC) & Earth and Life Institute (ELI) Université catholique de Louvain (Deleersnijders E., Lambrechts J., Gourgue O., de Brye B.)
https://sites.uclouvain.be/slim/

General overview of the radioactive plume



Scenario description

- Source term:

Based on the estimated total release inside the reactor building Doel 1 to 4

Scenario	Fraction	^{131}I MBq	^{137}Cs MBq
		≈2.00E+11	***≈2.00E+11***
Scenario 1	2.0E-08	2.0E+03	2.0E+03
Scenario 2	2.0E-07	2.0E+04	2.0E+04
Scenario 3	2.0E-06	2.0E+05	2.0E+05
Scenario 4	2.0E-05	2.0E+06	2.0E+06
Scenario 5	**2.0E-04**	**2.0E+07**	**2.0E+07**
Scenario 6	2.0E-03	2.0E+08	2.0E+08
Scenario 7	2.0E-02	2.0E+09	2.0E+09
Scenario 8	2.0E-01	2.0E+10	2.0E+10
Scenario 9	2.0E+00	2.0E+11	2.0E+11

Scenario description

- Partition Coefficient: Based on values of ERICA Tool

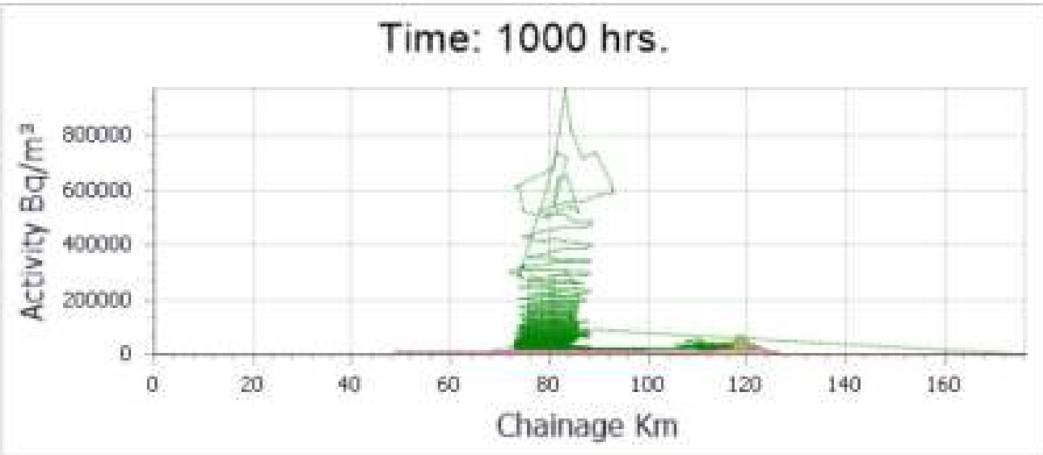
Scenario	Fraction	^{131}I L/kg *1.00E+02*	^{137}Cs L/kg *1.00E+04*
Low Kd	1.E-01	1.E+01	1.E+03
High Kd	1.E+01	1.E+03	1.E+05

- Discharge time: **24hr**.

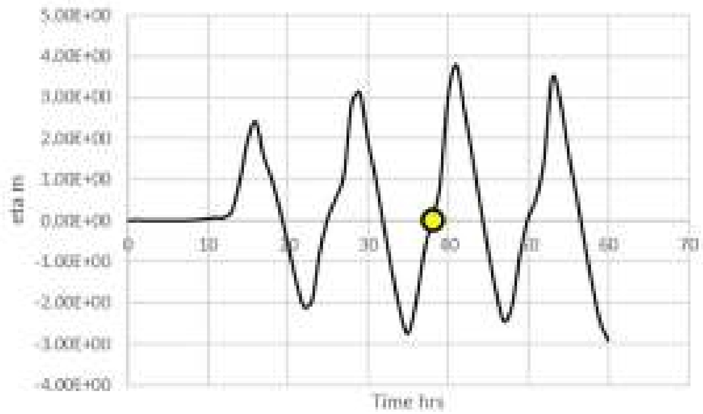
Scenario description

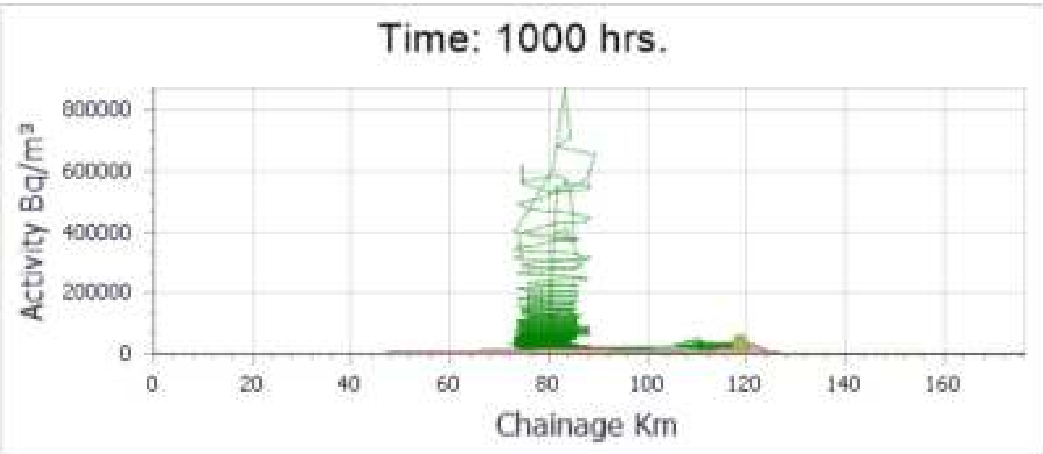
Scenario ^{137}Cs

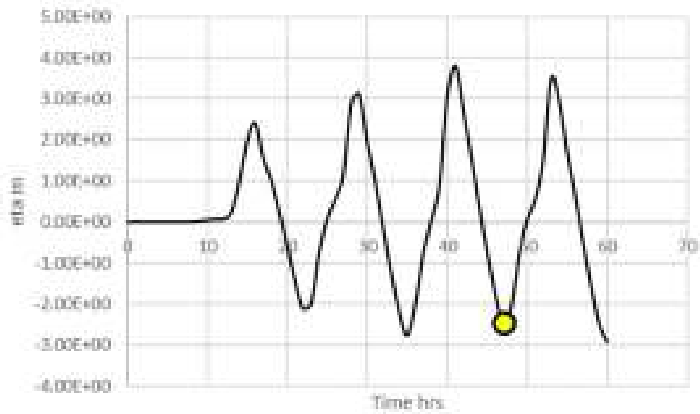
- Longitudinal profile



Release time

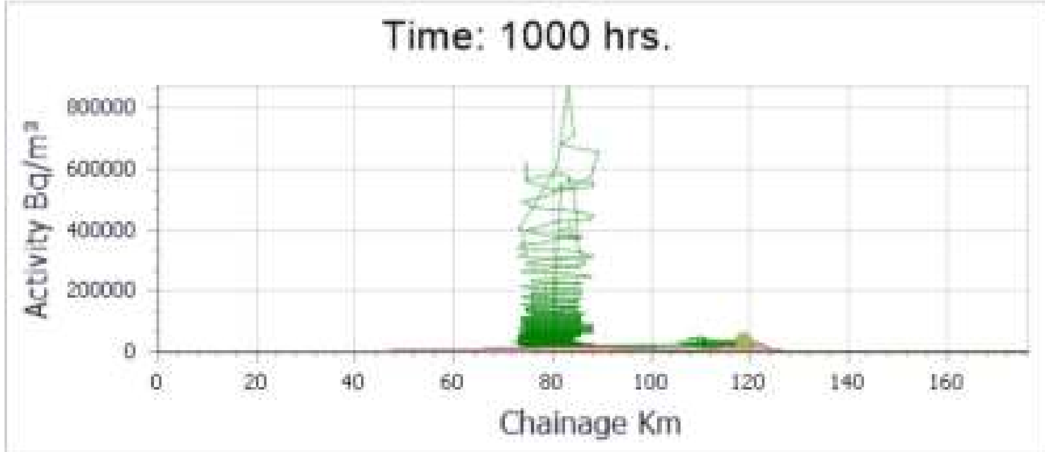




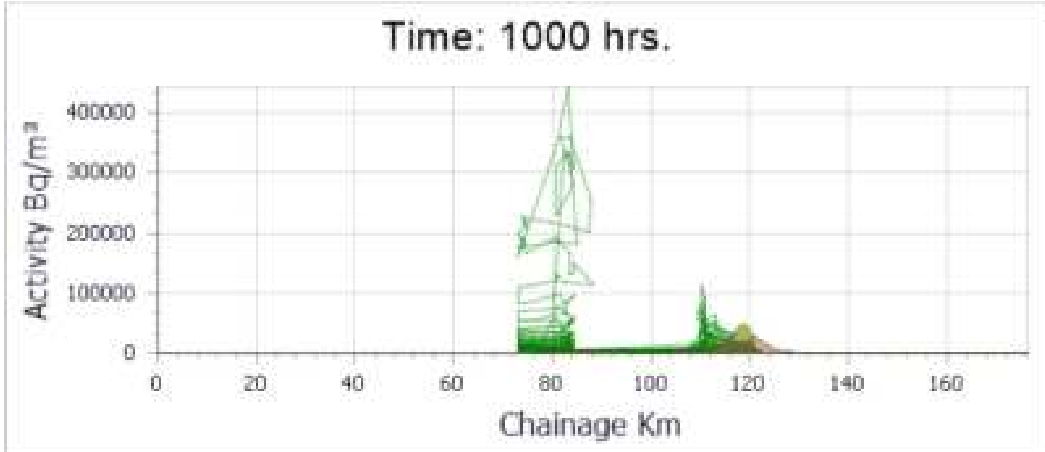


Scenario ^{137}Cs

- Longitudinal profile



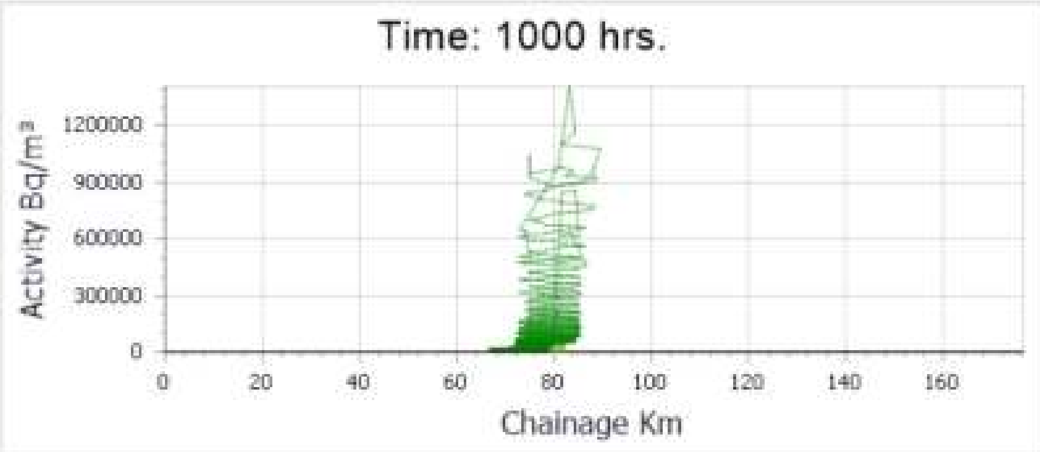
Low Kd scenario



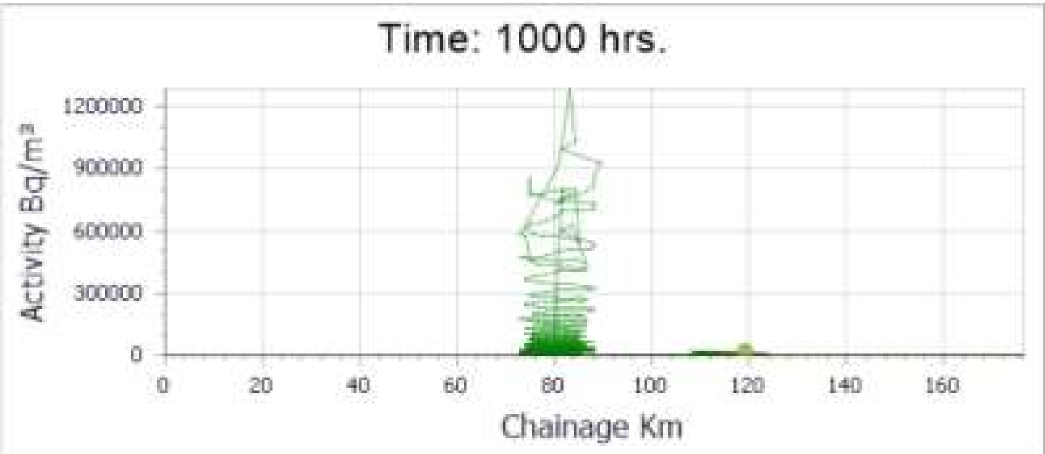
High Kd scenario

Scenario ^{131}I

- Longitudinal profile

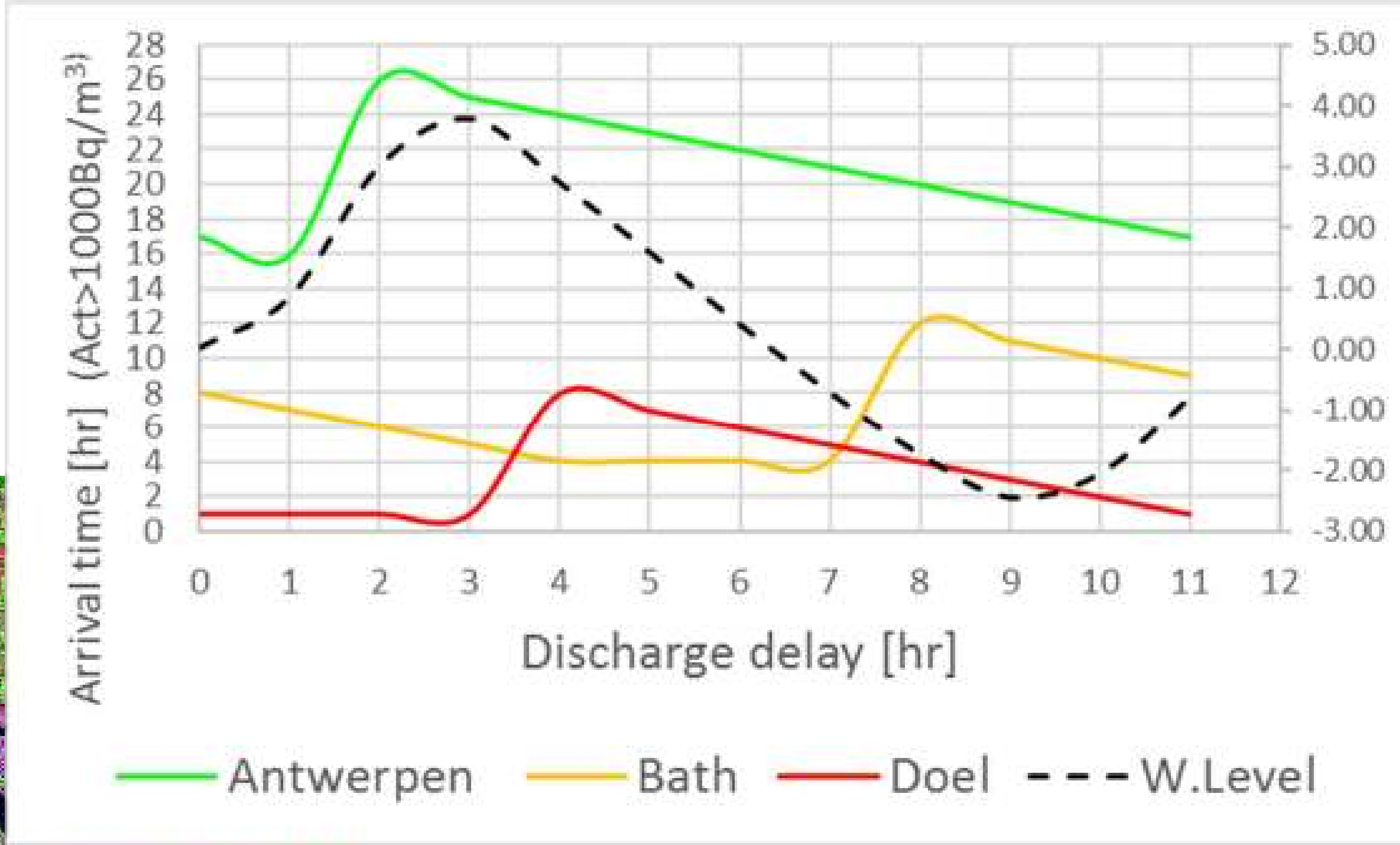


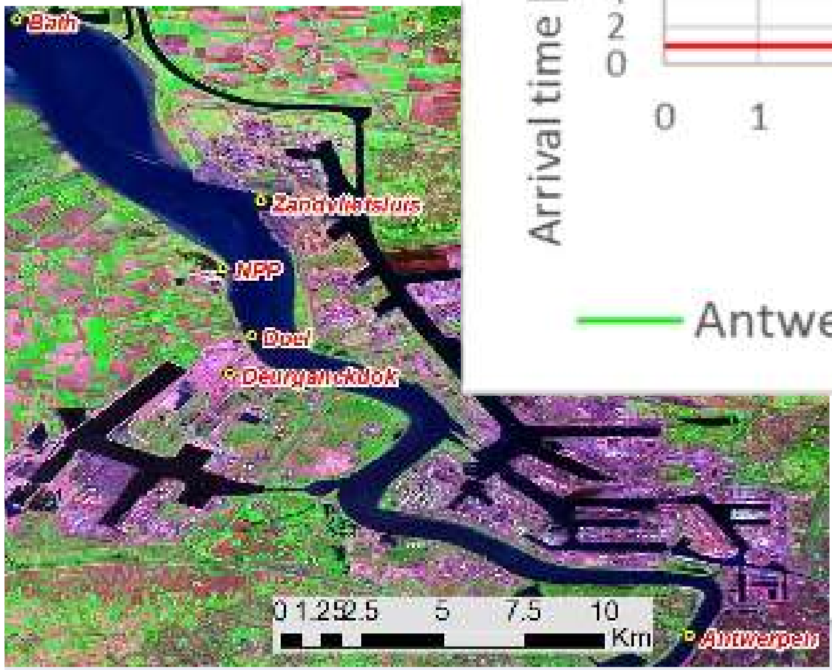
Low Kd scenario



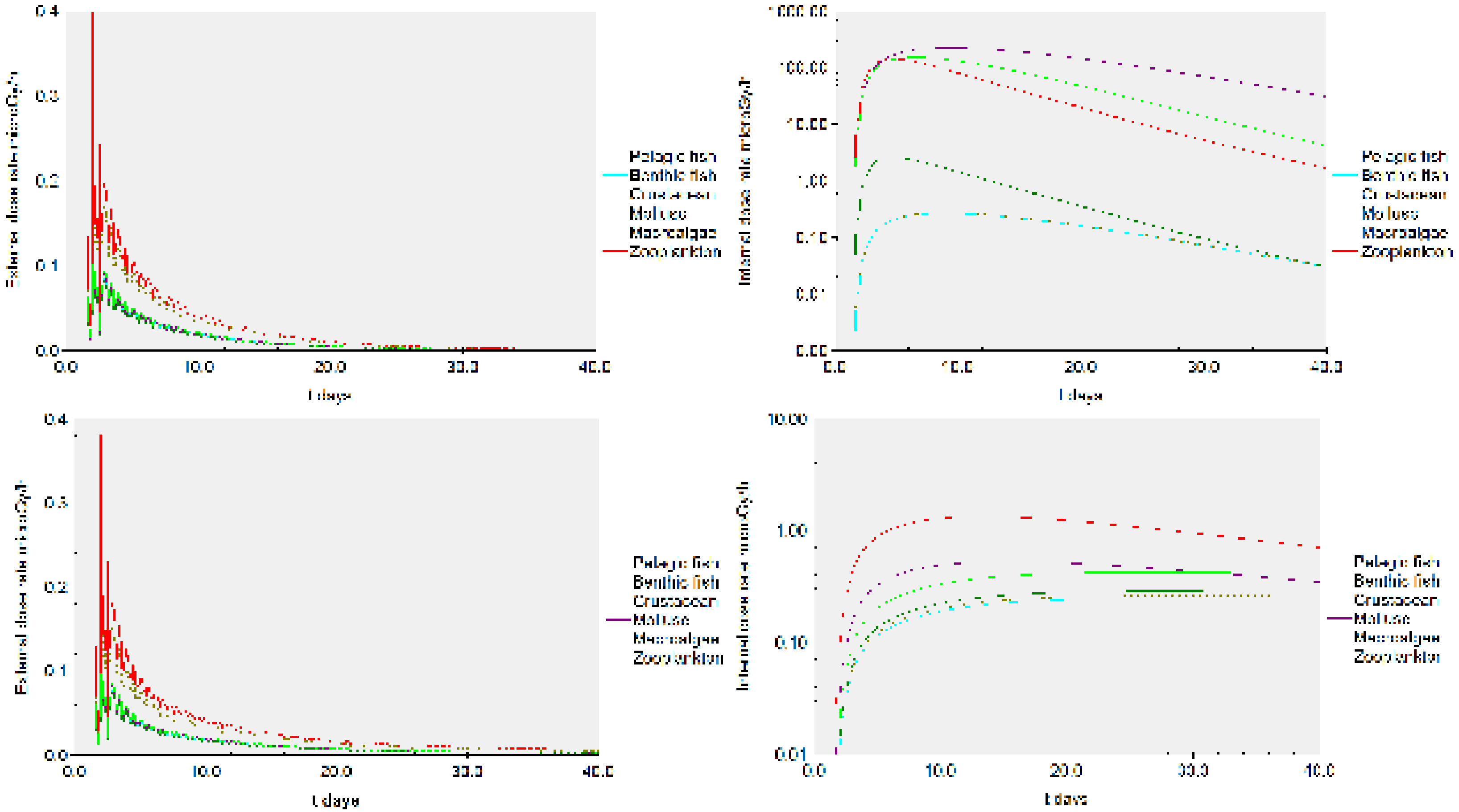
High Kd scenario

Time of arrival





Dose to biota-Doel Low Kd



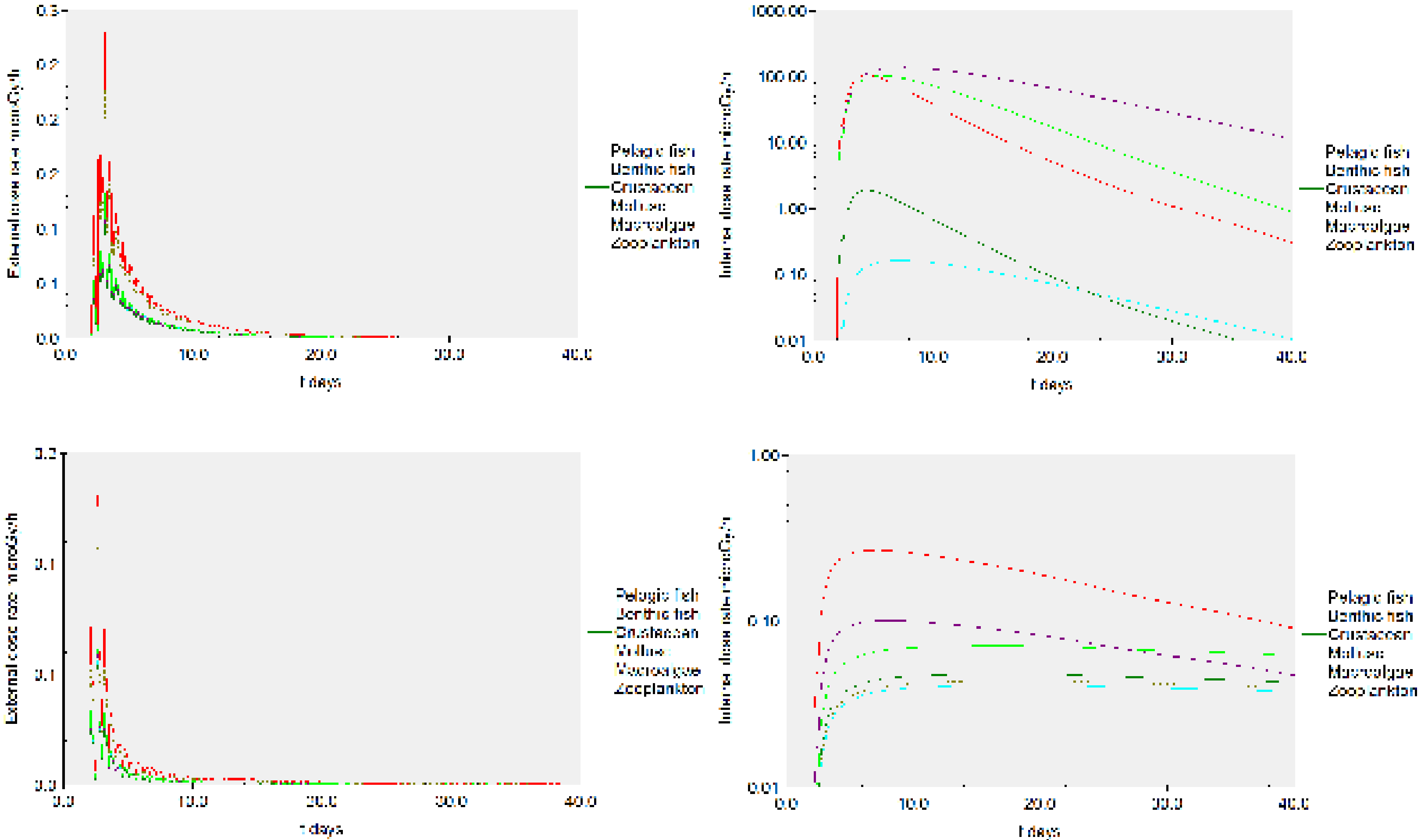
^{131}I

^{137}Cs

Computed with D-DAT model

J. Vives i Batlle, R.C. Wilson, S.J. Watts, S.R. Jones, P. McDonald, S. Vives-Lynch, Dynamic model for the assessment of radiological exposure to marine biota, Journal of Environmental Radioactivity

Dose to biota-Doel High Kd



^{131}I

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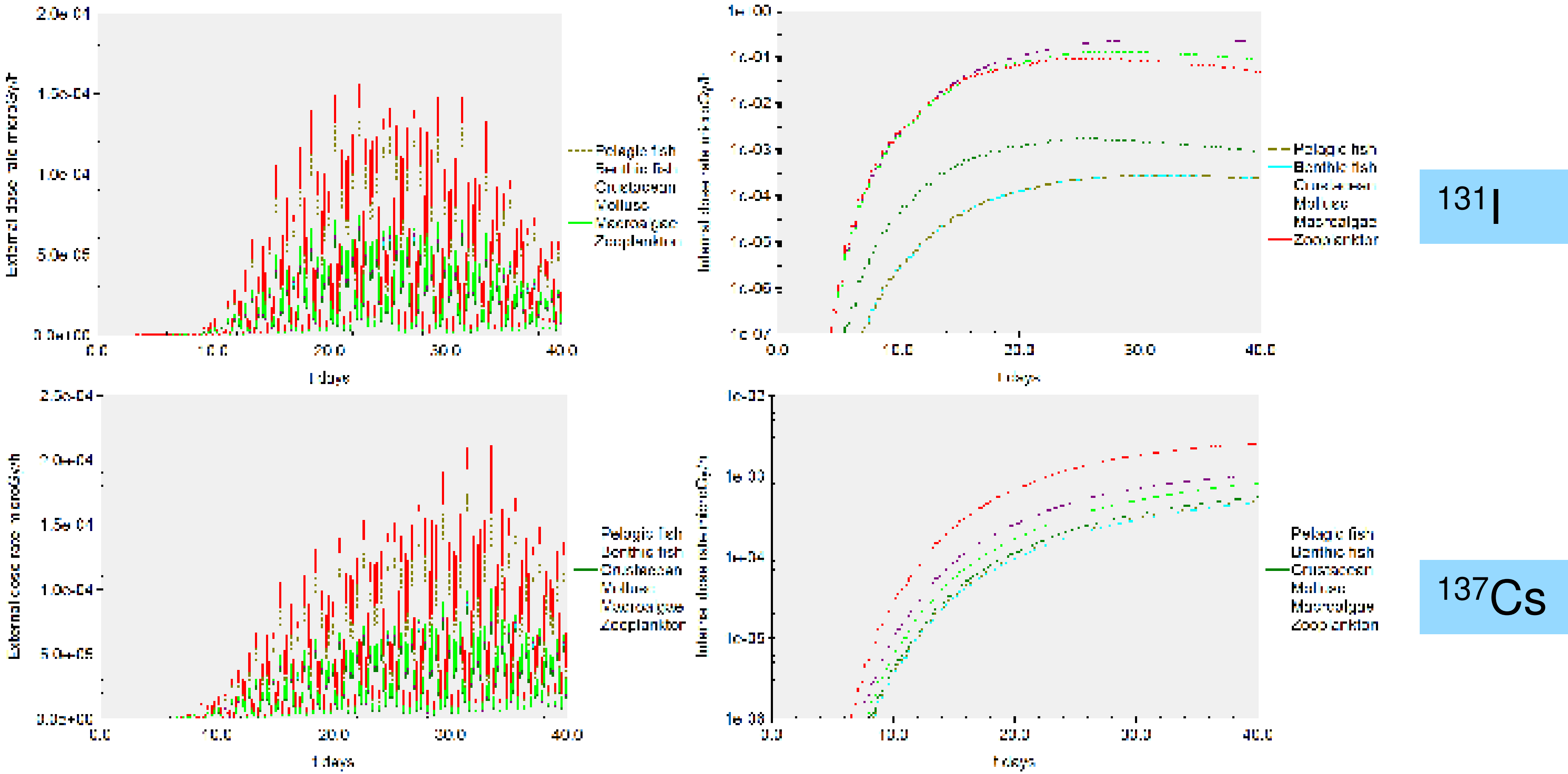
Computed with D-DAT model

J. Vives i Batlle, R.C. Wilson, S.J. Watts, S.R. Jones, P. McDonald, S. Vives-Lynch, Dynamic model for the assessment of radiological exposure to marine biota, Journal of Environmental Radioactivity

Dose to biota-Vlissingen Low Kd



Computed with D-DAT model

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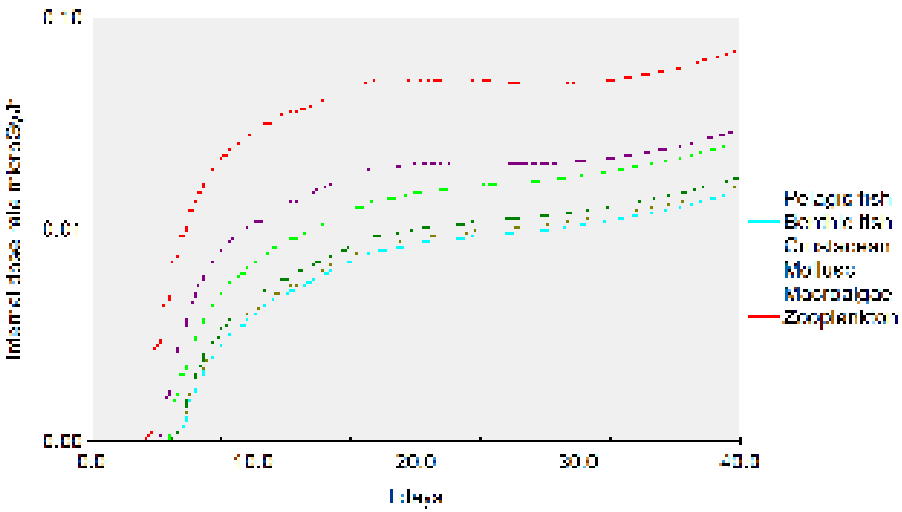
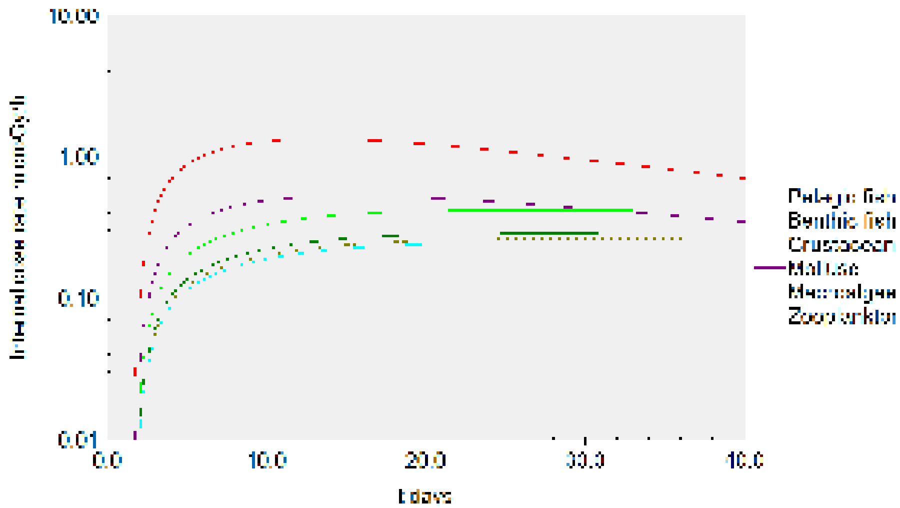
Dose to biota

- The **dose estimation** was done **based on** the assumption of **stationary biota**. However **it can be improved** by coupling the model **with a Particle tracking model**.

Dose to biota



Particle tracking approach



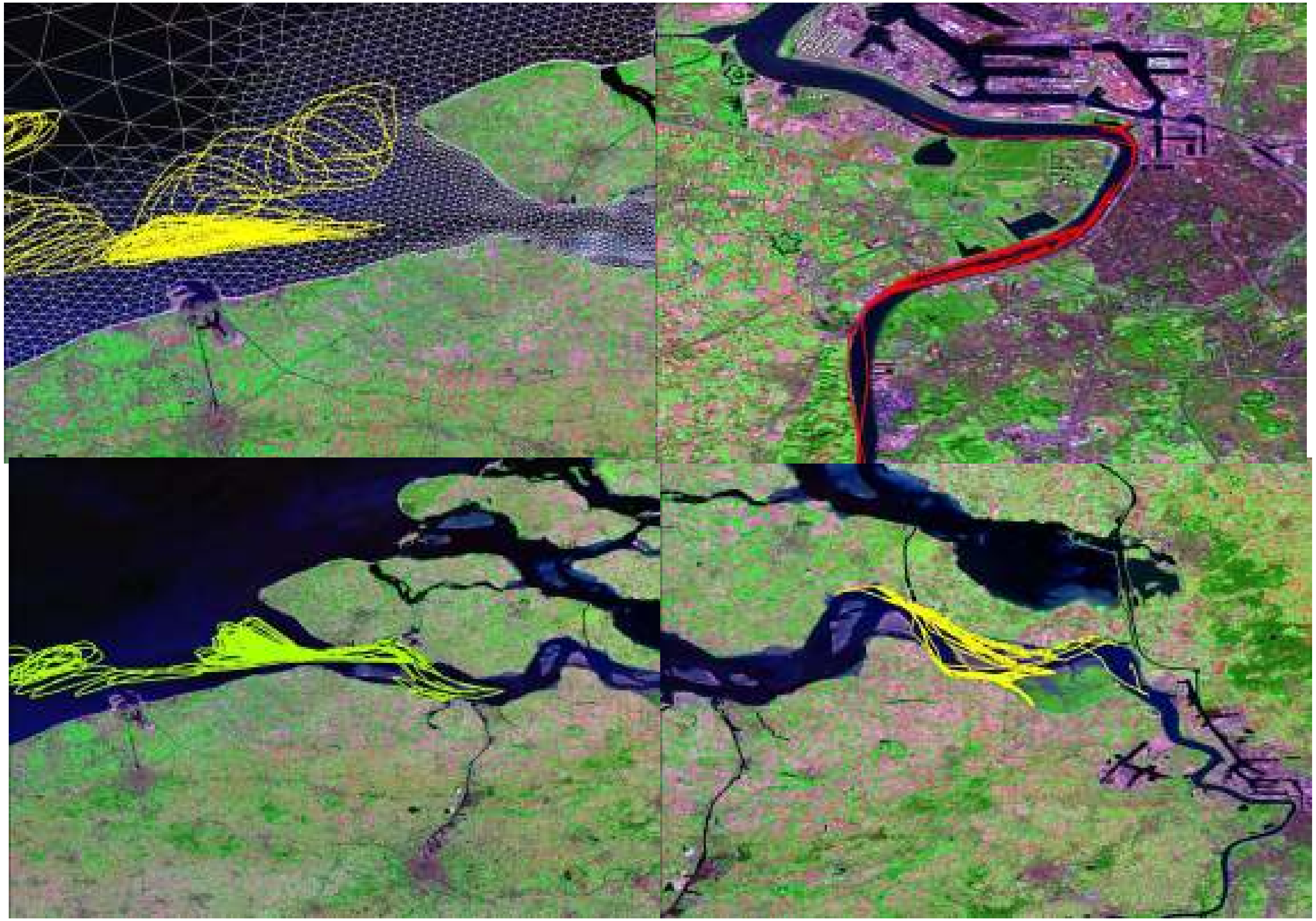
Static approach

Computed with D-DAT model

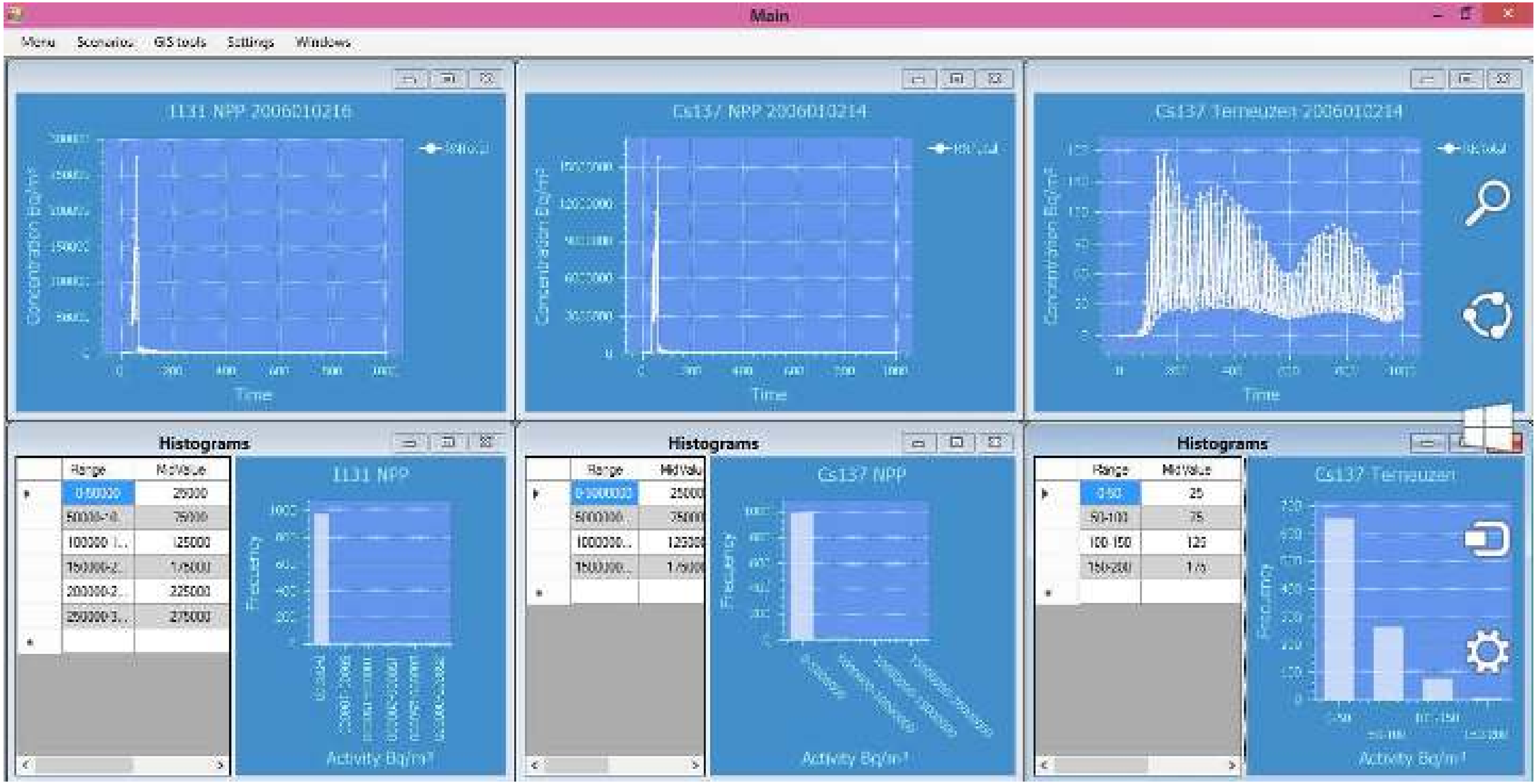
J. Vives i Batlle, R.C. Wilson, S.J. Watts, S.R. Jones, P. McDonald, S. Vives-Lynch, Dynamic model for the assessment of radiological exposure to marine biota, Journal of Environmental Radioactivity

Dose to biota-Particle tracking

Dose to biota-Particle tracking



DSS tool Development



Conclusions

- SLIM-RN model has the required flexibility for fast impact assessments
- The Partition coefficient shows an important effect on the magnitude of the activity in the water column
- The influence of the tides on the RN distribution is stronger near the discharge point but it reduces at the mouth of the estuary
- The zone with the highest activity remains around ±10 km from the discharge point
- This studies tries to bridge the gap between research model and assessment tool

Thank you very much for your attention

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Belgian Nuclear Research Centre

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