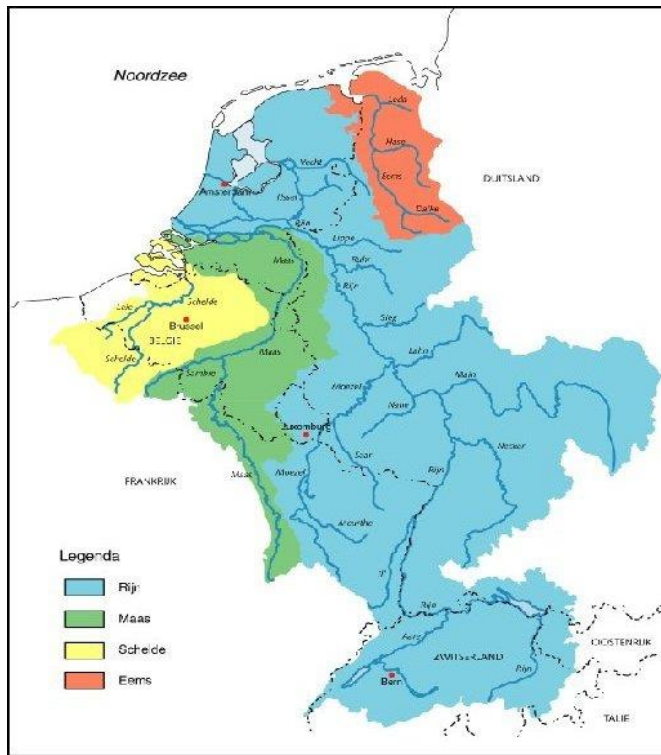




Rijkswaterstaat
Ministry of Infrastructure and the
Environment



A future Rhine model for accidental spills?

RPS-ASA model Chemmap

Jaap van Steenwijk,
Bert van Munster,
Rudi Heymen.

Supported by RPS-ASA and Deltares

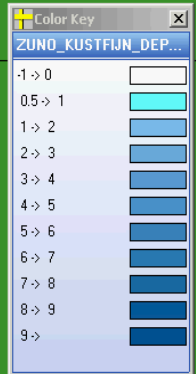
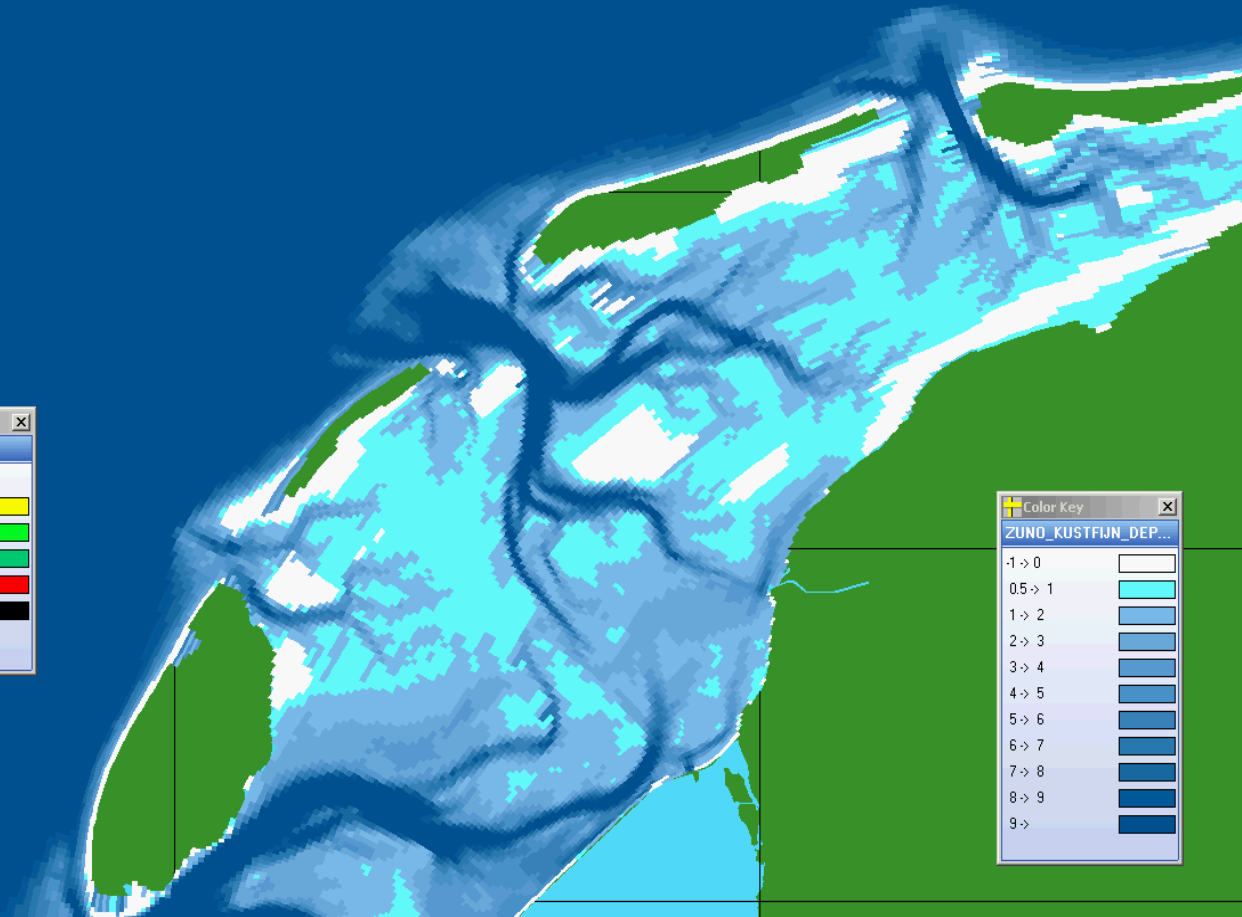
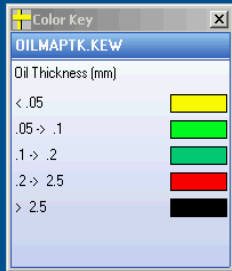
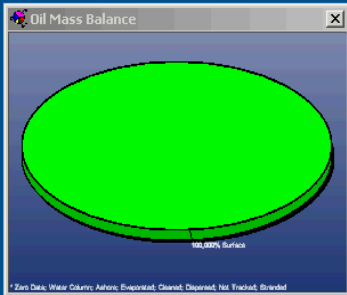


Modeling environmental incidents

- In case of an incident with chemicals we want to know how substances spread out in environment and there effects.
- So Rijkswaterstaat (RWS) has models for paths and fate of oils and chemicals in our water environment.
- We use the hydrodynamic information from the models that calculate the water levels and flows.
- Our Meteorological institute delivers a wind field for modelling drifting and volatile substances
- Few examples:
 - Oil in the North sea
 - Styrene in the Western Scheldt

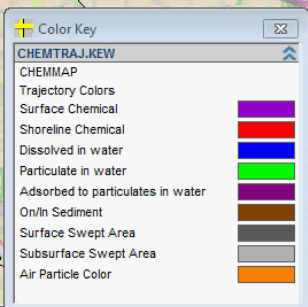
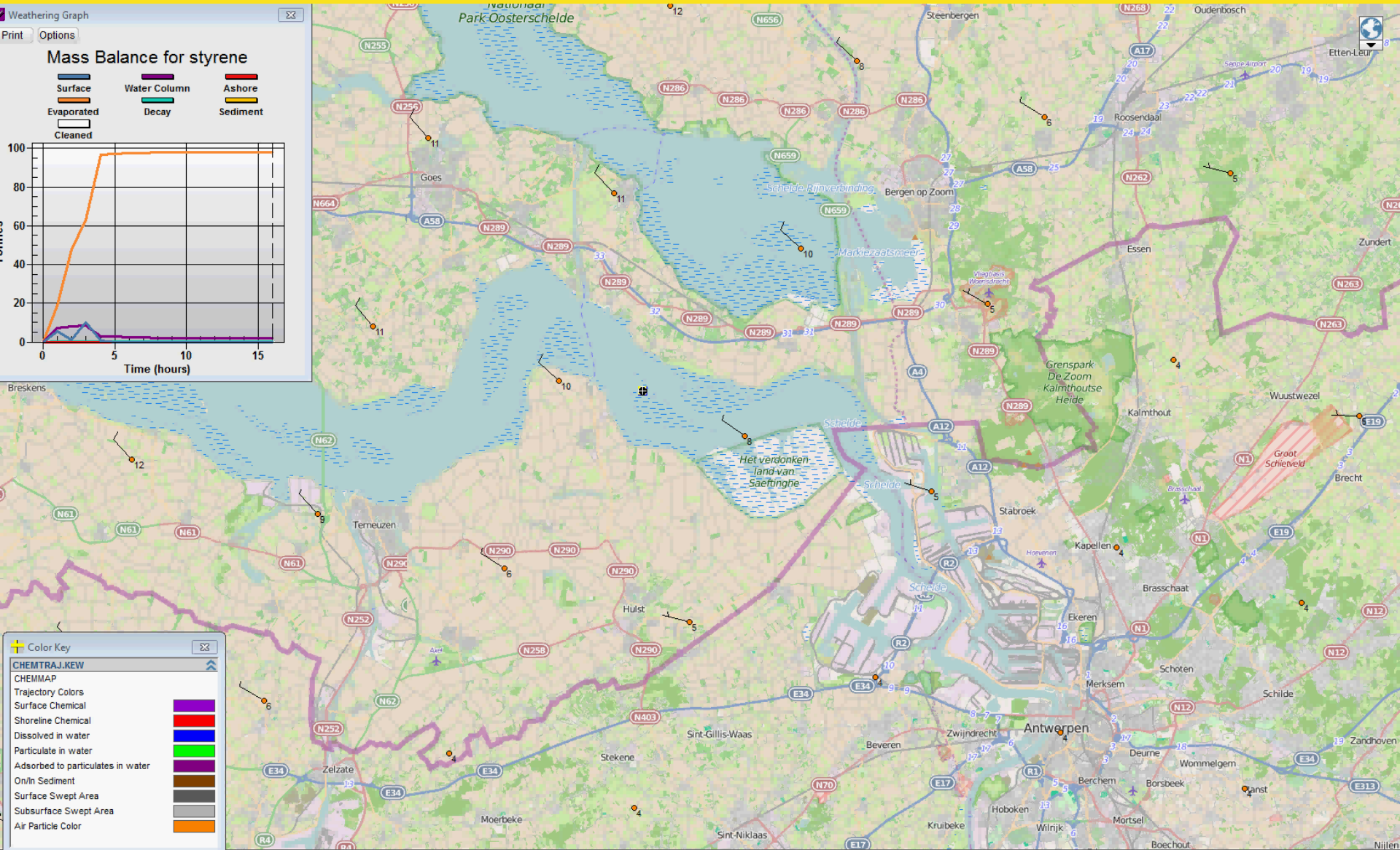
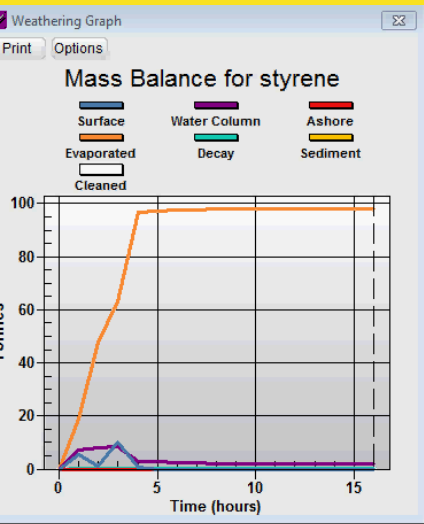


diepwater
Noordzee 60 uur



Collision January 17 2015

spill 140 m³ (?)
Styreen/ethylbenzene





Project scope

- In the past various departments of RWS used different software's. We started in 2007 with harmonization.
- For salt waters, notably North Sea and Waddensea RWS adopted ASA's software suite (Oilmap, Chemmap). Chemmap uses particle tracking to forecast fate and transport of such spills.
- The model framework combines operational forecast results of 2Dsimulation models.
- RWS strives for harmonization with freshwater lakes and rivers. Main motivation: a uniform working environment which is highly relevant during "stressful" situations.



RPS ASA Role – Model/data integration

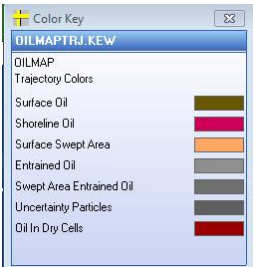
- **RPS ASA Role**: to provide tools to predict the movement and fate of Oil and Chemical spills, and to support Search & Rescue operations (SAR-Coast Guard).
- **How**: customizing RPS tools (OILMAP, CHEMMAP, SARMAP), using MATROOS database with operational forecasting of water and wind.
- **Tools**: OIL/SAR/CHEMMAP have same User Interface (> ease of use) but have different inputs and outputs (> challenge).
 - Oil & SAR has been customized to take into account varying water depths (flooding/drying)
 - Chemmap has been adjusted to operate in rivers.



Emergency Response:

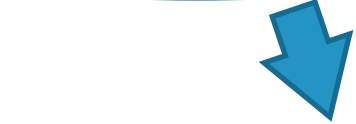
User creates spill/SAR scenario and ask inputs to MATROOS database

HTTP / XML



Database:

Bathymetry for Area of Interest



Used by the model to "strand" and "float" the oil or SAR object

{t, xyz}

Chemical Spill Model



- CHEMMAP is a 3D chemical pollutant transport model. It requires 2/3D currents and interacts with coast & sea/river-floor.
- River models provides 1D River points and those get converted to a 2D currents field to be used in CHEMMAP.



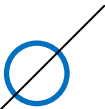
Script in CHEMMAP simplifies the workflow ("point and click"), no external steps required. Use of MATROOS server request (html/xml).



Coastline (river shoreline) and Bathymetry imported into CHEMMAP on-the-fly



SOBEK calculation points having dynamic flow results (Q_{1D})



2D section on basis of $Width_{1D}$ and location of other points.



$$V_{2D} = f(Q_{1D}, W_{1D}, A_{1D})$$

Direction: towards next section

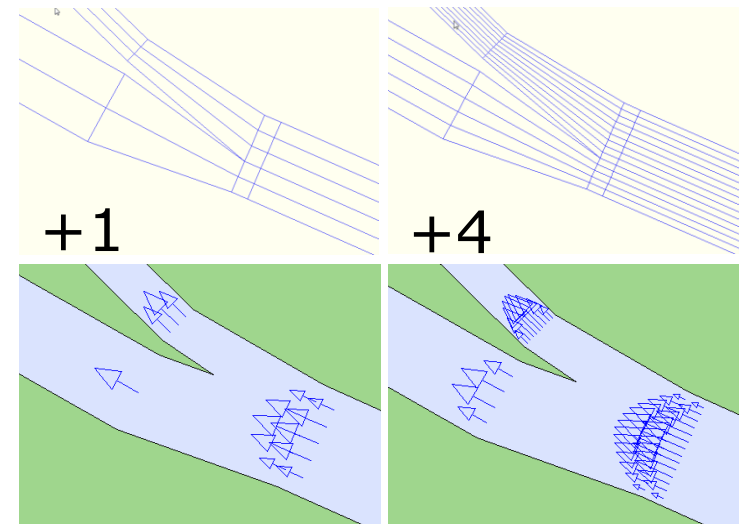
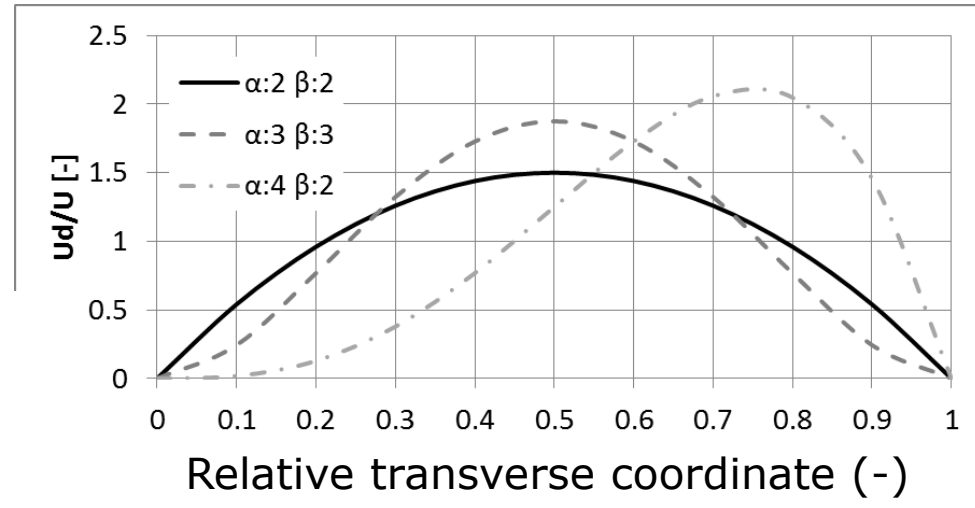
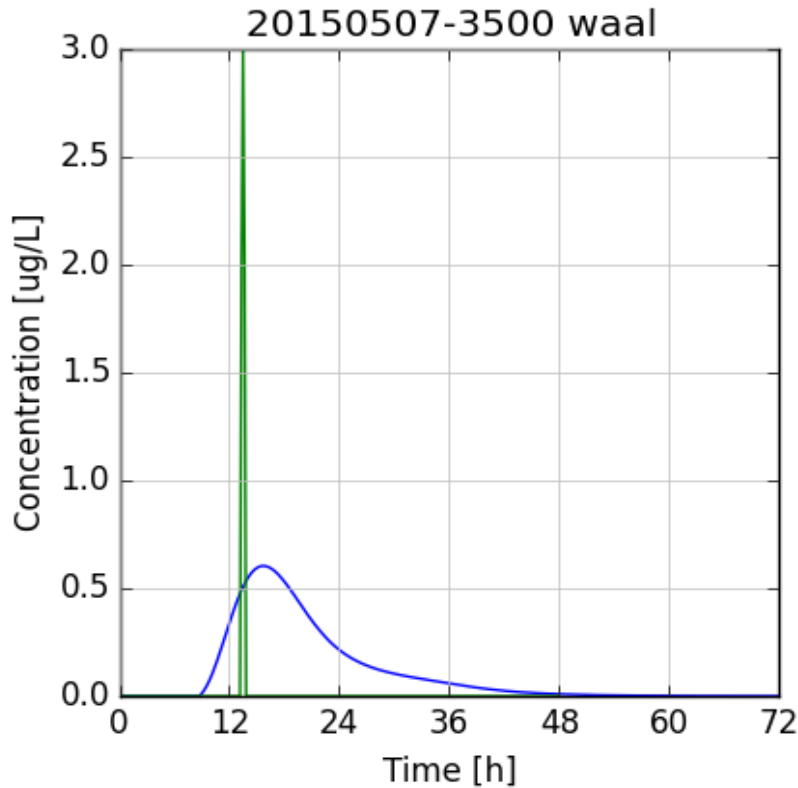


CHEMMAP uses average of 4 corners → extra sections required to prevent particles from sticking to the wall.



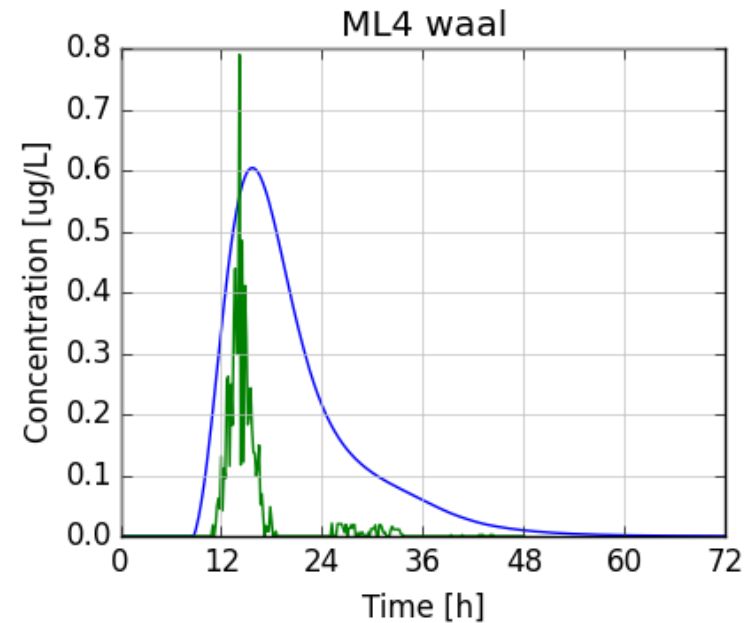
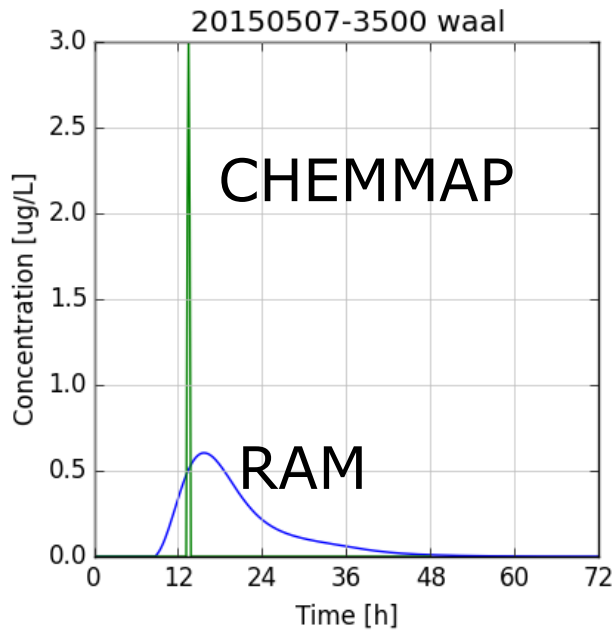
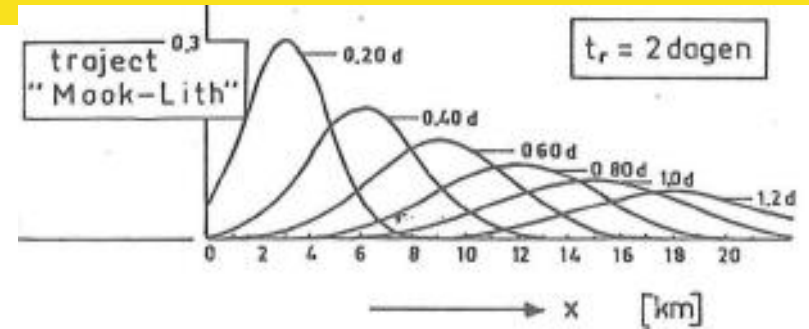


1D river flow + uniform dispersion =
too low longitudinal mixing!





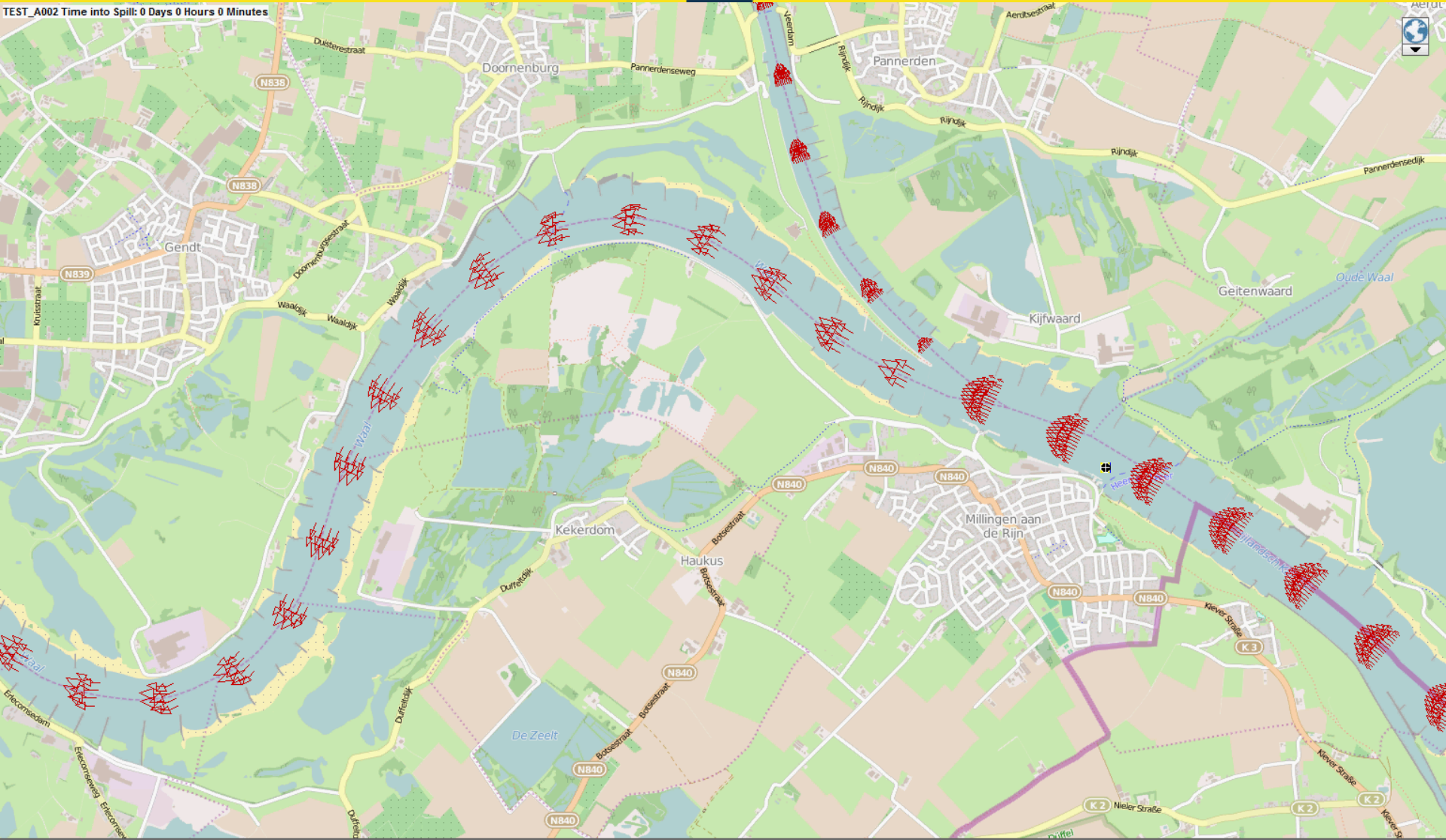
Calibration options



RAM: Accidental Spill Model for river Rhine



TEST_A002 Time into Spill: 0 Days 0 Hours 0 Minutes



Conclusions



1. The model framework for the sea is expandable with river systems and covers the full domain of interest: catchment to coast.
2. Using existing operational hydrodynamic models
3. RWS has extended the model of the Rhine till Maxau
4. Extension to Bodensee, side branches is possible
 1. If hydrological data is available
5. Transport in water and in the air (volatile compounds)
6. Database with chemicals (CHEMMAP) and crude oils (OILMAP) available.
7. Uniform approach minimises operation & maintenance costs for RWS

Chemmap main screen

Look and feel userinterface



The screenshot displays the Chemmap software interface. At the top is a menu bar with options: File, Zoom, GIS, Data, MODEL, Model Output, Tools, COASTMAP, and Help. Below the menu bar is a toolbar with icons for various functions like Zoom In, Zoom Out, Pan, Point, Polyline, Polygon, Move Object, Edit Vertices, Add Current Vector, Grid Cell, Distance, and Redraw. The main area is a map showing a river system with green land and blue water. The map is labeled "Map presentation of the Model results". On the left side, there is a "GEO Data" panel with "Map options" for "Model" and "Geography". The "Model" section includes "Scenario - IKSRI" (checked) and "Depths - IKSRI_DELTARES_RIVERS", "Currents -", and "Winds - IKSRI_". The "Geography" section lists several shapefiles, including "AANLOOP_ETRS89_GEOGR.SHP", "BLOKIND_ETRS89_GEOGR.SHP", "BONN2006_ETRS89_GEOGR.SHP", "DIEPELUN_NAP_10M_ETRS89_GE...", "GRENS12M_LENTE2009_ETRS89...", "LANDPOLY_WORLD.SHP", "NAP20DOOR_ETRS89_GEOGR.SHP", "VSS_BEGRENZING_ETRS89_GEO...", "VSS_SYMBOLEN_ETRS89_GEOG...", and "VSS_ZONES_ETRS89_GEOGR.SHP". At the bottom, there is a "Time Slider" showing a timeline from 25-2-2016 20:00:00 (GMT+1) to 26-2-2016 20:00:00 (GMT+1). The status bar at the bottom right shows the current time: 52.3035 N, 4.7029 E and Time into Spill: 0 Days 0 Hours 0 Minutes.

Menu Bar
Model functionality

Map
presentation of the
Model results

GEO Data
Map options

Time Slider



Create New Scenario

The screenshot displays the COASTMAP software interface. The 'File' menu is open, with 'New Scenario' highlighted and a red '1' next to it. The map area shows a river network on a green background. A red '2' and the text 'Click in the map for a spill site' with a red arrow point to a crosshair marker on the river, which is circled in red. The interface includes a menu bar (File, Zoom, GIS, Data, MODEL, Model Output, Tools, COASTMAP, Help), a toolbar with icons for Polygon, Move Object, Edit Vertices, Add Current Vector, Grid Cell, Distance, and Redraw, and a status bar at the bottom with a timeline from 25-2-2016 20:00:00 (GMT+1) to 26-2-2016 20:00:00 (GMT+1).



New Scenario

File Zoom GIS Data MODEL Model Output Tools COASTMAP Help

Info Zoom In Zoom Out Pan Point Polyline Polygon Move Object Edit Vertices Add Current Vector Grid Cell Distance Redraw 52.1711 N, 4.7061 E
Time into Spill: 0 Days 0 Hours 0 Minutes

GIS Legend Live Data

Model

- Scenario - IKSR1
- Depths - IKSR1_DELTARES_RIVERS
- Currents -
- Winds - IKSR1_

Geography

- AANLOOP_ETRS89_GEOGR.SHP
- BLOKIND_ETRS89_GEOGR.SHP
- BONN2006_ETRS89_GEOGR.SHP
- DIEPTELUN_NAP_10M_ETRS89_GE...
- GRENS12M_LENTE2009_ETRS89_...
- LANDPOLY_WORLD.SHP
- NAP20DOOR_ETRS89_GEOGR.SHP
- VSS_BEGRENZING_ETRS89_GEO...
- VSS_SYMBOLEN_ETRS89_GEOG...
- VSS_ZONES_ETRS89_GEOGR.SHP

Chemical Model - Scenario

Scenario Spill Winds Currents Water Air Review

Scenario Name: IKSR1
Description: Demo Chemmap
Release Type: Point

Latitude: 51.74885 N Longitude: 6.41504 E

Track Spill in
 Water
 Air
 DD DD
 DD MM.MM
 DD MM SS

Spill Start Time: 25-2-2016 20:00 Time Zone: (GMT+01:00)

Simulation Length: 24.0 Hours Days (Predict how far into the future)

Save as Default Run Trajectory Model Next Close

25-2-2016 20:00:00 (GMT+1) 25-2-2016 20:00:00 26-2-2016 20:00:00 (GMT+1)



Benzene Spill

File Zoom GIS Data MODEL Model Output Tools COASTMAP Help

Info Zoom In Zoom Out Pan Point Polyline Polygon Move Object Edit Vertices Add Current Vector Grid Cell Distance Redraw

52.1711 N, 4.7061 E
Time into Spill: 0 Days 0 Hours 0 Minutes

GIS Legend Live Data

Model

- Scenario - IKSRI
- Depths - IKSRI_DELTARES_RIVERS
- Currents -
- Winds - IKSRI_

Geography

- AANLOOP_ETRS89_GEOGR.SHP
- BLOKIND_ETRS89_GEOGR.SHP
- BONN2006_ETRS89_GEOGR.SHP
- DIEPTELUN_NAP_10M_ETRS89_GE...
- GRENS12M_LENTE2009_ETRS89_...
- LANDPOLY_WORLD.SHP
- NAP20DOOR_ETRS89_GEOGR.SHP
- VSS_BEGRENZING_ETRS89_GEO...
- VSS_SYMBOLEN_ETRS89_GEOG...
- VSS_ZONES_ETRS89_GEOGR.SHP

Chemical Model - Spill

Scenario **Spill** Winds Currents Water Air Review

Chemical Spill Release Options

Spill Amount: 1,000.00 Tonnes

Spill Duration: 2.000 Hours (length of time chemical was released)

Release Depth: 0.5 (m)

Release Area (m²): -1.00

Release Thickness (m): 0.500000000

Set particle diameter (m)

Chemical Databases

Master Database

Personal Database

Search

BARITE
BARIUM CARBONATE
BARIUM CHLORIDE
BENSULFIDE
benzaldehyde
benzamide
Benzene

Save as Default Previous Run Trajectory Model Next Close

25-2-2016 20:00:00 (GMT+1) 25-2-2016 20:00:00 26-2-2016 20:00:00 (GMT+1)



Get Wind Data

The screenshot displays the COASTMAP software interface. The main window shows a map with various geographical features and a data table. A dialog box titled "Chemical Model - Winds" is open, highlighting the "Winds" tab. The dialog box contains the following information:

- Scenario:** Scenario
- Spill:** Spill
- Winds:** Winds (highlighted with a red box)
- Currents:** Currents
- Water:** Water
- Air:** Air
- Review:** Review

Below the tabs, there are radio buttons for "Manual Winds", "Wind File", "COASTMAP" (selected), and "No Winds". The "COASTMAP" section lists the following data sources:

- MATROOS WIND VITAAL INTERNET
- ! MATROOS WIND VITAAL INTRANET
- ! MATROOS WIND NIET-VITAAL INTERNET
- ! MATROOS WIND NIET-VITAAL INTRANET

The "File Information" section shows:

- File Name: IKSRI_1.NC
- Start Date: 25-2-2016 19:00:00
- End Date: 26-2-2016 19:00:00
- File Size: 23 KB

At the bottom of the dialog box, there are buttons for "Save as Default", "Previous", "Run Trajectory Model", "Next", and "Close".



Get Current Data

File Zoom GIS Data MODEL Model Output Tools COASTMAP Help

51.7323 N, 6.4358 E
Time into Spill: 0 Days 0 Hours 0 Minutes

GIS Legend Live Data

Model

- Scenario - IKSRI
- Depths - IKSRI_DELTARES_RIVERS
- Currents - IKSRI_MATROOS_STR...
- Winds - IKSRI_1

Geography

- AANLOOP_ETRS89_GEOGR.SHP
- BLOKIND_ETRS89_GEOGR.SHP
- BONN2006_ETRS89_GEOGR.SHP
- DIEPTELUN_NAP_10M_ETRS89_GE...
- GRENS12M_LENTE2009_ETRS89_...
- LANDPOLY_WORLD.SHP
- NAP20DOOR_ETRS89_GEOGR.SHP
- VSS_BEGRENZING_ETRS89_GEO...
- VSS_SYMBOLEN_ETRS89_GEOG...
- VSS_ZONES_ETRS89_GEOGR.SHP

Chemical Model - Currents

Scenario Spill Winds **Currents** Water Air Review

Current File COASTMAP EDS No Currents

MATROOS STROMING VITAAL INTERNET

- MATROOS STROMING VITAAL INTRANET
- MATROOS STROMING NIET-VITAAL INTER...
- MATROOS STROMING NIET-VITAAL INTRA...

Incorporate Deltares Rivers

When "Incorporate Rivers" is checked on, a script developed by Deltares will be run. This script prepares inputs for the chemical model. Please note: output files generated by this script (currents, land/water boundary, and depths) will automatically be loaded into the chemical model run form. These files will not need to be re-selected by the user. Click on Get Data to trigger the script.

Deltares

IKSR1_MATROOS_STROMING_VITAAL_INTERNET3.NC **Downloading @ 1750,60kb/s 49%**

Cancel AOI Size User Defined

Save as Default Previous Run Trajectory Model Next Close

25-2-2016 20:00:00 (GMT+1) 25-2-2016 20:00:00 26-2-2016 20:00:00 (GMT+1)

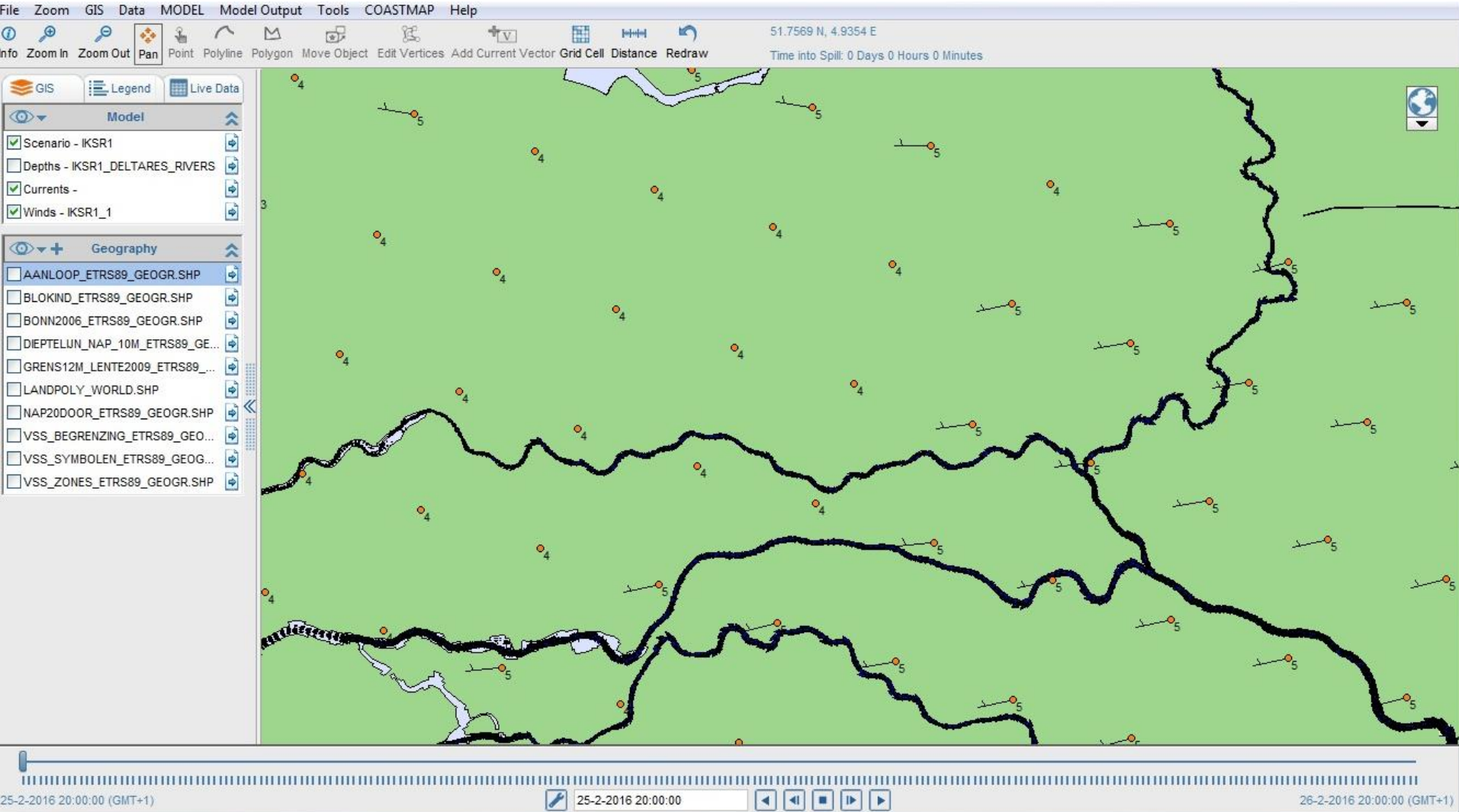


Executing River Script

The screenshot displays a GIS application window with a map in the background. A dialog box titled "Chemical Model - Currents" is open in the foreground. The dialog has several tabs: "Scenario", "Spill", "Winds", "Currents" (highlighted with a red box), "Water", "Air", and "Review". Below the tabs, there are radio buttons for "Current File", "COASTMAP EDS" (selected), and "No Currents". A list of files is shown, with "MATROOS STROMING VITAAL INTERNET" selected. To the right of the list, there is a checkbox labeled "Incorporate Deltares Rivers" which is checked and highlighted with a red box. Below the list, there is a text box with the following text: "When 'Incorporate Rivers' is checked on, a script developed by Deltares will be run. This script prepares inputs for the chemical model. Please note: output files generated by this script (currents, land/water boundary, and depths) will automatically be loaded into the chemical model run form. These files will not need to be re-selected by the user. Click on Get Data to trigger the script." Below the text box, there is a "Get Data" button and a dropdown menu for "AOI Size" set to "User Defined". At the bottom of the dialog, there is a progress bar showing "Download Complete" and "Executing Python Script", both highlighted with a red box. The progress bar is currently at the "Executing Python Script" stage. The background map shows a river network with various colored areas representing different land/water boundaries. The status bar at the bottom of the application shows the date and time: "25-2-2016 20:00:00 (GMT+1)".



Wind and Current Data



Water Parameters



The screenshot displays the COASTMAP software interface with the 'Chemical Model - Water' dialog box open. The dialog box is divided into several sections:

- Scenario**: Includes buttons for Scenario, Spill, Winds, Currents, **Water** (highlighted with a red box), Air, and Review.
- Environmental Information**: Contains sub-sections for Wind Information, Temperature, and Suspended Sediments.
- Salinity or Density**: Contains sub-sections for Salinity (ppt) and Density (sigma).
- Coastline-Bathymetry Options**: Contains sub-sections for Grid/Boundary File and Depth Grid.

Key parameters and settings visible in the dialog box:

- Wind Information**: Use Constants. Wind Factor (%) is 3.50, Wind Angle (degrees) is 20.00. Model Will Calculate Wind Drift.
- Temperature**: Constant, 10 °C. Monthly Average. Varied.
- Suspended Sediments**: Concentration (mg/l) is 10.000000.
- Salinity (ppt)**: Constant, 32.00. Monthly Average. Varied.
- Density (sigma)**: Constant, 30.00. Varied.
- Coastline-Bathymetry Options**: Grid/Boundary File is IKSR1_DELTARES_RIVERS.shp. Constant Depth (m) 10.0. Depth Grid is IKSR1_Deltares_Rivers.DEP.

The background shows a map with a river network and various data layers. The status bar at the bottom indicates the date and time: 25-2-2016 20:00:00 (GMT+1).

Air Parameters



File Zoom GIS Data MODEL Model Output Tools COASTMAP Help

Info Zoom In Zoom Out Pan Point Polyline Polygon Move Object Edit Vertices Add Current Vector Grid Cell Distance Redraw

51.7323 N, 6.4358 E
Time into Spill: 0 Days 0 Hours 0 Minutes

GIS Legend Live Data

Model

- Scenario - IKSRI
- Depths - IKSRI_DELTARES_RIVERS
- Currents -
- Winds - IKSRI_1

Geography

- AANLOOP_ETRS89_GEOGR.SHP
- BLOKIND_ETRS89_GEOGR.SHP
- BONN2006_ETRS89_GEOGR.SHP
- DIEPTELUN_NAP_10M_ETRS89_GE...
- GRENS12M_LENTE2009_ETRS89_...
- LANDPOLY_WORLD.SHP
- NAP20DOOR_ETRS89_GEOGR.SHP
- VSS_BEGRENZING_ETRS89_GEO...
- VSS_SYMBOLEN_ETRS89_GEOG...
- VSS_ZONES_ETRS89_GEOGR.SHP

Chemical Model - Air

Scenario Spill Winds Currents Water **Air** Review

Environmental Information Output Options

Air Temperature
10 °C °F

Surface Roughness
Open

Concentration Grid Options
 Default Grid Fixed Grid Options
Horizontal dimensions of concentration: 50
Vertical dimensions of concentration grid: 5

Atmospheric Model
Model Time Step (min): 1
Number of Particles: Medium
Maximum Height (m) to track atmospheric plume: 100.0

Dispersion
 Model calculates Dispersion (3D)
 User defined stability class
Air Stability: Neutral
 User-specified Dispersion
Horizontal Dispersion (m²/s): -1.00000
Vertical Dispersion (m²/s): -1.00000

Save as Default Previous Run Trajectory Model Next Close

25-2-2016 20:00:00 (GMT+1) 25-2-2016 20:00:00 26-2-2016 20:00:00 (GMT+1)



Review Spill and Data

The screenshot shows a GIS application window with a 'Chemical Model - Review' dialog box open. The dialog box has a 'Review' button highlighted with a red box. Below the dialog box, a timeline shows the simulation period from 25-2-2016 20:00:00 to 26-2-2016 20:00:00. The simulation parameters are as follows:

Scenario:	IKSR1	Spill Duration:	2 Hours
Description:	Demo Chemmap	Simulation Length:	24 Hours
Start Time:	25-2-2016 20:00:00	Grid File:	basemap 2016.shp
Spill Location:	51.7488 N, 6.415 E	Current File:	IKSR1_DELTARES_RIVERS.NC
Chemical Type:	Benzene	No. Wind Files:	1
Spill Amount:	1000 Tonnes	Wind File:	IKSR1_1.NC



Chemical Model

File Zoom GIS Data MODEL Model Output Tools COASTMAP Help

Info Zoom In Zoom Out Pan Point Polyline Polygon Move Object Edit Vertices Add Current Vector Grid Cell Distance Redraw 52.274 N, 5.0575 E
Time into Spill: 0 Days 0 Hours 0 Minutes

GIS Legend Live Data

Model

- Scenario - IKSR1
- Depths - IKSR1_DELTARES_RIVERS
- Currents -
- Winds - IKSR1_1

Geography

- AANLOOP_ETRS89_GEOGR.SHP
- BLOKIND_ETRS89_GEOGR.SHP
- BONN2006_ETRS89_GEOGR.SHP
- DIEPTELUN_NAP_10M_ETRS89_GE...
- GRENS12M_LENTE2009_ETRS89_...
- LANDPOLY_WORLD.SHP
- NAP20DOOR_ETRS89_GEOGR.SHP
- VSS_BEGRENZING_ETRS89_GEO...
- VSS_SYMBOLEN_ETRS89_GEOG...
- VSS_ZONES_ETRS89_GEOGR.SHP

Chemodel - [Chemical Model]

File Edit View State Window Help

```

*--* Chemical Fates Model *--*(2015 12/ 1 17:33)

Scenario Name : IKSR1

Chemical Spilled      : Benzene
Amount Spilled       : 1000.00 metric tons
Release Duration (hrs) : 2.0

Spill Location:
Longitude (deg., min.) : 6 24.9022 (E) = 6.41504 (E)
Latitude (deg., min.) : 51 44.9309 (N) = 51.74885 (N)
Release Depth (m)      : 0.5

Spill Starts         : 25 Feb. 2016 at time 20:00
Simulation Length (days) : 1.000

Time  %Surf  %WCol  %Atmos  %Decay  %Sedmt  %Shore  %Strnd  %Out TotalMass  WE Curr SN  WE Wind SN
-----  -----  -----  -----  -----  -----  -----  -----  -----  -----  -----  -----
11.75  0.0     16.8    82.9    0.2     0.0     0.0     0.0     0.0    1000.00  -172.2  173.1   0.2   1.5

Current File: IKSR1_DELTARES_RIVERS.NC
Wind File: IKSR1_1.NC

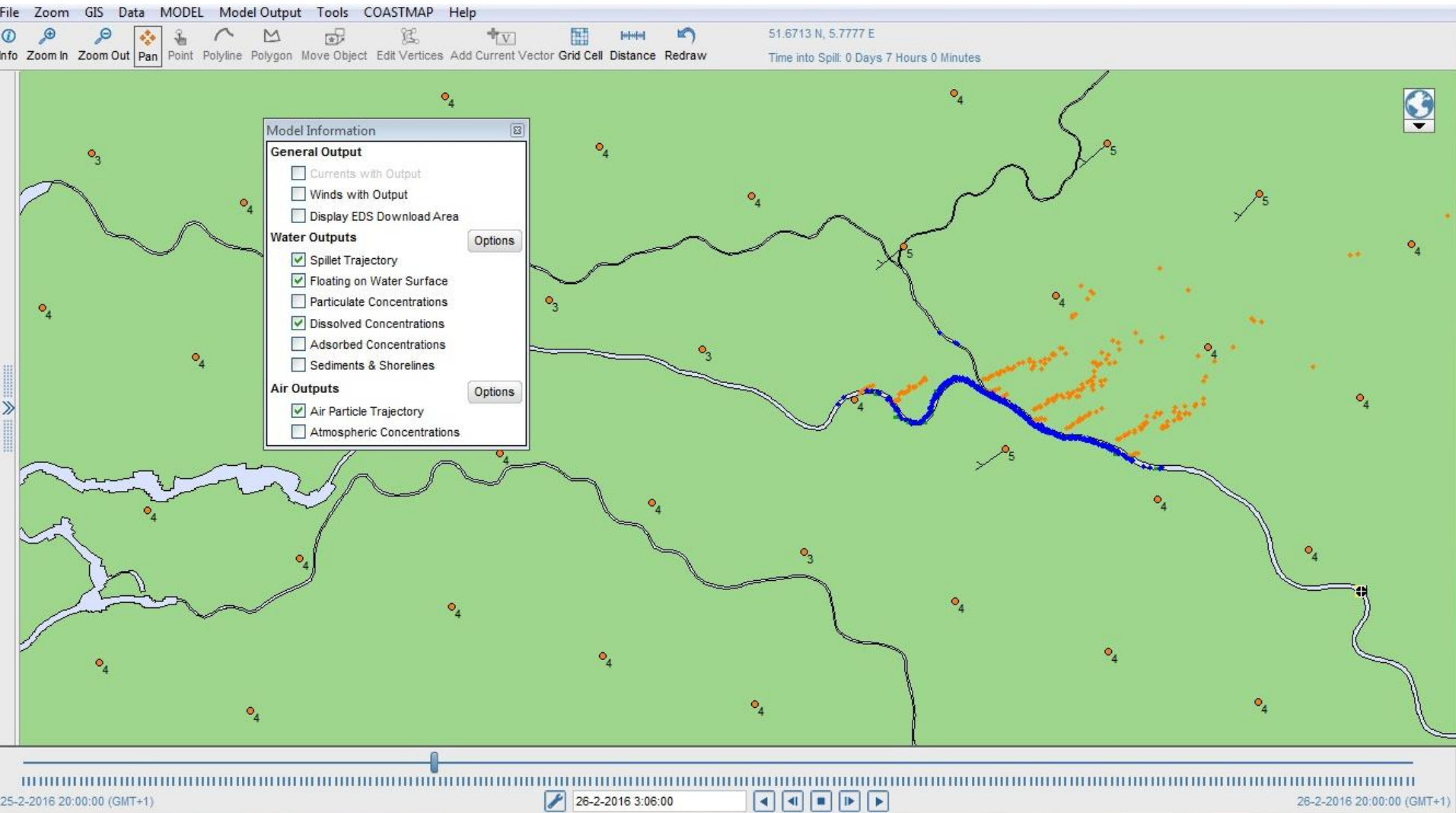
```

Running

25-2-2016 20:00:00 (GMT+1) 25-2-2016 20:00:00 26-2-2016 20:00:00 (GMT+1)



Model Results (base map)





Model Results (open street map)

File Zoom GIS Data MODEL Model Output Tools COASTMAP Help

Info Zoom In Zoom Out Pan Point Polyline Polygon Move Object Edit Vertices Add Current Vector Grid Cell Distance Redraw 51.8163 N, 5.4698 E Time into Spill: 0 Days 7 Hours 0 Minutes



25-2-2016 20:00:00 (GMT+1) 26-2-2016 3:06:00 26-2-2016 20:00:00 (GMT+1)



Model Display Options

File Zoom GIS Data MODEL Model Output Tools COASTMAP Help

52.0677 N, 5.3792 E
Time into Spill: 0 Days 7 Hours 0 Minutes

IKSR1 - Kladblok

Bestand Bewerken Opmaak Beeld Help

Chemical Fates
Scenario :IKSR1
Tonnes

Time(hours)	Surface	waterColumn	Ashore	Evaporated	Decayed
00,0	000,0	000,0	000,0	000,0	000,0
00,25	078,53365	159,9934	000,0	011,45067	000,02227
00,5	103,4473	216,9757	000,0	054,51644	000,0606
00,75	137,9605	258,9494	000,0	102,9762	000,11393
01,0	165,4721	296,9163	000,0	162,4315	000,1801
01,25	178,9136	342,7621	000,0	228,0664	000,25791
01,5	196,9757	378,7145	000,0	298,9635	000,3463
01,75	200,2281	426,0685	000,0	373,2587	000,44463
02,0	212,1796	334,8693	000,0	452,3992	000,55192
02,25	134,5797	326,163	000,0	538,615	000,64229
02,5	077,20609	319,9127	000,0	602,1611	000,72018
02,75	042,00869	312,0739	000,0	645,1277	000,78963
03,0	024,02885	302,8379	000,0	672,2795	000,85374
03,25	012,84636	290,4217	000,0	695,8187	000,91322
03,5	006,63747	281,381	000,0	711,0118	000,96972
03,75	003,58308	270,3524	000,0	725,0411	001,02345
04,0	002,62428	265,3443	000,0	730,9554	001,076
04,25	002,06834	252,3194	000,0	744,4864	001,1259
04,5	001,42258	247,282	000,0	750,1207	001,17468

Weathering Graph

Print Options

Mass Balance for Benzene

Chemical Mass Balance

Water Column 21.07%

6.16% Decayed

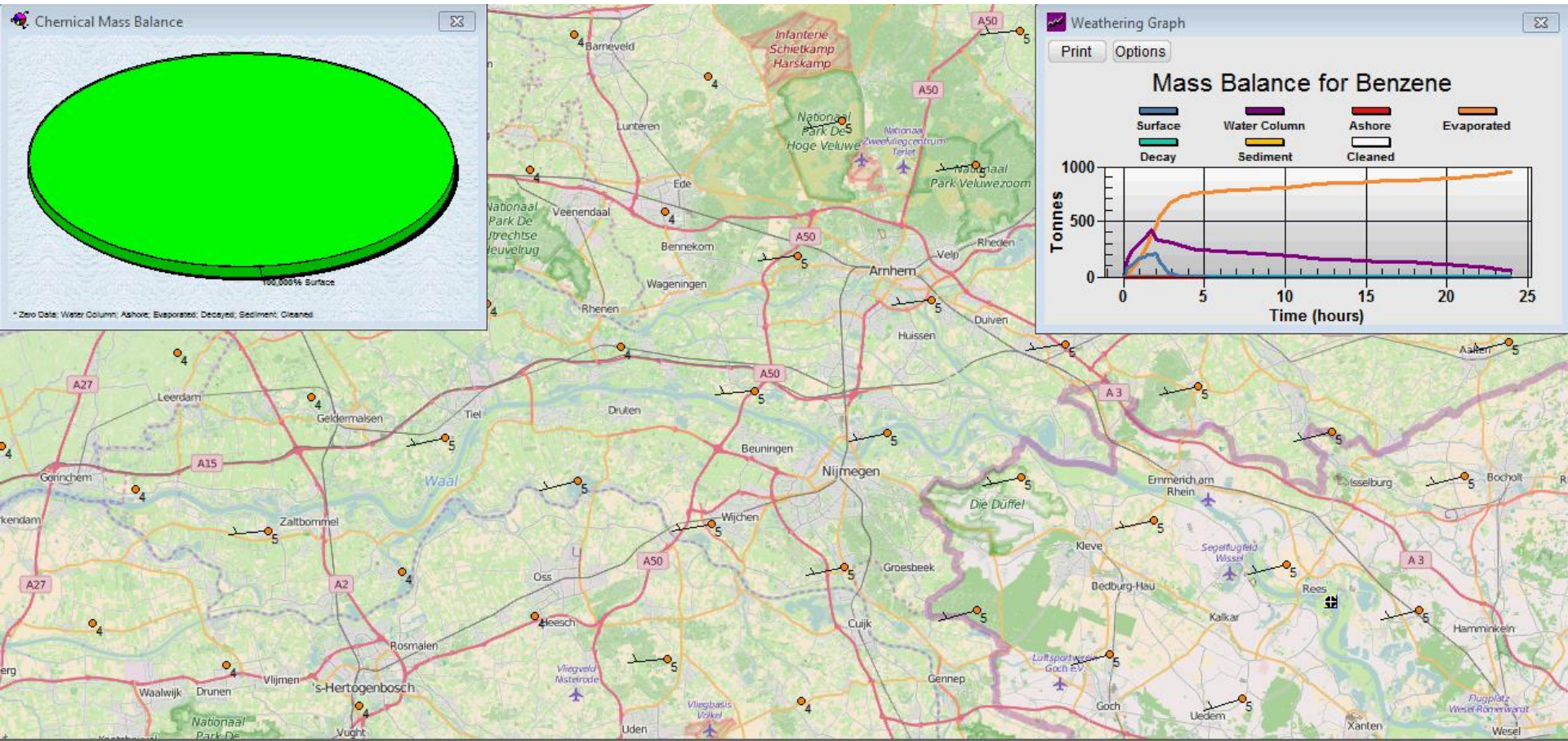
77.60% Evaporated

*Zero Data: Surface, Ashore, Sediment, Cleaned

25-2-2016 20:00:00 (GMT+1) 26-2-2016 3:06:00 26-2-2016 20:00:00 (GMT+1)



Model Results (movie)





Thank you for your attention

2020 > ????

