Spatial modelling of oil risks in the Gulf of Finland

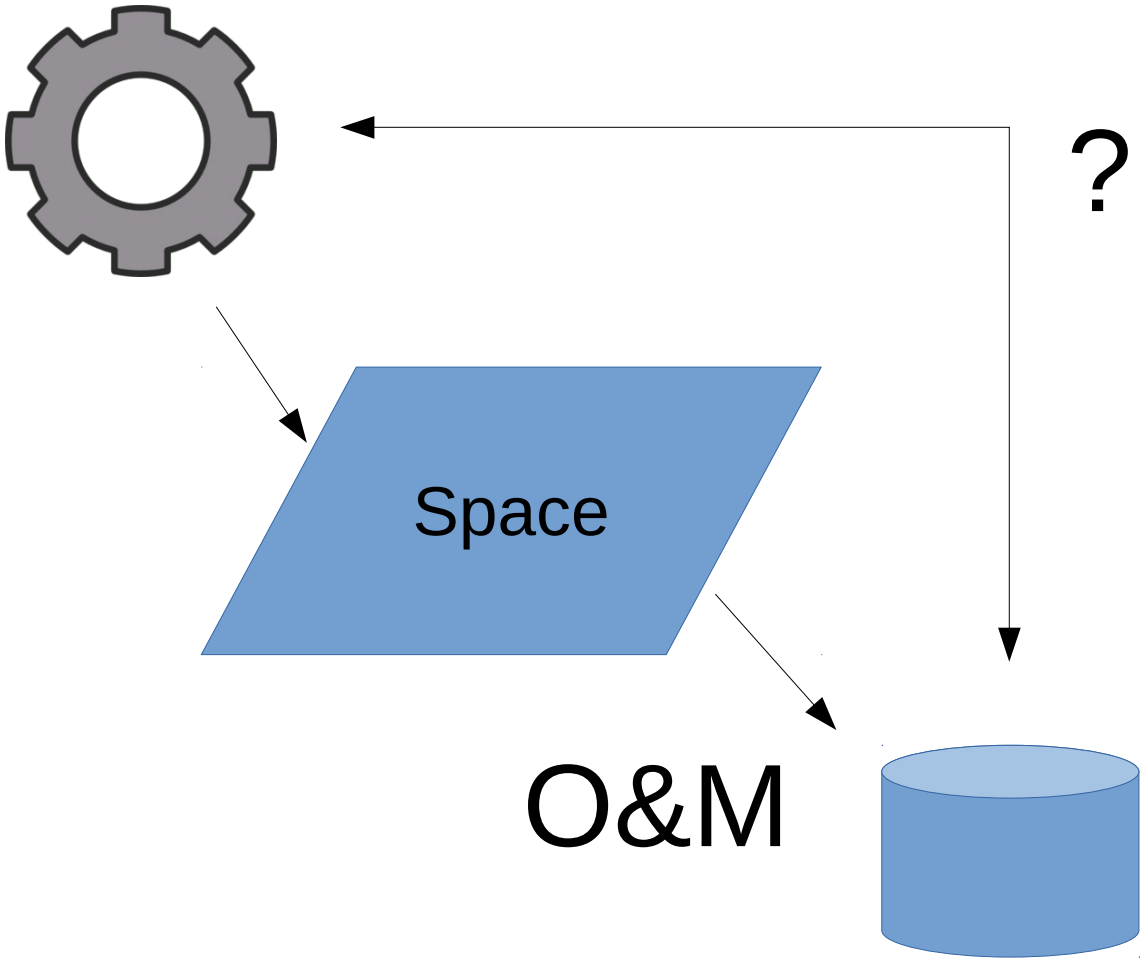
WGMABS meeting, Helsinki, 13.4.2015

Ari Jolma
Biwatech Ltd

Topics

- Spatial modelling
- Oil risk management workflow
- Information needs
- Data management and information systems

Spatial modelling



?

Pitfalls:
Spatial autocorrelation
MAUP
Ecological fallacy
Non-uniformity of space

Spatial data:
Points
Locations
Lines
Tracks, Borders
Areas
Fields
Scalar f., Vector f.

Why spatial models?

- To explain patterns in spatial data
  - (point) patterns: density, distances between
- To include space in predictions
- To enable exploration and understanding of the real world process

D. O'Sullivan and D. Unwin. Geogrpahic Information Analysis

Types of spatial models

- Statistical
- Dynamic physics-based simulation models
- Cellular automata
- Agent-based models

Oil risk management workflow

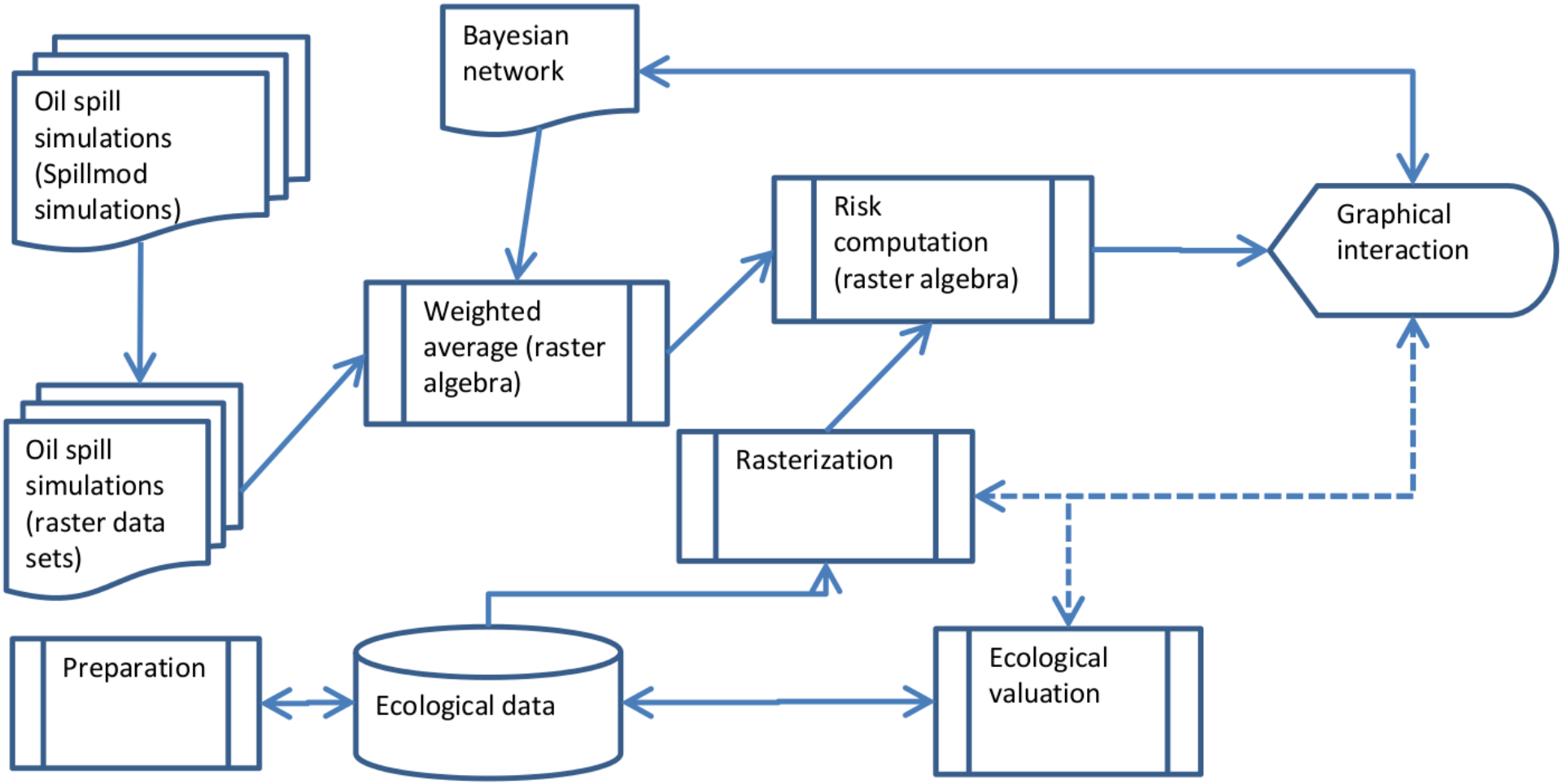
- Contingency planning

- What are the probable locations for accidents?
- How will the oil spread?
- Where are the values to protect?
- How to distribute the combating gear?

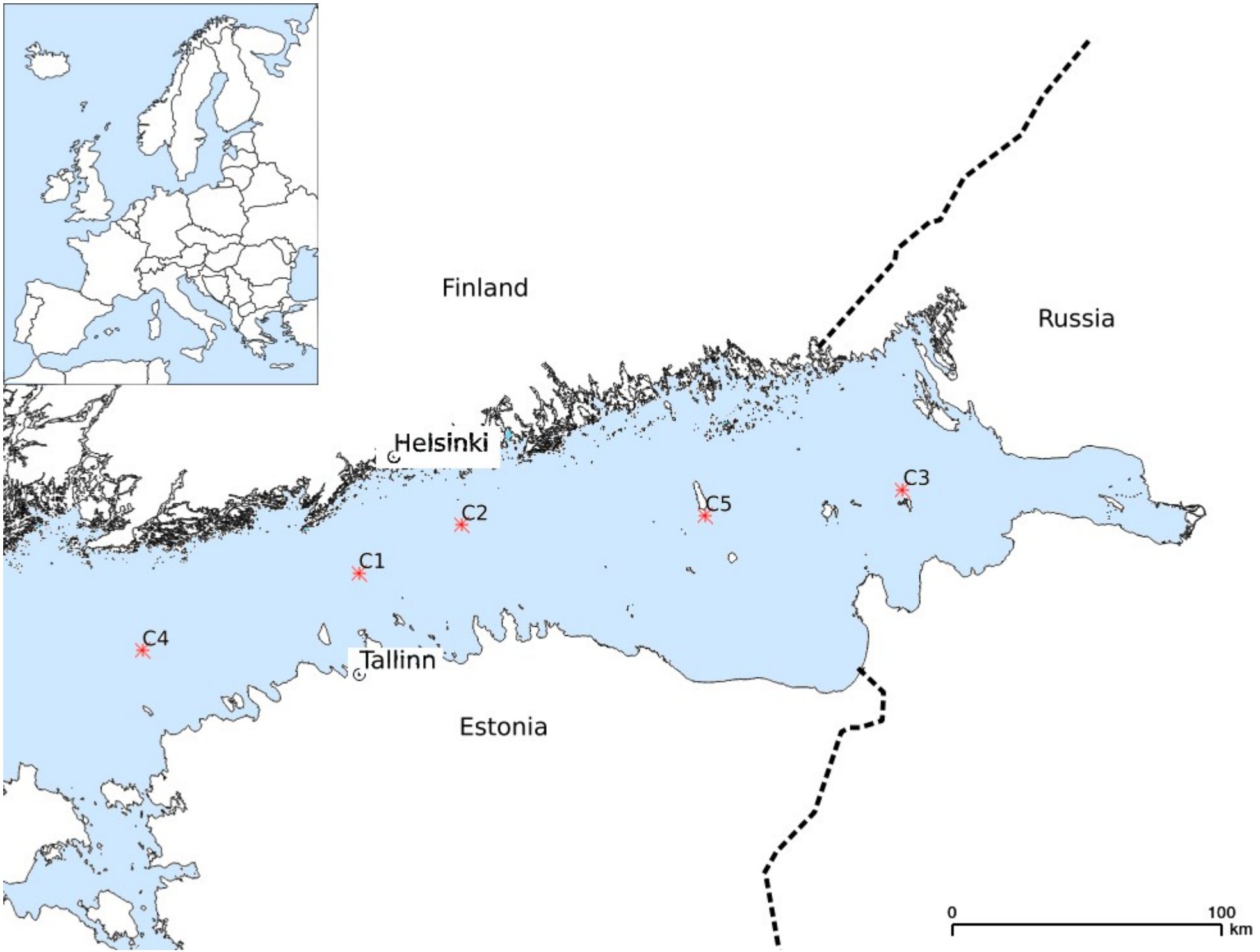
Oil risk management workflow

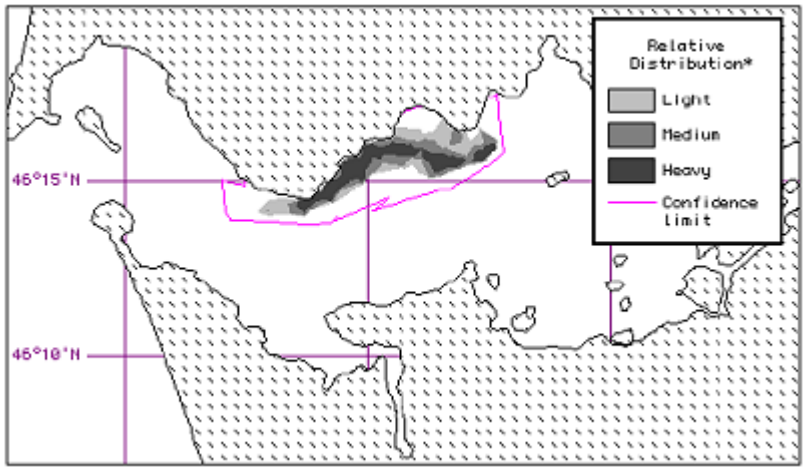
- Operational planning

- What is the location of accident?
- How will the oil spread?
- Where are the values to protect?
- How to use the combating gear?

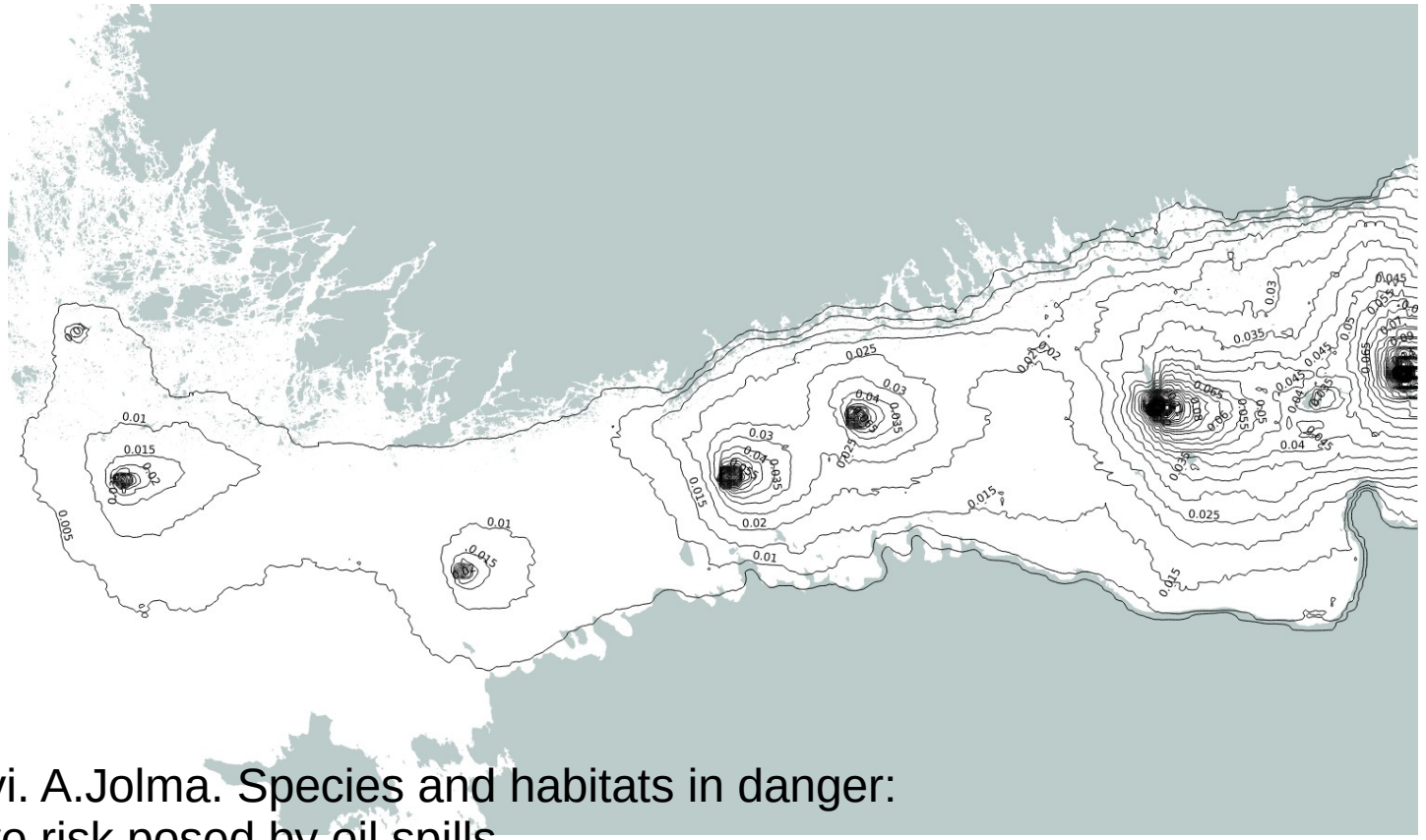


A. Jolma, A. Lehikoinen, I. Helle, R. Venesjärvi. 2014. A software system for assessing the spatially distributed ecological risk posed by oil shipping. Environmental Modelling and Software. 11/2014; 61:1–11. DOI: 10.1016/j.envsoft.2014.06.023

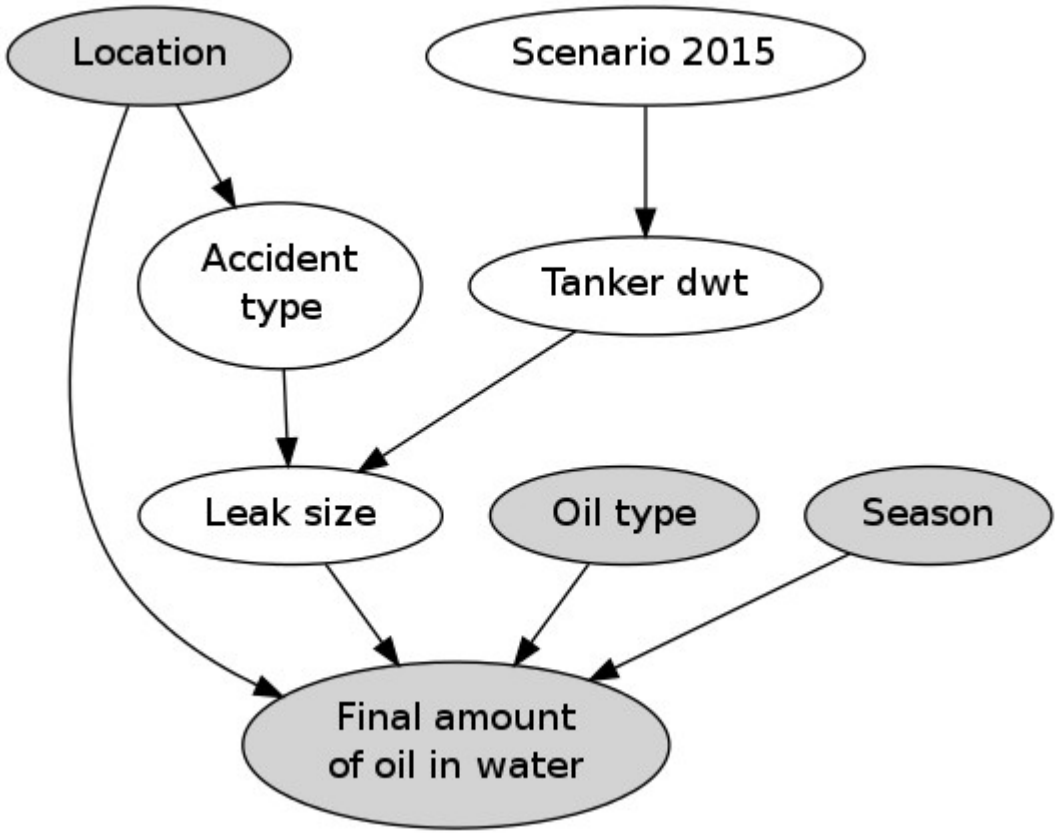

Finland
Russia
Helsinki
C1
C2
C3
C4
C5
Tallinn
Estonia
0
100
km



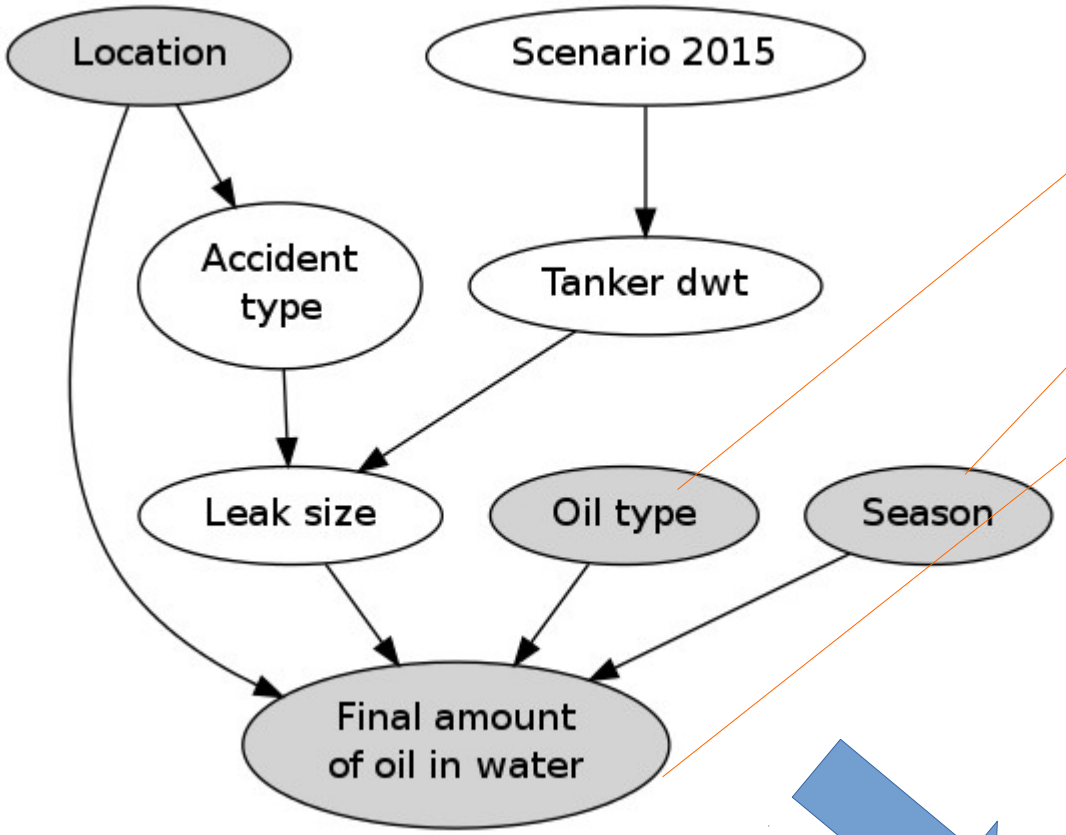
http://www.mapcruzin.com/free-gis-software/gnome-gulf-oil-spill-noaa-software.htm



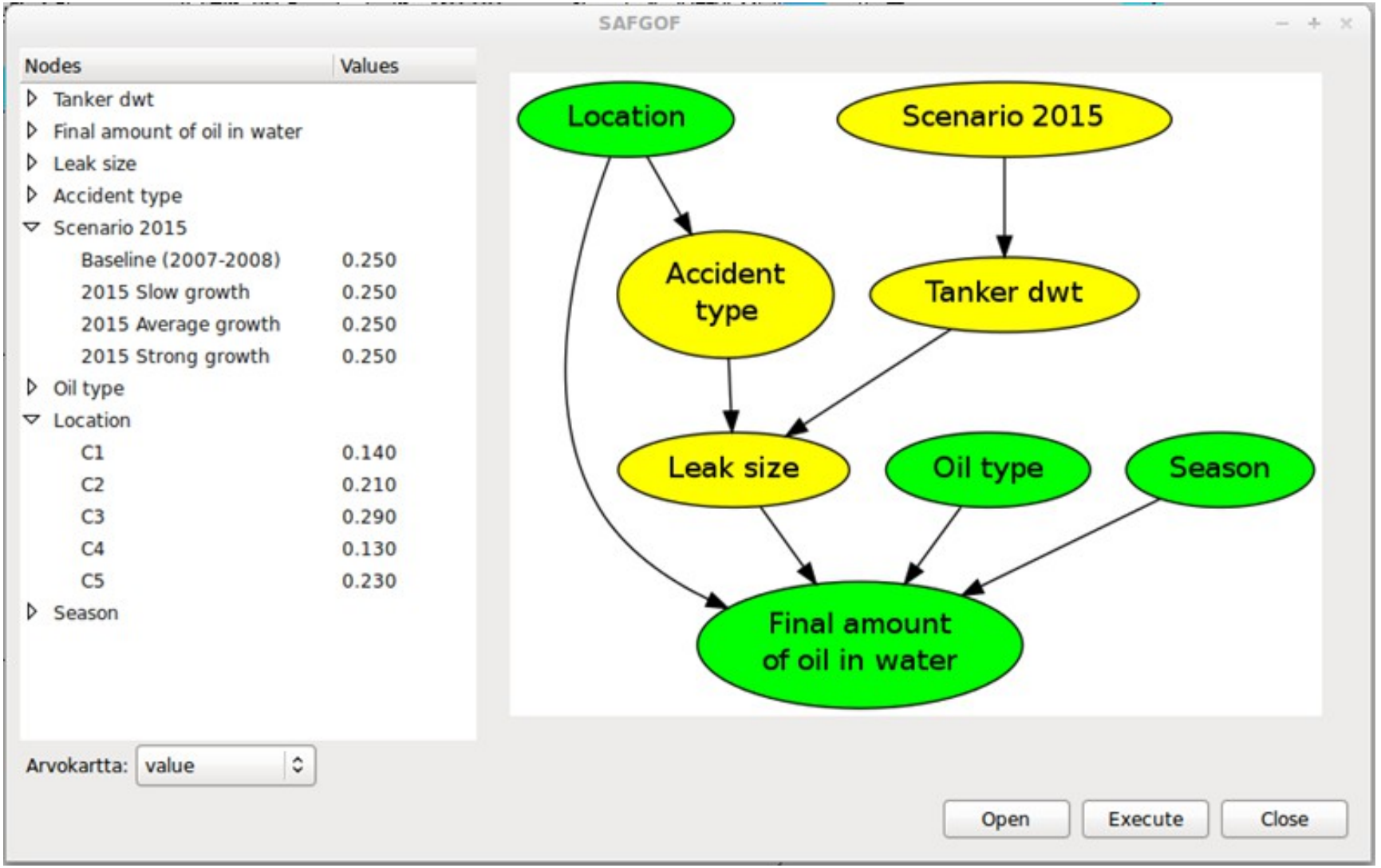
I.Helle, R.Venesjärvi. A.Jolma. Species and habitats in danger: Modeling the relative risk posed by oil spills in the northern Baltic Sea (submitted)



A.Lehikoinen, M. Hänninen, J.Storgård, E. Luoma, S. Mäntyniemi, S. Kuikka. 2015 A Bayesian network for assessing the collision induced risk of an oil accident in the Gulf of Finland. Environmental science & technology 03/2015;



Location	Oil type	Season	Final	Probability
1	1	1	1	0,0634508777
1	1	1	2	0,0648946099
1	1	1	3	0,0396621819
1	1	1	4	0,0252413141
1	1	2	1	0,016853058
1	1	2	2	0,0836847274
1	1	2	3	0,0907683383
1	1	2	4	0,035723717
1	1	3	1	0,03449606
1	1	3	2	0,068514151
1	1	3	3	0,0230147562
1	1	3	4	0,0029933087
1	1	4	1	0,0749549566
1	1	4	2	0,0643282231
1	1	4	3	0,0919806592
1	1	4	4	0,0202919019
1	2	1	1	0,057812311
1	2	1	2	0,0348615487
1	2	1	3	0,0996158751
1	2	1	4	0,0303573118
1	2	2		0,0229449462
1	2	2		0,0211996873
1	2	2		0,0857546183
1	2	2		0,0764006348
1	2	3		0,0857884451
1	2	3		0,0337338795
1	2	3		0,0074541045
1	2	3		0,0510017846
...				


SAFGOF
Nodes
Values
Tanker dwt
Final amount of oil in water
Leak size
Accident type
Scenario 2015
Baseline (2007-2008) 0.250
2015 Slow growth 0.250
2015 Average growth 0.250
2015 Strong growth 0.250
Oil type
Location
C1 0.140
C2 0.210
C3 0.290
C4 0.130
C5 0.230
Season
Arvokartta: value
Location
Scenario 2015
Accident type
Tanker dwt
Leak size
Oil type
Season
Final amount of oil in water
Open
Execute
Close

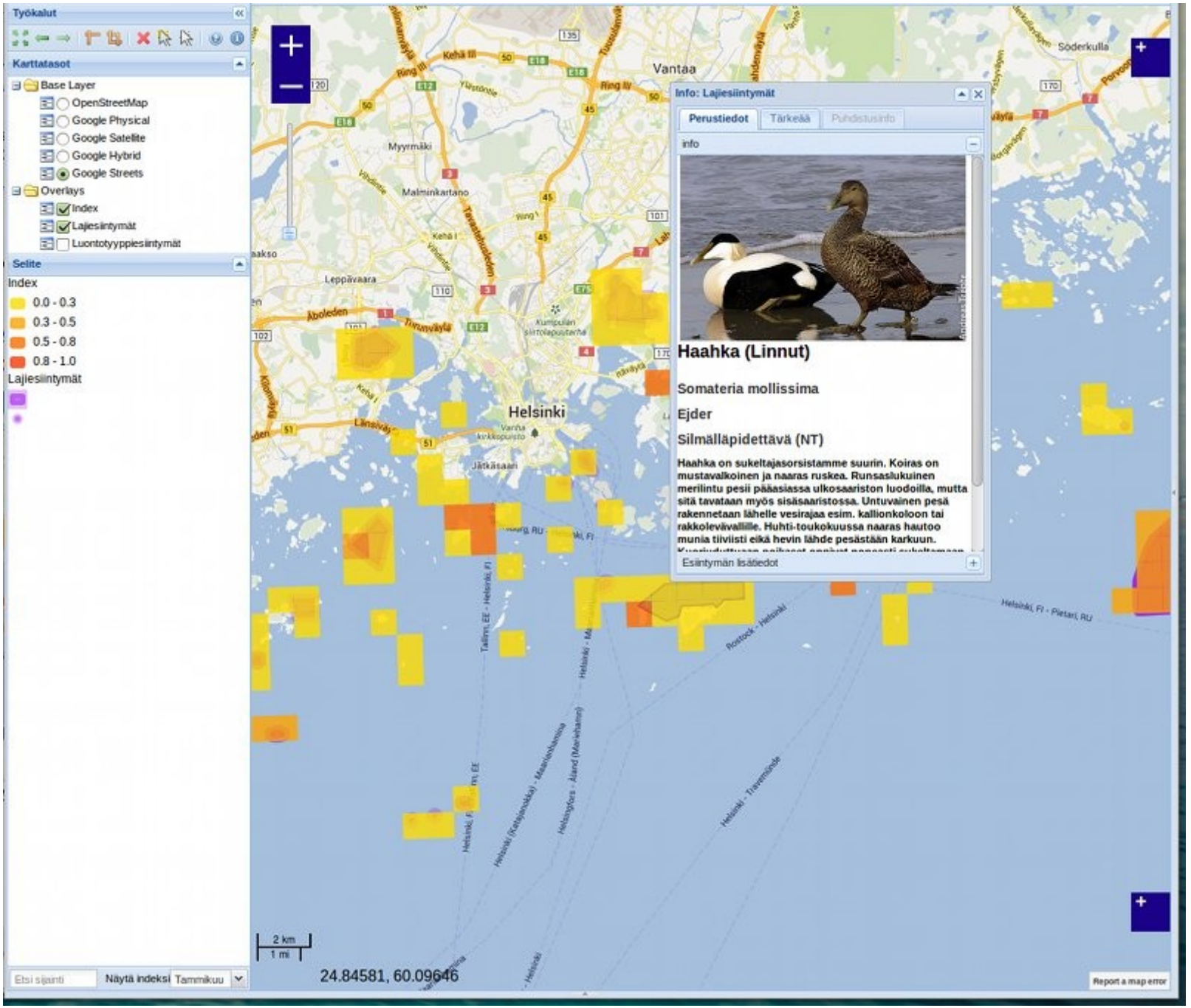
Information needs

- Location of oil slick
- Prediction of the oil movement
- Shoreline sensitivity maps
- Clean-up guidelines
- **Links** between different type of data, information, and knowledge
  - spatial links, knowledge-based links
- **Who** needs the information
- **Where** is the information needed

A. Altartouri, E. Ehrnsten, I. Helle, R. Venesjärvi, A. Jolma. 2013.
Geospatial Web Services for Responding to Ecological Risks Posed by Oil Spills
Photogrammetric Engineering and Remote Sensing 10/2013; 79(10): 905-914.

Spatial information technology

- Hardware, software, data develop fast
- Mobile technology
- Client – server
  - data, geospatial data
  - maps
- Semantic technology
  - automatic recognition of topics and concepts
  - information and meaning extraction
  - categorization



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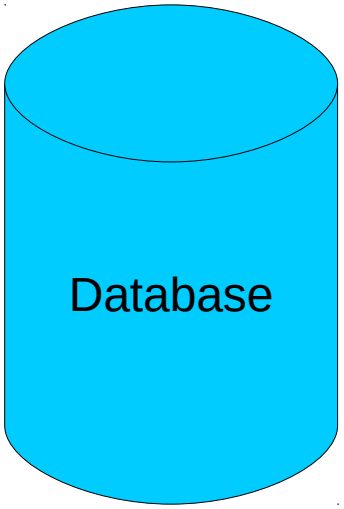


phpPgAdmin

- Servers
- PostgreSQL
  - eurajoki
  - lahti
  - maasto
  - oilrisk
    - Schemas
      - public
        - Tables
        - Views
        - Sequences
        - Functions
        - Full Text Sear
        - Domains
  - oilrisk_2014-05-27
  - pj
  - postgis
  - postgres
  - test
  - topcons

PostgreSQL 9.3.6 running on **localhost**:5432 -- You are logged in as user "**ajolma**" SQL | History | Find | Logout

phpPgAdmin: PostgreSQL: oilrisk: public:

Tables | Views | Sequences | Functions | Full Text Search | Domains | Privileges | Export

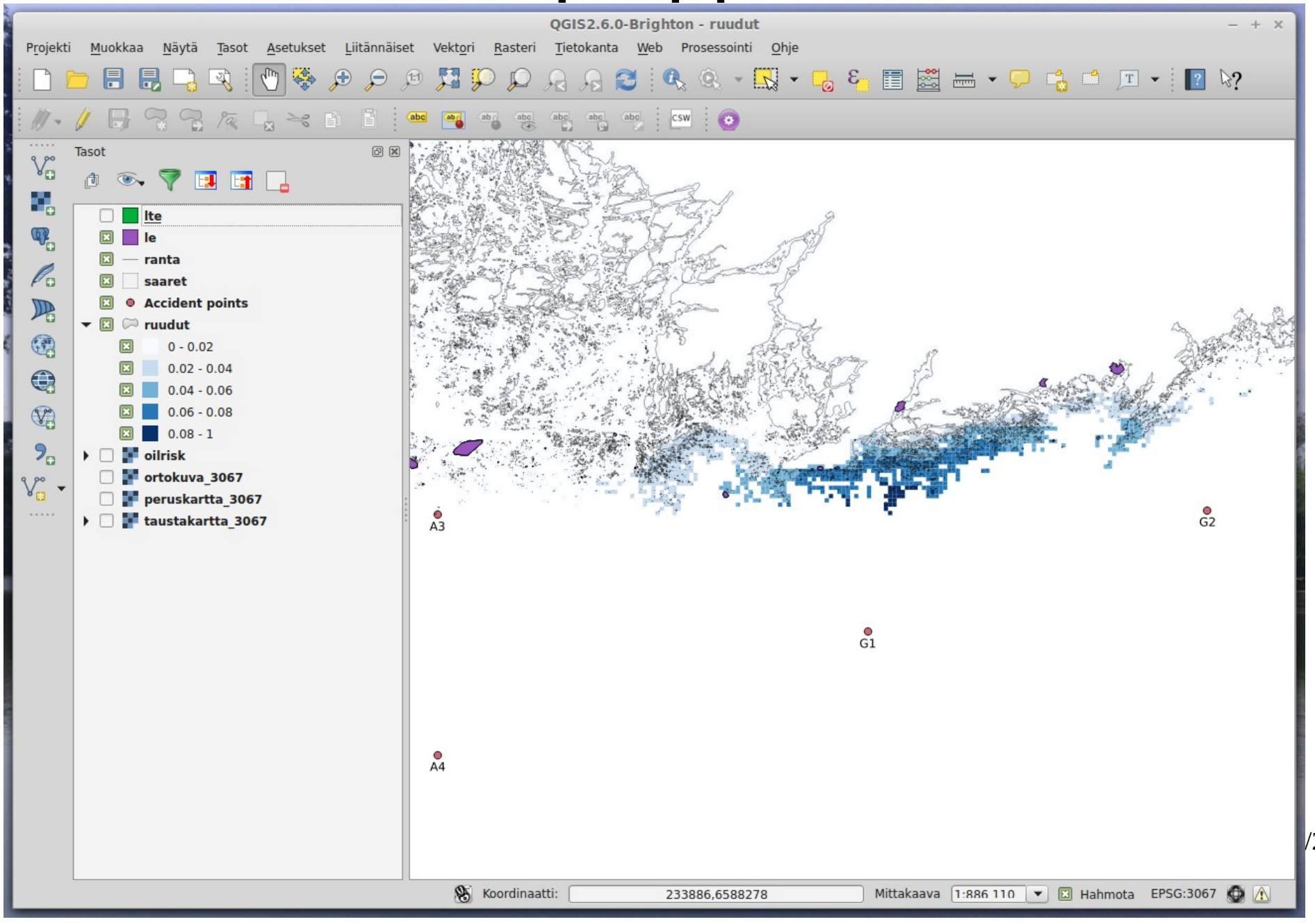
Table	Owner	Tablespace	Estimated row count	Actions	Comment
Accident points	ajolma		10	Browse Select Insert Empty Alter Drop Vacuum Analyze Reindex	
IUCN luokat	ajolma		6	Browse Select Insert Empty Alter Drop Vacuum Analyze Reindex	
Laji- ja luontotyyppikuvausten lähteet	ajolma		14	Browse Select Insert Empty Alter Drop Vacuum Analyze Reindex	
Lajiesiintymät	ajolma		3646	Browse Select Insert Empty Alter Drop Vacuum Analyze Reindex	*
LajiesiintymätX	ajolma		84	Browse Select Insert Empty Alter Drop Vacuum Analyze Reindex	Identtiset tai muuten poistettavat esiintymät
Lajiryhmät	ajolma		45	Browse Select Insert Empty Alter Drop Vacuum Analyze Reindex	*
Lajit	ajolma		1381	Browse Select Insert Empty Alter Drop Vacuum Analyze Reindex	* Tiedot lajeista, joiden esiintymiä on
Luontotyypit	postgres		28	Browse Select Insert Empty Alter Drop Vacuum Analyze Reindex	*
Luontotyypit2Puhdistusmenetelmät	ajolma		78	Browse Select Insert Empty Alter Drop Vacuum Analyze Reindex	testitaulu
Luontotyypit_Puhdistus	ajolma		144	Browse Select Insert Empty Alter Drop Vacuum Analyze Reindex	* tiedot puhdistusmenetelmien soveltuvuudesta luontotyypeille
Luontotyyppiesiintymät	ajolma		1548	Browse Select Insert Empty Alter Drop Vacuum Analyze Reindex	*
LuontotyyppiesiintymätX	ajolma		97	Browse Select Insert Empty Alter Drop Vacuum Analyze Reindex	Identtiset tai muuten lähes samat esiintymät
Puhdistettavuudet	ajolma		0	Browse Select Insert Empty Alter Drop Vacuum Analyze Reindex	
Puhdistusmenetelmäsuositukset	ajolma		3	Browse Select Insert Empty Alter Drop Vacuum Analyze Reindex	*
Puhdistusmenetelmät	ajolma		17	Browse Select Insert Empty Alter Drop Vacuum Analyze Reindex	*
Sijaintimäärittelyt	ajolma		2	Browse Select Insert Empty Alter Drop Vacuum Analyze Reindex	* Miten esiintymän sijainti on määritelty.
Suojeluarvot	ajolma		288	Browse Select Insert Empty Alter Drop Vacuum Analyze Reindex	* Asiantuntijoiden määrittelemät suojeluarvot
Tietokannat	ajolma		9	Browse Select Insert Empty Alter Drop Vacuum Analyze Reindex	* (entinen Tietolähteet)
Viitteet	ajolma		31	Browse Select Insert Empty Alter Drop Vacuum Analyze Reindex	* Kirjallisuusviitteet tiedoille, jos on.
edits	ajolma		6	Browse Select Insert Empty Alter Drop Vacuum Analyze Reindex	
hiekkarannat	ajolma		1	Browse Select Insert Empty Alter Drop Vacuum Analyze Reindex	
i1km	ajolma		0	Browse Select Insert Empty Alter Drop Vacuum Analyze Reindex	
iOILRISK	ajolma		8063	Browse Select Insert Empty Alter Drop Vacuum Analyze Reindex	* OILRISK indeksigrid
iOILRISK_1km	ajolma		1740	Browse Select Insert Empty Alter Drop Vacuum Analyze Reindex	*
ile1km	ajolma		0	Browse Select Insert Empty Alter Drop Vacuum Analyze Reindex	
ilte1km	ajolma		0	Browse Select Insert Empty Alter Drop Vacuum Analyze Reindex	
jalopuulehdot	ajolma		1	Browse Select Insert Empty Alter Drop Vacuum Analyze Reindex	
le2cell	ajolma		20320	Browse Select Insert Empty Alter Drop Vacuum Analyze Reindex	* Tapaukset, joissa lajiesiintymä leikkaa ainakin osittain 200 m solun
le2cell_1km	ajolma		3016	Browse Select Insert Empty Alter Drop Vacuum Analyze Reindex	*
le2lte	ajolma		913	Browse Select Insert Empty Alter Drop Vacuum Analyze Reindex	* Tapaukset, joissa lajiesiintymä ja luontotyyppiesiintymä ovat ainakin osittain päällekkäin
le2ruudut	ajolma		871	Browse Select Insert Empty Alter Drop Vacuum Analyze Reindex	Lajiesiintymät, jotka sijaitsevat ainakin osittain ruudun alueella
le2ruudut0	ajolma		919	Browse Select Insert Empty Alter Drop Vacuum Analyze Reindex	
linnut_tiira2010	ajolma		247	Browse Select Insert Empty Alter Drop Vacuum Analyze Reindex	
lintudata1	ajolma		617	Browse Select Insert Empty Alter Drop Vacuum Analyze Reindex	
lintudata4	ajolma		599	Browse Select Insert Empty Alter Drop Vacuum Analyze Reindex	
lt_in_ruudut0	ajolma		631	Browse Select Insert Empty Alter Drop Vacuum Analyze Reindex	luontotyyppien määrät ruuduissa
lte2cell	ajolma		1694	Browse Select Insert Empty Alter Drop Vacuum Analyze Reindex	* Luontotyyppiesiintymät, jotka leikkaavat ainakin osittain 200 m solun
lte2cell_1km	ajolma		1634	Browse Select Insert Empty Alter Drop Vacuum Analyze Reindex	*

OILRISK database

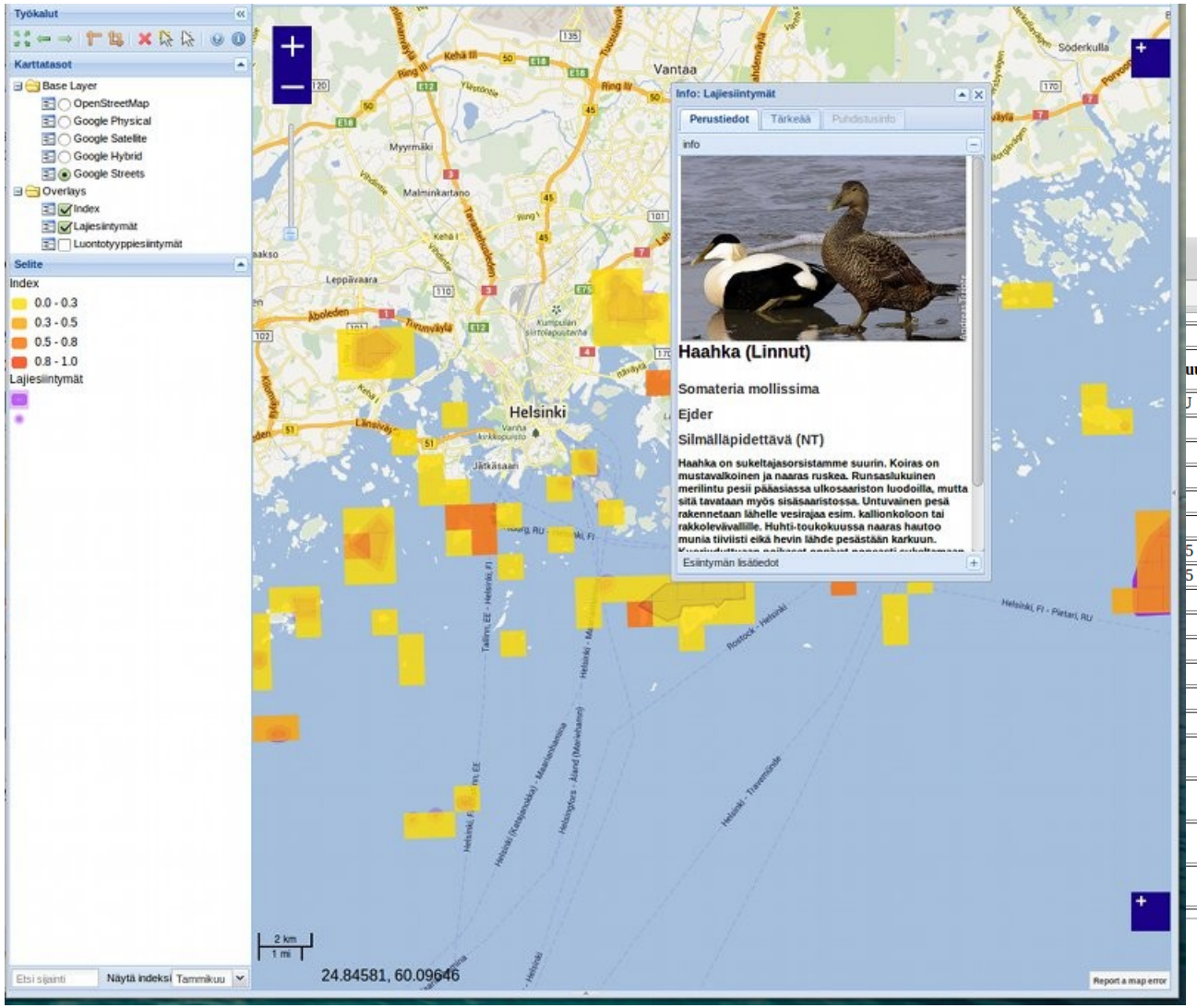
- Developed in several projects from several sources, now an offline relational database (PostgreSQL+PostGIS)
- Occurrences of species and habitats vulnerable to maritime oil spills on the Finnish coast of GoF
- Protection values, Cleaning methods, Species data, etc.
- Gridded data: 200 m x 200 m, 1 km x 1 km
- Index computation code

T.Ihaksi, T.Kokkonen, I.Helle, A.Jolma, T.Lecklin, S.Kuikka. 2011. Combining conservation value, vulnerability, and effectiveness of mitigation actions in spatial conservation decisions: an application to coastal oil spill combating. Environmental Management 03/2011; 47(5):802-13.

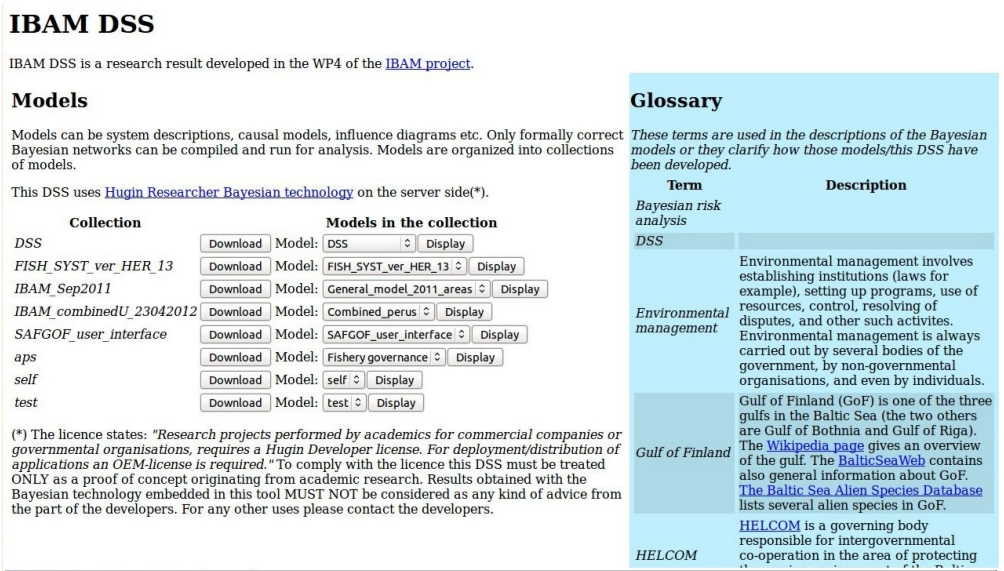
Desktop applications

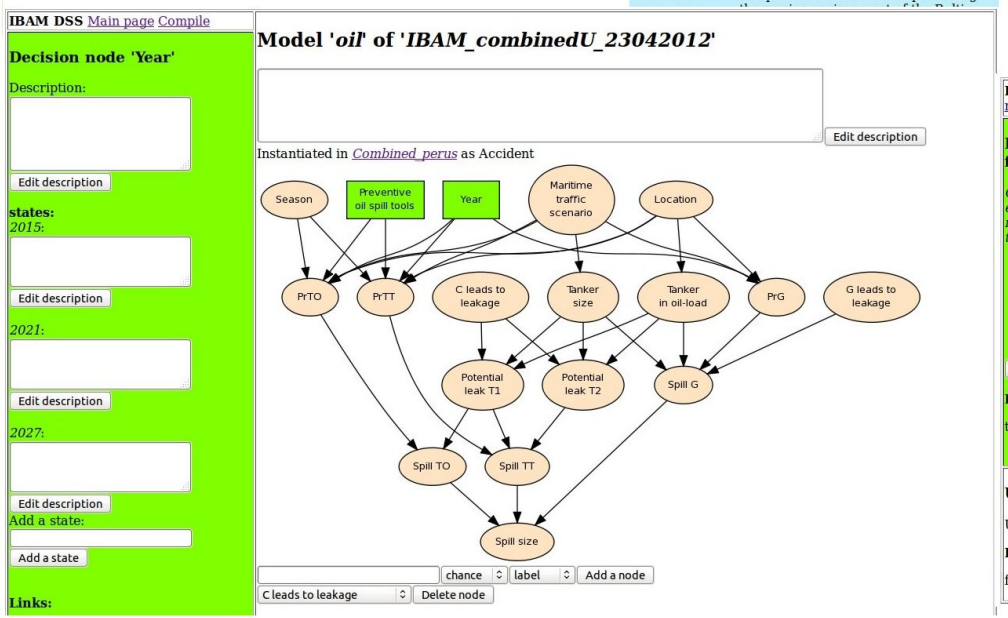


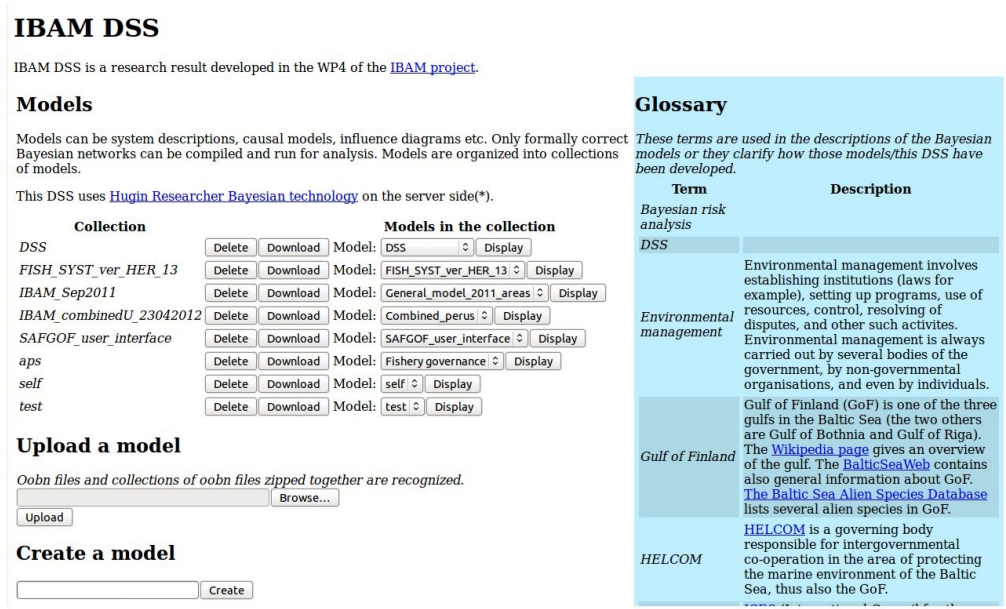
Web pages and applications

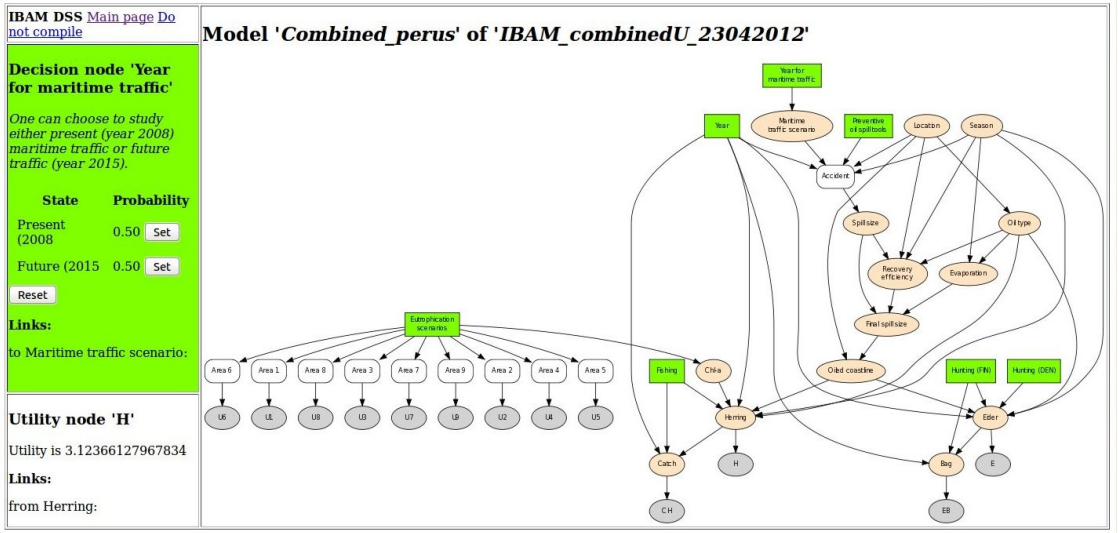


Luontotyyppiesiintymä										
uu	vastuu	vastuu	direktiivi	direktiivi	direktiivi	direktiivi	vastuu ja direktiivi	vastuu ja direktiivi	vastuu ja direktiivi	vastuu ja direktiivi
J	EN	CR	NT	VU	EN	CR	NT	VU	EN	CR
	0.36	0.51	0.55	0.9	0.95	1	0.56	0.91	1	1
	0.41	0.56	0.6	0.95	1	1	0.61	0.96	1	1
	0.46	0.61	0.65	1	1	1	0.66	1	1	1
	0.51	0.66	0.7	1	1	1	0.71	1	1	1
	0.63	0.735	0.775	1	1	1	0.785	1	1	1
5	0.415	0.565	0.605	0.955	1	1	0.615	0.965	1	1
5	0.465	0.615	0.655	1	1	1	0.665	1	1	1
	0.515	0.665	0.705	1	1	1	0.715	1	1	1
	0.64	0.74	0.78	1	1	1	0.79	1	1	1
	0.68	0.76	0.8	1	1	1	0.81	1	1	1
	1	1	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	1	1	1
	0.51	0.765	0.805	1	1	1	0.815	1	1	1
	1	1	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	1	1	1









A.Jolma, A.Altartouri, I. Ferencik. 2012. Distributed Environmental Modeling. In: R. Seppelt, A.A. Voinov, S. Lange, D. Bankamp (Eds.) (2012): International Environmental Modelling and Software Society (iEMSs) 2012 International Congress on Environmental Modelling and Software. Managing Resources of a Limited Planet: Pathways and Visions under Uncertainty, Sixth Biennial Meeting, Leipzig, Germany. http://www.iemss.org/society/index.php/iemss-2012-proceedings. ISBN: 978-88-9035-742-8

Web services

- Client + server
  - Client = desktop application, web application/page, another server, ...
- Spatial data services well established
  - Web Map/Feature/Coverage
- O&M services exist and used
- Semantic data services
- Ad hoc services

Conclusions

- Spatial data essential for oil risk management
- Workflows complex and need multiple types of data
- Distributed systems have potential to make effective collaboration including modeling possible
- Data and model sharing institutions are developing but there are hurdles