DiPol

WP "SIMACLIM"

Compiled by Jos van Gils, Ivonne Stresius and Jørgen Krogsgaard Jensen

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Contents

1. Introduction

Measures to counteract adverse climate-related impacts need to be planned well in advance and based on a sound knowledge of the complex interactions in the triangle river-urban area-coastal waters. Such measures need to be cost-effective and provide the best results against the lowest expenses. To help regional and national decision makers to adapt their management to the changing climate, it is necessary to provide insight in the impacts of climate change on water quality and evaluate the consequences of potential measures. WP 4 "SIMACLIM" addressed these issues by means of simulation programs and an open web-based knowledge platform (WKP) for sharing data and experience.

The specific objective of the WKP is to share the data collected in DiPol and the results based on that data. The WKP consists of two elements. An OpenEarth[1]/GoogleEarth application arranges the presentation of the DiPol data and information derived directly from those data. MapMyClimate is used to disseminate additional information about the results obtained at the DiPol Local Case Studies.

2. SIMACLIM simulation programmes

Two interacting simulation programmes have been developed in WP SIMACLIM. **Figure 1** shows their respective roles and interactions.
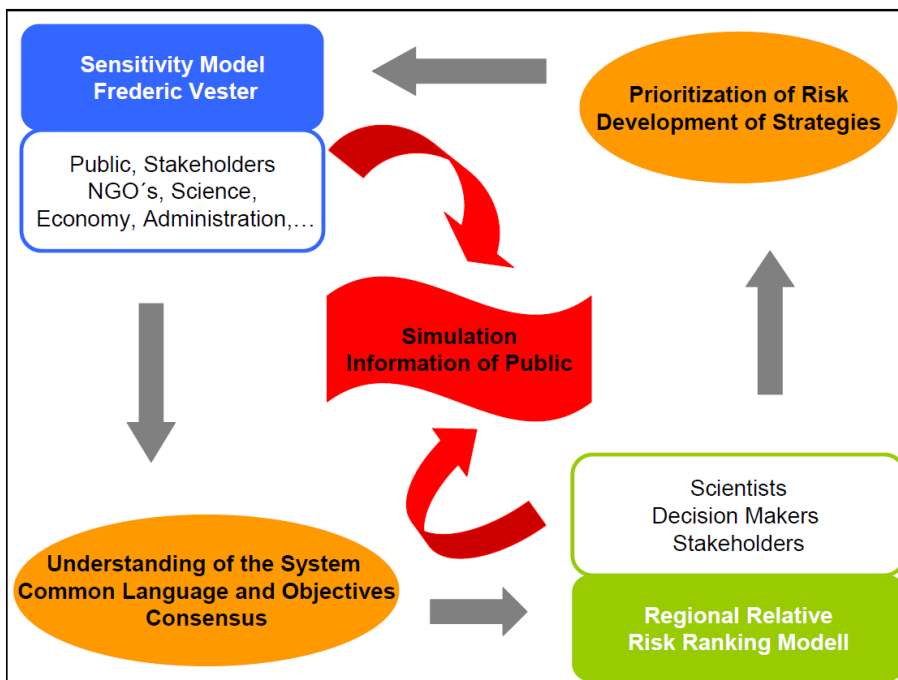

Figure 1:   Structure of SIMACLIM

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[1] www.openearth.nl: open source management of Data, Models and Tools for marine & coastal science & technology

The first part of SIMACLIM is a system analysis by the Sensitivity Model by Frederic Vester®, a planning- and management tool for complex systems. In DiPol, the dedicated software for this model was used, but the important steps of the Sensitivity Model can be carried out using just excel files. The Sensitivity Model is a tool for analysing complex, socio-economic-ecologic systems by using the principles of fuzzy logic and pattern recognition. In this way, the Sensitivity Model allows the analysis of such complex systems by the human brain. Not only hard data, but also "soft" (qualitative) data can be included. Main features of the method are the mediation capacity and the visualization of complex connections and interdependencies. The application of the Sensitivity Model requires the active involvement of participants, in an interactive way of working and in a continuous, open dialog, embracing interactions and self-regulation of all components of the system. Therefore, this part of SIMACLIM is well suited for public participation and should preferably be carried out with stakeholders from different parts of the assessed system like NGO´s, scientists, members of administration and citizens.

For SIMACLIM, the Sensitivity Model has been connected to the Regional Relative Risk Ranking Model (4RM) developed by Landis and Wiegers. The 4RM is a model for ecological risk assessment which is used to assess and prioritize risks by a relative ranking. It is possible to assess the risk for multiple stressors to multiple endpoints. The application of the 4RM in DiPol is based on an excel file. During the project, a visual basic program was developed to simplify the application. The 4RM combines information of stressors (e.g. pollutants), their sources, the existing habitats in different regions of the study area and the indicators (values to protect), and calculates a relative risk for these indicators. The regions, habitats, stressors, sources and indicators need to be defined for every individual application, together with the relations between them in a qualitative way. This relies partly on numeric data, but also on expert judgement.
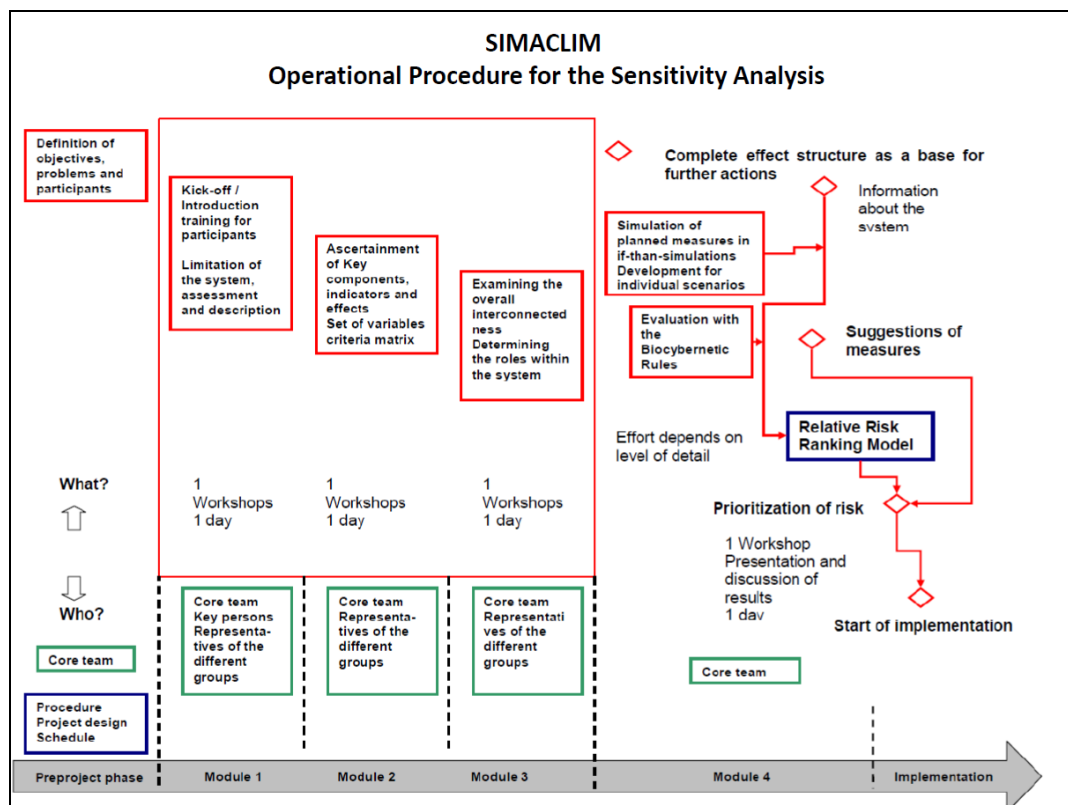

Figure 2:   Operational Procedure of SIMACLIM

During the development of SIMACLIM, it turned out that the sensitivity analysis delivers a lot of information that can be used to define the 4RM application, in particular about the indicators. The results of the 4RM deliver a prioritization of risks and form the basis for the development of intervention strategies. Just like the Sensitivity Model, the 4RM model can be used with participation of decision makers and stakeholders.

For the application of SIMACLIM, workshops have been organised with stakeholders, scientists, decision makers and students from partner schools in order to develop, test and improve SIMACLIM. At the general DiPol project meetings, workshops have been arranged to exchange information and discuss the case specific characteristics for the procedure and results. **Figure 2** shows the recommended operational plan for the application of SIMACLIM, including the time schedule and the organisation of the necessary workshops. The application of SIMACLIM is a cyclic process, where information from one model is used to improve the other model until there are sufficient results for the assessed topic. At the end of the process the results could be visualized and presented. For a discussion of the application of these tools to DiPol's Local Case Study Areas, we refer to the WP5 report.

3. SIMACLIM results

In this section we illustrate the results from the SIMACLIM simulation models for the Hamburg case study. The Sensitivity Model revealed a list of variables to be considered, see **Figure 3**. The Sensitivity Model also revealed a very high number of feedback loops between these variables (illustrating the system complexity) and long feedback cycles (indicating delayed system responses to external changes or interventions). "Compliance with laws" turns out to be an important lever in the system, influenced strongly by another key variable "commitment of citizens". This illustrates that the administrative bodies as well as the public play an important role.

The results from the sensitivity analysis were used to set up the 4RM application. **Table 1** shows the definition of the 4RM configuration. The 4RM model calculates the relative risks for each region and visualizes these risks in diagrams. **Figure 4** shows some typical results for the Harbour-Industry region, from sources of pollutants to indicators.

The region Harbour-Industry shows, compared to the other regions, the highest overall risks. The highest risk in this region is produced by historical pollution sources from soil and sediment. This holds for all indicators, except for the hygiene indicator. Also urban run-off presents a high risk to most indicators.

Overall view of all variables

1 * Hydraulic Structures
2 * Occurrence extrem Water Levels
3 * Run-off Wilhelmsburg
4 * Groundwater Level
5 * Intensity Water Use
6 * Infrastructure
7 * Productivity
8 * Water Quality
9 * Sediment Quality
10 * Air Quality
11 * Soil Quality
12 * Compliance of Laws
13 * Impervious Areas
14 * Ecological Quality
15 * Emissions
16 * Traffic Volume
17 * Quality of Life
18 * Intensity of Conflicts
19 * Spending Capacity
20 * Diversity of population
21 * Education
22 * Commitment of citizens
23 * Public Participation
24 * Political Acceptance

Figure 3: List of variables to be considered in the Hamburg Case Study derived from application of the Sensitivity Model

Table 1: Input to the 4RM model – Hamburg case study.

| Regions	Habitats	Sources	Indicators	Stressors
Harbour-Industry	Freshwater Mudflats	Historic Sources -Soil	Chemical Water Quality	Pathogens
Urban Areas	Canals	Combined Sewage Overflows	Ecological Water Quality	Organic Pollutants
Flooded Areas	Harbour Basins	Traffic	Chemical Sediment Quality	Pesticides
Agricultural Areas		Industrial Effluents	ToxicitySediment	Herbicides
		Urban Areas Run-off	Accumulation of Pollutants in Fish	
		Agricultural Areas Run-off	Hygiene	
		Air Pollution /Deposition		
		Elbe-High Discharge		
		Historic Sources in Sediment		
		Elbe- Low Discharge		
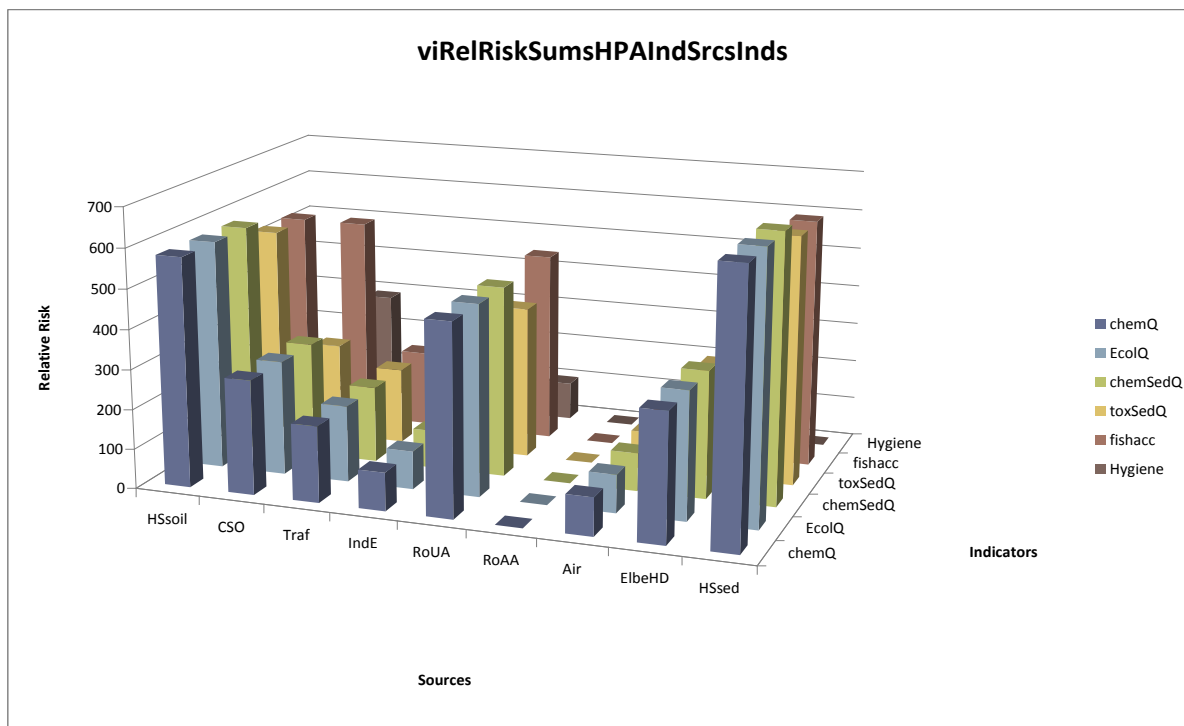
Figure 4:   Relative risks from sources to indicators in harbour/industrial areas.

4. OpenEarth/GoogleEarth presentation of project data & the DiPol database

The DiPol partners have collected complex data (in WP3). WP4 arranged for the storage of these data in a central database. This was a prerequisite to derive information from these data that enables decision makers to choose cost-effective, adaptive measures to counteract climate change impacts on water quality.

To allow better interpretation, all analysed samples have been characterised with respect to the hydrological conditions during sampling. Furthermore, the analysis results have been processed to provide "integrated parameters", in order to simplify the interpretation and to allow comparison between samples and study sites. Examples of such integrated parameters are overall chemistry indicators (msPAF, Toxic Units), observed toxic potency (in-vitro bioassays on extracts) and observed biological quality (in-vivo assays). These results have also been stored in the database.

An OpenEarth script has been developed to convert the database tables to file formats that can be loaded in GoogleEarth for presentation purposes (**Figure 5**).
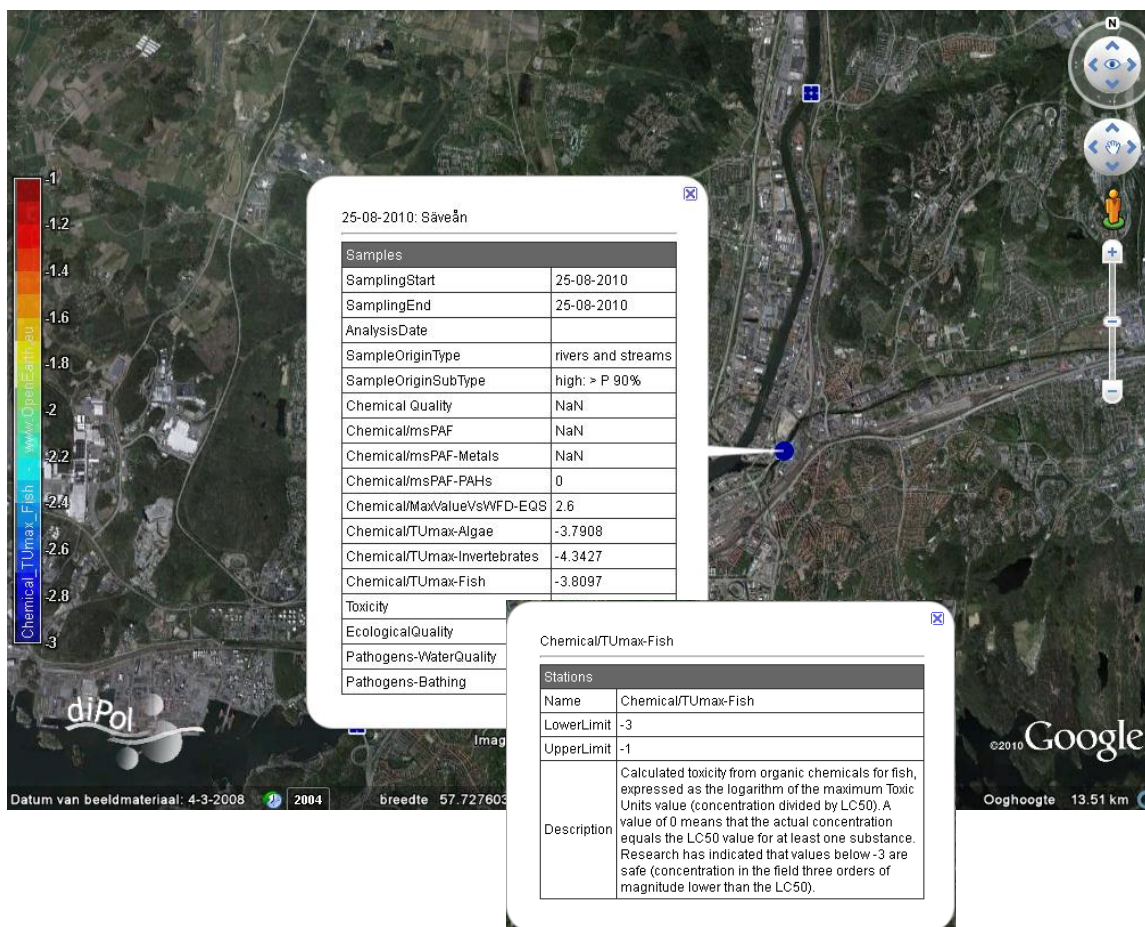
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Figure 5:   WKP GoogleEarth based presentation framework, showing: (a) stations on map, (b) values of a user-selected integrated parameter (TUmax-Fish) by colours, (c) explanation of user-selected integrated parameter (TUmax-Fish), and (d) tabular overview of all available integrated parameters for a user-selected sample.

The DiPol database has a dual objective: (1) to store the water, suspended matter and sediment analyses results collected within DiPol, and (2) to provide a basis for interpretation of these results. **Figure 6** shows the database structure. In the database, 10 different data sets have been included, comprising over 500 samples and over 14,000 individual data entries. **Table 2** provides an overview of these data sets.
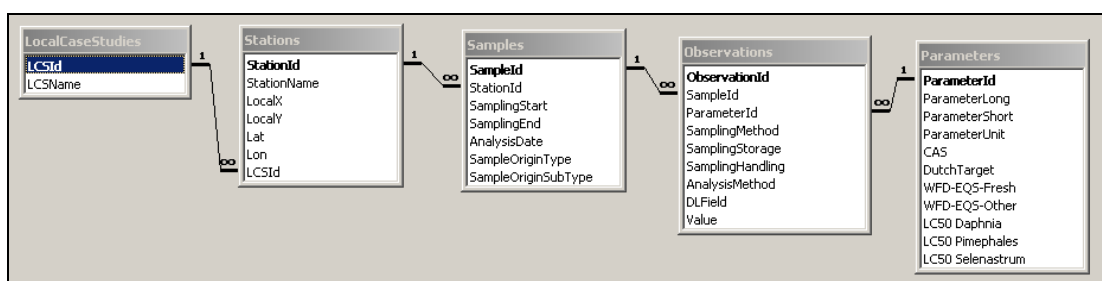

Figure 6:   DiPol database structure.

Table 2: Overview of data sets in the DiPol database.

Data set	Description	Nr of Samples	Nr of Data entries
Copenhagen-Basin K	Water quality of inlet and outlet of Kalveboderne Lagoon	78	1370
Copenhagen-Ejby Bog	Water quality of Ejby Bog	14	278
Copenhagen-Harrestrup	Water quality and microbiological parameters of the Harrestrup stream	166	1602
Copenhagen-Orestad	Water quality of urban runoff, effect of collection and treatment	10	289
Gothenburg	Water quality in rivers and city canals in the Gothenburg area	20	872
Oslo	Water quality in the Akerselva Stream	25	1620
Hamburg-Wilhemsburg (A)	Microbiological parameters and nutrients in the Wilhemsburg area, Hamburg	72	499
Hamburg-Wilhemsburg (B)	Water Quality in the Wilhemsburg area, Hamburg	58	6761
Hamburg-Elbe Sediments	Sediment quality in the Elbe estuary from Hamburg towards the coastal waters	72	1398
Hamburg-students	Data collected by secondary school pupils from Wilhemsburg, Hamburg	10	87
	Total of all data sets:	*525*	*14776*

5. Integrated parameters to characterise water, suspended matter and sediment

The DiPol database in total contains 421 different combinations of parameters, matrices (water, SPM, sediment) and analysis methods. Because every sample comprises its own subset of these 421 combinations, it is very difficult if not impossible to judge the results and to compare different sites or samples. Having recognised this problem along the way, DiPol experts decided to use integrated parameters to characterise the quality of water, SPM and sediment samples. These integrated parameters can be referred to as "calculated toxicity" or "measured toxic potency". Their general use is that they greatly reduce the amount of information to be processed by the human mind, thus allowing for easier comparison of samples and sites and thus for easier identification of trends and gradients.

Some methods to derive the "calculated toxicity" have been derived from the EU funded European Research Project MODELKEY[2]. Three types of integrated parameters are used to characterise the samples:

- Toxic Units (TU): the logarithm of the maximum value for any substance analysed of the ratio between the actual concentration and the LC50 is determined. Correlation with observed ecological effects has pointed out that a value of log(TUmax) < -3 offers no ecological risk, where a value of log(TUmax) > -1 offers a high ecological risk. This way of calculating toxicity can be differentiated between different species groups (algae, macro-invertebrates and fish).
- The Multi-substance potentially affected fraction of species (msPAF) calculates the relative share of the species that are expected to be affected by the measured cocktail of chemicals (taking into account) mixture toxicity. A value of msPAF < 0.05 is generally considered to represent an

acceptable ecological risk where a value of msPAF > 0.5 can be considered to offer a high ecological risk.

- The maximum ratio between the observed concentration and the Water Framework Directive related Environmental Quality Standards. This ratio should be below 1.0.

The "measured toxic potency" is determined by a series of in vitro bio-assays on sediment extracts. The results of these bio-assays are converted to one integrated "toxic potency", as discussed in the WP 3 report. This toxic potency is included in the DiPol database and the GoogleEarth presentation facility.

6. MapMyClimate

The platform MapMyClimte (www.mapmyclimate.com) was originally established in support to the climate conference COP15 in Copenhagen in December 2009. The basic idea is to have a platform where people can learn (through interactive response) how their own behaviour impacts the climate change. Furthermore, the platform is used for presenting different types of results from climate change related projects and activities. The DiPol project has decided to use this platform for dissemination of the main outcomes from the four case studies in Hamburg, Oslo, Gothenburg and Copenhagen. The DiPol results are presented in a concise form that is easily accessible to an interested but non-technical and non-scientific audience. **Table 3** provides an overview of the main results included in MapMyClimate.

Table 3: Overview of main results included in MapMyClimate.

Hamburg	Oslo	Gothenburg	Copenhagen
Results are presented on: - Elbe Estuary, - Whilhelmsburg, - Mud Flats, - Impact of high discharges, - Impacts of rain events. Concentrations in water, sediment and fish are given together with a discussion of toxicity and impact on environment.	Results are presented on: - Akerselva, - Inner Harbour, - Outer Harbour, - Inner Oslo Fjord - Bekkelaget Water Treatment Plant. Site descriptions and potential impact from climate change is presented for each of the locations.	Results are presented on: - DiPol in general - Pollution pathways - Air deposition - Urban surfaces - Surface waters - Urban groundwater - GIS-mapping - Climate change - Adaptive management - Analysis and communication - Risk ranking	Results are presented on: - DiPol in general - Harrestrup Catchment - Basin K - Ejby Bog - Rainwater pond - Bymoserende - Local rain water handling - Stream pollution - Lagoon Pollution - Rain Garden - Climate Change Results from monitoring and modelling the impacts in the catchment and description of adaptive measures to counteract effects from climate changes is included.

Figure 7 shows an impression of the MapMyClimate presentation of the Copenhagen case study results (Harrestrup Catchment). The description of the cases and the main outcomes can be approached both from a scroll down menu and by clicking on green pins on the map. The map presentation has the well-known GoogleEarth look-and-feel.
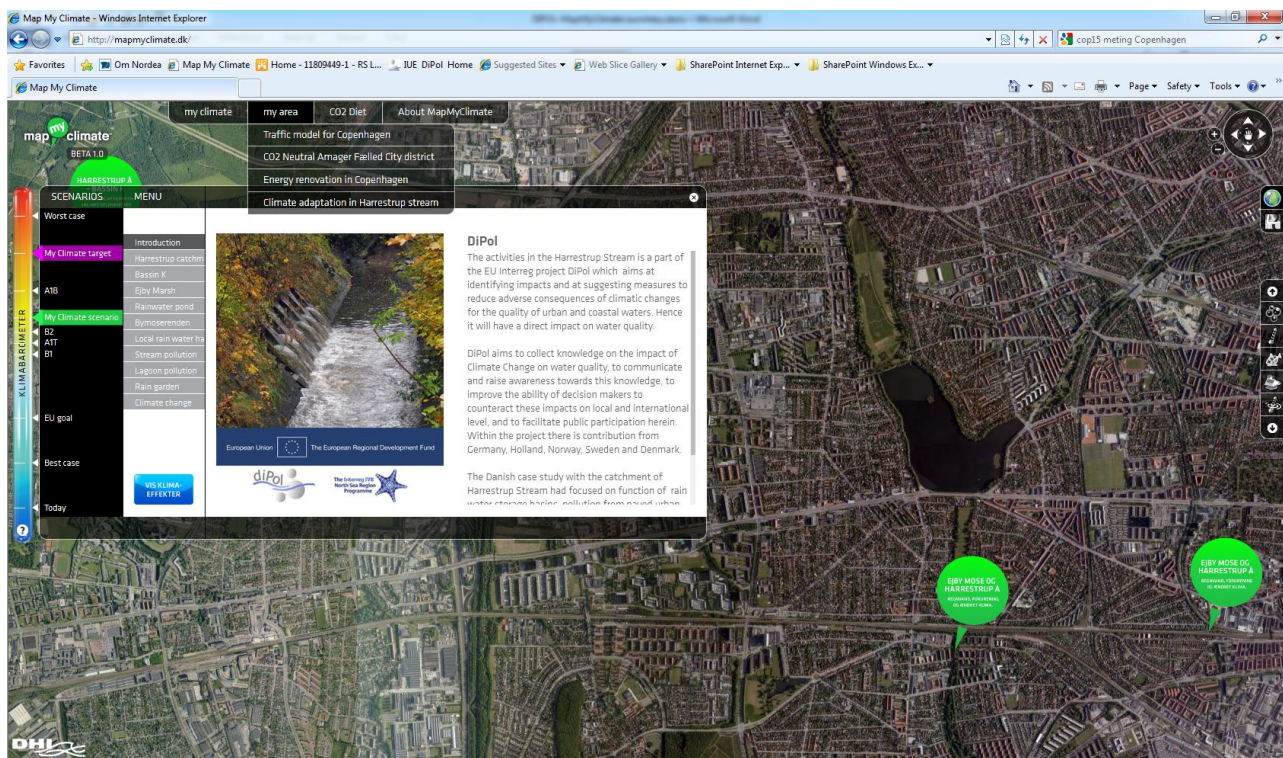
Figure 7: Impression of the MapMyClimate presentation of the Copenhagen case study results (Harrestrup Catchment).