Developing the DayWater Adaptive Decision Support System for urban stormwater source control: a challenge!

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ABSTRACT

Although urban stormwater management (USWM) is essential for controlling both flooding and pollution problems, decision-making in any USWM project is especially complex since it involves a large number of stakeholders and large variety of domains of knowledge, i.e. both technical (hydraulic, chemical or eco-toxicological) and managerial (planning, assessing, decision-making, etc…).

In order to facilitate the sustainable management of urban water management, an Adaptive Decision Support System (ADSS) for stormwater source control will be developed by a consortium of seven European research institutions and three private companies. The resulting 3-year research project (DayWater) started in December 2002 with financial support from the European Commission (5th Framework Programme).

The major challenges of the DayWater project are presented and discussed in relation with the following points: cross-disciplinary partners, coverage of the European scale, strong end-user involvement, consideration of decision-making procedure in urban stormwater issues.

This paper aims to compare the original work plan with the progress achieved to date and to analyse the reasons for both the success and difficulties encountered by the DayWater consortium as an example of a European research project dealing with a complex context.

KEYWORDS

Flooding, Research dissemination, Research management, Source control, Stormwater, Urban water management, Water quality

INTRODUCTION

Runoff water concepts, such as stormwater source control, encounter difficulties with regard to adoption. Their complex interaction with urban life and development, necessitates the collection of heterogeneous data and information, and are followed by complex decision-making processes between numerous stakeholders (Deutsch and Deroubaix, 2003).

The DayWater project aims at building a prototype of an adaptive decision support system (ADSS) related to urban stormwater pollution source control (Scholes et al., 2003; Förster *et al.*, 2004; Sieker et al., 2005). This decision support system (DSS) intends to be adaptive to internal (variety of stakeholder viewpoint and knowledge) and external (spatial scale, climatic conditions) changes. It is used for stormwater which is treated locally in urban areas using various source control techniques such as detention and re-use, swales and soakaways, catch-basins, wetlands, ponds, porous paving etc.

The involvement of 14 potential end-users and 10 scientific partners during DayWater project preparation and its 3 year development of an Adaptive Decision Support System (ADSS), was one of the ambitions of the project. As the DayWater project wanted to create a multi-disciplinary Decision Support System, the collaboration of scientists with different backgrounds and interests, such as urban hydrology, engineering, risk assessment, social

sciences and information technology seemed a logical consequence. The scientific partners were intended to come from different countries in order to guarantee a large diversity of climatic conditions and regulatory framework encountered in Europe.
The initially planned work schedule does not correspond in all terms with the actual work progress. This is related to the chosen diversity of involved disciplines and countries, as well as to the large number of involved institutions. As an example of a European research project dealing with a complex context, this paper presents the ADSS development procedure and describes the major results at the end of the second project year, together with the encountered difficulties.

ADSS DEVELOPMENT PROCEDURE

DayWater consortium
Ten scientific partners consorted together in order to represent a broad knowledge domain involved in USWM and various climatic conditions from Polar circle to Mediterranean Sea (Viklander *et al.,* 2003). Nevertheless this scientific consortium is dominated by engineers and urban hydrologists and contains only a small number of experts in socioeconomics or information technology. Thus the ADSS is not based on traditional DSS tools, as it is adaptive both to spatial scale and to the variety of stakeholder viewpoints and knowledge. It intends to summarise the professional experience of these scientists in USWM, including 3 private consultants with a strong contact with end-users in this field.
In order to benefit from the common knowledge within the scientific consortium, most of the work packages (WPs) identified in the DayWater project involve several or even all partners. Taking into account the important difference of national procedures, a common understanding of the goals and methods involved in each task is needed to achieve representative results, this requests deep interaction between research teams. The role of the project coordinator is not limited to the harmonious organisation of parallel development of tasks, but also appears when different opinions are expressed within the consortium and a consensus has to be found, in order to continue the progress of the work plan.

End-user involvement
As stated in the assessment report on the DayWater project, after submission to the European Commission (EC), "the proposal is a research project with a strong (and healthy) focus on end-users and demonstration aspects". In order to collect their major concerns and needs in USWM, all scientific partners are in regular contact with 14 core end-users (CEU), as well during the DayWater project preparation as during its 3 year development period (Table 1). These CEU represent a large variety of private companies, local, county or catchment basin institutions or associations. The number of end-users was further extended, at the end of the first project year, during 8 DayWater regional conferences (Table 2): one of the aims of these conferences was to increase the diversity of USWM projects and to establish an extended end-user (EEU) group, for further testing of ADSS set of components. For obvious geographic and linguistic reasons, local DayWater partners are in charge of the contact to their national end-users.

Initial core end-user questionnaires: The most original challenge of the DayWater research project is clearly the involvement of the future end-users of the ADSS prototype. At the very beginning of the project, scientific partners developed together a questionnaire to collect details on the actual CEU needs, as well as the context of their IUSWM projects and decisions (Table 1).

Table 1: DayWater core end-users (CEU) group

DENMARK	**FRANCE**
? Copenhagen Energy	? Agence de l'Eau Seine Normandie
? Karlebo Municipality	? Conseil Général de Seine St. Denis
	? Syndicat Marne Vive
GERMANY	**GREECE**
? City of Dresden	? Municipal Water Supply and Sewerage Company of Patras
? Wupperverband	? Ministry of Environment, Planning & Public Works
NETHERLANDS	**SWEDEN**
? City of Nijmegen	? Stockholm Vatten
	? City of Luleå
UNITED KINGDOM	
? Countryside Strategic Projects	
? Harrow Engineering Services	

Table 2: Participation of possible end-users to DayWater Regional Conferences (October - November 2003)

Conference venue (Country)	Participants: external + CEU + DayWater partners	Municipalities or technical services of cities	Regional or national non profit organisations	Private companies
Paris (France)	25 + 7 + 7 = 42	9	6	4
Prague (Czech Republic)	22 + 0 + 10 = 32			
Athens (Greece)	71 + 7 + 10 = 87	36	7	3
Deventer (Netherlands)	14 + 1 + 13 = 28	7	5	0
Berlin (Germany)	27 + 3 + 10 = 40	4	1	1
Stockholm (Sweden)	14 + 2 + 5 = 21	10	1	
Braintree (United Kingdom)	30 + 2 + 5 = 37	5	5	10
Jütland (Denmark)	18 + 4 + 5 =27	6	2	5
TOTAL	312	77	27	23

Table 3: Structure of the questionnaire used for collecting the DayWater core end-user needs in integrated urban stormwater management issues

Questionnaire fields	Number of questions
End-user characteristics	15
Catchment's geographical characteristics and encountered urban water management problem	5
Specific stormwater problems	11
Stormwater plans and policies	4
Contact with other water management organisations	4
Available data and tools	10
On-going projects	6
Societal activity	6
European and national legislation	4
Economical aspects	3
Cultural and historical aspects	3
Other fields of urban policy	3

These questionnaires, filled by the 14 CEU with the help of the local partners, were received after a four months delay and thoroughly analysed by all WP leaders. The "Report including end-user information and mental maps" defined the end-users needs for stormwater management. These needs had to be met in the "Terms of Reference" (ToR) of the ADSS in order to clarify the objectives and characteristics of each component and of the whole ADSS. As some needs were interfering with others, they had to be classified and evaluated. This often led to a national focus, as partners concentrated on the needs described by their local end-users.

Testing of ADSS component: The end-users' involvement increased with the progress of the ADSS development. The partner in charge of the field testing set up a "Methodology for homogenous testing of ADSS components". With the help of this document each partner was invited to conduct the testing of set of components with the local end-users, i.e. both the CEU and EEU ones, in order to collect feedback data on (Mousset *et al*., 2005):

a) Global appreciation of the tested set of components, including both communication and scientific components,
b) Verification of the adaptability of the set of components to the context of the project,
c) Evaluation of the quality of the achieved results,
d) Evaluation of the usefulness of the achieved results,
e) Evaluation of the decision support function.

The major difficulty encountered during these testing operations was the lack of sufficient development of all ADSS components. In fact many components had to be presented to end-users through "Power Point" viewers, as only a few were available on the Web based system.

Testing of global ADSS: The final testing phase covers the whole ADSS prototype, which is to be tested on four case studies during the last DayWater project year (2005). The case study sites were selected out of the expression of interest of the CEU. The selection of these case study sites was based on the geographical, climatic and organisational diversity. Furthermore the following criteria were taken into account:

a) The willingness and manpower of the involved end user,
b) The availability of data necessary for feeding the widest range of ADSS components,
c) The diversity of the stages of the subprojects within the same project and,
d) The diversity of stakeholders involved in the same project.

The result of this full ADSS testing operation should be used for revising the final version of the ADSS prototype. In order to allow such feed-back, these testing operations have to be finalised in time. Some of the components or external tools will not be completely finalised prior to the end-user assessment, as already experienced with the ADSS components testing.

ADSS DEVELOPMENT RESULTS AND DISCUSSION

The DayWater project follows both top-down and bottom-up approaches: 1) top-down, as scientists provide up to date scientific results, related to urban runoff water; 2) bottom-up, as the stakeholders in USWM are fully involved in the project, from the beginning of the ADSS design until the full testing of the prototype (Förster et al., 2004).

Attention to end-user needs

One of the project specificities is the end-user involvement during the whole project preparation and development of the ADSS prototype. At the same time, this challenge became one of the most difficult tasks of the project. Consulting 14 core end-users (Table 1), within the development phase, proved to be very long and demanded a high effort of follow-up by the team coordinating the field testing. The procedure was very heavy in terms of

organisation, as each scientific partner is in charge of the continuous contact with local end-users; this means numerous reminders via e-mail and telephone to the local partners. The delays caused by the difficulties in finding common meeting dates for partner and end-users, seem to be minor in national terms, but are accumulating at the project scale and result in difficulties in terms of project progress.
On the other side, end-users complain not to be sufficiently informed on the overall project advancement. It was stated that the bi-annual DayWater newsletter does not contain enough detailed information and therefore does not replace a regular contact between the national scientific partner and the end-users, which demands availabilities on both sides. Despite inviting all CEU to the annual project meetings and presenting them the demonstrations of all available ADSS components, their knowledge about the DayWater project is often limited to the component developed by their respective national scientific partner.

Common definition of ADSS structure and functionalities
The intrinsic difficulties of a multidisciplinary and multinational project are obvious. First of all, even when scientific partners were working in the same field, there is a common language to be found for the project inherent terms. It took a long time before every partner became aware of such language problems. Such misunderstandings were both related to the common use of the English language, and to different cultural approaches, such as the way to be understood outside the scientific field. Different professional backgrounds may cause different definition of technical and trivial terms. Nearly all partners have experience in international projects and should therefore be aware of these kinds of problems, but there is still a gap between the simple knowledge of the existence of these problems and the realised awareness and resulting behaviour. A cautious behaviour means verification of e-mails or reports directly with the responsible person, in case of seemingly offensive statements. There is clearly a lack of understanding to be stated, which might be due to little willingness, to work overload or to ignorance of intercultural differences. Thus the personal encounters, during numerous work meetings, were found necessary for the success of the DayWater development.

Development of ADSS components
The ambition and expectations on the ADSS prototype were differing a lot during the first two project years. At the beginning of the project, it was difficult to have a realistic frame of all the interactions in the project due to its complexity. Each partner developed "his" components mostly independent to the other components and their mutual requirements. The ToR of the ADSS was expected to remediate this problem, demanding every component developer to describe his requirements and his contribution to the other components and to the general ADSS structure. The partners felt not able to do so, as the inter-relations were only discovered step by step, parallel to their development. This is in contradiction to the function of the ToR, which should be the reference document to the prototype development. Furthermore the initial work plan did not specifically mention the dates of delivery of each ADSS component. This omission made it difficult to make each partner understand the consequences, caused by delays within elaboration of their component specification and implementation in the Web based ADSS tool.

Attention to decision-making procedures
The analysis of the decision-making process (DMP) in USWM projects is a good example for this intercultural and interdisciplinary misunderstanding (Deutsch *et al.*, 2004). Consultant engineers conceive the DMP in a different way than researchers and south European countries do not consider the DMP as north Europeans do. Thus it was found necessary to integrate, in

the ADSS system, several tools aiming at helping decision-makers to negotiate with all stakeholders involved in the USWM project and to facilitate a consensus.

Unresolved difficulties

The last outstanding difficulty of the DayWater project is the sustainability of the ADSS prototype. Who will continue the ADSS development, enrich the databases and tools, and disseminate a commercial product? All contacted end-users strongly express their concern on this point, stating that their personal involvement in the ADSS testing procedures requires such ADSS sustainability.

The ADSS prototype has been developed in English, the common project language, but for an adoption in many European countries a translation of all documents, software and tools is necessary. Nevertheless, within the duration and the budget of the DayWater project, there is no possibility of translation in other European languages.

Taking into account the characteristics of European research and technology development (RTD) projects, there is only one possibility to finalise, promote and disseminate a product: a creation of a commercial company, which should strongly associate private and public institutions, part of the CEU and EEU network of DayWater.

ADAPTIVE DECISION SUPPORT SYSTEM CHARACTERISTICS

ADSS functions

The ADSS target user is the urban water manager with a good technical know-how, who is willing to promote stormwater source control strategies. A certain motivation is indeed needed to convince the numerous stakeholders of the effectiveness of those "Best Management Practices".

The ADSS is based on the typical structure of DSS which has four main functions:

a) The library function, organising information on stormwater source control matters (knowledge databases),
b) The management function, supporting the definition of the urban stormwater problem,
c) The analysis function, enables a pre-selection of the data for the defined problem and a comparison of the different solutions,
d) The communication function, supporting the negotiation between stakeholders and facilitating a consensus.

The user can run the ADSS in two different modes. The graphical Interface Hydropolis supports the free navigation, whereas a short questionnaire enables a guided use of the system.

Structure of the ADSS

The ADSS is a combination of simulation models, assessment tools, databases and guidance documents. It is designed to facilitate the information management and the preparation of decisions, both in free and guided mode, using the graphical Hydropolis interface.

A first set of components consists in knowledge bases, helping the user to describe his USWM project through technical, economical, political and environmental databases:

- Structural and non-structural Best Management Practices (BMP),
- Pollution sources,
- Priority pollutant and fate of them within BMPs,
- Ambition reflection and water aspects (Lems and Valkman, 2004),
- Policy instruments information,
- Stakeholders involved at different stages of an USWM project,

- Case studies, which can be enriched by all ADSS users who wish to share their experience,
- Indicators for BMP comparison.

A second set of components, mostly external, but linked to the ADSS through XML file exchange, allow the user to compare the possible solutions for his USWM project and obtain rapidly a consensus with all involved stakeholders:

- BMP dimensioning,
- Cost assessment,
- Construction of the Matrix of Alternatives and Multi Criteria Analysis (Ellis *et al*, 2004),
- Pre diagnostic road map,
- Source (STORM) and Flux (SEWSYS) models,
- Uncertainty profiler,
- Risk assessment, through a Chemical Hazard Identification & Assessment Tool (CHIAT) (Eriksson *et al.*, 2004),
- Vulnerability assessment and GIS mapping (FLEXT).

CONCLUSION

The diversity of the DayWater partners, i.e. 3 consulting companies and 7 academic institutions located from the Polar Circle to the Mediterranean Sea, cover most of geographical, climatic and administrative USWM conditions. Such diversity, create frequent discussions, delays, but also represent more efficiently the situation of European countries, i.e. the major aim of such RTD projects. The involvement of possible end-users both prior and during the development of the ADSS prototype, although difficult and time consuming, is clearly a key issue for the success of the ADSS, i.e. its adequacy to actual end-user needs.

This paper is written at the end of the second project year and there is another year left for the development of the ADSS components, their assessment by end-users and for the development of the final ADSS prototype. Nevertheless the consortium should start to prepare the ADSS prototype completion, promotion and dissemination, in association with the network of associated end-users. Besides several presentations made during 10ICUD conference and its specific sessions devoted to CityNet research cluster, another important opportunity will be the final DayWater conference and workshop to be held at ENPC, in Paris suburb, on 3-4 November 2005. The ADSS prototype will be distributed to all participants who will be invited to ADSS component demonstrations. Finally, selected papers presented at this conference will be collected into a final DayWater publication.

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