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Environmental Decision Support Systems: from science to market

Poch, M.*, Comas, J.*,, Rodríguez-Roda, I.*,**, Sànchez-Marrè, M.*** and Cortés, U.*****
*Laboratory of Chemical and Environmental Engineering (LEQUIA), Universitat de Girona, Campus de Montilivi s/n, 17071 Girona, Catalonia
**Catalan Institute for Water Research (ICRA), Parc Científic i Tecnològic de la Universitat de Girona, Emili Grahit ,101- 17003 Girona Girona, Catalonia
***Knowledge Engineering and Machine Learning Group (KEMLG), Computer Science Dept., Universitat Politècnica de Catalunya-BarcelonaTech, Jordi Girona 1-3, 08034 Barcelona, Catalonia

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Summary of key findings

The complexity inherent for managing water systems infrastructures requires new tools that must be increasingly more efficient, integrating data, information and knowledge. Among them, Environmental Decision Support Systems (EDSS) are an striking tool that has received great interest in the academic domain in the last twenty years to improve the management of water-related systems. Recently, several thoughtful reviews have identified key challenges and best practices in their development and use. One of the major criticisms is that there is not a wide and generalised use of deployed EDSS in the society.

Four case studies will be described and compared in this presentation, identifying the key aspects that conditioned the initial conception of the EDSS and their evolution that determined the final success/failure of the tool. Our experience shows that if we want to increase the adoption of EDSS by intended end users, the success is not only related with the traditional aspects considered in the development but also with other tacit aspects not always considered at the beginning. The key challenges, tools and practices determining how to cross the existing gap between science and market are highlighted.

Background and relevance

Our growing comprehension of the water-related problems, the availability of ever-finer modelling techniques, the huge amount of deployed sensors, the evidence that the extensive pressure over the resources exerted by a demanding and growing population is causing a strain on the environment as well as affecting global economy. The combination of all those factors leads to the conclusion that water systems are complex to be managed and composed of multiple interacting agents, or variables. All this requires advanced management tools, like mathematical models or tools capable of integrating heuristic knowledge and quantitative information such as Environmental Decision Support Systems (EDSS),

EDSS are intelligent information systems for environmental applications, which are able to integrate mathematical and statistical models for numerical computations with artificial intelligence tools to emulate human-kind reasoning and behaviour, and which reduce the time in which decisions are made, and improve the consistency and quality of those decisions. EDSS have been increasingly applied in a more intense and efficient way recently, in particular, to the case of wastewater treatment (Olsson et al., 2014) or river basins (Volk et al., 2010).

Like other tools used to manage complexity in water quality systems, the two main steps to deploy an EDSS are the development step and the use and transfer step. Historically, due to the complexity of the development step, most efforts have been devoted to that phase, and just a few examples devoted to the use and transfer step can be found. Several methodologies have been proposed in the literature to the development step of EDSS (Poch et al., 2004 or Van Delden et al., 2011). These methodologies propose the basic steps, the tools and main concepts to be taken into account to develop successful EDSS.

In our opinion, the satisfactory results obtained illustrate the consensus that a significant degree of maturity has been reached in EDSS development. However, as the result of ten years of deploying EDSS, the authors want to outline that the use and transfer step has surprisingly become the main obstacle for a general application and transfer of the EDSS technology to society. The obtained results are still not so satisfactory/successful by means of generalization and commercialization tasks. Main key challenges in this step according to McIntosh et al. (2011) are: wide use, generalised system, adoption and longevity, and evaluation of the system. If these challenges are not well addressed, EDSS might not reach the market, even though they could potentially benefit the environment and savings.

The aim of the paper is to present the authors experience in developing and transferring four case studies of EDSS in the Wastewater Treatment domain: (i) PSARU EDSS, commissioned by the Catalan Water Agency to a consortium of research groups with the objective to select the most appropriate wastewater treatment and disposal system for 3500 communities with less than 2000 inhabitants existing in Catalonia; (ii) ATL EDSS, to optimize the operation of the biological processes of municipal wastewater treatment plants; (iii) NOVEDAR EDSS, developed in the framework of an academic research project with the aim to select the optimal integration of technologies (both conventional and innovative) for the treatment of a specific wastewater in a specific location; (iv) COLMATAR EDSS, to improve the integrated control of the biological and filtration processes of membrane bioreactors (MBR) for wastewater treatment, in terms of effluent quality and operational costs.

Results and discussion

The information related to the objectives and development for each EDSS and the evolution of the four EDSS will be highlighted in the presentation as a basis for the final comparison and discussion.

For the PSARU EDSS, although there were multiple contacts and negotiations, neither the research groups nor the administration were able to transfer and apply the EDSS to other regions facing the same problem. Somehow, we believe that this is a general situation in many EDSS. They are designed and used for a punctual requirement (which somehow justifies its construction), but are no longer in use afterwards.

The entity owner of the WWTP where the first version of ATL EDSS was validated identified a market opportunity in the product commercialization, and became main partner of the spin-off created to commercialize it. The first and main task of the company was the adaptation of the product (and its implementation protocol) to the real market needs. Currently, the spin-off SISLtech has successfully implemented an evolved version of ATL EDSS to more than one hundred plants worldwide, including La Farfana (Santiago de Chile), one of the biggest wastewater treatment plants in the world.

The university consortium decided that the best way to ensure the maintenance of the NOVEDAR EDSS was to transfer the system to the market and receive funding from the own users. NOVEDAR EDSS was presented to several water companies and one of them was interested in reaching an agreement for license commercialization. The intellectual propriety rights (IPR) were shared and distributed between the universities that developed the system.

The COLMATAR EDSS was initiated from the academic world although, from the very beginning, several wastewater practitioners identified the relevance of the proposal and showed potential interest to collaborate. On the other hand, the EDSS was protected by means of a Spanish patent, owned equally by the university and the company. In this case, the best solution was to look for an industrial partner, working on process automation and control, interested in exploiting the patent.

According to our experience, the end user engagement certainly may help to ensure longevity of the EDSS, but to do that the involvement should not be only during the development and application phases but also during the commercialisation and dissemination phases. If the idea is good enough, researchers can become the driving force and achieve the product longevity, even though through a longer adoption process. This pathway requires higher activation energy, but might end up with a more favourable outcome. Although it seems contradictory, for some cases the lack of end user involvement at the beginning of the process can be at long term beneficial.

The complete set of key challenges, tools and practices (user engagement and business plan) involved in the use and transfer step of the four EDSS will be carefully discussed in the presentation.

Conclusions

Although each analysed case provided different experiences, it is possible to identify a set of common traits in these processes. In all cases, there was a situation where we were standing, what has been identified as the death-valley. It is the moment where the product developed by the academics has already reached a level of maturity and that is left with no interest for researchers to investigate further on that particular subject, but usually it does not meet still the requirements needed to be in the market. New stages should be defined in order to achieve this goal.

As a summary, the current situation that must be faced to build widely usable EDSS is crossing the death-valley to obtain a useful and generally used EDSS for the society (market). Key challenges as well tools and practice to be successful in the use and transfer step will be supported and illustrated by the analysis of four EDSS in the wastewater treatment domain. We think that it might be interesting to compare these results with others recently detected from mathematical modelling tools applied to environmental problems.

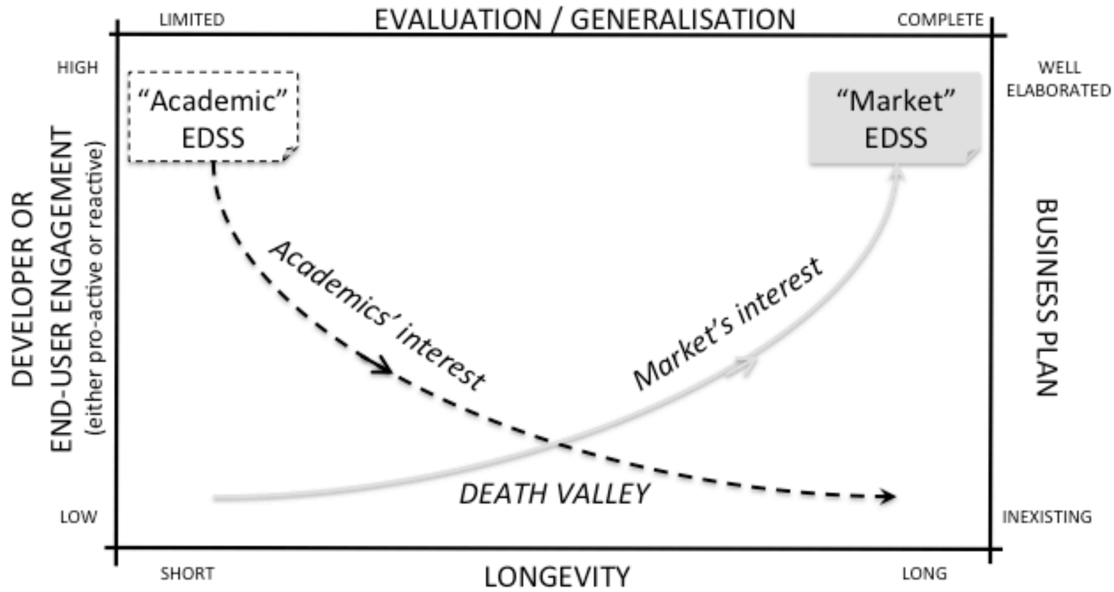

Figure 1.1 Challenges for a generalised use and transfer to market.

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