Jul 1st, 12:00 AM

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iEMSs 2008: International Congress on Environmental Modelling and Software
Integrating Sciences and Information Technology for Environmental Assessment and Decision Making
4th Biennial Meeting of iEMSs, http://www.iemss.org/iemss2008/index.php?n=Main.Proceedings
M. Sànchez-Marrè, J. Béjar, J. Comas, A. Rizzoli and G. Guariso (Eds.)
International Environmental Modelling and Software Society (iEMSs), 2008

A Multi-Agent system for water management in river basins

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***Keywords**:* Multi-Agent systems; Wastewater management; Modelling

Wastewater management in river basins is becoming increasingly complex. Whilst there is an urge to reduce the ecological imbalances in fluvial ecosystems, more wastewater has to be treated because of both demographic and industrial growth. Furthermore, given the intrinsic multidimensionality of river basins, its management must take into account all the agents that affect and are affected by the wastewater Aulinas *et al.* [2007].

Traditionally hydraulic infrastructures for sanitation have been managed separately, taking into account only the characteristics of the water at the entry and exit points of each installation. The current tendency promoted by the Water Framework Directive is to treat the hydrographic basin as a single area of operations within which hydraulic infrastructures have to be managed in an integrated manner, taking into account the condition of the receptor environment Devesa [2006].

In our work, we are implementing this integrated approach with a Multi-Agent system (MAS) at catchment scale that integrates the main water systems involved (*i.e.,* sewage system, Waste Water Treatment Plants and River) by means of agents who model real environmental situations and work collaboratively for achieving the system's goals.

The aim of our MAS is to cope with the complexity related to the decision-making processes found in the river basins management (*e.g.*, uncertainty, intrinsic instability, approximate knowledge, multidimensionality of river basins). The MAS can simulate different scenarios for evaluating the consequences of critical processes in a river catchment system in order to recommend alternative courses of actions and thus provide support in the decision-making of river basins management Rendon *et al.* [2006].

Our software tool is an extension of the agent platform Jadex. We incorporated the artificial intelligence technique *Rule-based reasoning* as the inference mechanism so we can have rule-based agents capable of representing domain knowledge. In the near future we plan to incorporate *Case-based reasoning* as well. For the design and development of a prototype for our case study we used the Prometheus methodology Padgham and Winikoff, [2004] and the agent platform Jadex Braubach *et al*. [2004] respectively.

The case of study is the *Besòs river basin*, located on the North East of the Mediterranean coast of Spain. The catchment area is one of the most populated catchments in Catalonia, having more than two million people connected. The scope of the study area is around the final reaches of the Congost River. The river sustains, in an area of 70 km^2, the discharges of four towns which are connected to two Waste Water Treatment Plants (WWTP).

The MAS features the main elements of the hydraulic infrastructure of our case of study, *the Besòs river basin*, and aims to manage the environmental system as a single area, integrating the two sanitation systems (La Garriga and Granollers) with their respective sewage systems and WWTP's, as well as the Besòs river as the receptor for their waste water. Other elements are rain control stations, river water

quality control stations, flow retention and storage tanks. There also is a sewer channel that connects both WWTPs, allowing to by-pass the flow from the La Garriga-WWTP to the Granollers-WWTP. To integrate knowledge and control the management of the Storage tanks we use decision trees defined in Devesa [2006]. The set of actuation rules represented in the trees aims to minimise the impact on the water quality of the river.

ACKNOWLEDGEMENTS

This work has been partially supported by the Spanish project TIN2004-01368 and European project Provenance IST-511085.

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