Supporting decision making in river basin systems using a declarative reasoning approach

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Abstract

River management conditions are highly variable and sometimes even unpredictable. Climatic, demographic, industrial and management or planning factors are the main sources of this variability that entails to consider more flexible ways to manage the system. Water pollution is an important problem of concern in river basins, principally for this abovementioned interconnection between all living and non-living elements of the river basin. In urban or industrial-dominated basins determining the threat of wastewater sources to assess the safety of actions is a key issue for the sustainable use and conservation of the resource.

However, the characterizing parameters involve an important degree of uncertainty, mainly related to their quality and quantity variability (*e.g.* different industries with several polluting substances quite different in their characteristics and their polluting potential, peak discharges, uncontrolled discharges due to changing conditions or emergences), and the available information and knowledge (*e.g.* disagreement among whether a toxic or a substance is or is not safe for the final receiving media, information form heterogeneous sources, imprecise and inconsistent information, *e.g.*). Given that taken decisions affect all of its components, challenges and special issues that should be given more attention in order to make useful tools for basin management include to model complexity, uncertainty treatment and institutional representation.

In this work, a framework able to capture the knowledge used for reasoning about problems at the river basin scale is proposed. This framework is specially addressed to model in a possibilistic declarative way that knowledge that might be helpful in situations of disagreement, conflict and uncertainty. The use of *declarative languages,* as *Answer Set Programming* (ASP) based on possibilistic theory, has proved to be able to capture knowledge bases with uncertain, inconsistent and incomplete information. ASP is one of the most successful logic programming approaches of the last two decades in the area of non-monotonic reasoning. It

is worth mentioning that the use of *possibility theory* as an alternative to model uncertainty by means of assigning degrees of belief (instead of mathematical probabilities), is helpful when dealing with some of the river basin problems. By using this formalization we illustrate how it is possible to represent *uncertainty*, *default assumptions* and *constraints*, all of them unavoidable features of river basin decision-making.