Summary

A proper drought preventive system management requires anticipating the possible effects that one episode may have on the system. However, this task reveals to be easy to say but harder to do. First, because of the high degree of uncertainty existing in future hydrological variables prediction. And second, because of the high risk of over reacting if the timing for mitigation measures activation is wrong, generating so-called artificial droughts. On this regard, drought plans supply tools to water managers to effectively handle scarce resources situations and preparing for future events. Anyway, the different operation strategies followed in different water resources systems make that the tools that reveal to be useful for some systems are not that effective in others.

Sometimes, due to lack of time and/or excess of confidence in works realized by third parties with good results for their cases, improper methodologies are implemented in systems with completely different requirements. The development and use of generalized methodologies applicable to different systems capable of yielding appropriate results for each case is then desirable. This is the case of generalized water resources systems modeling tools that allow homogenizing processes while still being particularized enough to yield results that suit the requirements of the system under study.

This thesis presents a series of tools aimed to advance in the analysis and understanding of water resources systems, with particular emphasis in drought prevention and risk management. The tools developed include a general optimization model for water resources schemes, capable of including a large amount of elements necessary for the creation of a detailed scheme of any resources system, and a risk assessment methodology based on Monte Carlo optimization fed with synthetic stochastic streamflow series. With these tools, it is possible to consider both the surface and groundwater components of the system under study within the optimization process. Optimization is based in iterative resolution of network flows. The consistency and efficiency of different resolution algorithms was tested in order to find a balance between run speed, number of iterations and consistency of results. Recommendations on the use of each algorithm were given due to the differences found between them.

The tools developed were applied to two real case studies in order to assess and complement the existing drought monitoring and early warning systems. In the first case, an alternative drought monitoring approach for the Orbigo River system (Spain), a within-year operated system, was proposed supported by the use of risk assessment methodologies. In the

second case, the tools were applied to a system with a completely different operation basis. It was studied how the optimal risk assessment methodology can complement the existing indicators system in the activation of the different drought scenarios at the Jucar and Turia River basins, with an over-year based operation. This time, the existing drought monitoring system is reliable but the newly applied methodology showed that it is capable of anticipating droughts and more alarmingly, something that is not wrong but even desirable in order to prevent episodes develop worse. In both cases, it is shown how anticipated assessment of the possible situation of the system allows a confident definition of drought scenarios with sufficient anticipation for the implementation of mitigating measures if necessary.

The use of model-based indicators in front of observed data based ones is complementary and thus they should be used jointly for improved preventive management of water resources systems. The use of optimization modeling during hydrological uncertainty periods is very appropriate due to systems operation rules are often defined for normality periods, and this kind of models do not require the definition of such rules to find the best management of the system.