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Participatory analysis of the Jucar-Vinalopo (Spain) water conflict using a Decision Support System

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Abstract: New water policies around the world are demanding more integrated, participatory, sustainable, efficient, and equitable planning and management of water resources. All this considerations introduce a higher degree of complexity into the already complex task of integrated water resources management. In the process of making good decisions, information must be managed and analyzed about the feasible alternatives, their impact on the multiple objectives, the tradeoffs among them, as well as risks associated with them. To elaborate and analyze such information, sound science, technology, and expertise have to be involved. Moreover, tools for data management and analysis, and models are needed in order to cope with the complexity, the basin scale scope, and the huge amount of information, alternatives, and scenarios. But frequently, decision makers, stakeholders and general public, that is, Policy Making Actors (PMA), are not prepared to produce and understand such information. Therefore, a transfer of technology and ideas from scientist to PMA is needed. This has to be an effective transfer in the sense that PMA must be able to apply the technology easily and in a repeatable and scientifically defensible manner. One of the best ways to conduct this transfer, and to build a shared vision of the basin, is through the joint development of Decision Support Systems (DSS). Furthermore, DSS are essential for the purpose of providing integration, easiness of use, sensitivity analysis, and risk assessment. In this contribution, their use in the participatory analysis of the Jucar-Vinalopo Project (JVP) water conflict is presented. The JVP is a transfer of water from the Jucar Basin to the Vinalopo Basin, both in Eastern Spain, which was approved in a Basin Plan in 1998. The project included an intake in a reservoir located the middle part of the Jucar river, and after a lift of 500m and 80 km of canals and pipes, it should deliver water to San Diego artificial reservoir, in the Vinalopo basin. Construction started in 2002, and in summer 2004, environmental organizations and traditional irrigation farmers of the lower Jucar Basin obtained from the newly elected Spanish government an opportunity to re-examine the project. A Participatory Technical Committee (TC) including all Policy Making Actors and experts in the subjects was working for 4 months in joint development of a DSS (including basic data). In order to simulate the alternatives, all data and scenarios were agreed. The TC obtained as results the trade-offs between demand water deficits and environmental requirements at Jucar River and Albufera wetland, and between potential average transfer and environmental requirements. A complete report was elaborated, including all agreements, disagreements and results, summaries and synthesis. The results were presented to a Broader General Committee including additional representatives of the Regional Governments, National Government, and European Commission. Finally, it was decided by the Ministry of Environment to modify the project to set up the intake of the transfer in La Marquesa small dam (close to the mouth of Jucar river by the Mediterranean Sea). Now, the new JVT project is under construction, and it will be finalized by 2010. DSS for JVP has been developed using AQUATOOL DSS shell developed at Technical University of Valencia (UPV), facilitating the development and use of the DSS. In fact, every one of the parties was able to use the resulting DSS in their PC, so that they could perform simulations on their own, or verify results offered by other parts. In this way, they were able to differentiate the objective elements from the subjective opinions on the alternatives and the results.

Keywords: *Decision Support Systems (DSS), Water Conflict Resolution, Integrated Water Resources Planning and Management, Spain*

1. INTRODUCTION

New water policies around the world are demanding more integrated, participatory, sustainable, efficient, and equitable planning and management of water resources (UNCED, 1998; NRC, 2000; EC, 2000). All this considerations introduce a higher degree of complexity into the already complex task of integrated water resources management. In the process of making good decisions, information must be managed and analyzed about the feasible alternatives, their impact on the multiple objectives, the tradeoffs among them, as well as risks associated with them. To elaborate and analyze such information, sound science, technology, and expertise have to be involved. Moreover, tools for data management and analysis, and models are needed in order to cope with the complexity, the basin scale scope, and the huge amount of information, alternatives, and scenarios. But frequently, decision makers, stakeholders and general public, that is, Policy Making Actors (PMA), are not prepared to produce and understand such information. Therefore, a transfer of technology and ideas from scientist to PMA is needed. This has to be an effective transfer in the sense that PMA must be able to apply the technology easily and in a repeatable and scientifically defensible manner.

One of the best ways to conduct this transfer and to build a shared vision of the basin is through the development of Decision Support Systems (DSS). These are suites of computer programs including, among others, geographically based design facilities, databases handling, integrated simulation and/or optimization models, and capabilities for analyzing and displaying the results, combined in a unique and user friendly control framework. The essential feature is having this interface that provides easiness of data management, model use and results analysis. DSS are essential for the purpose of providing integration, easiness of use by PMA, and shared vision for conflict resolution. They are also very valuable for sensitivity analysis, and risk assessment (Andreu et al., 2008). Many examples of DSS developments are presented and/or reviewed by Labadie et al. (1988), Loucks and Da-Costa (1991), Reitsma et al. (1996), McKinney et al. (1999), Loucks et al. (2005). But, few of these DSS are actually used regularly in real cases of water resources planning, management, or conflict resolution. In this paper, a real case of use of DSS in the participatory analysis of the Jucar-Vinalopo Project (JVP) water conflict, in Spain, is presented. The DSS for this purpose was developed using Aquatool DSS shell developed at Technical University of Valencia (UPV) (Andreu et al., 1996). A short description of Aquatool can be found in Andreu et al., 2009 (in this same volume), as well as its regular use in a real case for drought management.

2. DESCRIPTION OF THE JUCAR-VINALOPO PROJECT

As depicted in Figure 1, and described in the companion paper just mentioned (Andreu et al., 2009), the Jucar Basin Agency (Confederacion Hidrografica del Jucar, CHJ) administers an extension of 42,989 km^2, including several adjacent basins that flow to the Mediterranean Sea, in Eastern Spain; and the use of models and DSS has played an important role in the development of the CHJ Basin Plans for almost two decades. In the cited paper, the Jucar Basin, the biggest of the adjacent basins (22,378 km^2) was described in more detail, as well as its water uses, and most relevant environmental issues. South of the Jucar Basin, the Vinalopo-Alacanti and Marina Baja water systems can be found. The Vinalopo-Alacanti water system occupies an area of 2.786 km^2. Main uses of water in Vinalopo-Alacantí, are irrigation (47.8%), urban supply (45.1%), and industrial supply (7,1%), with a total use of water higher than the renewable resources of the system, producing an intense overexploitation of the aquifers in the area (a deficit of 94 hm^3/year) , and in some places the water table has fallen up to depths of 500 m. In Marina Baja (583 km^2) water is used mainly for urban supply (59.40%) and irrigation (40.28%), and the total demand is 67 hm^3/year, which is 17 hm^3/year more than the renewable resources of the system, producing a deficit in urban water supply that is presently covered by imports of water from Jucar river basin when reserves in Marina Baja are low.

One of the measures designed in the Basin Plan of 1998 (CHJ, 1998) in order to reduce aquifer overexploitation in Vinalopo-Alacanti, and urban water deficit in Marina Baja, was the Jucar Vinalopo Project (JVP), which is a transfer of water from the Jucar river Basin to the Vinalopo-Alacanti-Marina Baja area. The project included an intake in Cortes reservoir, located the middle part of the Jucar river, and after a lift of 500 m and 80 km of canals and pipes, it should deliver water up to 80 hm^3/year to the Vinalopo basin, as shown in path (a) of Figure 1. Construction started in 2002, but environmental organizations and traditional irrigation farmers of the lower Jucar Basin still showed an opposition to the project. The concern of NGO's was the environmental state of Jucar River and Albufera wetland after project implementation, and the concern of the traditional farmers was a decrease of reliability in their supply, given that their intakes are located downstream of the transfer intake. Traditional farmers were demanding a JVP intake downstream of their intakes, as shown in path (b) of Figure 1.

3. THE PARTICIPATORY COMMITTEES

In August 2004, opponents of JVP obtained from the Spanish Ministry of Environment an opportunity to re-examine the project. A Group of Study (GS) including all Policy Making Actors was appointed. In the GS were present representatives of the Ministry of Environment, CHJ, Valencia Regional Government, water users in donor and receptor basins, environmental NGO, as well as independent invited experts, some of them from universities. The GS, in its first meeting session, decided to appoint a smaller and specialized working group, which they named Technical Committee (TC), in order to analyze the technical viability of the project, and bring a report to the main GS. The first author of the present paper was appointed as the chairman of the TC, and as representative of CHJ, and other members were: a technical representatives of the Valencia Regional Government, of traditional lower Jucar basin irrigators, of the irrigators in Vinalopo-Alacanti, of urban supply entity of Marina Baja, of AJUSA (state owned company responsible for the implementation of JVP), and of SEIASA (state owned company responsible for improvement of irrigation infrastructure in the lower Jucar). In total 9 meetings took place from September 2004 to January 2005, each one lasted a working day, more or less. At every meeting, besides the regular attendants, there were also experts in the subject to be dealt in the session, either invited by the TC, or by any of the stakeholders. In all the process, transparency (i.e., publicity and availability of data, assumptions and models); and participation and involvement of stakeholders in the TC were promoted and achieved.

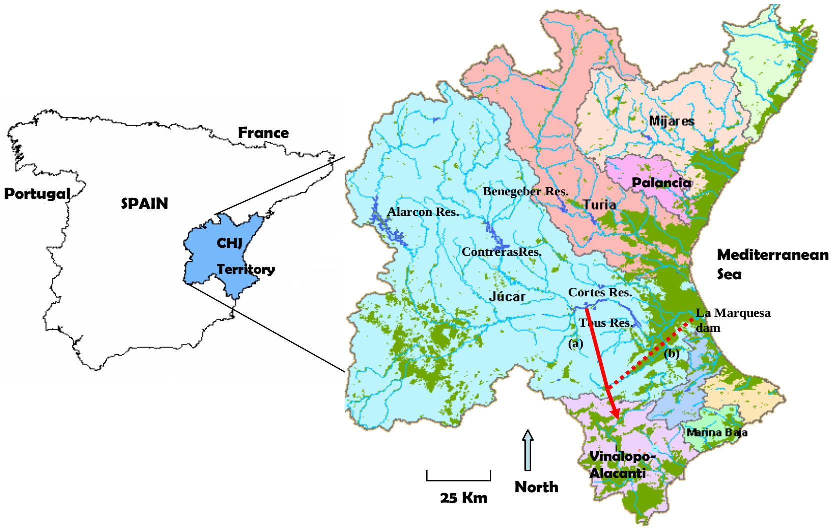

Figure 1. Location of CHJ and JVP project.

4. THE JOINT DEVELOPMENT OF THE COMMON DSS

As mentioned before, at CHJ there was a tradition of DSS use for the technical analysis of Basin Plans. Therefore, an existing DSS for the Jucar Basin was used as the starting point for the methodology adopted for the analysis. It was clear, from the beginning, that there were many and large disagreements among the parties in relationship with subjects that could be objectified (e.g., assessment of water resources in the Jucar Basin), as well as on many other aspects that are less easy to objectify (e.g., environmental requirements in the Jucar river, or in the Albufera lake and wetlands), and even on the technical measures that could or should be adopted in order to improve reliability of water uses and environmental requirements (e.g., on the degree of efficiency improvement in traditional irrigated areas, on the degree of treated wastewater reuse, on the degree of groundwater extraction from aquifers, and on cost recovering from transfer recipients).

But, as the main objective of steps 1 to 4 was to obtain a DSS that could be accepted by all participants as a common shared vision of the system, in order to proceed with the following steps, an exhaustive review of all the components of the existing DSS was performed, and was the path to drive the works for attaining this objective. The main points of discussion were the following:

a) Hydrological scenarios to use in the analysis. Natural hydrological time series at several points in the basin were available for the period 1940-2003, showing a significant change in mean values in the last 25 years of the series. The subject of the debate was if the hole time series should be used for the analysis (i.e., a higher amount of water resource), or only the last 25 years of data should be used (hence, lower amount of water resources). Both scenarios were considered and simulations and assessments were performed for both scenarios.

b) Environmental requirements at several places in the Jucar Basin, and also for wetland and lake maintenance at the Albufera Natural Park. After many hours of work and discussions, including relevant experts in these subjects, no agreement was reached on which values should be set up as objective values for these requirements, and therefore would be used as constraints for the water use in the system. Therefore, it was agreed to parameterize the values of the ecological flows in four critical points of the basin, in a range of values, resulting in 8 different scenarios for ecological flows to be considered. In a similar way, the environmental needs of the Albufera Natural Park, reflected in total water inflow (i.e., natural surface and subsurface inflows, returns flows from irrigation of rice fields in the wetland, and additional supply from Jucar and/or Turia rivers) were considered adopting 5 different values as scenarios.

c) Technical measures that could be included in the management of the system in order to improve reliability of water uses and environmental requirements. The debate was centered on the degree of efficiency improvement that could be achieved in traditional irrigated areas, on the degree of treated wastewater reuse that could be available, and on the degree of groundwater extraction from aquifers that could be sustainable. The cost recovering of some of these additional measures from transfer recipients was also under discussion. Finally, a set of 15 scenarios for measures was defined, including 2 basic scenarios. Basic scenarios where scenarios in which the JVP was not included, in order to provide a base line for comparison.

It is important to point out that, even though for these points no agreement was obtained as single values for the issue, and the use of scenarios was the way to solve the question, the gap of disagreement between the parties was narrowed very much after the information analysis, debates and discussions with experts. So, the range of the scenarios was much narrower than the initial disagreement, and, in fact, the most extreme values in the ranges of scenarios adopted were not seriously considered by the proposing parties, reflecting only strategic positions in the conflict. And all parties agreed that the DSS resulting from the joint development was a reliable tool in order to be used to assess the alternatives. Since Aquatool DSS shell works on personal computers Windows environment, each party was able to install the DSS in its computer, and to run any alternative by its own, either among the common alternatives, or any other alternative that they could imagine, or in order to test the results obtained by other parties in their alternatives.

5. THE SIMULATION AND ANALYSIS OF THE ALTERNATIVES

A total of 630 common alternatives were resulting as a combination of the scenarios defined. From them, rationality was applied in order to reduce them to the order of 400 after a preliminary analysis. And these were simulated and a summary of results was produced for each alternative in the form that can be seen in Figure 2. The figure is presented just in order to illustrate the form of the summary, not to be read nor interpreted in the context of the present paper. As it can be seen, in the upper left part, there was a table describing the alternative (a), and tables summarizing the significant average annual flows in the system (b), the maximum and average annual deficit in significant demands (c), the ecological flows indicators for significant parts of the Jucar river (d), the water quality indicators for the lower Jucar river (e), and the costs of operation (f). Also included in the summary card there were graphs showing time series for the flows (g), and time series of supplies to selected demands (different colors for surface water and groundwater) and the corresponding deficits, and the flows of water exported to Vinalopo-Alacanti-Marina Baja system (h).

As it can be imagined, 400 of these cards are too much information in order to be useful for decision making. Therefore, syntheses of the results were produced for this purpose. Figures with the trade-offs between demand water deficits and environmental requirements at Jucar River and Albufera wetland, and between potential average transfer and environmental requirements were produced, as some examples depicted in Figure 3. In Figure 3 (a), trade-offs between average urban water deficits (y axis) and environmental requirements at Jucar River (x axis) and Albufera wetland (each of the 4 lines corresponds to a level of total inflows to the lake). In Figure 3 (b), trade-offs between average agricultural water deficits and environmental requirements at Jucar River and Albufera wetland are displayed in a similar way. Figures of type a and b and d were produced for each one of the 15 scenarios of technical measures mentioned above, and for each hydrological scenario of the 2 mentioned above. In Figure 3 (c), trade-offs between potential transfer to Vinalopo-Alacanti-Marina Baja (y axis) and environmental requirements at Jucar River (x axis) and Albufera wetland are displayed. Three groups of 4 lines each can be seen, the group on top corresponds to the maximum average transfers of all hydrological scenarios, the group in the center to the average transfers for the complete 1940-2003 hydrological scenario, and the group at the bottom to the average transfers for the complete 1978-2003 hydrological scenario. As before, each of the 4 lines in a group corresponds to a level of total inflows to the lake. Figures of type c were produced for each one of the 15 scenarios of technical measures mentioned above.

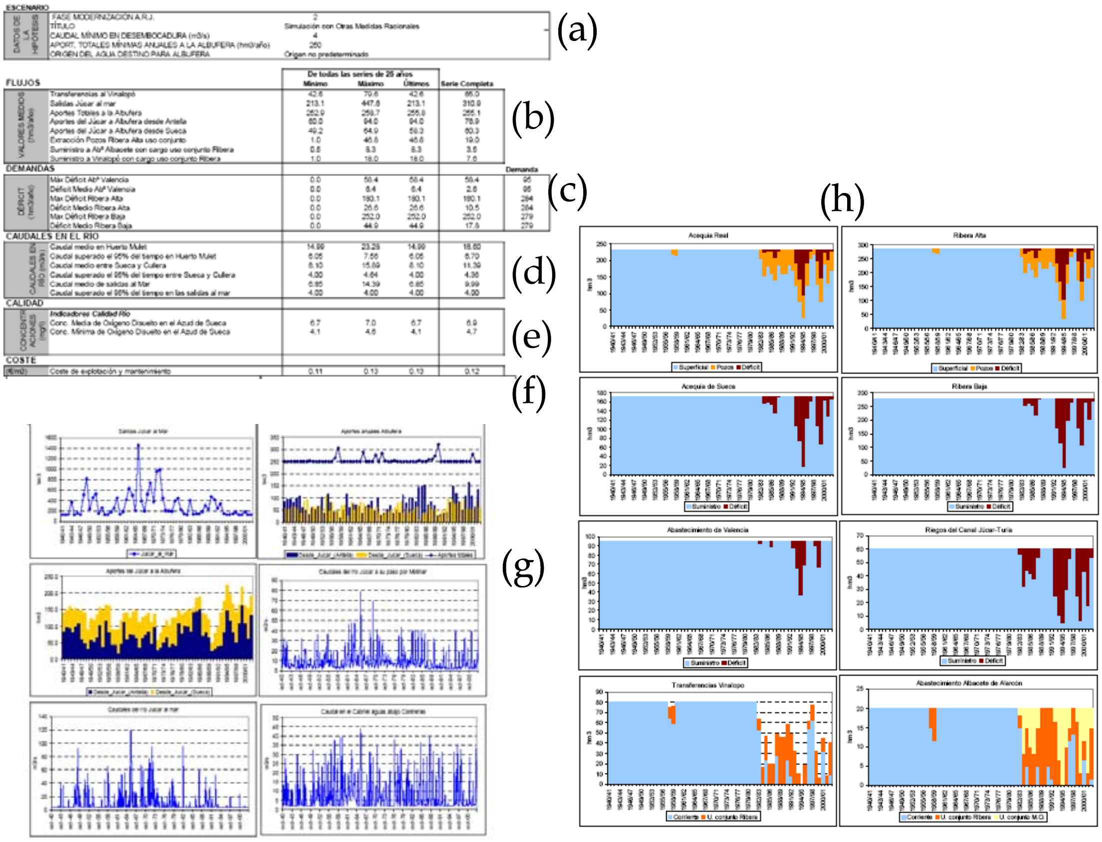

Figure 2. Card with the summary of the results for an alternative simulated with the DSS.

In Figure 3 (d), trade-offs between potential transfer to Vinalopo-Alacanti-Marina Baja (y axis) and environmental requirements at Jucar River (x axis) and Albufera wetland are displayed (each line corresponds to a level of total inflows to the lake), but, in this case the alternative represents a JVP with the intake at Marquesa small diversion dam, close to the mouth of Jucar river, and downstream of all the intakes of the traditional users. Figures of type d were produced for two scenarios of technical measures mentioned above, and for each hydrological scenario of the 2 mentioned above. The one depicted in the figure is for the last 25 years of hydrological inflows, and for the minimum level of additional technical measures.

6. THE REPORT OF THE TECHNICAL COMMISION AND THE FINAL DECISION

After the assessment of all the alternatives was performed, all the results were handled to the parties, and there were asked to present a document with their own conclusions, and to explain them in a meeting of the TC. After a debate, a complete report was elaborated by the TC (CHJ, 2005), including the agreements and disagreements about all the subjects studied; as well as the results, summaries and synthesis of the assessment of the alternatives. There was no agreement on a final conclusion about the feasibility of the project, as it was being constructed, so each party's conclusions were included in the document. The report was presented to the broader GS in a session in which additional representatives of the European Commission, which was partly financing the project, were present. Finally, and after two additional meetings of the GS, it was decided by the Ministry of Environment to modify the project to set up the intake of the transfer in La Marquesa small dam (close to the mouth of Jucar river by the Mediterranean Sea), as shown in path b of Figure 1, and to devote the water transferred only to irrigation, while future urban water deficits in Marina Baja will be covered by desalination plants. Now, the new JVT project is under construction, and it will be finalized by 2010. It must be said that current opposition to the new solution for JVP comes from the Regional Government and the recipient basin users. The main claims are about water quality, and about the desalination issue.

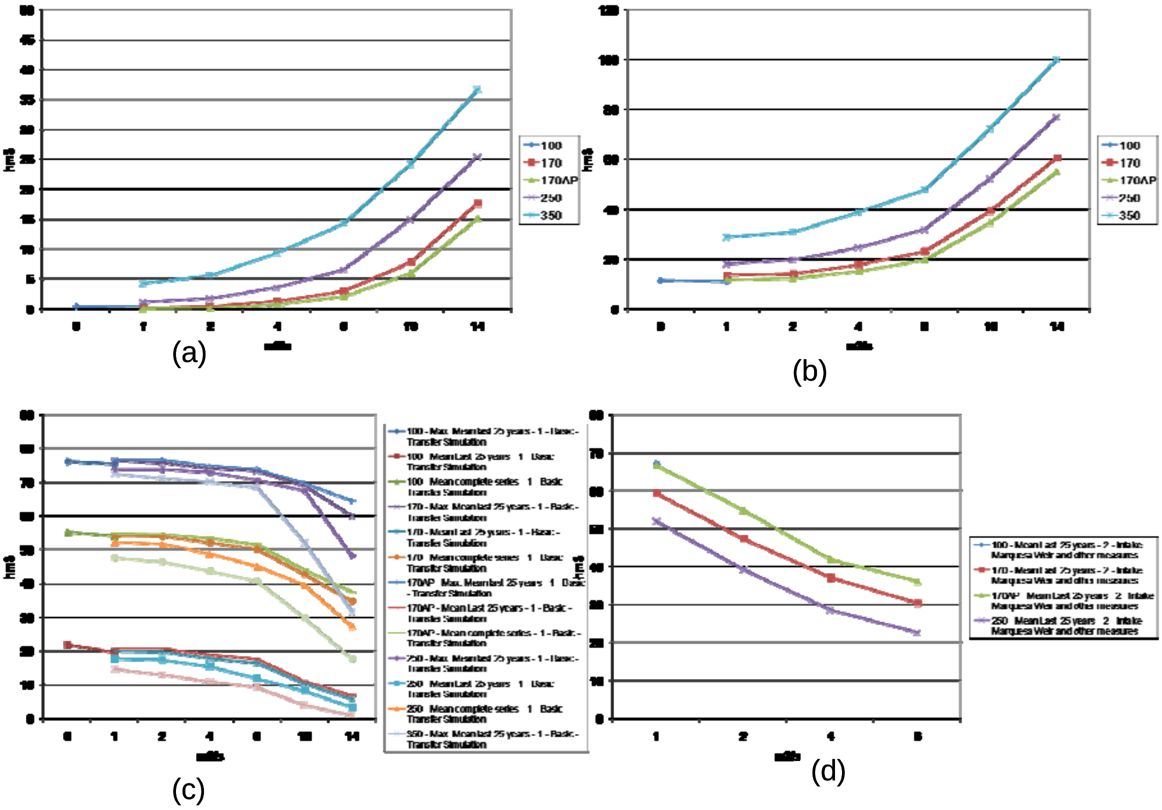

Figure 3. ***Synthesis graphs to display trade-offs between fulfillment of uses, ecological flows, wetland inflows, and water transferred to Vinalopo-Alacanti-Marina Baja area.***

7. CONCLUSIONS

The real case of joint development of a DSS for the Jucar Basin and Jucar-Vinalopo Project (JVP) in a participatory committee for set up to analyze the viability of JVP has been presented. Four months of regular meetings were devoted by the TC to review all the components and models included in the DSS, and the outcome was an agreed DSS considered by all the parties as a common shared vision of the water systems, and also as a reliable tool to assess the alternatives.

More than 400 alternatives were assessed by the TC, and a report was produced containing the results, syntheses and summaries, as well as the agreements and disagreements on its interpretation by the parties. A broader Group of Study debated about this, and finally the Ministry of Environment took the decision to change the project for a new intake downstream of all current users' intakes. It was very interesting to see how along the process of joint DSS development, the different parties were gaining insight on the functioning of the water system, and on the relevant issues discussed. Objectivity was gained in many of them, and a systematic approach of scenarios definition was able to produce trade-off curves as help for decision making in this kind of multi objective and multi party conflict. The DSS for Jucar Basin and JVP was developed using Aquatool DSS shell, facilitating the development and use of the DSS (by the TC and also by each party).

So, as a conclusion it can be stated that transparency, participation, and negotiation, are essential factors in conflict resolution, and that the joint development and use of models and DSS, oriented to the assessment of alternatives, as shared vision of the system, enhances very much this process, contributing to create an atmosphere of more confidence and understanding on the techniques, models and tools from the non technical parties. Also, using the DSS as a driving force, more rationality is introduced in the debate, in opposition to debates that are based fundamentally on opinions, or on political positions. Of course, that after this enlightening process, final decisions, as has happened in this case, will come from those entitled by the society to take the decisions.

Even though CHJ had already used DSS for more than a decade before the case presented, this case has reinforced the role of DSS in water planning and management at CHJ, and also paved the road for a difficult task that had to be undertaken immediately after the case presented. It was the management of the 2005-2008 drought episode at Jucar river Basin, as described in Andreu et al. (2009). The inertia of solving problems and conflicts in such a participatory way was very good for the development of the drought mitigation process.

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