Appendix 1 Spatial Decision Support System – participatory design

The spatial decision support system (SDSS) is embedded in a webpage and has 3 principal components (figure A1.1): (1) a management system for the spatial database, (2) a mathematical model to create water management alternatives quantified by a set of indicators, (3) an evaluation tool based on multicriteria evaluation.

The ensemble has a final user interface linked to maps and is accessible through the internet. Whereas the general architecture of the tool (using MCA and spatially distributed hydrological and socio-economic modelling) was predefined by the researchers, the stakeholders co-designed the tool in following specific aspects: (1) the SDSS web interface (with general socio-economic and legal information on the basin, calendar and blog) and type of maps used (google earth basin diagnosis and p-mapper indicator queries), (2) the selection and calculation procedures for the socio-economic and environmental indicators, (3) the definition and parameterization of alternatives and scenarios used in the comparative MCA analysis for planning and (4) the visualization options of individual and group voting on water management alternatives, including individual and group ranking of alternatives as well as a variance map displaying the differences in opinions between stakeholders and indicators. The participatory design and inclusion of stakeholders' opinions was achieved both through in-depth interviews and the debates in the workshops, incorporating modifications following stakeholder needs. This ensures that the stakeholders are involved in all phases of the hydrological planning, including the underlying information sources and design of tools used.

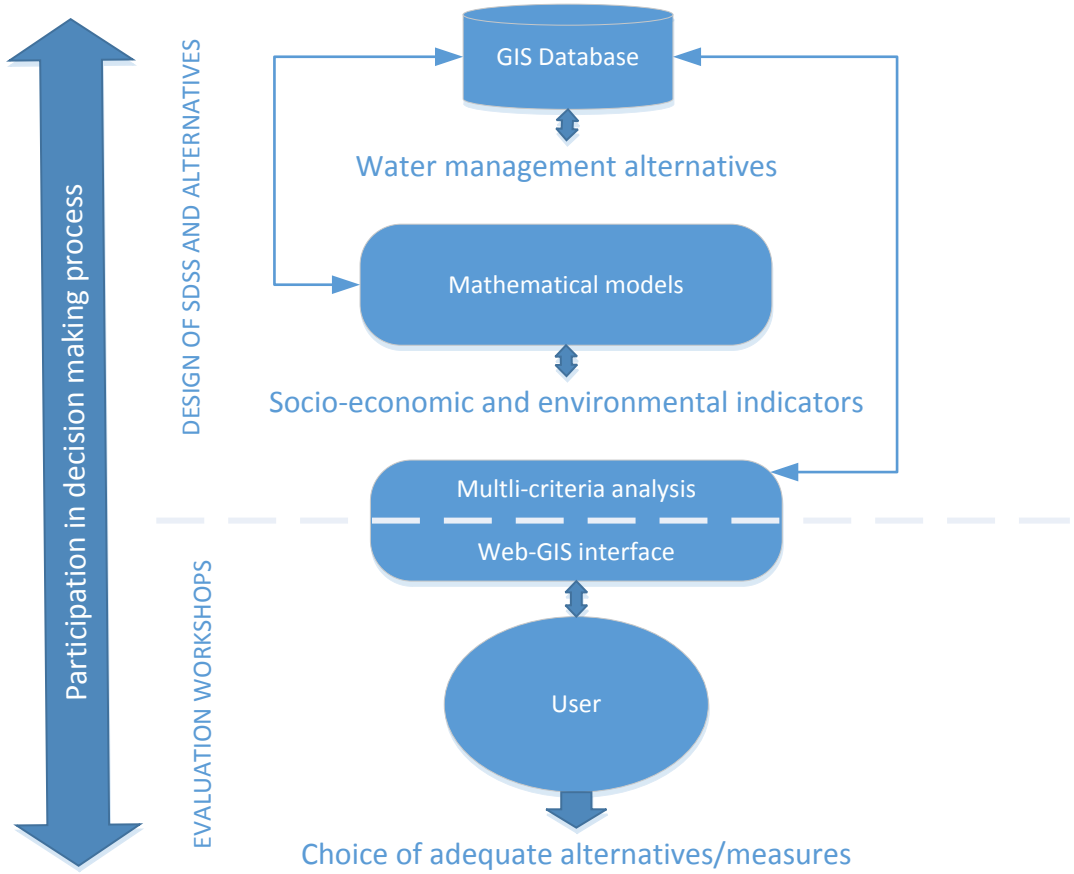

Figure A1.1: Architecture of the spatial decision support system (SDSS), with (1) a spatial database manager, (2) a scenario and alternatives generator and (3) a user interface embedded in a web 2.0 environment

To increase accessibility for the administration and the general public, the SDSS tool and the supporting webpage were developed in an "open" source philosophy and according to the guidelines of the EU INSPIRE[1] directive. This means that the web environment and all its embedded applications use free software programmed with open codes and facilitate data exchange. This allows it to be updated and improved at any time thereby facilitating its access by the general public through internet.

The ALTAGUAX multicriteria analysis tool is based on a subset of 15 indicators (5 economic, 5 social and 5 environmental) that were selected through a participatory priorization process out of an extended list of 46 indicators, themselves based on literature review of indicators for (ground)water management. Figure A1.2 shows the extended list of indicators and selected indicators highlighted in grey. Calculation procedures are explained in the web application altaguax.unesco-ihe.org and further detailed in Altaguax project documents (available upon request). In addition to these indicators, the group requested to include a “new” indicator on environmental quality (in addition or replacing the more restricted indicator on “groundwater quality”). Discussions on the quantification protocol for such an indicator were inconclusive.

ENVIRONMENTAL
Groundwater quality (GQ)
Salinization of aquifer
Relative quantity of depurated wastewater
Treatment need for consumption of groundwater
Reuse of depurated wastewater (WR)
Groundwater depletion (GD)
Total extraction of aquifer in function of estimated recharge (TAR)
Quantity of groundwater resources available per user
Total exploitatoin of groundwater resources
Variation in surface water fluxes
Terrain value
Evolution of protected natural areas (%increase/ decrease)
Urban development increase
Quantity of internal renewable resources* in relation to groundwater
Volumen of groundwater pumped in relation to non-conventional resources*
Dependency of agricultural population on groundwater (DAG)
Dependency of tourism on groundwater
Groundwater pumped in function of total amount of water for human consumption

ECONOMIC
Distribution efficiency (DE)
Irrigation efficiency (IE)
Pumping costs (Kwh or /m³)
Transfer costs (Kwh or /m³) (CC)
Decontamination costs
Recharge costs for recuperaton of aquifer (Kwh/ m³)
Total energy consumption (Kwh/m³) (TEC)
Percentage of subsidies on water price
Price of water in relation to operation and maintenance costs (WPC)
Water productivity (/m³)
Water productivity (EAJ/m³)

SOCIAL
Income per capita
Income per sector
Consumption power in relation to water price
Risk of not being able to supply water for human consumption (RU)
Risk of not being able to supply water for irrigation (RA)
Rate of accesability to drinking water (AC)
Rate of human migration
Percentage of tourists
Employment created (EAJ/m³)
Employment rate
Implication of stakeholders (IS)
Private water uses in relation to uses with a public concession
Institutional transparency
Possibility to influence decision making
Information distributed by the administration competent in water issues
% private water enterprises in relation to public enterprises
Control performed by competent administration (quality and quantity) (IC)

* desalinated and depurated wastewater /
EAJ = Equivalent of 1 person labor day

Figure A1.2: List of indicators based on literature presented to the multi stakeholder working group and highlighted selected indicators (5 environmental, 5 social and 5 economic).

[1] Infrastructure for Spatial Information in the European Community, 2007