TECHNICAL OVERVIEW OF AQUATOOL

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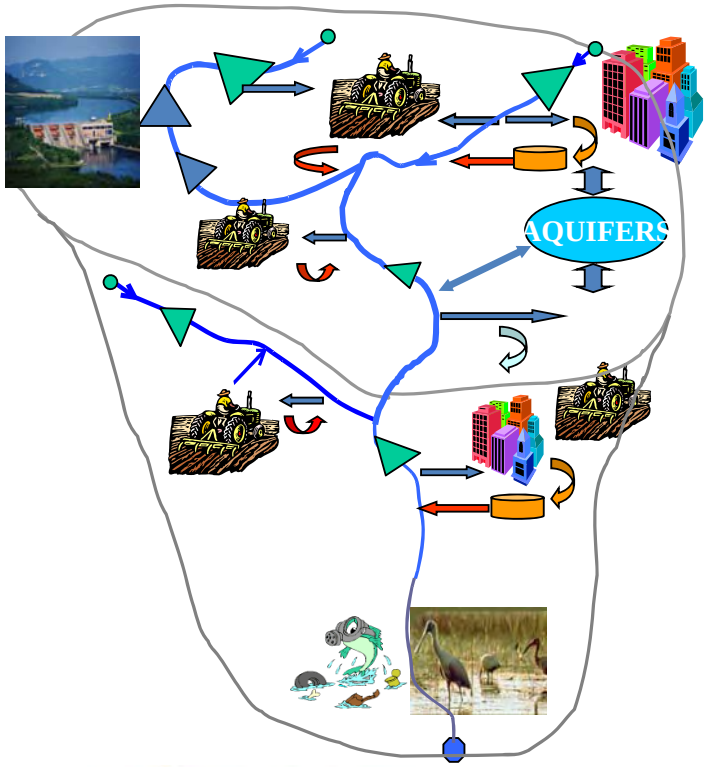
WR Systems INTEGRATE at the BASIN SCALE: WaterBodies, W.Uses (Demands), Infrastructures



- **Complex relationships that affect water availability both in SPACE &TIME**
- **Implications on all aspects (w. quality, environment, economy, …) can only be captured by means of adequate integrated modeling**

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Integrative DSS

- In order to complete basin identification, and for the development of further analysis activities, it is crucial to have
- a DSS integrating, in a single model and for the entire basin, all the relevant
  - surface water elements (e.g., river reaches, lakes, ...),
  - aquifers,
  - infrastructures (e.g., dams, reservoirs, diversions, returns, groundwater abstraction, ...),
  - water uses (e.g., agricultural uses, urban uses, industrial uses, ...),
  - environmental requirements on flows,
  - water rights and priorities, and operating rules for the system.

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DSS Shells (DSSS)

- Generalized tools to build DSS,
- bring the possibility of relatively easy, systematic and homogeneous application of DSS over wide regions, as for instance many river basins in Spain
- provide guidance in the development of the DSS

AQUATOOL:

DSSS designed for integrated management of complex water resource systems

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The DSS allows the user to:

- Input and modify the space configuration of a water resource system
- Edit and manage geo-referenced data bases containing physical characteristics, management characteristics
- perform simulation runs of the management for multiple different alternatives, time horizons and scenarios, using different hydrological data and also different operating policies.
- **Obtaining multi-objective performance indicators (reliability, resiliency and vulnerability); and environmental requirements indicators**.

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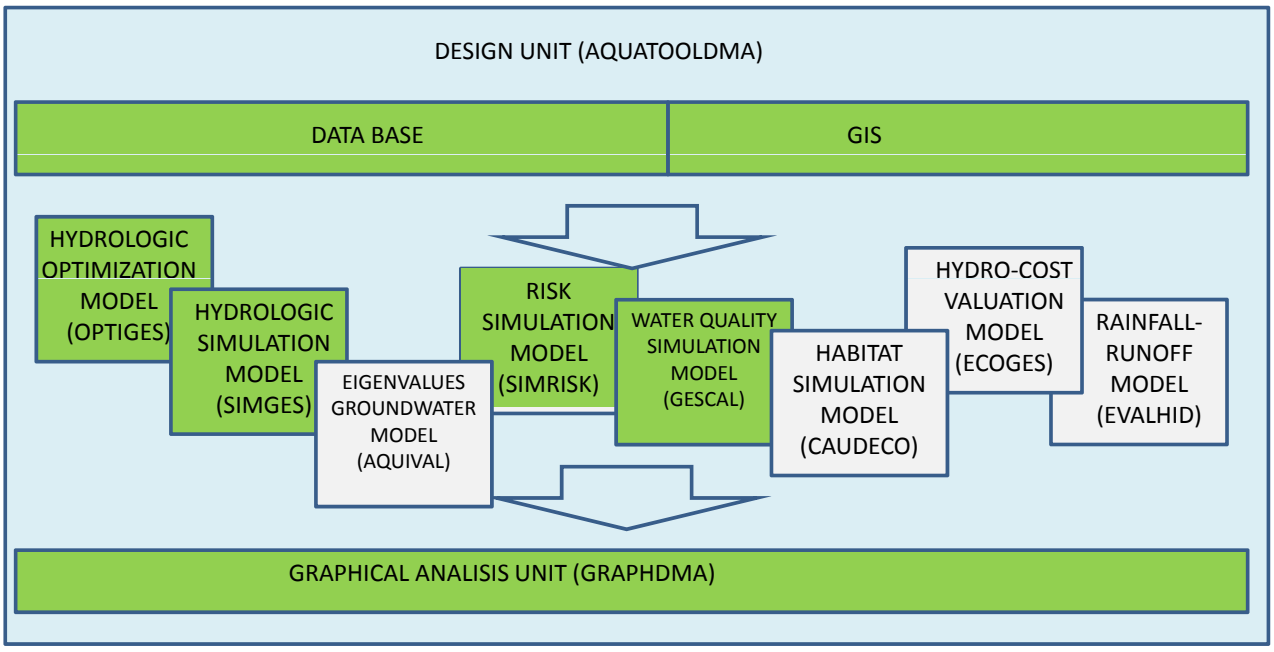
Aquatool structure



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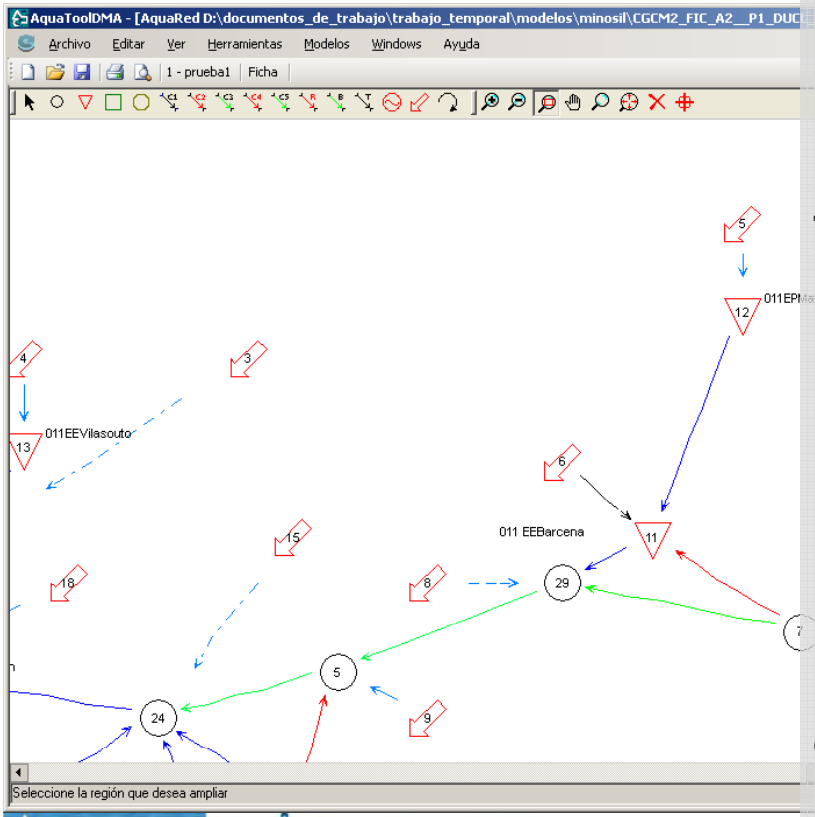
Design tool



A unique and user friendly interface that provides easiness of data management, model use and results analysis.

The DSS allows the user to:

- Input and modify the space configuration of a water resource system
- Edit and manage geo-referenced data bases containing physical characteristics, management characteristics
- Direct acces to the different calculation modules
- Graphical annalisis of results
- Define and compare different alternatives.

Data base designed as MS Acces DB
Connection to GIS shp

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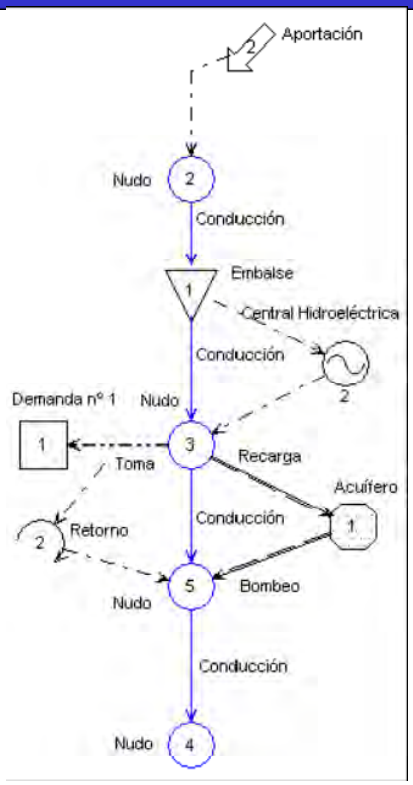
HIDROLOGIC SIMULATION and OPTIMIZATION MODEL (SIMGES AND OPTIGES)



Elements

- Resources: given inflows
- Transport system: channels and rivers
- Regulation: reservoirs and aquifers
- Hydropower stations
- Consumptive demand system: channels, water users and returns to water system

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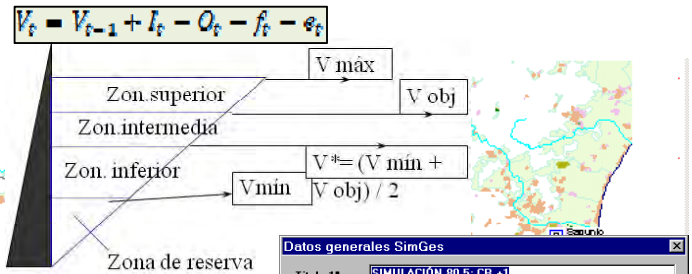
SIMGES & OPTIGES: WATER MANAGEMENT SIMULATION AND OPTIMIZATION

for given hydrologic inflows scenarios

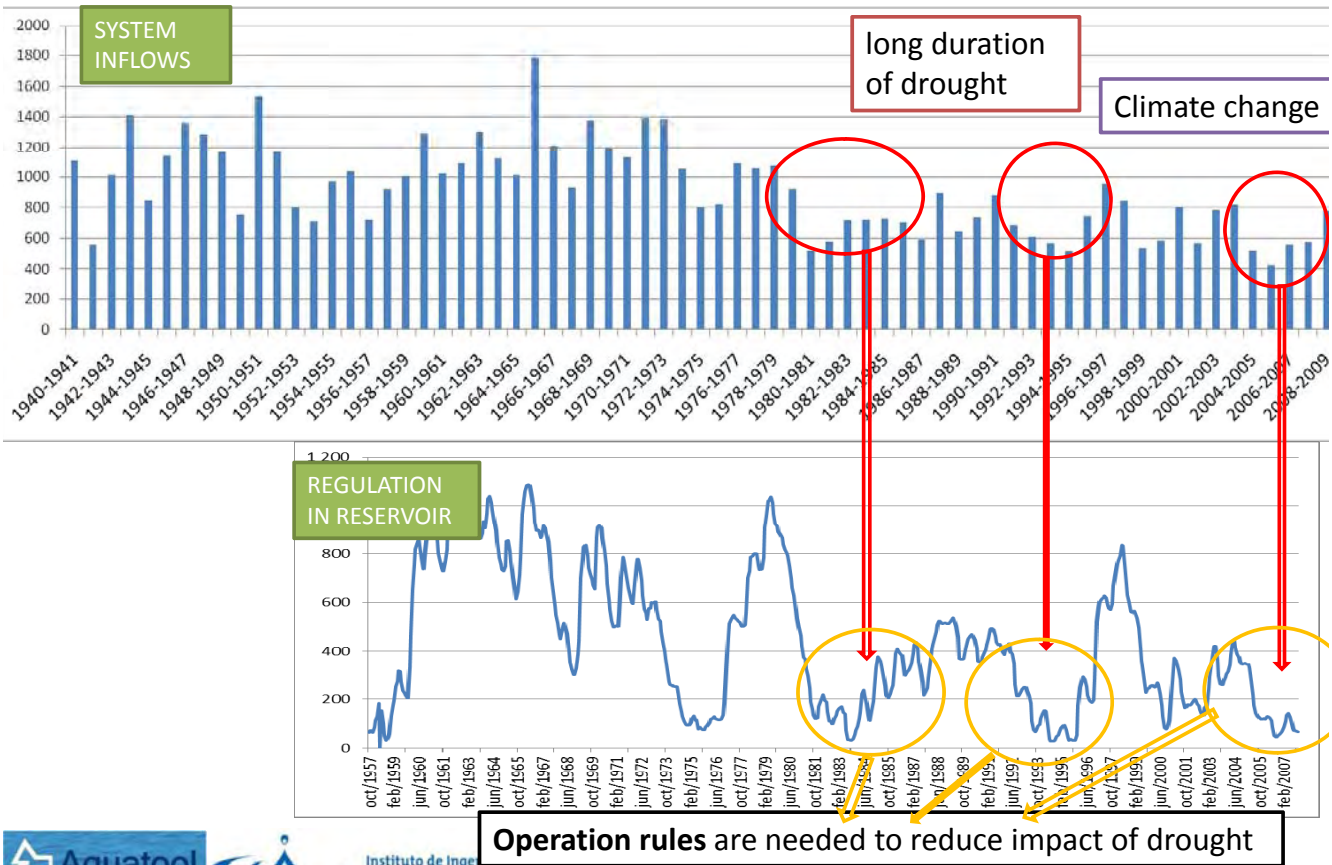


INTERNAL PROCESS:

In every month, a network flow optimization algorithm (Out-of-kilter) finds a flow solution which is compatible with the physical restrictions, and tries to minimize weighted deviations from operating rules (Target supplies, flows, and reservoir storage); respecting priorities.

Iteration is needed to take into account non-linearities and surface-groundwater relationships.

Analisis of management of drouht problems

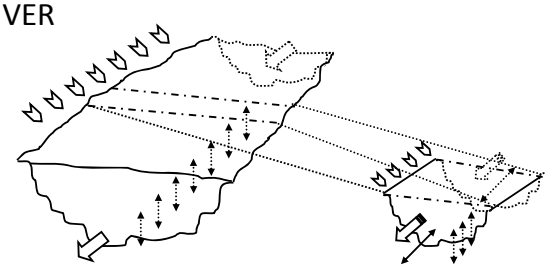


WATER QUALITY SIMULATION MODULE

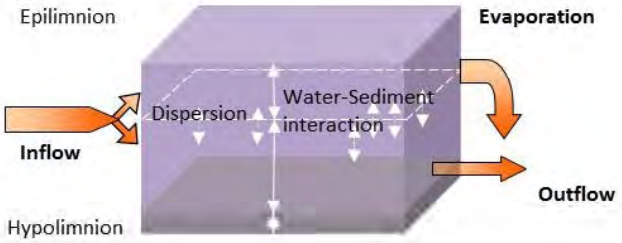
Water quality model coupled with a simulation model..

- SIMULATES W.Q. FOR THE ENTIRE SYSTEM
- Mechanicistic model for rivers and reservoirs.
- Conventional constituents.
  - Temperature
  - Arbitrary constituents
  - DO + OM
  - Nitrogen cycle
  - Eutrophication problem.

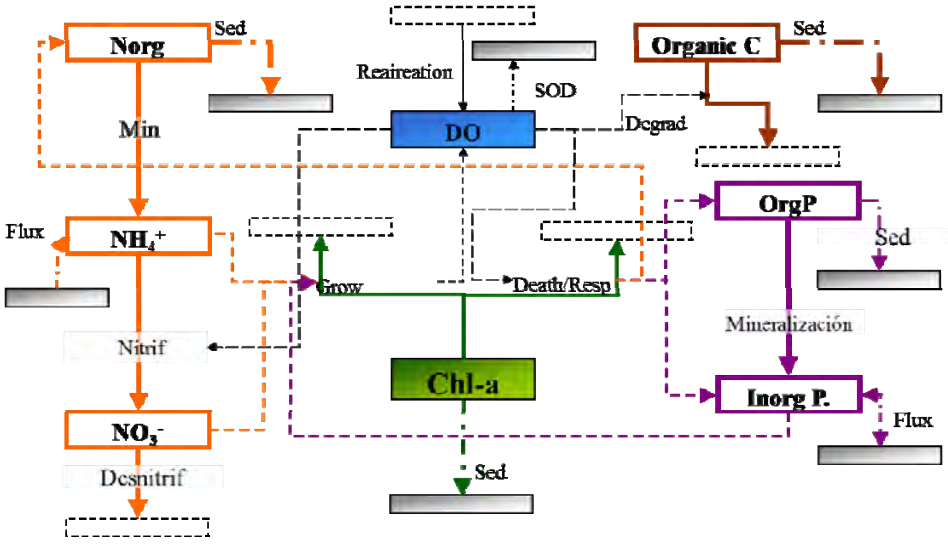
RIVER



RESERVOIR



NITROGEN CYCLE ORGANIC CYCLE PHOSPHORUS CYCLE



NEW

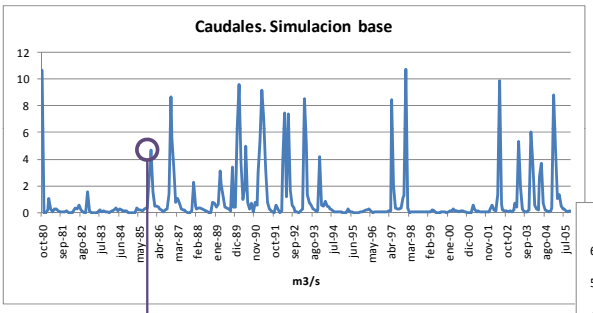
MODELING OF TOXIC POLLUTANTS

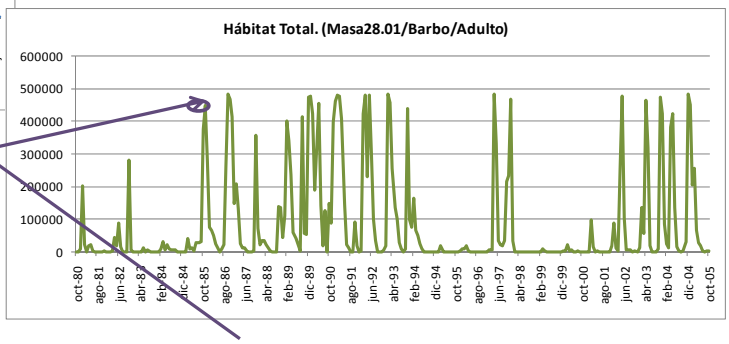
W.Q. results used to modify constraints in simulation & to predict the impact of corrective measures in an integrated way at basin scale and assessing the real efficiency of the measures

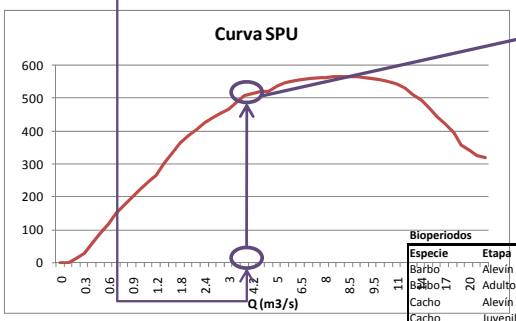
CAUDECO– Ecological flows module

OBJECTIVE OF THE MODULE

•Estimation of Total Habitat Series in different water bodies, species and ages for different management alternatives.







Bioperiodos

Especie	Etapa	Oct	Nov	Dic	Ene	Feb	Mar	Abr	May	Jun	Jul	Ago	Sep
Barbo	Alevín												
Barbo	Adulto												
Cacho	Alevín												
Cacho	Juvenil												
Cacho	Adulto												

INCORPORTAING ECOLOGICAL ASPECTS IN PLANNING AND MANAGEMENT STUDIES

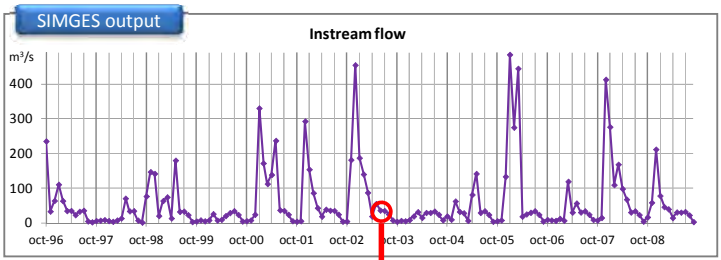
CAUDECO: waited habitat on management alternatives

OBJECTIVE

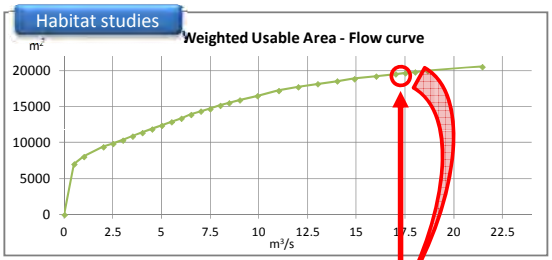
To obtain Habitat Time Series for different species and water bodies under a defined water management of a water resources system

CAUDECO inputs

SIMGES output



Habitat studies

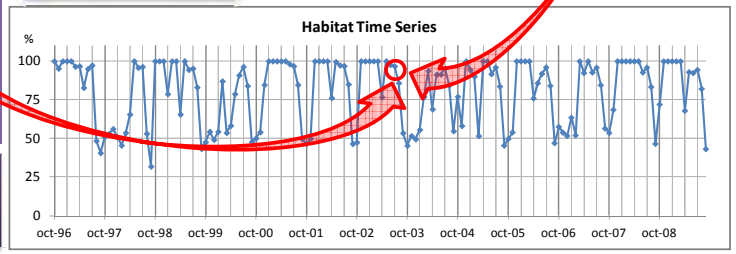


Habitat studies

Bio Periods

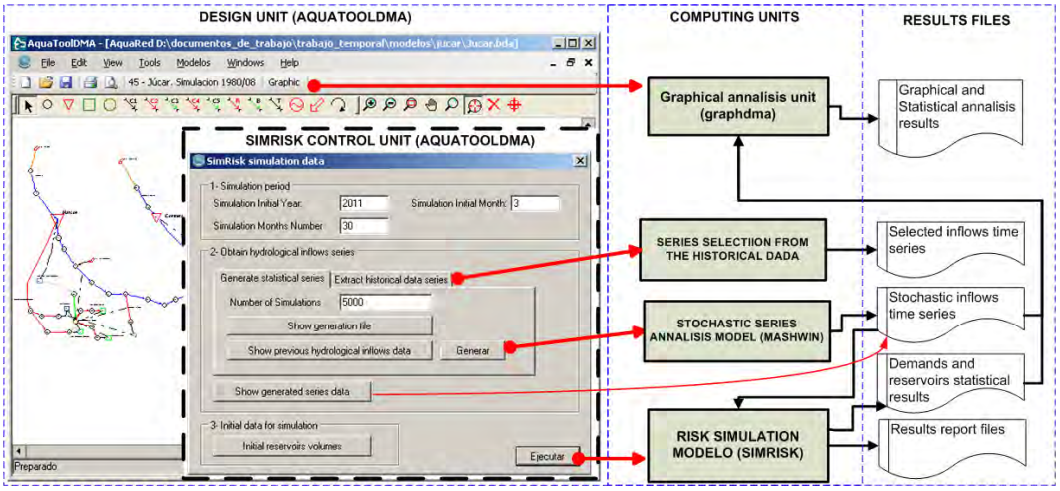
Species	Size	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept
Luciobarbus b.	Large												
Luciobarbus b.	Small												
Squalius c.	Large												
Squalius c.	Medium												
Squalius c.	Small												

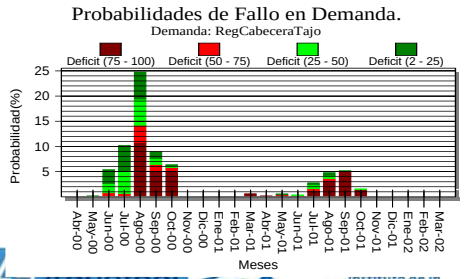
CAUDECO output

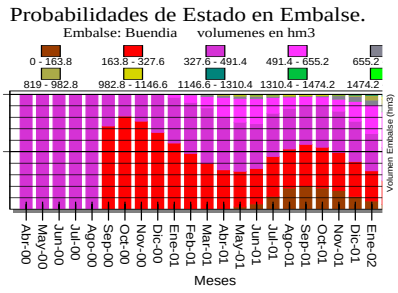


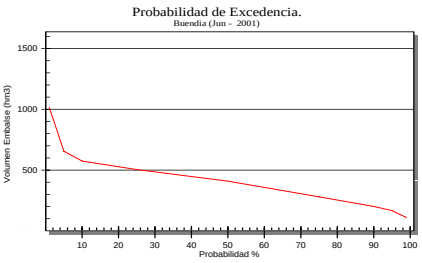
Other outputs
- Habitat Duration Curves
- Cumulated Habitat Time Series
- Other habitat availability indicators

Risk annalisys unit: Simrisk

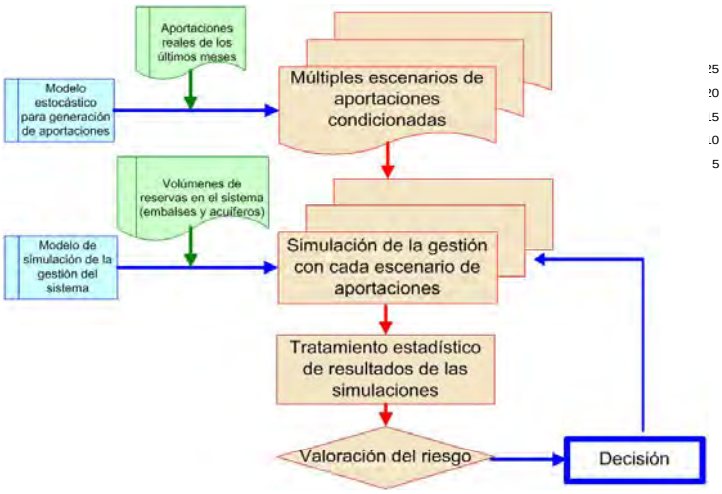


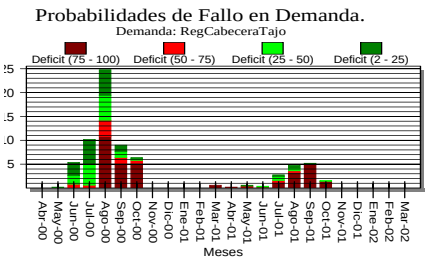


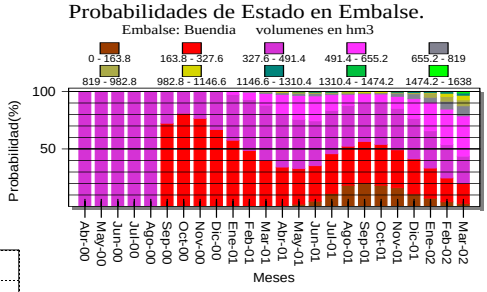


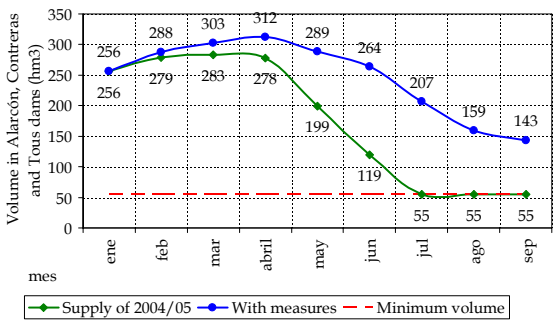


Risk based management method

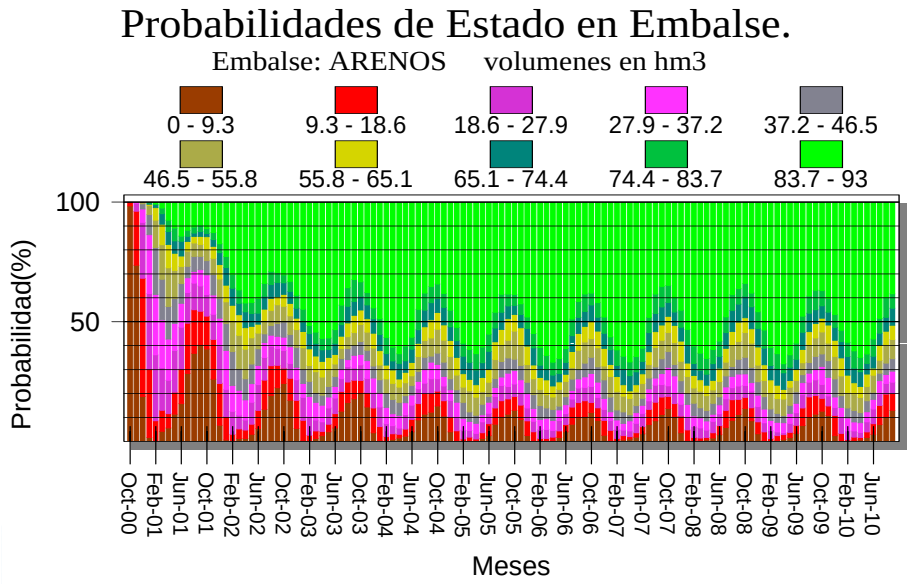








- **Risks associated to planning decisions (design of the system):**
  - **unconditioned multiple future hydrological scenarios for very long time horizons**
  - **after the effect of initial conditions are dissipated, the probabilities stabilize:**

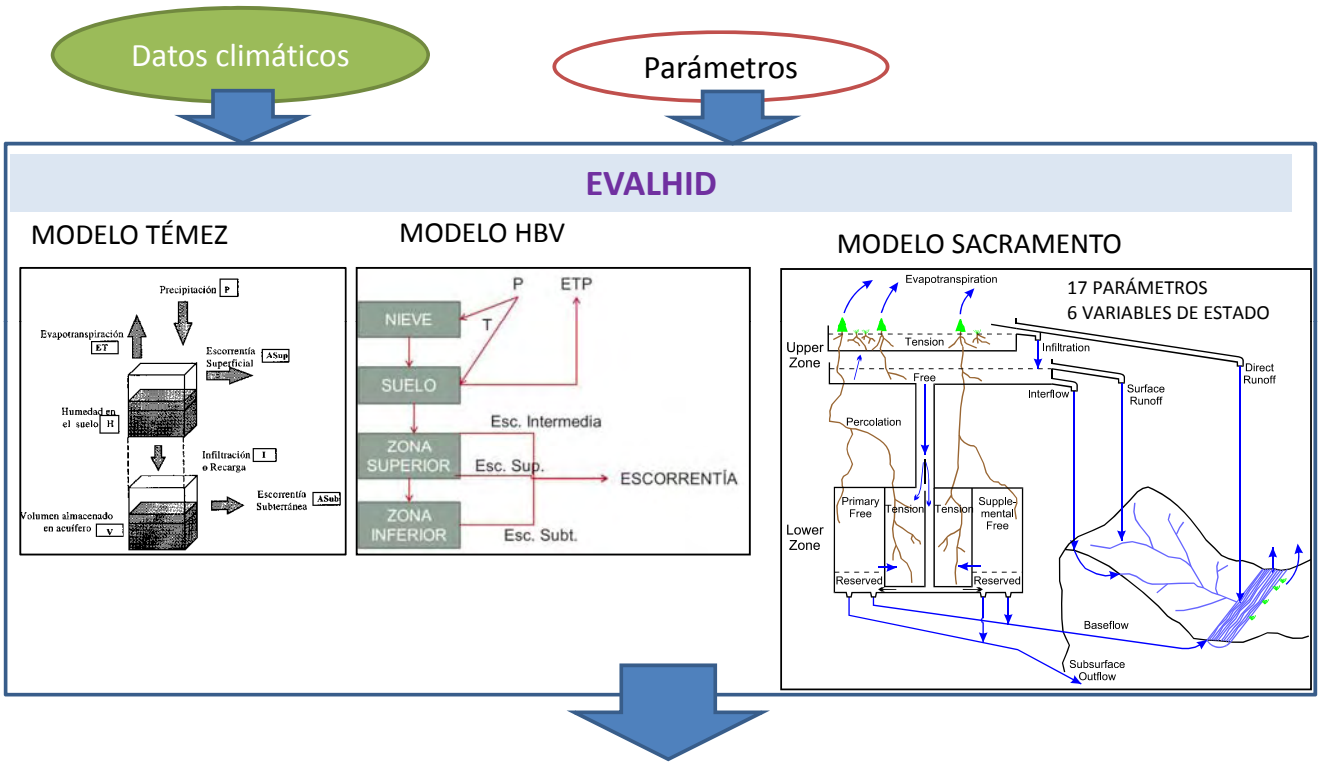


Long term measures

EVALHID

HERRAMIENTA PARA LA EVALUACIÓN DE RECURSOS HÍDRICOS ENLAZADA CON LOS MODELOS DE SIMULACIÓN DE LA GESTIÓN

- CARACTERÍSTICAS.
  - Modelo agregado – semidistribuido (modelación por subcuencas de tamaño libre).
  - Varios modelos disponibles en la misma aplicación: Témez, HBV, Sacramento, GR2M, …
  - Funcionamiento independiente o conjunto con SIMGES.
    - Se utilizar para obtener algunas o todas las series de aportaciones
    - Proporciona series de recarga por lluvia a acuíferos (según modelos)
  - Escala temporal configurable (diaria, mensual).
  - Las salidas de las cuencas se pueden acumular en "puntos de desagüe".
  - Posibilidad, para cualquier modelo, de no modelar la parte subterránea y sacar la infiltración por archivo para que sea una entrada de acuífero de Aquatool u otro programa.



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GIS and Aquatool

- Link Aquatool-GIS (optional)
  - Database connection
  - Edit elements data on GIS window
  - View results on GIS window
  - Export results syntesis to GIS format
  - Export results to GIS-WEB support
- Flow model on GIS map (future)

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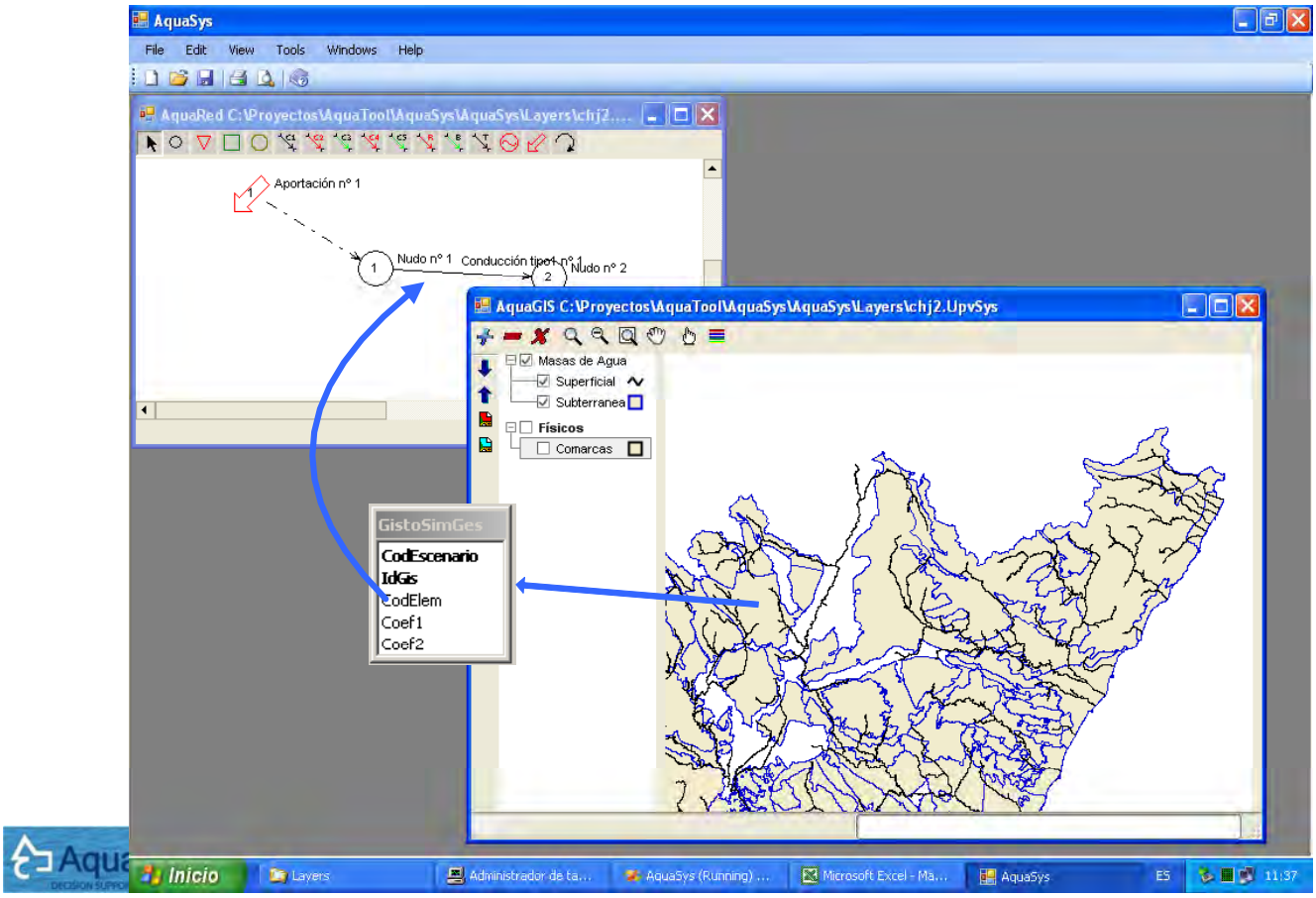
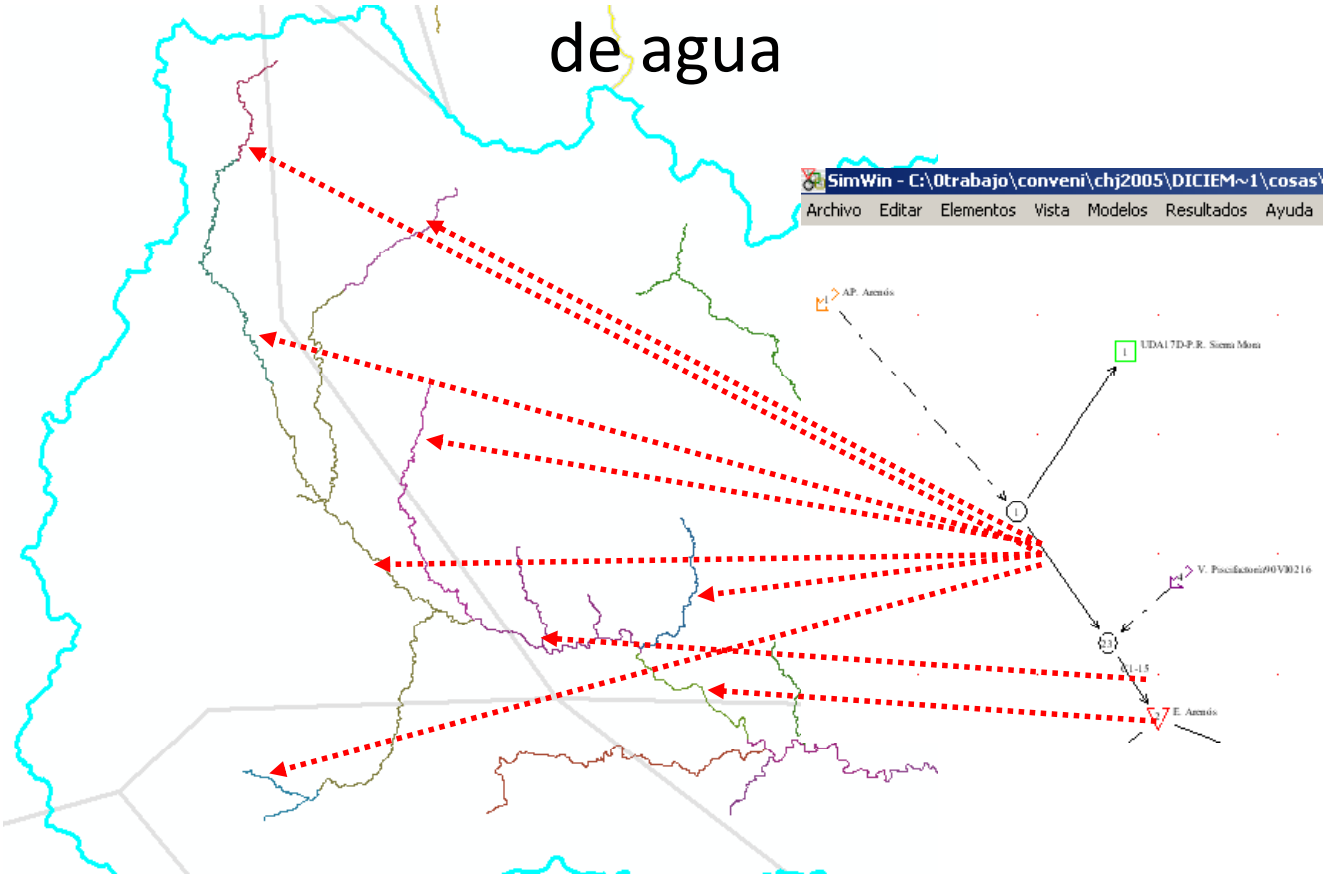
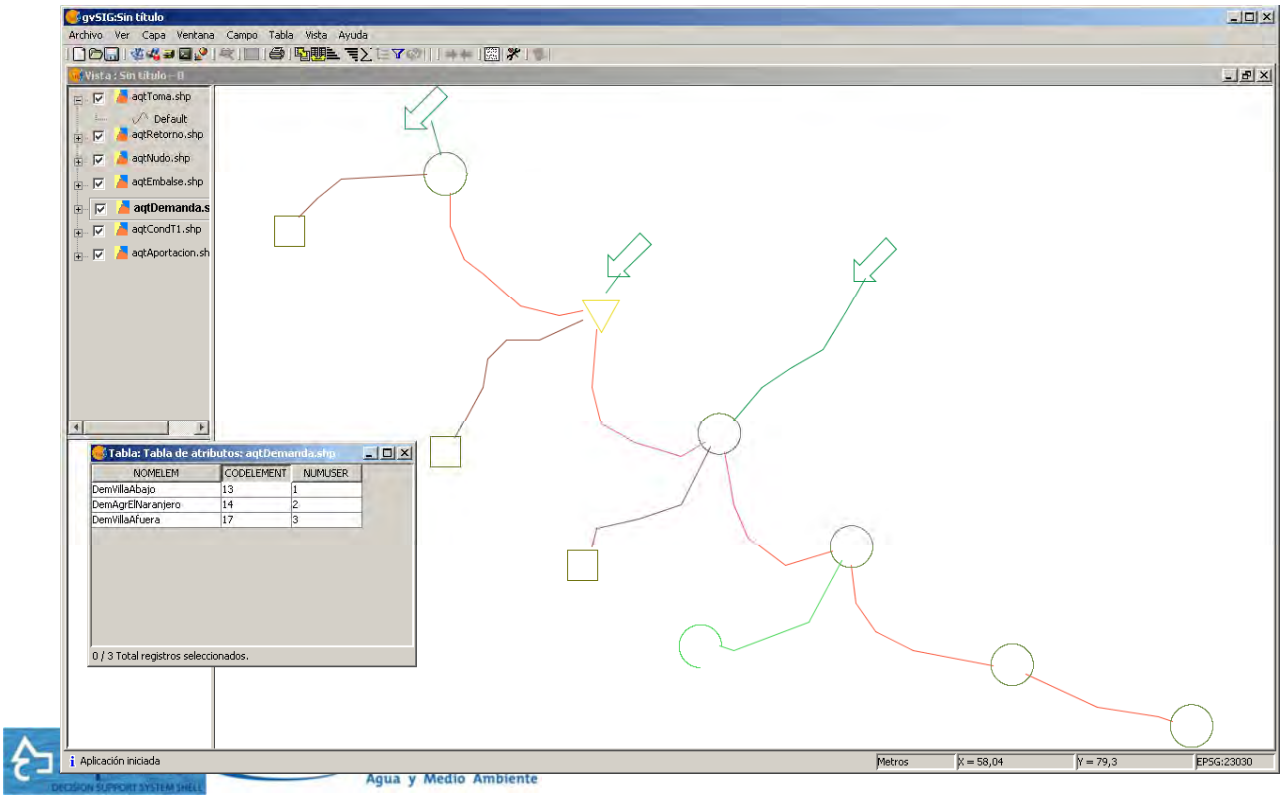
Connect aquatool elements to GIS elements



Extrapolación de resultados a masas de agua



Vista en GIS con tabla de atributos

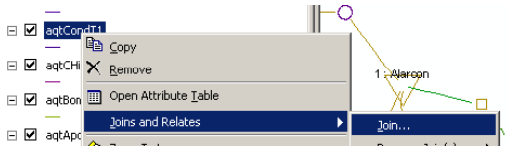


Conectar a base de datos.

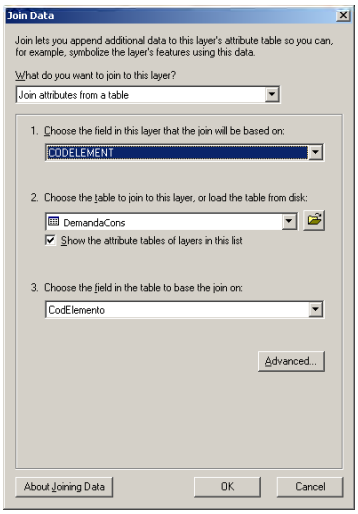
Los visores de GIS ofrecen la posibilidad de vincular una capa de SHP a una tabla de base de datos. Para ello solo hace falta disponer de un campo común.

Para hacerlo en arcview el proceso es el siguiente:

1. Exportar el esquema en forma de un SHP por cada tipo de elemento.
2. Cargar la capa de imagen SHP en arcview (p.e. "aqtdemandas.shp")
3. Hacer una copia del archivo de base de datos del modelo en otro con extensión "mdb"
4. Cargar la tabla de datos en arcview (igual que se cargan las imágenes).
5. Sobre la leyenda de la capa de imagen pedir la opción "join" (btn dcho → "Joins and relates" → "Join …"



6. El menú siguiente pide seleccionar los campos enlazados en ambas capas. Los campos a enlazar son "CODELEMENT" con "CodElemento"



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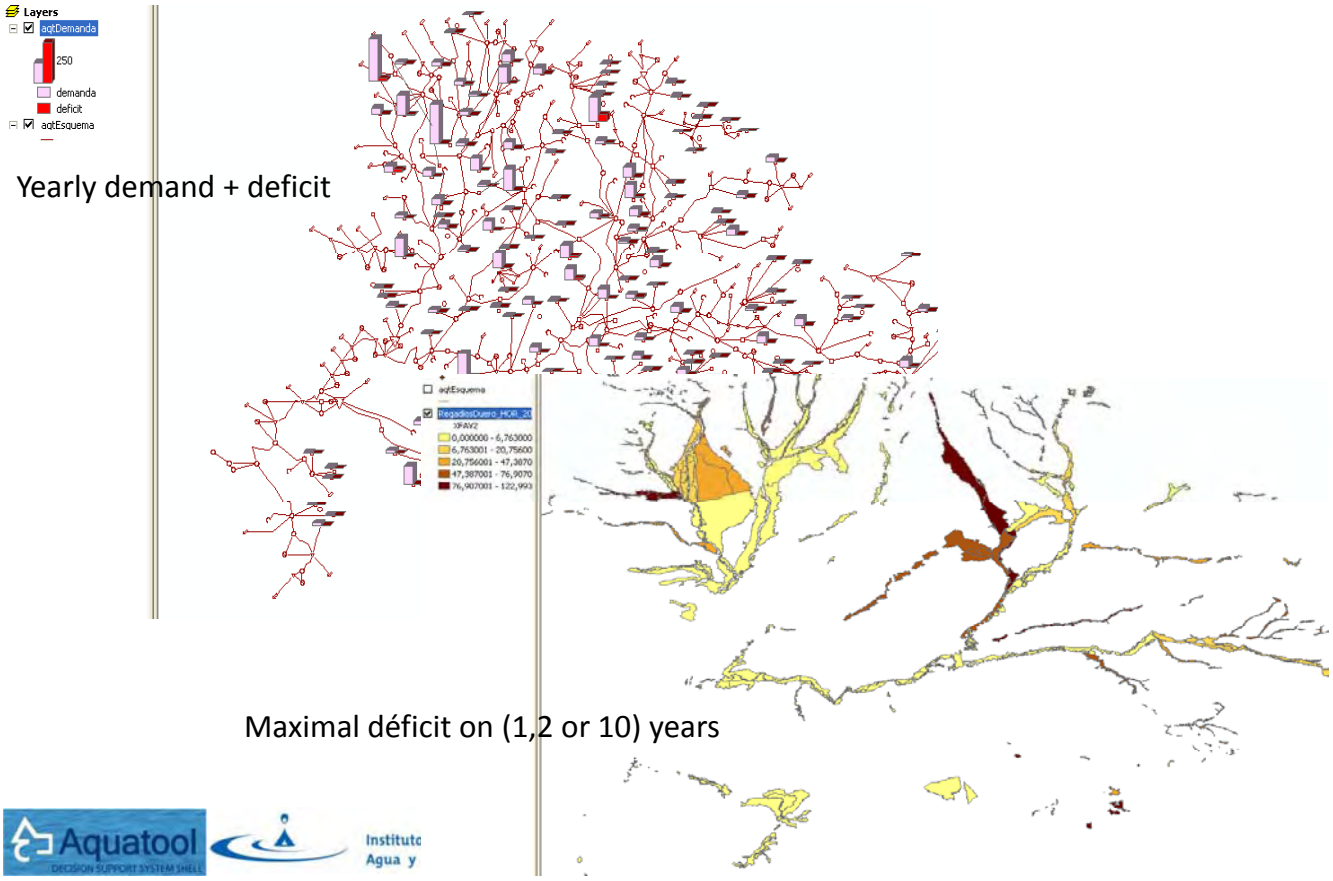
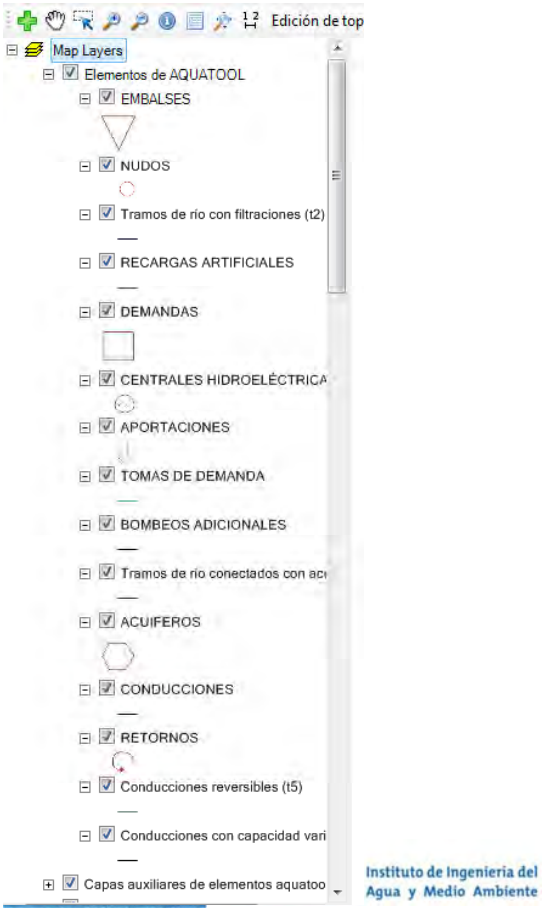
Export and view aquatool's results on GIS



Yearly demand + deficit

Maximal déficit on (1,2 or 10) years

Flow model on GIS map



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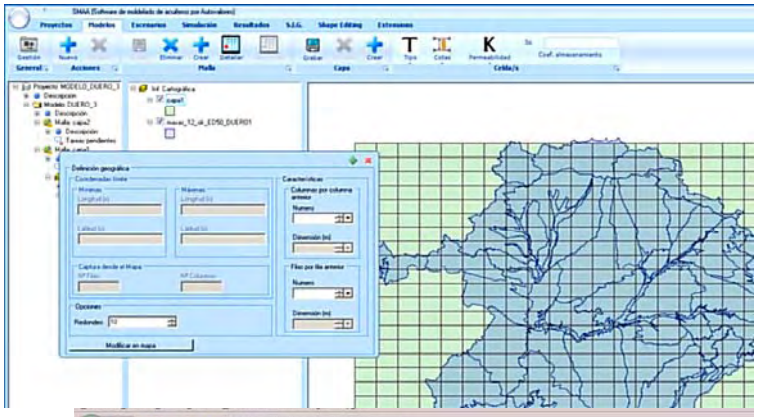
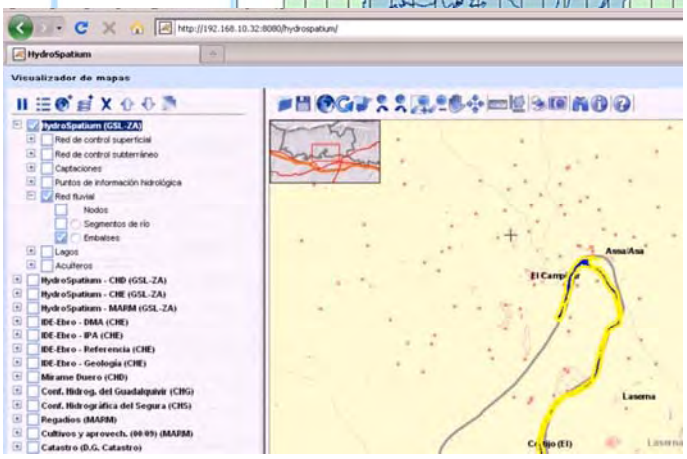
Interaction with software developed by collaboration with other entities

- SMAA
  - Aquatool's aquifer simulation model (aquival) managed on a GIS assisted tool (company: TRAGSATEC)



- HIDROSPATIUM
  - General spatial data infrastructure. It implements data and results of aquatool. (company : Geoslab and ZetaAmaltea)



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Aquatool short history

Modules development	Application
1982 – 90 Simulation module	Duero, Turia, Palancia, Guadalfeo
1987 - 93 Optimization module; groundwater module	Segura; Eugui, Estella y Guindano en Navarra; Iregua en Logroño; Ebro
1992 Graphic interface (simwin, optiwin)	1995-1999 Hydrologic Plans: Júcar, Tajo, Segura, Guadiana, ¿others?; PHN: Spain
1997 Risk analisis modules (simrisk, mashwin, …)	Jucar, Tajo, Segura
2000-… Water quality simulation module (gescal)	Water Framework Directive: Jucar Pilot basin; Duero; Segura; …
	Some European and American basins (research works)
2006- … New graphic interface	Hidrologic Plans: all spanis basins (simges and gescal)
2010-... Habitat simulation module (Caudeco)	Júcar, Duero

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