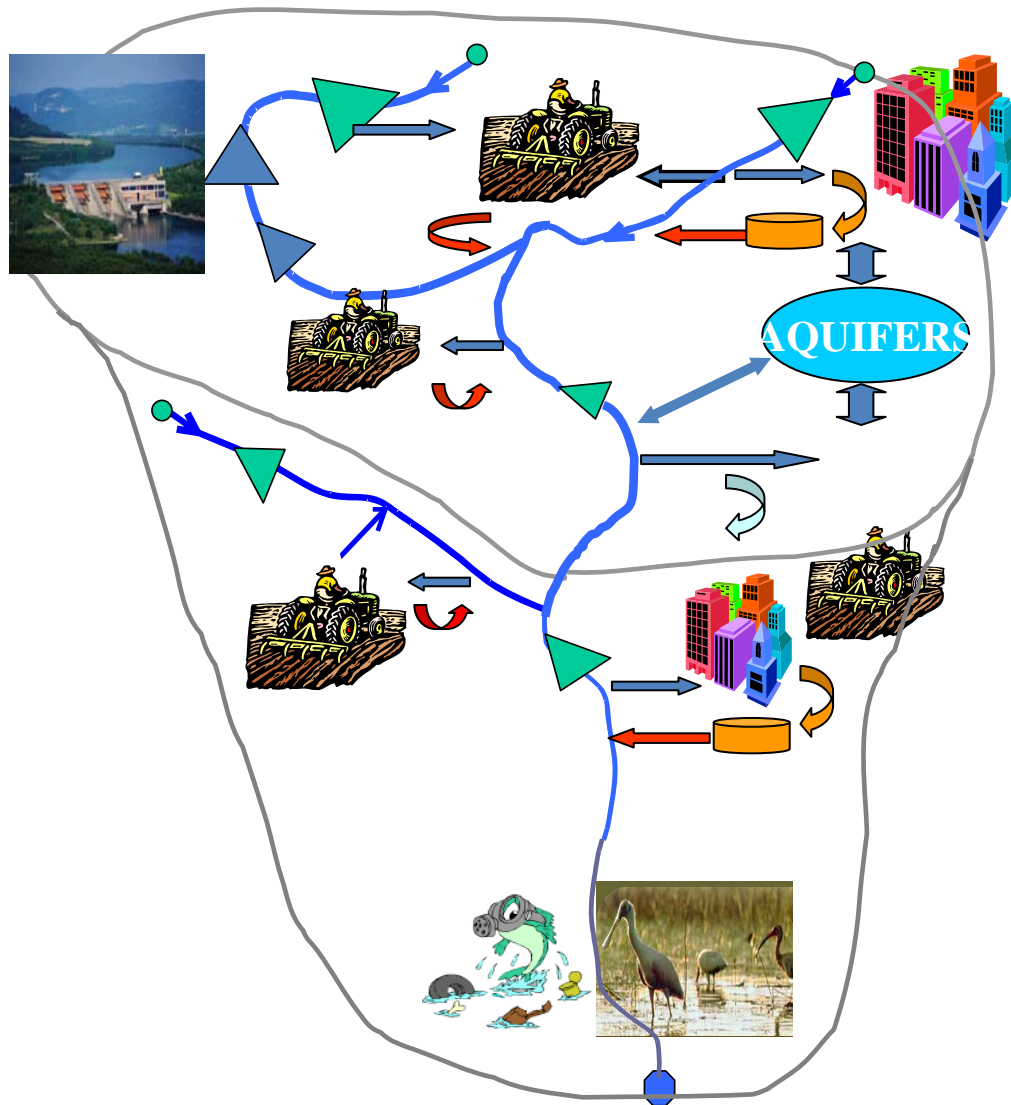# TECHNICAL OVERVIEW OF AQUATOOL

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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**

AQUIFERS

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
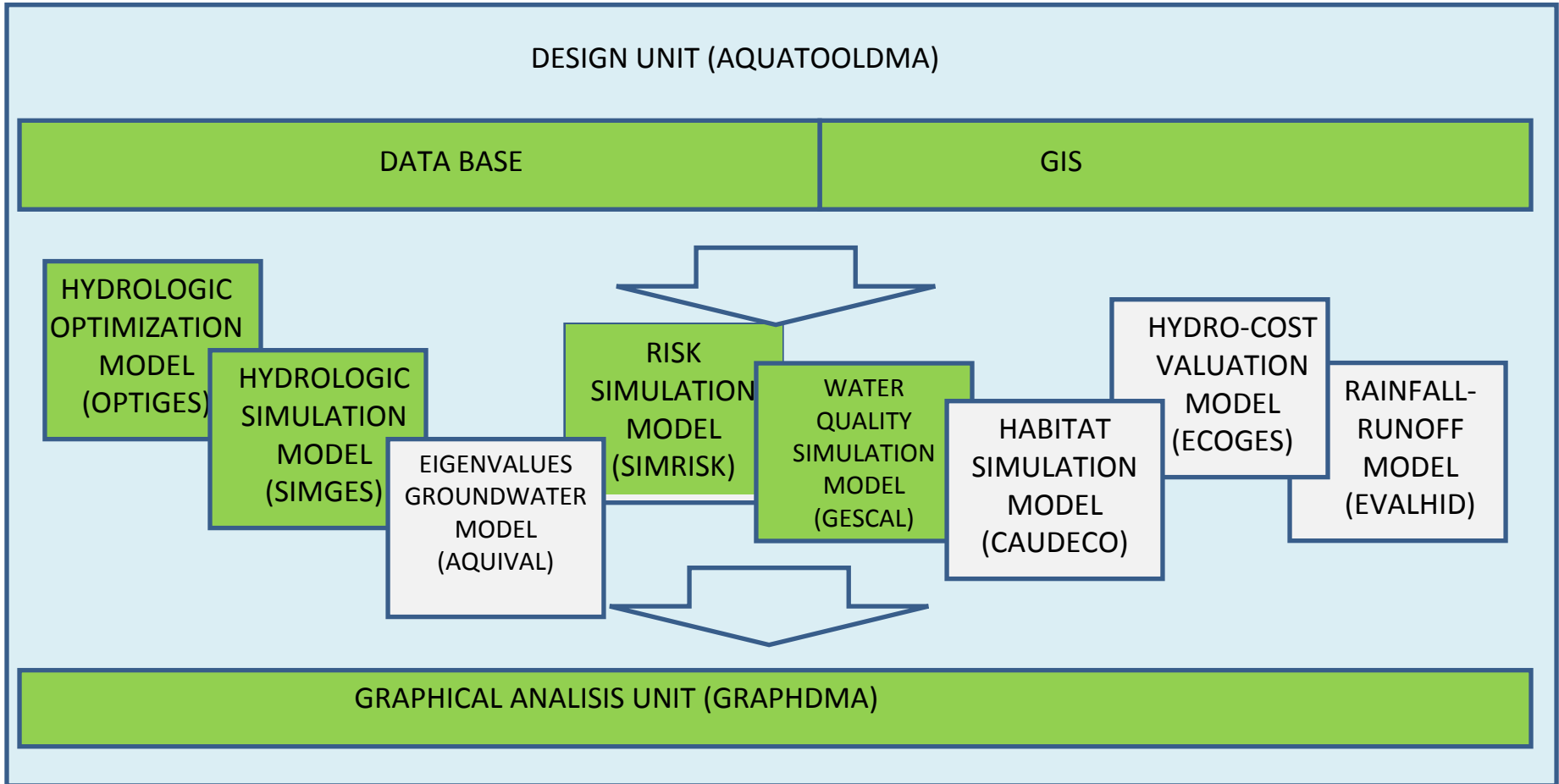
The DSS allows the user to:

➢ 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**.
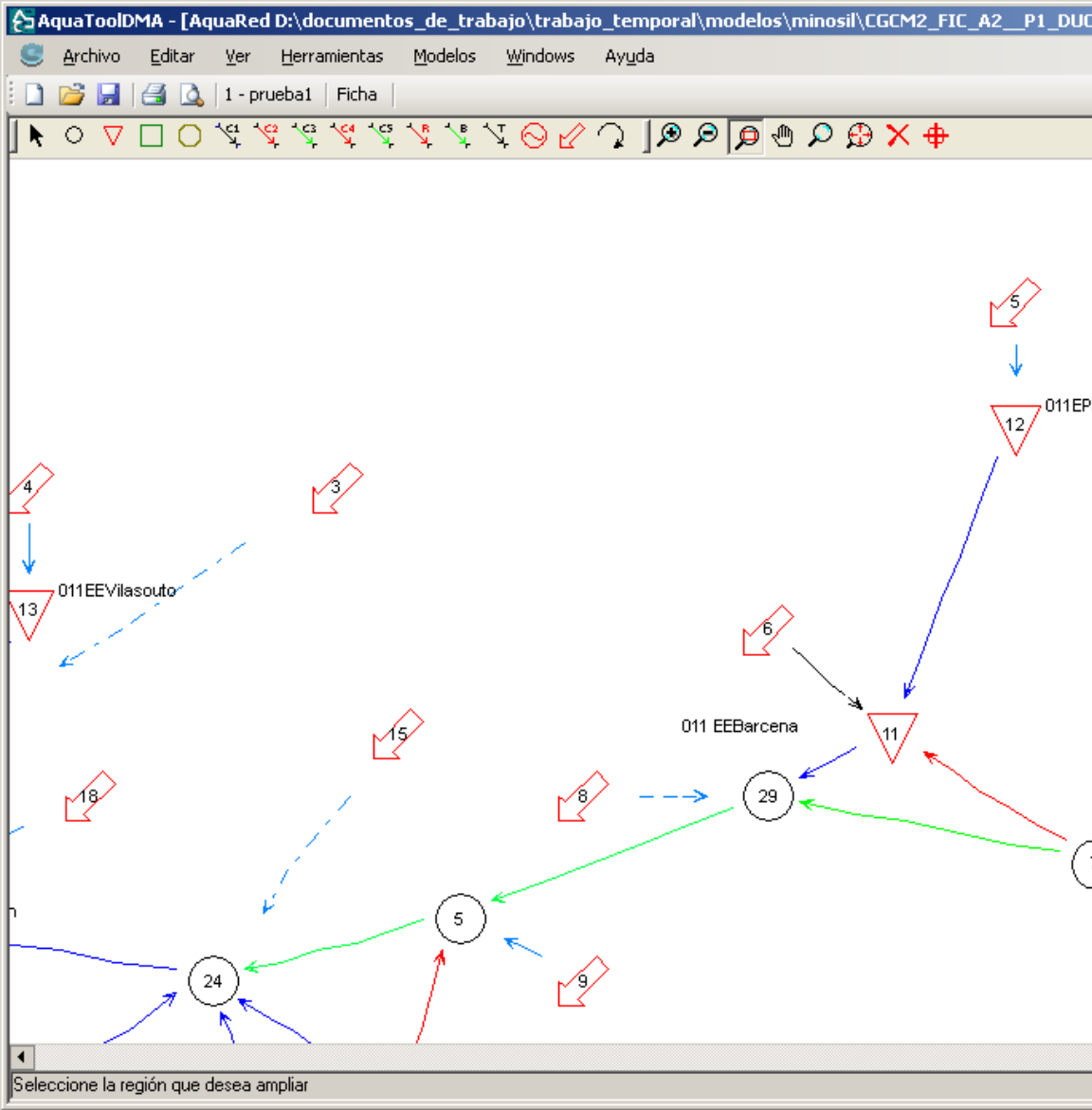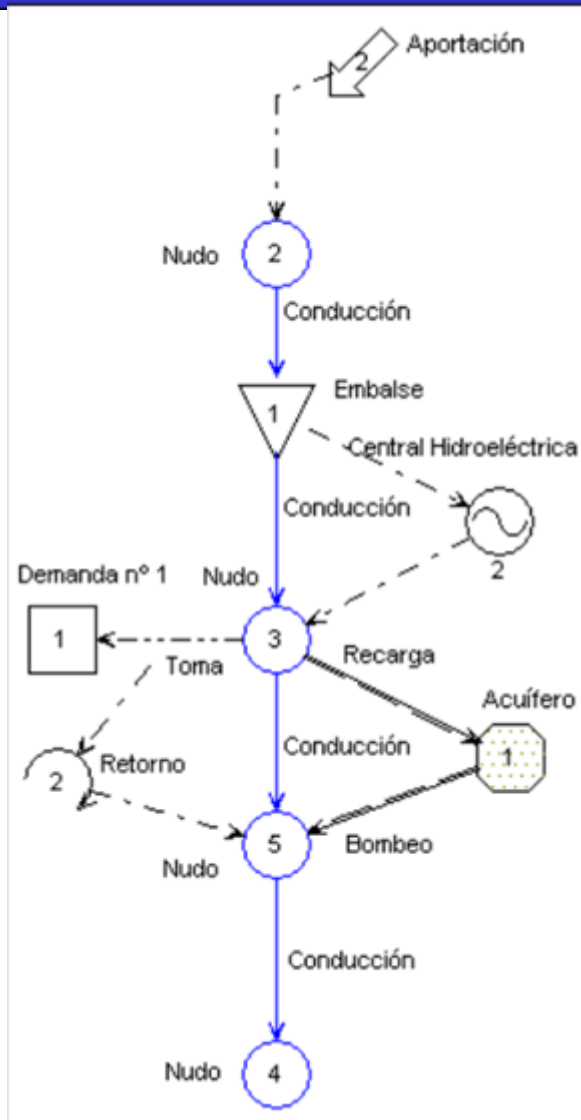
Aquatool structure

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

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

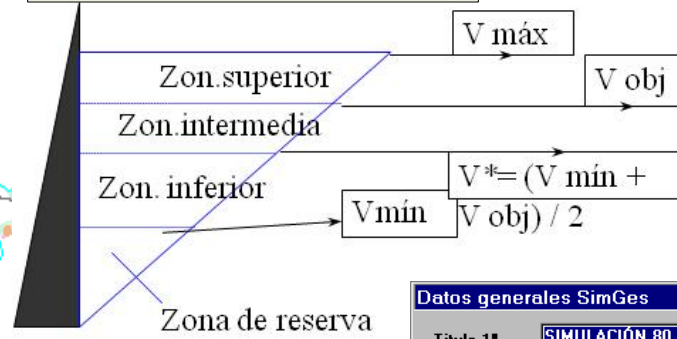# SIMGES & OPTIGES: WATER MANAGEMENT SIMULATION AND OPTIMIZATION

for given hydrologic inflows scenarios

$$V_t = V_{t-1} + I_t - O_t - f_t - e_t$$

V máx

Zon.superior

V obj

Zon.intermedia

Zon. inferior

$V^* = (V \ mín + $

V mín

$V \ obj) / 2$

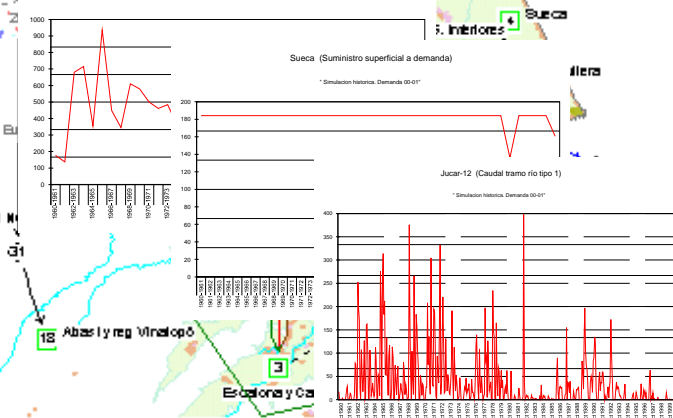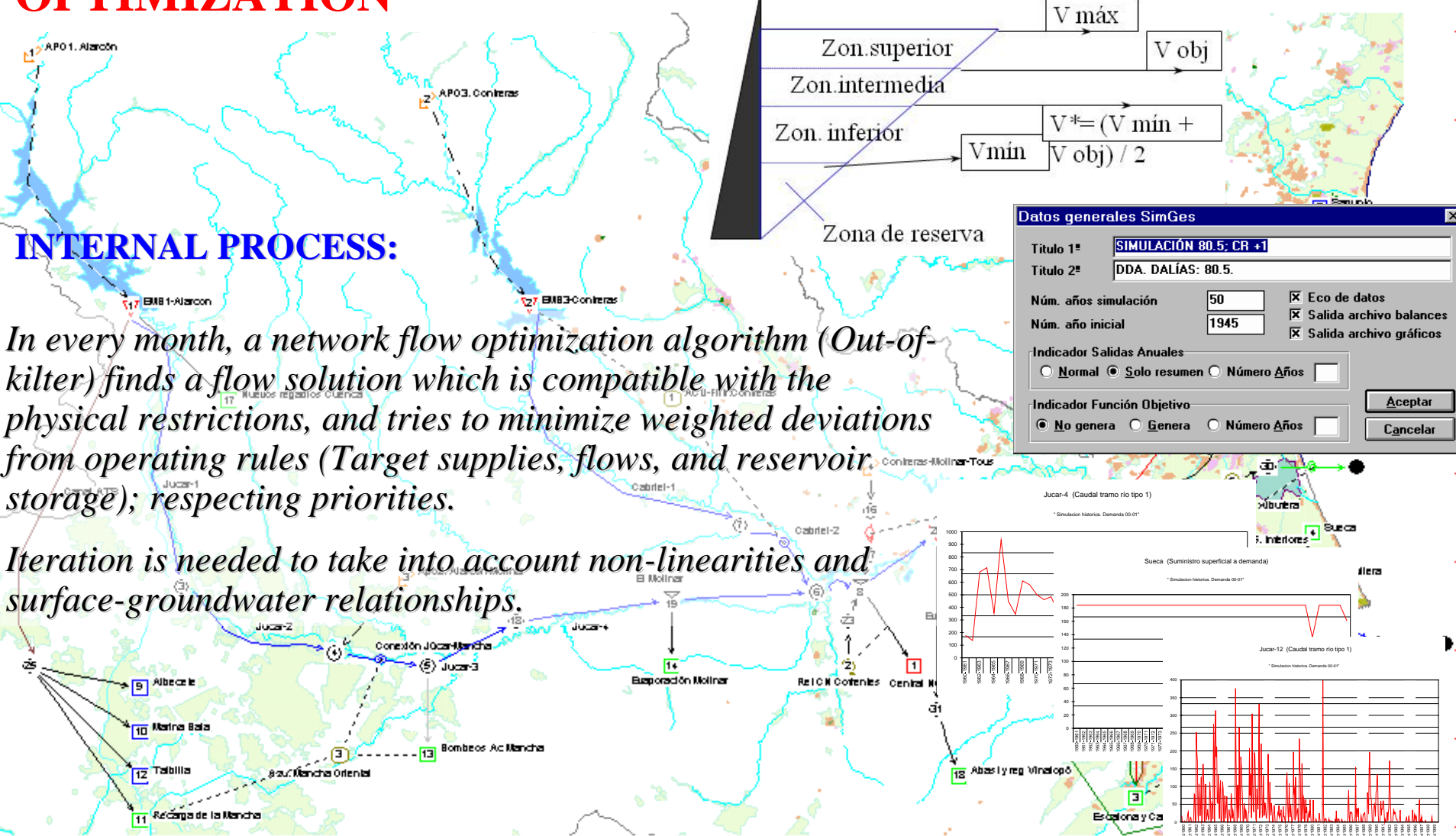Zona de reserva

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.

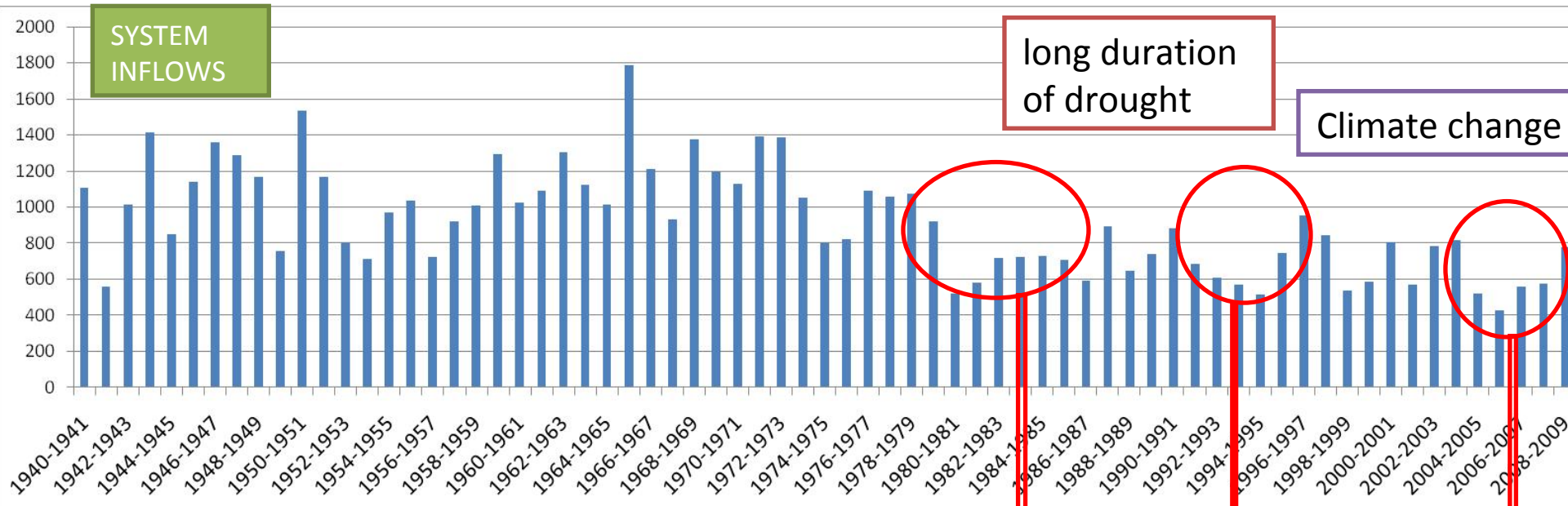*Iteration is needed to take into account non-linearities and surface-groundwater relationships.*

Datos generales SimGes

Título 1ª	SIMULACIÓN 80.5; CR +1
Título 2ª	DDA. DALÍAS: 80.5.

Núm. años simulación 50
Núm. año inicial 1945

[X] Eco de datos
[X] Salida archivo balances
[X] Salida archivo gráficos

Indicador Salidas Anuales
( ) Normal (•) Solo resumen ( ) Número Años [ ]

Indicador Función Objetivo
(•) No genera ( ) Genera ( ) Número Años [ ]

Aceptar
Cancelar

Analisis of management of drouht problems

SYSTEM INFLOWS

long duration of drought

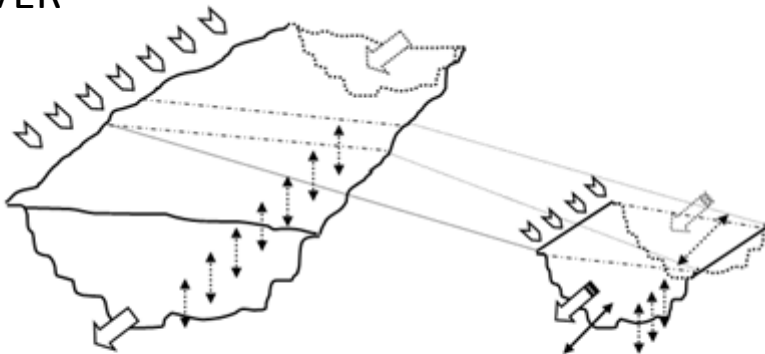Climate change

REGULATION IN RESERVOIR

Operation rules are needed to reduce impact of drought
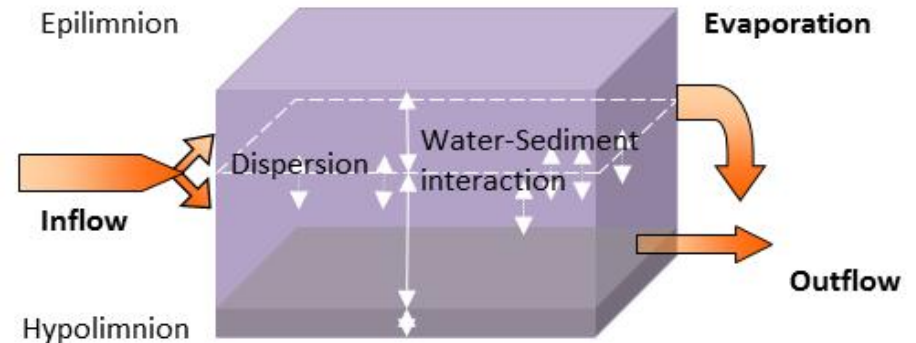
WATER QUALITY SIMULATION MODULE

Water quality model coupled with a simulation model..

➢ SIMULATES W.Q. FOR THE ENTIRE SYSTEM

➢ Mechanicistic model for rivers and reservoirs.

➢ Conventional constituents.

- o Temperature
- o Arbitrary constituents
- o DO + OM

- o Nitrogen cycle
- o Eutrophication problem.
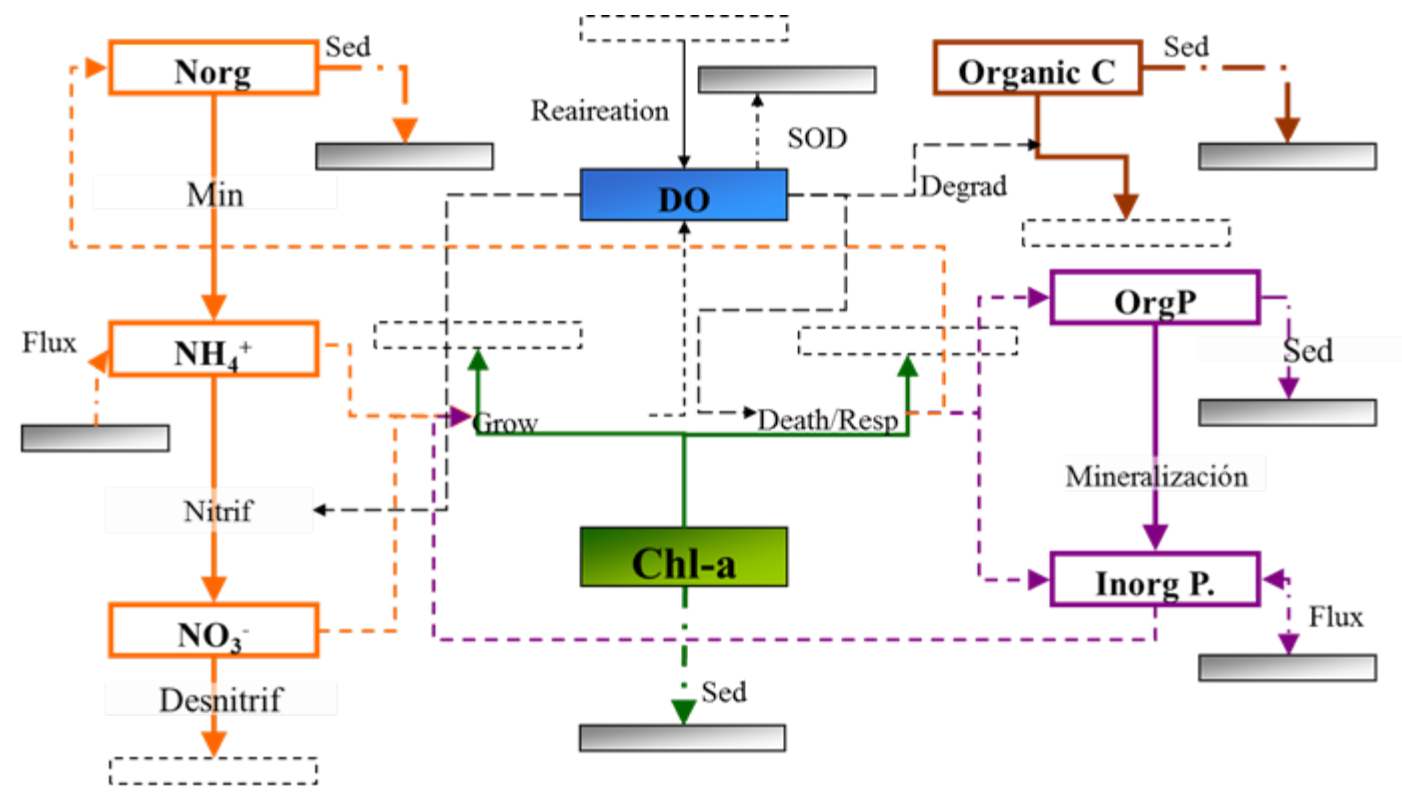
RIVER

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
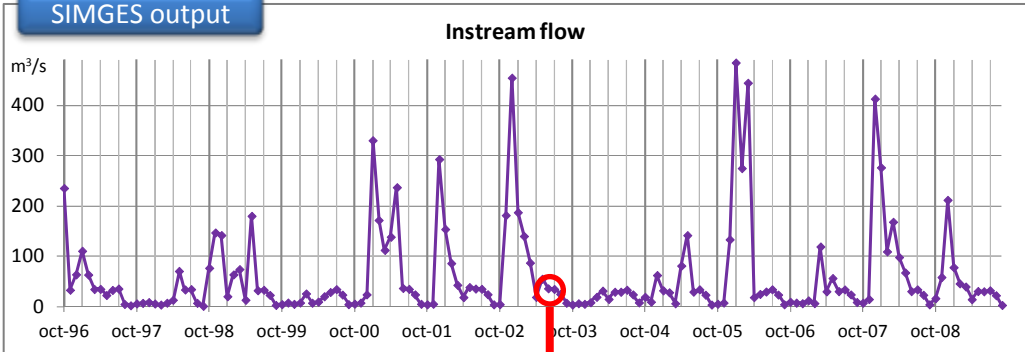
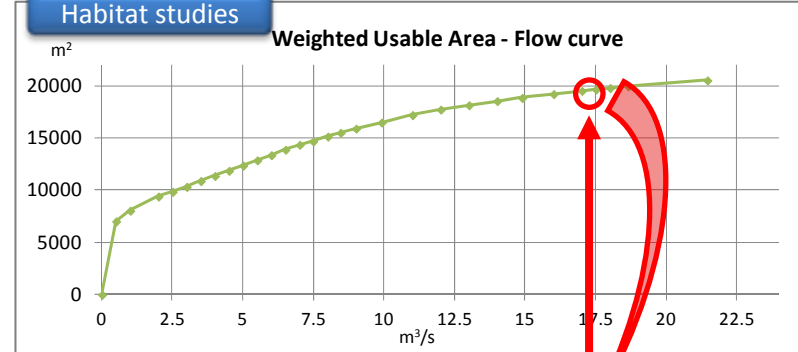# CAUDECO: waited habitat on management alternatives

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

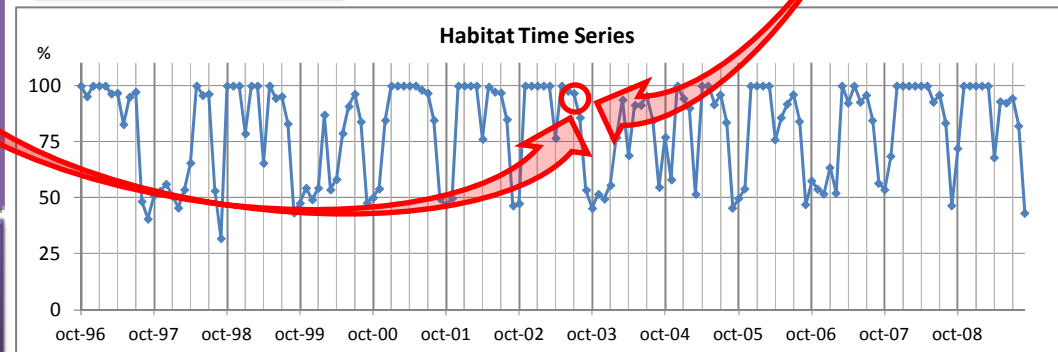### CAUDECO inputs

SIMGES output

Instream flow

Habitat studies

Weighted Usable Area - Flow curve

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

Habitat Time Series

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

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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Other mediterranean basins

Neretva

Cuencas internas de Cataluña

Tajo

Júcar

Flumendosa - campidano

Segura

Adra

Salso-Simeto

Southern Conveyor Project

Muluya

Usuarios
agencias públicas

- Agencia Andaluza del Agua
- Agencia Catalana del Agua
- Aguas de barcelona
- Canal de Isabel II
- Centro de Estudios Hidrográficos del CEDEX
- Confederación hidrográfica del del Cantábrico
- Confederación hidrográfica del Duero
- Confederacion hidrografica del Ebro
- Confederación hidrográfica del Guadalquivir
- Confederación Hidrográfica del Guadiana
- Confederación Hidrográfica del Júcar

- Confederación hidrográfica del Miño-Sil
- Confederacion hidrografica del Segura
- Confederacion hidrografica del Tajo
- Diputación de Alicante
- Ens d'Abastament d'aiga- A.T.Ll.
- Instituto Geologico y Minero (ITGME)

- Agence de bassin du Cheriff Zharez (Argelia)
- Agencia de riegos de Medoza (Argentina)
- Organismo binacional gestión cuencas lago Titicaca (Peru, Bolivia)
- organo de gestión del sistema Lerma-Chapala (Mexico)
- Public Company for Water area of the Adriatic Sea Catchements (Bosnia)

Usuarios

Empresas

- AQUAPLAN
- AYESA
- BS Ingenieria
- CETAQUA
- EPTISA
- ESTRAINSA
- Hermanos garrote
- IBERHIDRA S.L.
- INITEC
- INITEC-INFRAESTRUCTURAS
- INTECSA-INARSA
- INYPSA
- PROINTEC
- CYGSA (antes SEGURPRESA)
- SENER INGENIERIA Y SISTEMAS
- TRAGSATEC SA
- TYPSA - TECNOMA
- FULCRUM

Instit. de investigación

- Universidad de Zaragoza
- Instituto Aragonés del Agua
- ETSI Agronomos de Cordoba
- Univ. de Avila.
- Universidad de Granada
- Universidad de la coruña
- Universidad de Madrid
- Universidad de Zaragoza
- Instituto Mexicano de tecnologías del agua (Mexico)
- Universidad De Chapingo (Mexico)
- Universidad Michoacana de SNH (Mexico)
- Univ.Católica de Chile (Chile)
- Universidade Do Porto (Portugal)
- University Basilicata (Italia)

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THANK YOU VERY MUCH