

SAID integrated web application for easier dam operation

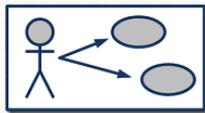
Sergio Romero
October 19 2016, Lourdes (France)



Integration dimensions

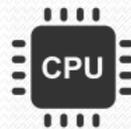
Integration scenarios

Identification of new scenarios, DSS interactions and constraints aimed at efficient river basin exploitation



Computational cores

Technological support for the coordination and communication of the computational cores of different DSSs



Data management

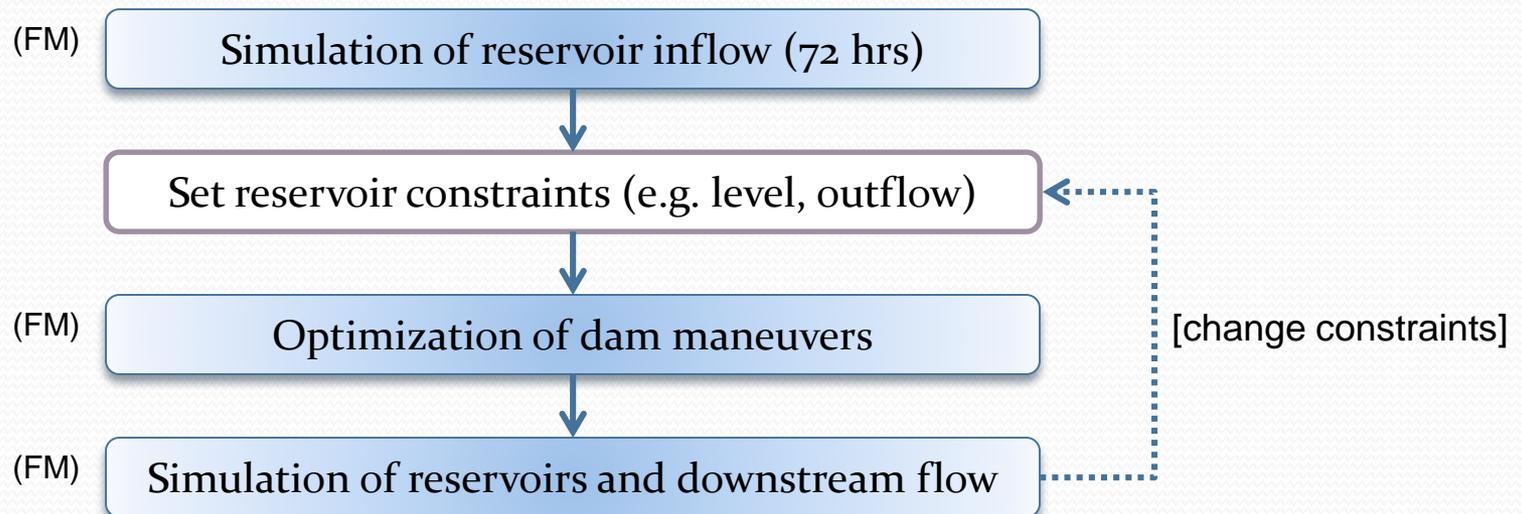
Repository of data series obtained from external systems, typically in different representation formats



Graphical user interface

Unified interface oriented to final users for the definition of scenario parameters and analysis of results

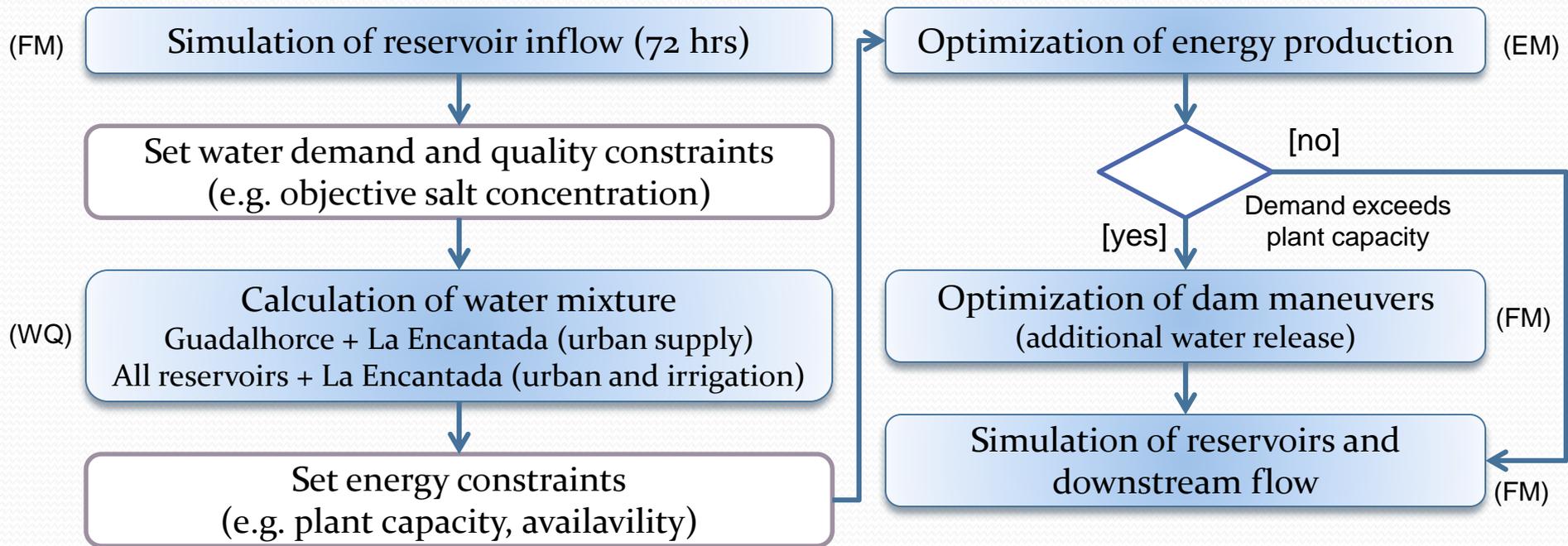
Integration scenario: Flood



NOTES

- Guadalhorce & Guadalteba modeled as one single reservoir
- Water quality and energy concerns not considered
- Results include the dynamic state of dam elements (outlets, spillways, ...)

Integration scenario: Ordinary



NOTES

- Objective salt concentration below 6 g/L (urban) and 0.8 g/L (urban+irrigation)
- WQ-DSS provides daily results and EM-DSS produces detailed hydrographs



Technological requirements

- **Distributed computing:** DSSs and peer applications running on different computers and networks require communication
- **Application heterogeneity:** windows-linux OSs, java-.net languages, web-desktop applications, consumer-producer patterns
- **Extensibility:** new DSSs could be added to the framework or the entire solution migrated to a different river basin
- **Real-time execution:** applications should react and produce results as soon as new input data are available (e.g. river flood)
- **Feasibility:** Moderate efforts to incorporate integration technology into existing DSSs (project deadlines)

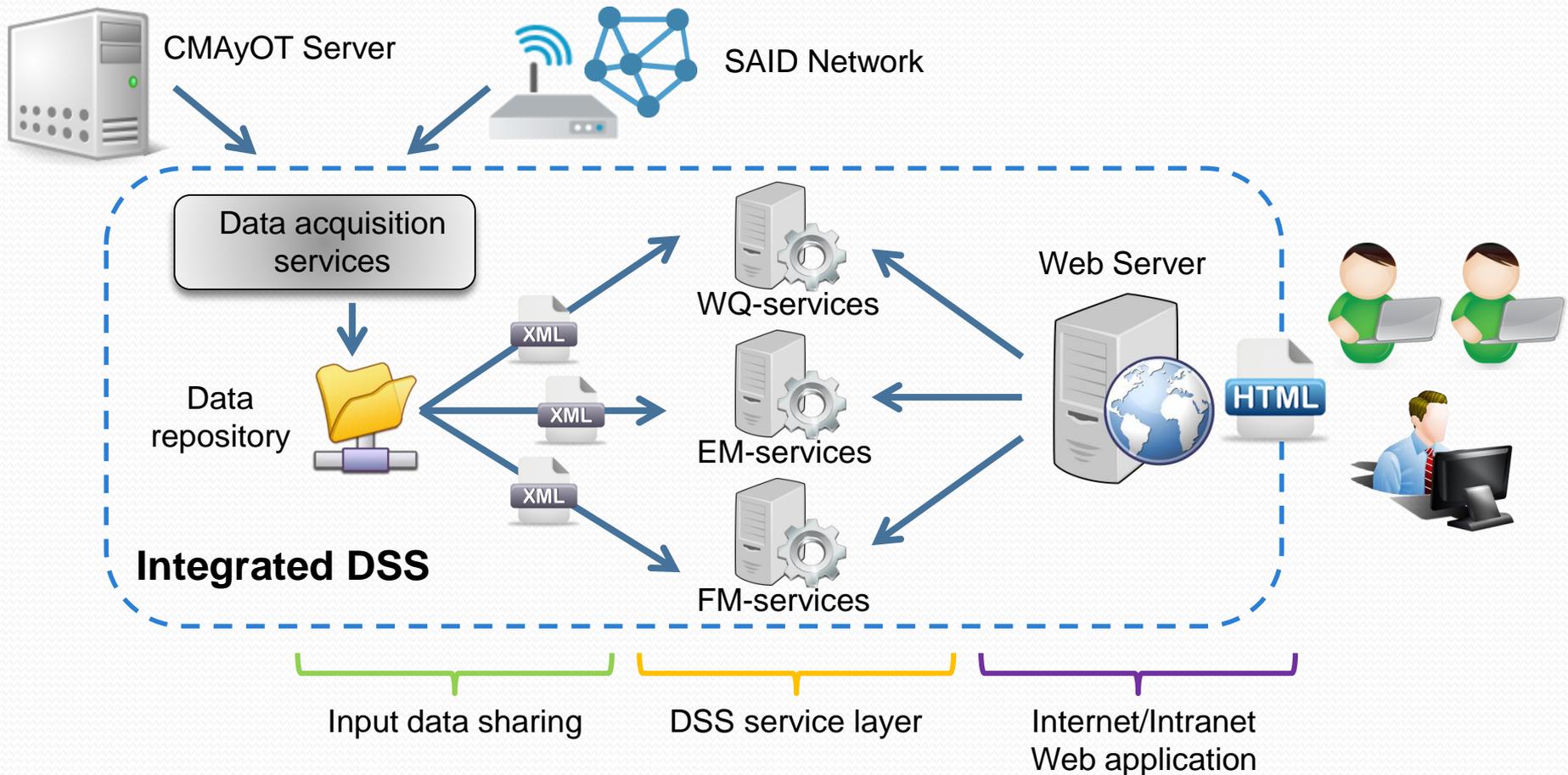
Service orientation

- SAID DSSs provide integration functionality by means of simulation, configuration and data query **machine-to-machine services**

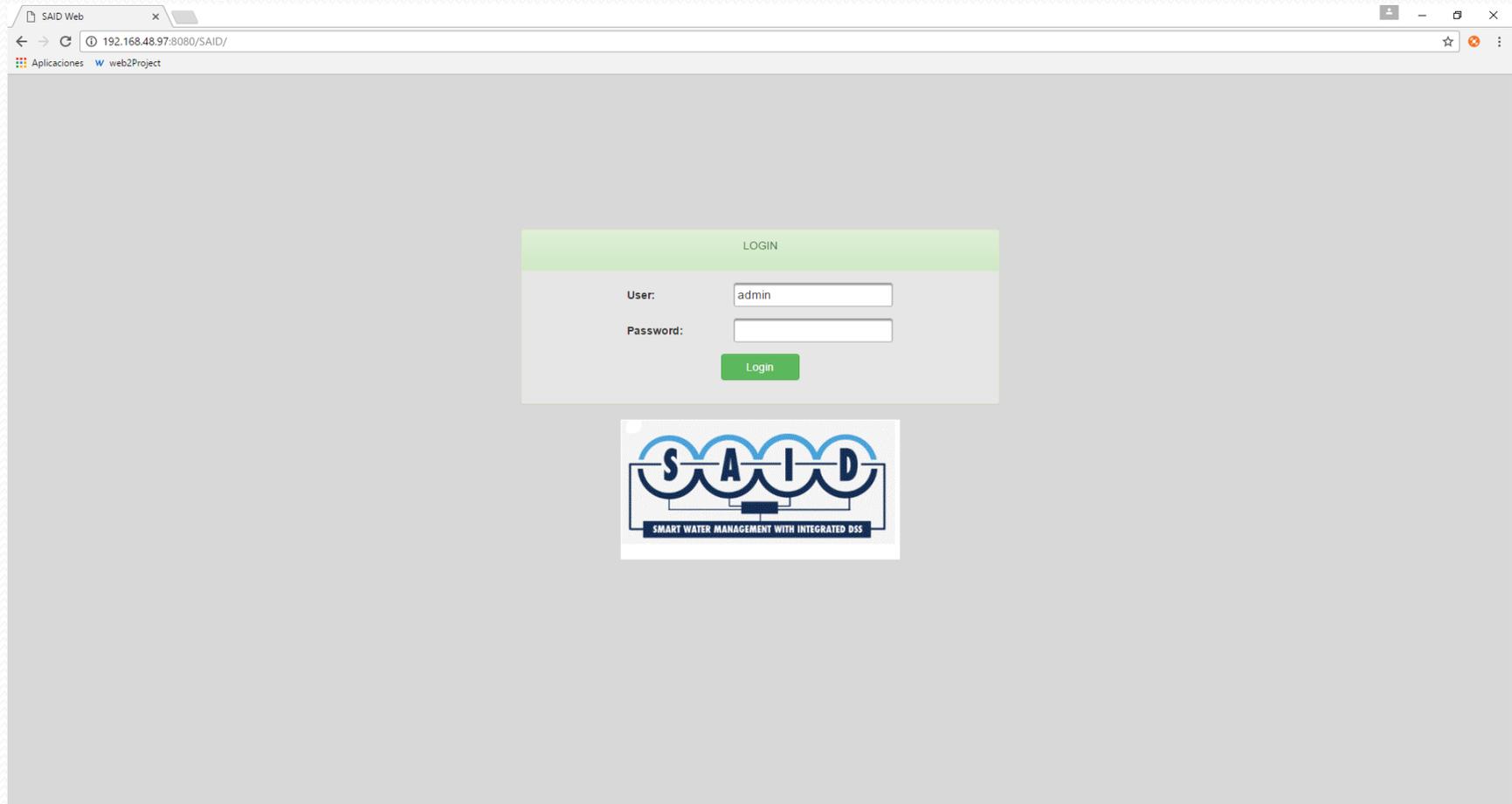
DSS	Description	Input	Output
<i>FM-DSS</i> <i>Hydroview</i>	<i>Run forecast simulation</i>	<ul style="list-style-type: none"> Time period Reservoir outflow 	<ul style="list-style-type: none"> Reservoir volume and inflow Water flow and level at control points Resultant flood plain
<i>FM-DSS</i> <i>BeDam</i>	<i>Synthesis of maneuvers</i>	<ul style="list-style-type: none"> Reservoir inflow Optimization mode Constraints 	<ul style="list-style-type: none"> Reservoir volume Outlet and spillway opening degree Total outflow of each reservoir
<i>WQ-DSS</i>	<i>Water mixture calculation</i>	<ul style="list-style-type: none"> Water demand Salt concentration Reservoir balance 	<ul style="list-style-type: none"> Composition of water mixture
<i>EM-DSS</i> <i>ELD</i>	<i>Power plant optimization</i>	<ul style="list-style-type: none"> Plant capacity Service time Released volume 	<ul style="list-style-type: none"> Optimal power plant hydrograph Energy production Total profit



Integrated DSS architecture



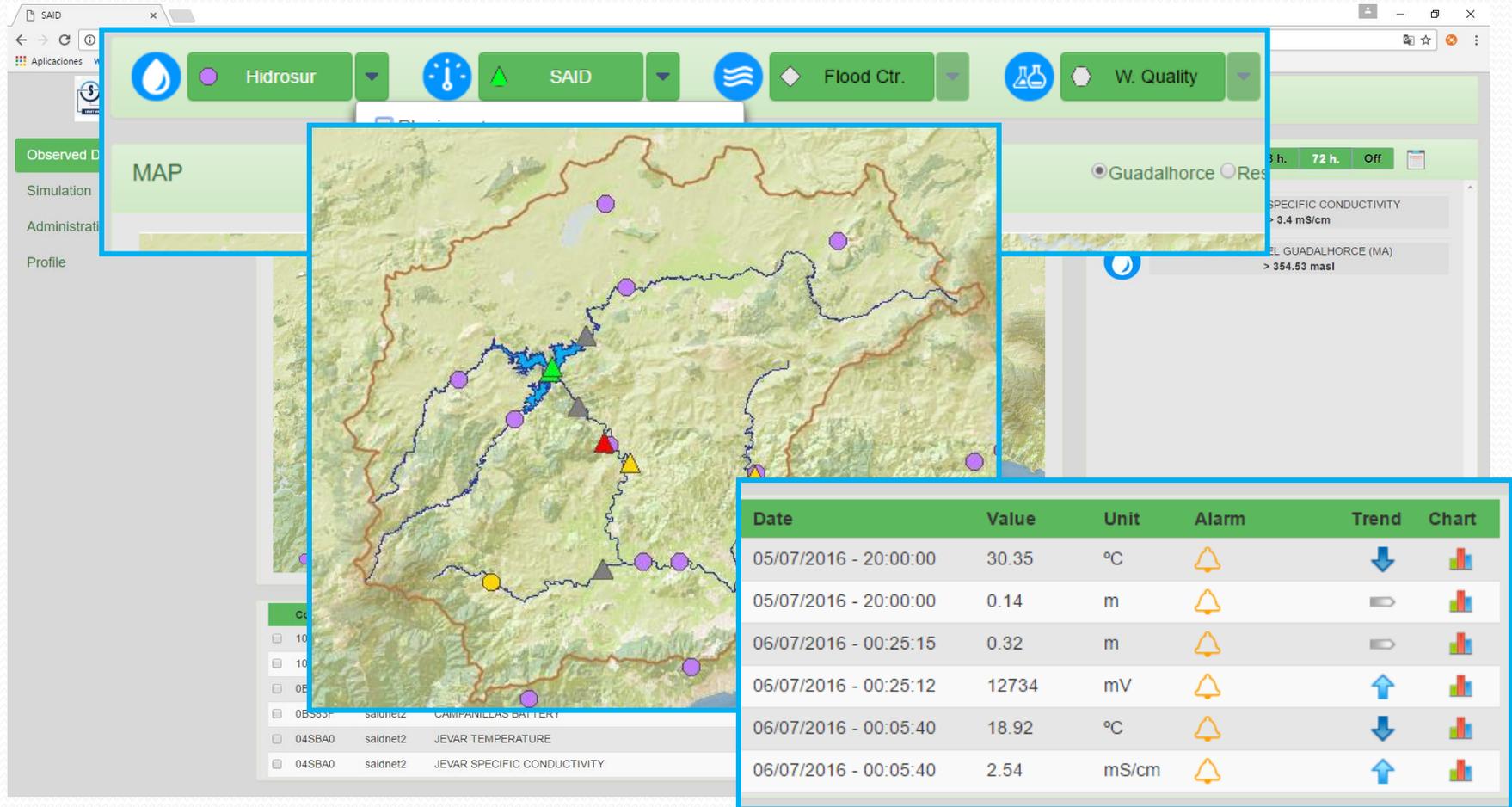
Integrated DSS: web interface



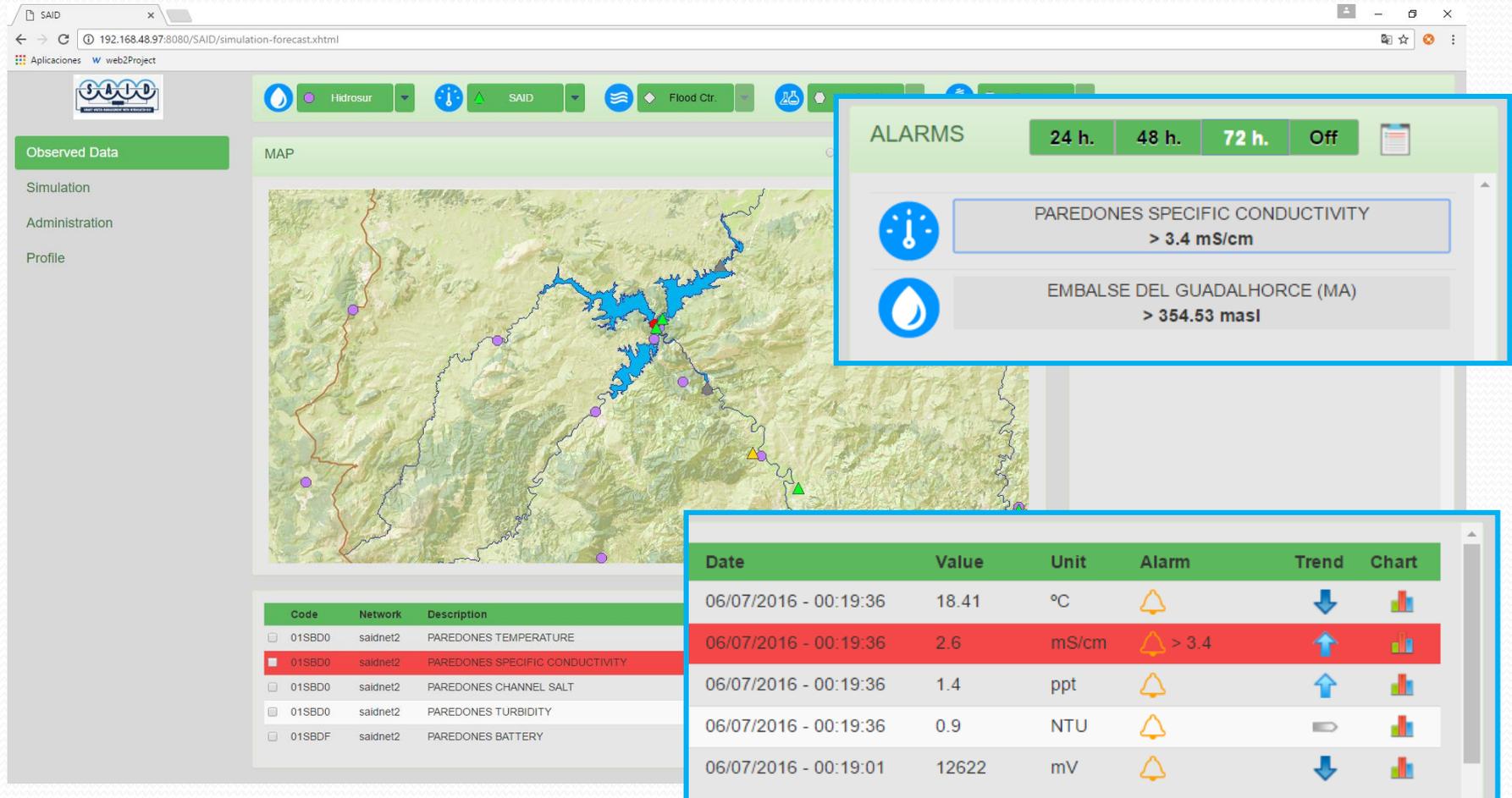
Tool for observed data



Observed data: networks



Observed data: alarms



The screenshot shows the SAID web interface. The browser address bar displays '192.168.48.97:8080/SAID/simulation-forecast.xhtml'. The interface includes a navigation menu on the left with 'Observed Data' selected. The main area shows a map of a water network with several monitoring points. A popup window titled 'ALARMS' is overlaid on the map, showing two active alarms:

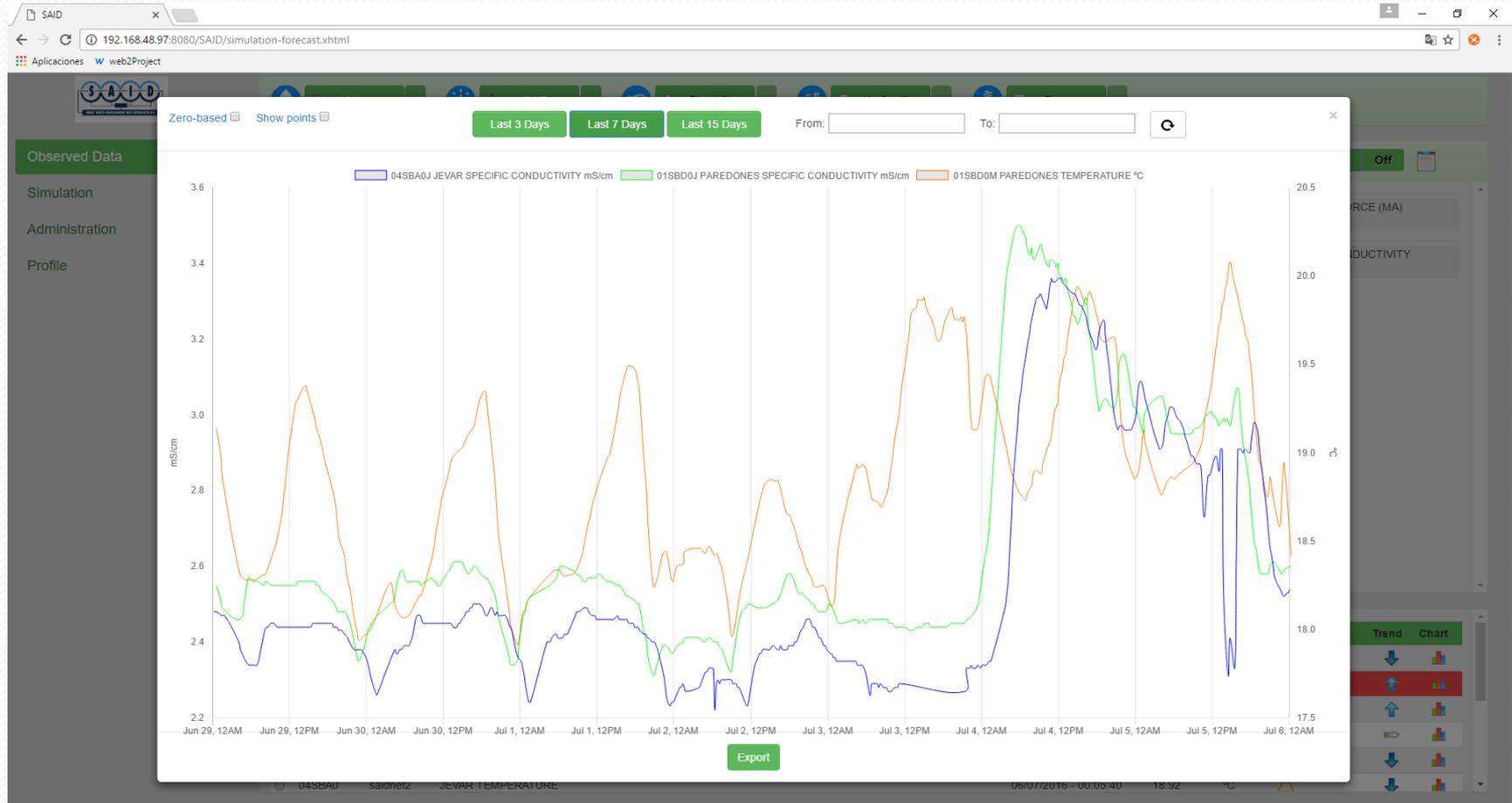
- PAREONES SPECIFIC CONDUCTIVITY > 3.4 mS/cm
- EMBALSE DEL GUADALHORCE (MA) > 354.53 masl

Below the map, a table lists the observed data for various monitoring points. The table has columns for Code, Network, Description, Date, Value, Unit, Alarm, Trend, and Chart.

Code	Network	Description	Date	Value	Unit	Alarm	Trend	Chart
<input type="checkbox"/>	01SBD0	saidnet2 PAREONES TEMPERATURE	06/07/2016 - 00:19:36	18.41	°C			
<input checked="" type="checkbox"/>	01SBD0	saidnet2 PAREONES SPECIFIC CONDUCTIVITY	06/07/2016 - 00:19:36	2.6	mS/cm			
<input type="checkbox"/>	01SBD0	saidnet2 PAREONES CHANNEL SALT	06/07/2016 - 00:19:36	1.4	ppt			
<input type="checkbox"/>	01SBD0	saidnet2 PAREONES TURBIDITY	06/07/2016 - 00:19:36	0.9	NTU			
<input type="checkbox"/>	01SBD0	saidnet2 PAREONES BATTERY	06/07/2016 - 00:19:01	12622	mV			



Observed data: graphs

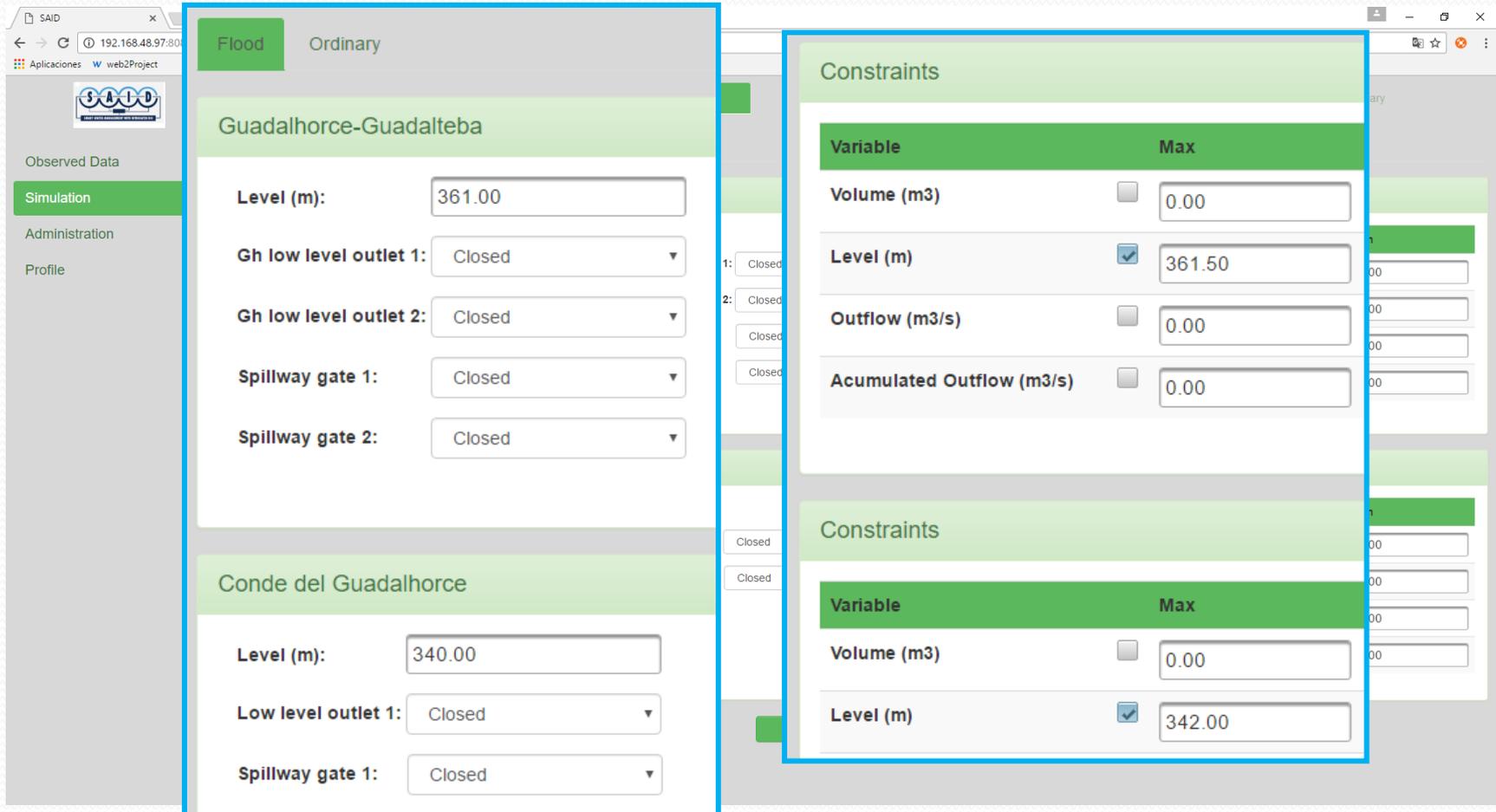


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Flood scenario simulation



Flood mode: constraints



Guadalhorce-Guadalteba

Level (m): 361.00

Gh low level outlet 1: Closed

Gh low level outlet 2: Closed

Spillway gate 1: Closed

Spillway gate 2: Closed

Conde del Guadalhorce

Level (m): 340.00

Low level outlet 1: Closed

Spillway gate 1: Closed

Constraints

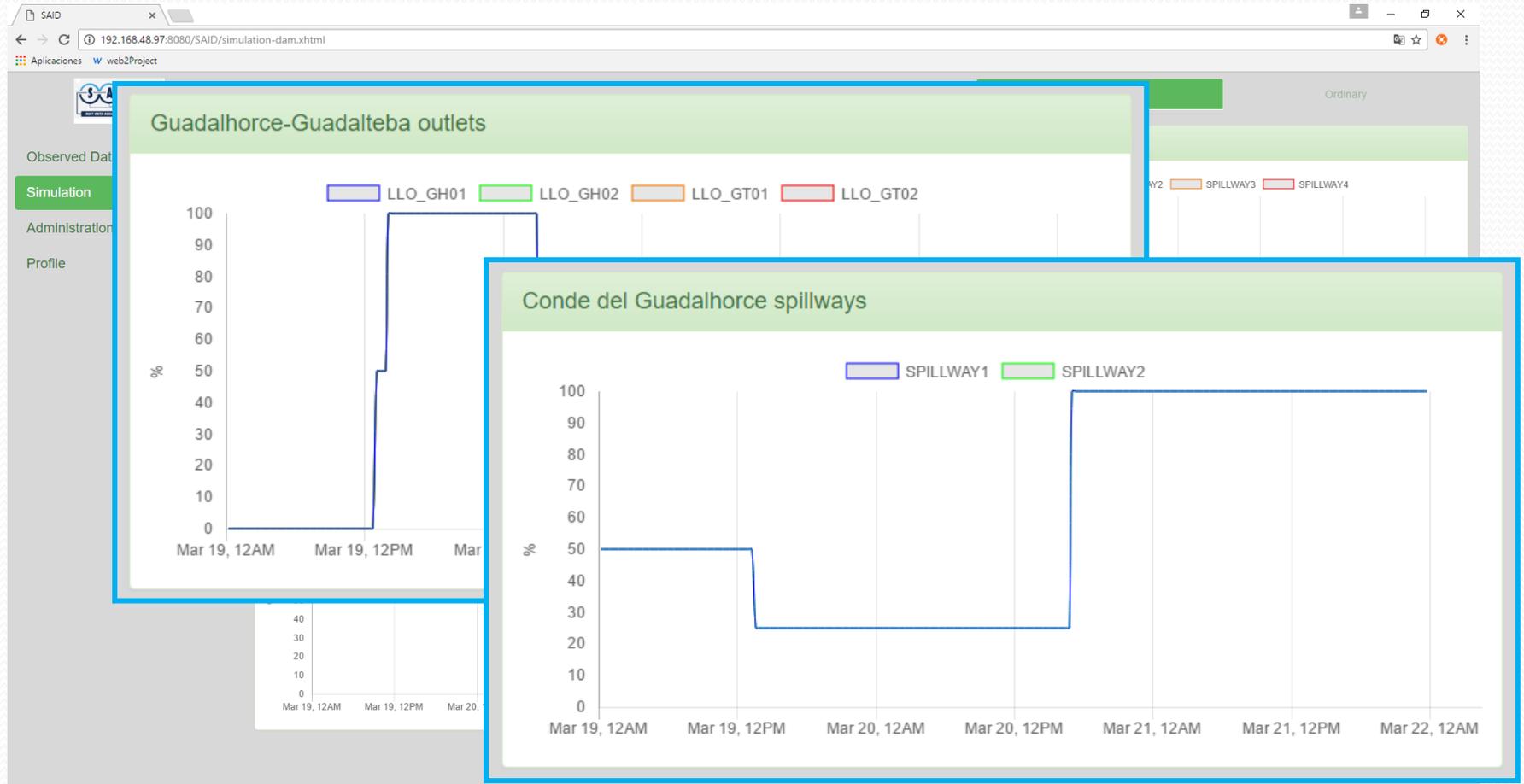
Variable	Max
Volume (m3)	0.00
Level (m)	361.50
Outflow (m3/s)	0.00
Acumulated Outflow (m3/s)	0.00

Constraints

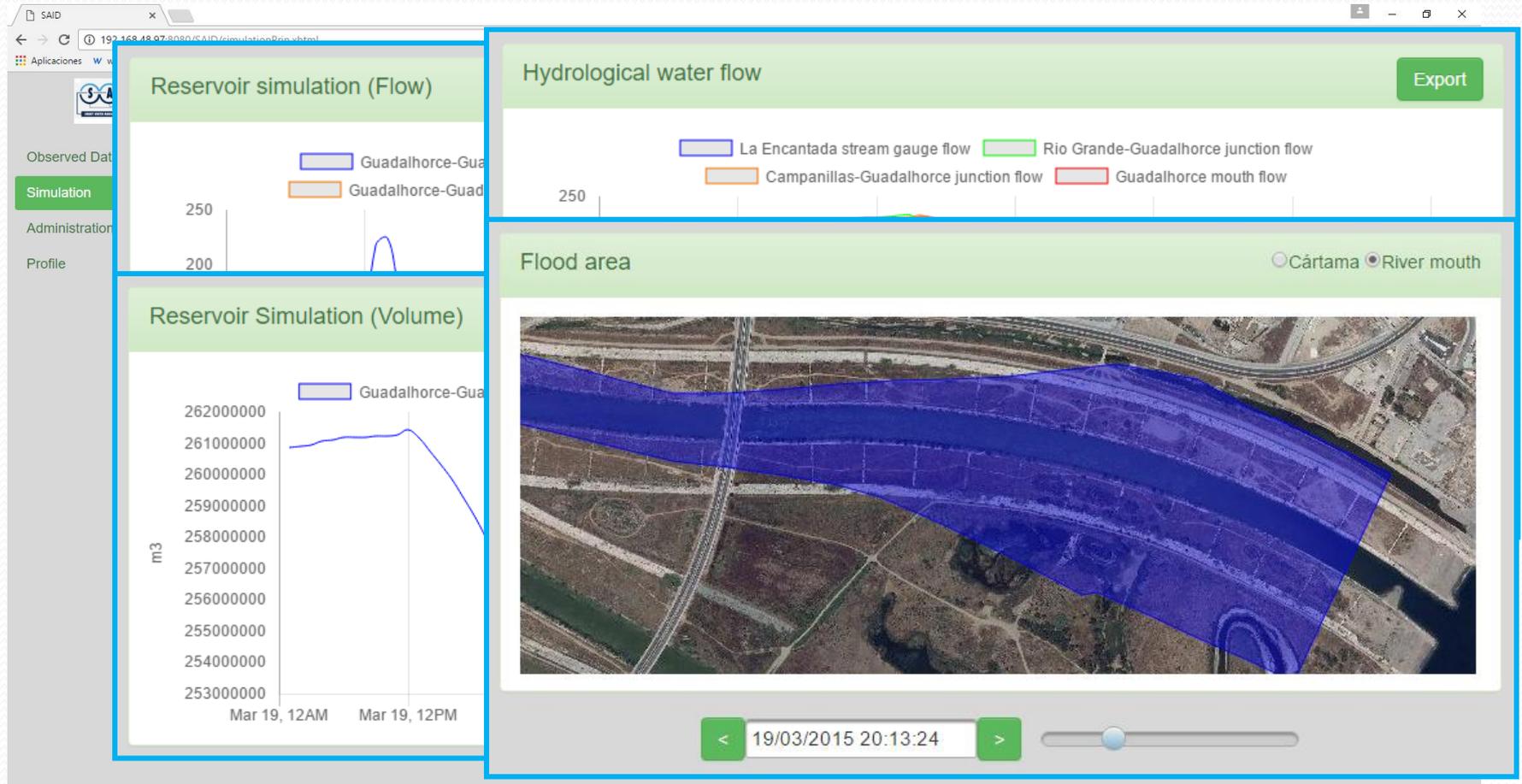
Variable	Max
Volume (m3)	0.00
Level (m)	342.00



Flood mode: manoeuvres



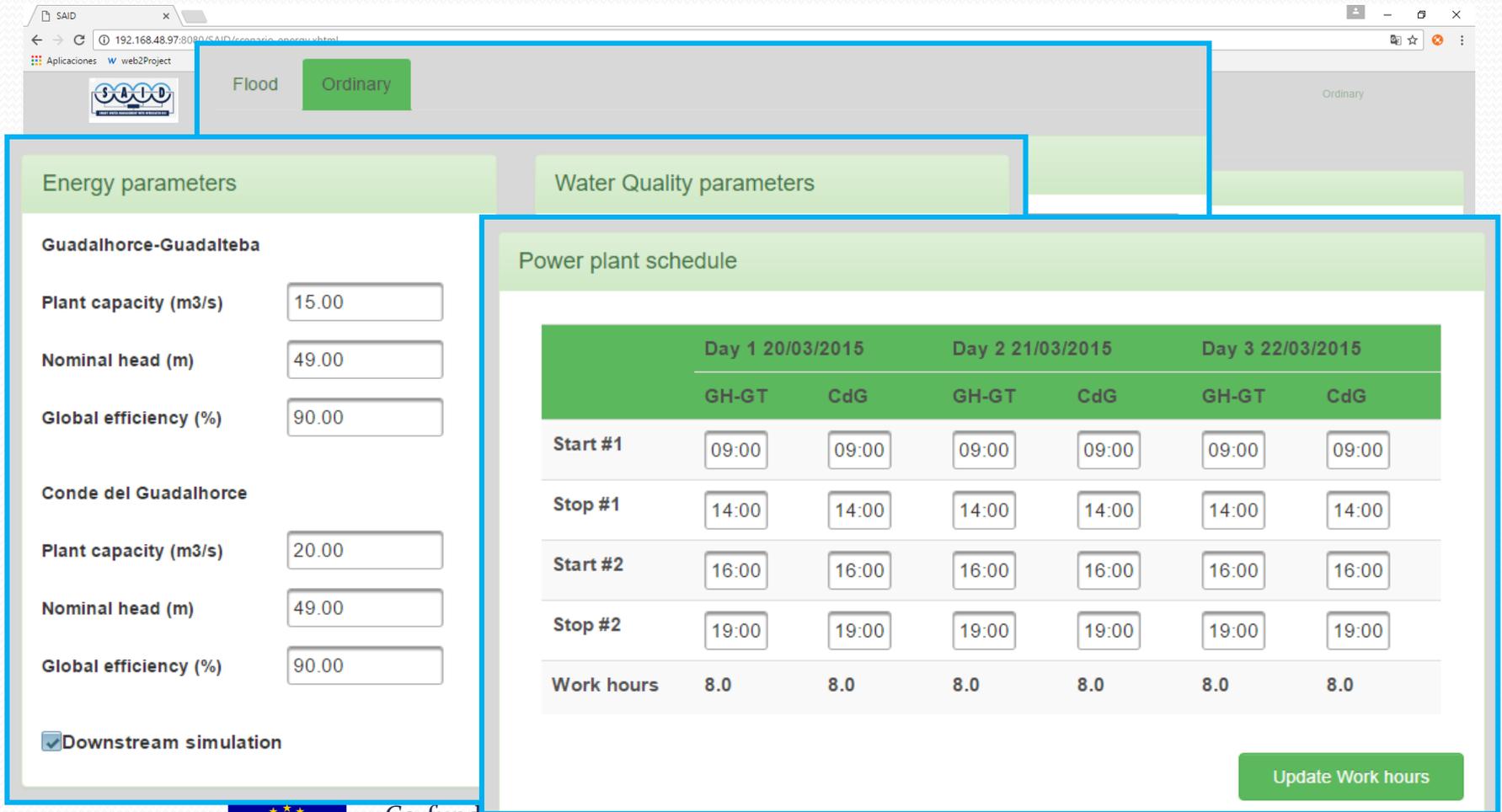
Flood mode: simulation



Ordinary scenario simulation



Ordinary mode: constraints



The screenshot shows the SAID web application interface. At the top, there are tabs for 'Flood' and 'Ordinary', with 'Ordinary' selected. Below the tabs, there are two main sections: 'Energy parameters' and 'Water Quality parameters'. The 'Energy parameters' section is further divided into two sub-sections: 'Guadalhorce-Guadalteba' and 'Conde del Guadalhorce'. Each sub-section has input fields for 'Plant capacity (m3/s)', 'Nominal head (m)', and 'Global efficiency (%)'. The 'Guadalhorce-Guadalteba' section has values of 15.00, 49.00, and 90.00 respectively. The 'Conde del Guadalhorce' section has values of 20.00, 49.00, and 90.00 respectively. There is a checkbox for 'Downstream simulation' which is checked. The 'Water Quality parameters' section is currently empty. To the right of the 'Energy parameters' section, there is a 'Power plant schedule' section. It contains a table with columns for 'Day 1 20/03/2015', 'Day 2 21/03/2015', and 'Day 3 22/03/2015'. Each day has two columns for 'GH-GT' and 'CdG'. The table shows start and stop times for two power plants (#1 and #2) and the resulting work hours. A green button labeled 'Update Work hours' is located at the bottom right of the 'Power plant schedule' section.

Energy parameters

Guadalhorce-Guadalteba

Plant capacity (m3/s): 15.00

Nominal head (m): 49.00

Global efficiency (%): 90.00

Conde del Guadalhorce

Plant capacity (m3/s): 20.00

Nominal head (m): 49.00

Global efficiency (%): 90.00

Downstream simulation

Water Quality parameters

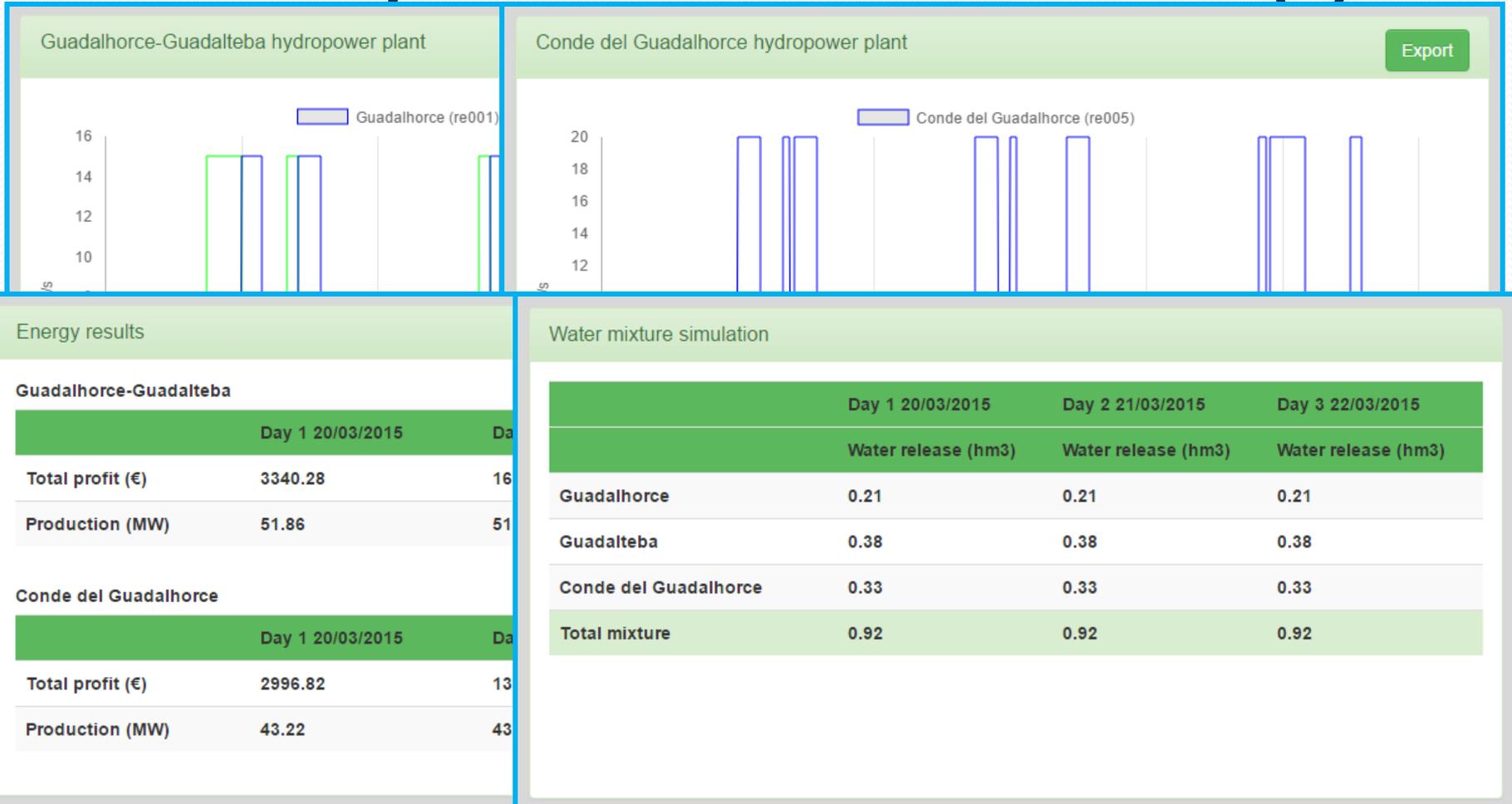
Power plant schedule

	Day 1 20/03/2015		Day 2 21/03/2015		Day 3 22/03/2015	
	GH-GT	CdG	GH-GT	CdG	GH-GT	CdG
Start #1	09:00	09:00	09:00	09:00	09:00	09:00
Stop #1	14:00	14:00	14:00	14:00	14:00	14:00
Start #2	16:00	16:00	16:00	16:00	16:00	16:00
Stop #2	19:00	19:00	19:00	19:00	19:00	19:00
Work hours	8.0	8.0	8.0	8.0	8.0	8.0

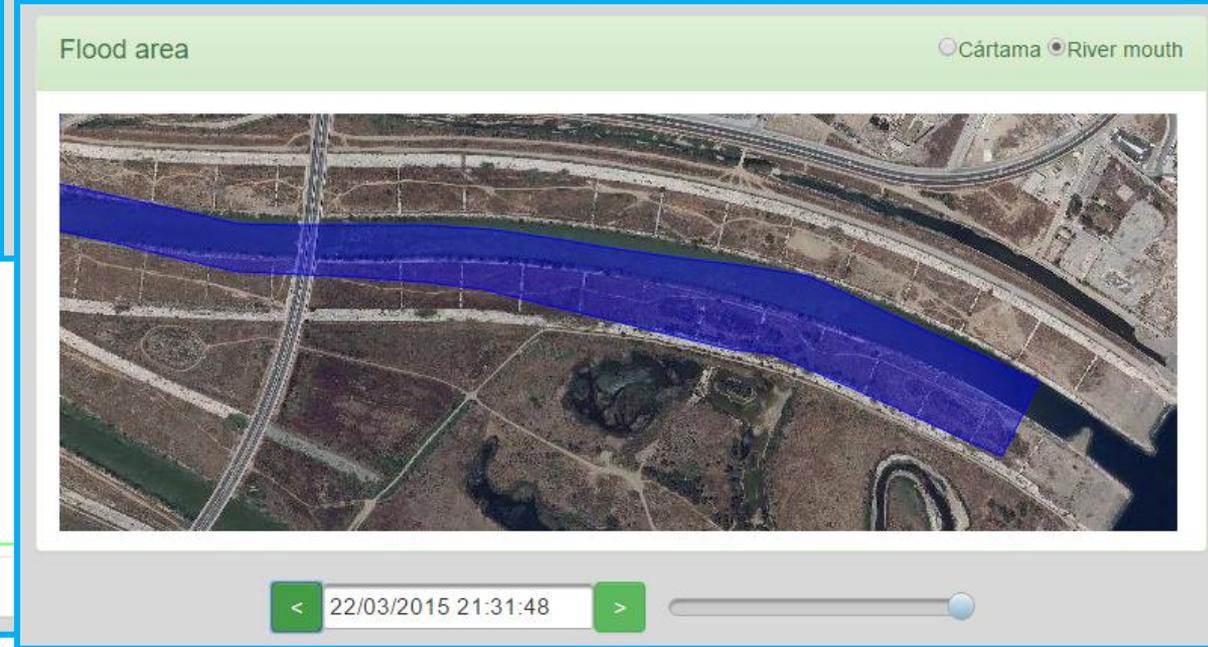
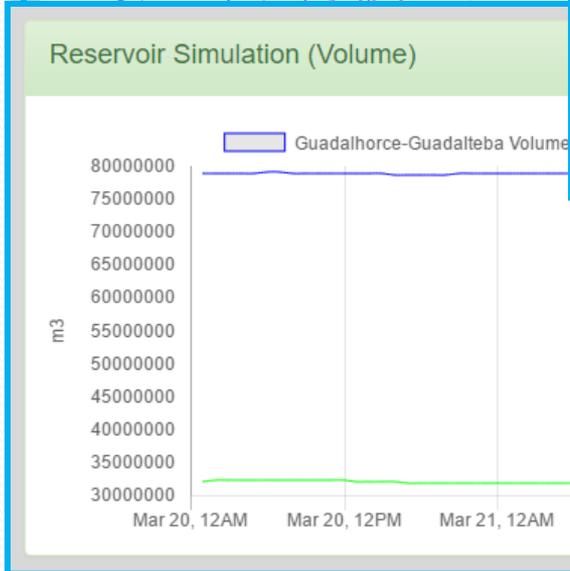
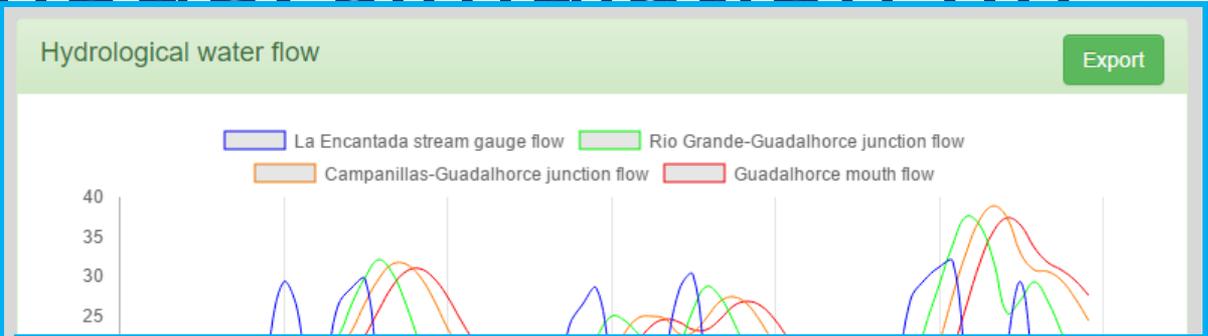
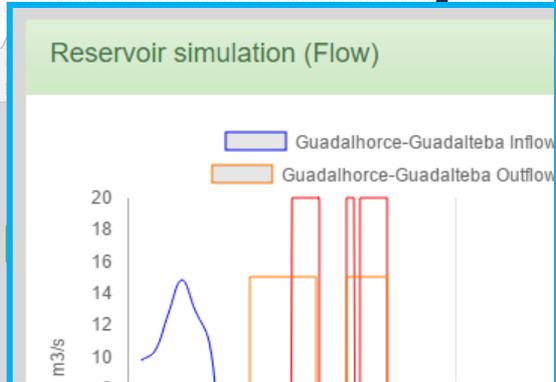
Update Work hours



Ordinary mode: simulation (I)



Ordinary mode: simulation (II)



Other features

- Predefined user roles and information levels
 - Access to specific collections of observed data/forecasts
 - Permissions to launch ordinary and/or flood simulations
- Concurrent access to the DSS
 - Multiple users can explore SAID data with a web browser
 - Simulations limited to a number of concurrent users
- Automatic update of river basin response
 - River model executed in a continuous basis (once a day)
 - Climate data and dam discharges in the last 24 hours used



Conclusions

- The Integrated DSS allows complex decision making based on parameters and objectives of different domains (flood control, water quality, energy production)
 - Monitoring of observed data and DSS variables
 - Predictive simulations involving multiple DSS interactions
- Required user interactions are greatly simplified
- The proposed framework is modular and reusable, and can be exported to other river basins with reasonable efforts
- Integration in SAID is being addressed using modern practices of distributed systems and software engineering



Thank you for your attention

www.said-project.eu

