Flow based vs. demand based energy-water modelling

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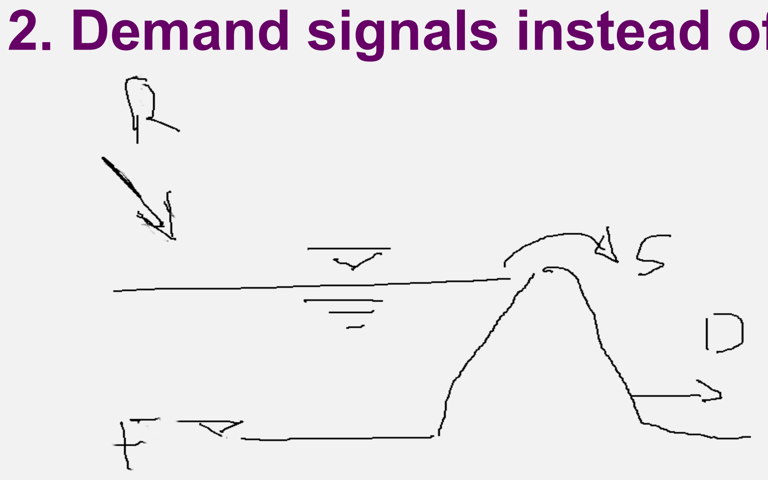
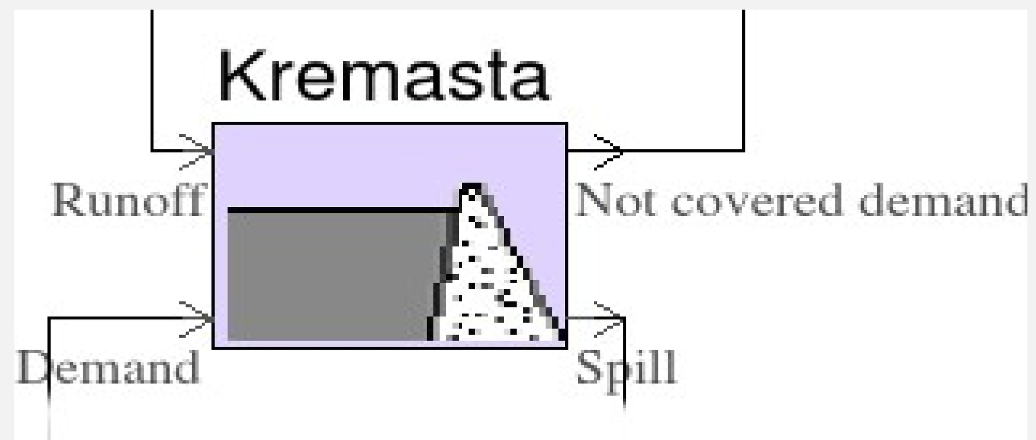
1. Introduction

The water flow in hydro-power generation systems is often used downstream to cover other type of demands like irrigation and water supply. However, the typical case is that the energy demand (operation of hydro-power plant) and the water demand do not co-incide. Furthermore, the water inflow into a reservoir is a stochastic process. For this reason, the assessment and optimization of the operation of hydro-power systems are complicated tasks requiring a support system that should not only simulate the water budget of the reservoirs, but also the restrictions imposed by the natural or artificial water network. UWOT is a bottom up urban water cycle model that simulates the generation, aggregation and routing of water demand signals. In this study, we explore the potentials of UWOT in simulating not only the demand signals but also the operation of a complex hydrosystem that includes energy generation. The evident advantage of this approach is the use of a single model instead of employing model coupling (one model for estimating demand and another for simulating the hydrosystem). An application of UWOT in a large scale system is attempted in mainland Greece in an area extending over 130×170 km².

2. Demand signals instead of flows (I)





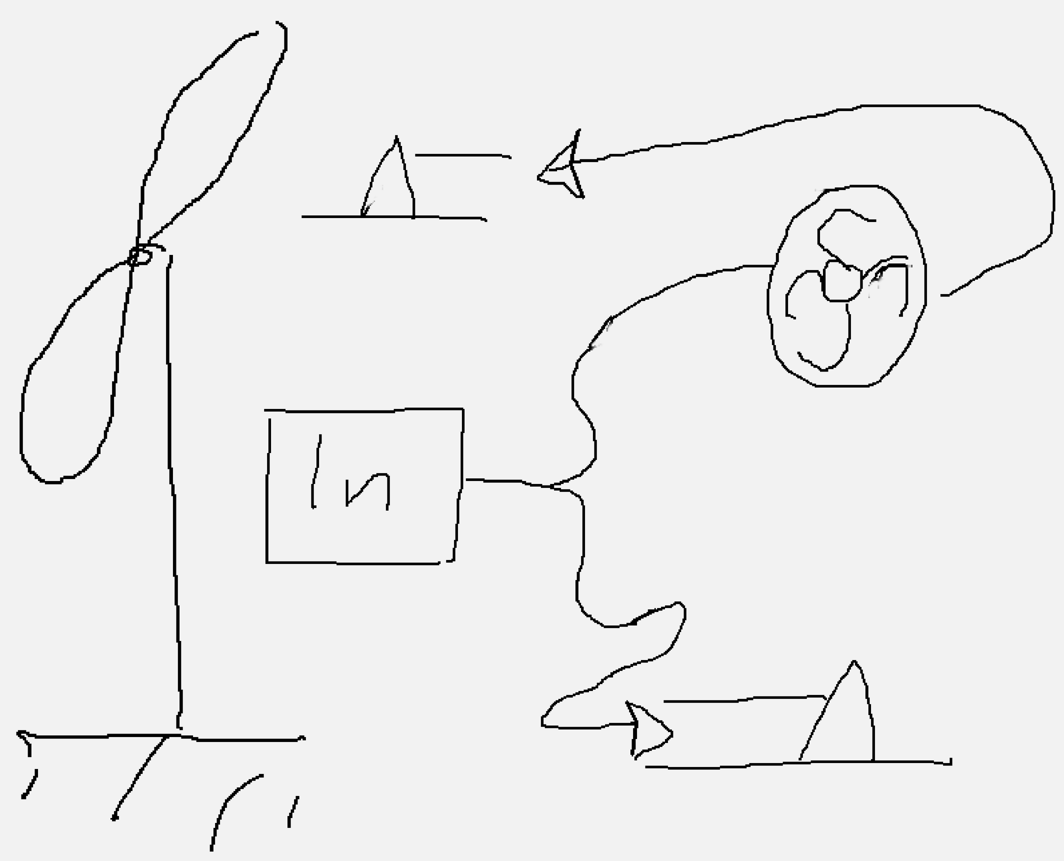
Typical reservoir water budget

- Upstream runoff plus rain *R*.
- Spills *S*.
- Release to cover demand *D*.
- If the reservoir gets empty, it will fail to cover a part *F* of the demand.

Everything is a demand signal

- An upstream component needs to discharge *Runoff*.
- A downstream component *Demands* water.
- Necessity to discharge *Spills*.
- *Not covered demand* if reservoir gets empty.

3. Demand signals instead of flows (II)

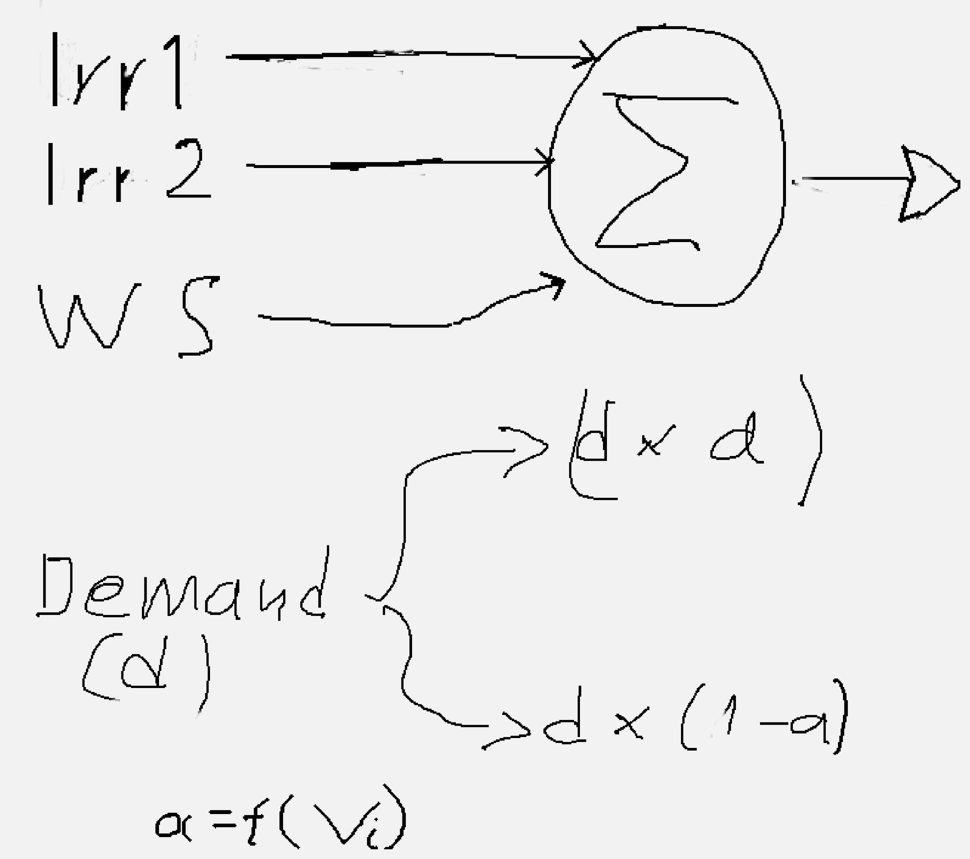


Connecting cascade reservoirs.

An operator creates a demand signal, which is forked into two branches. One branch, after passing through a hydro-turbine, is connected to the Demand port of the upstream reservoir and the other branch is connected to the Runoff port of the downstream reservoir.

In case of a pump-storage (the operator can be a wind-turbine), one branch is connected to the Demand port of the downstream reservoir and the other branch is connected to the Runoff port of the upstream reservoir.

4. Routing the demand signal



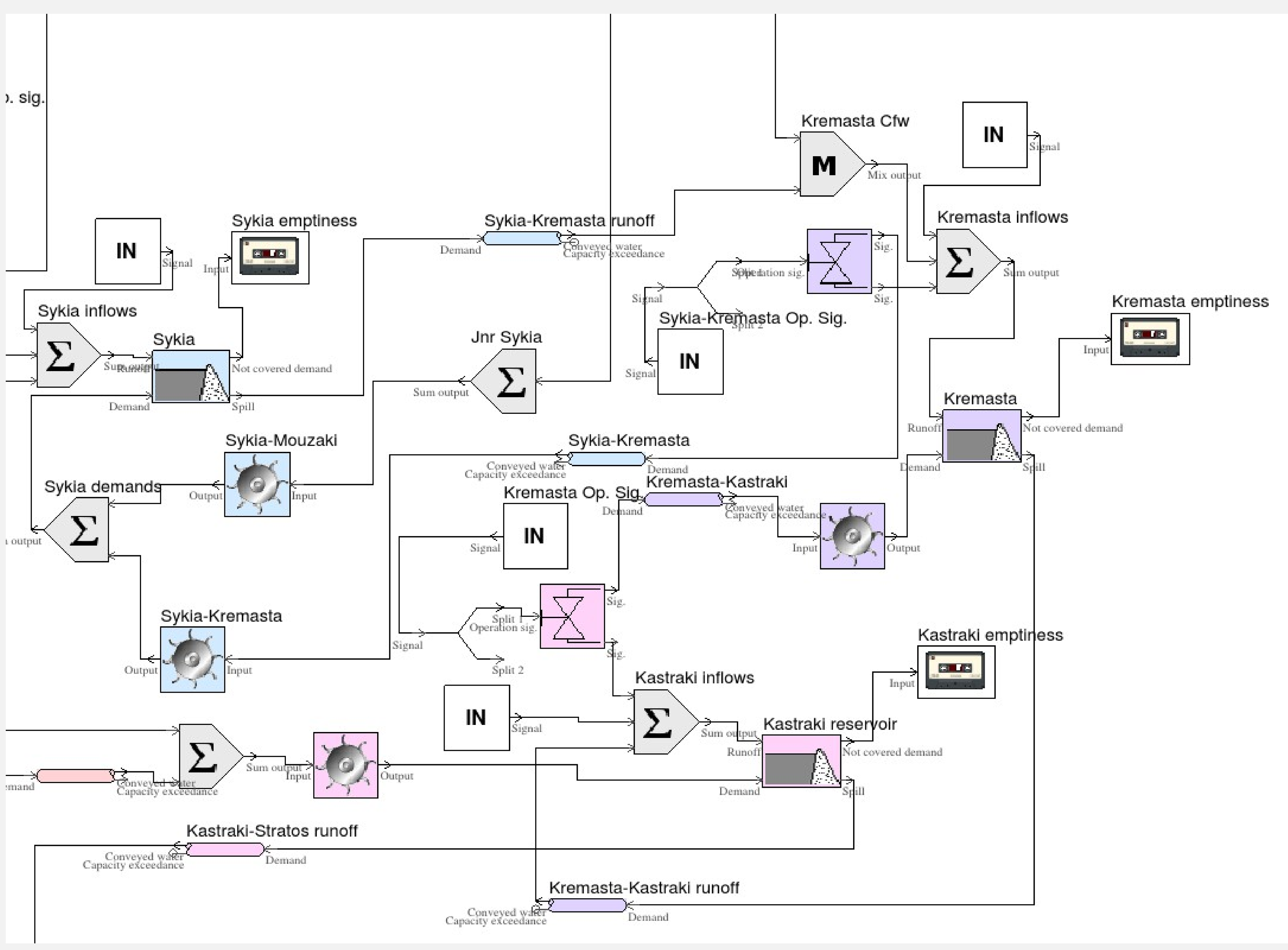
Aggregating demand signals.

Signals from various water consumers (irrigation, water supply, etc.) can be easily aggregated with simple summation.

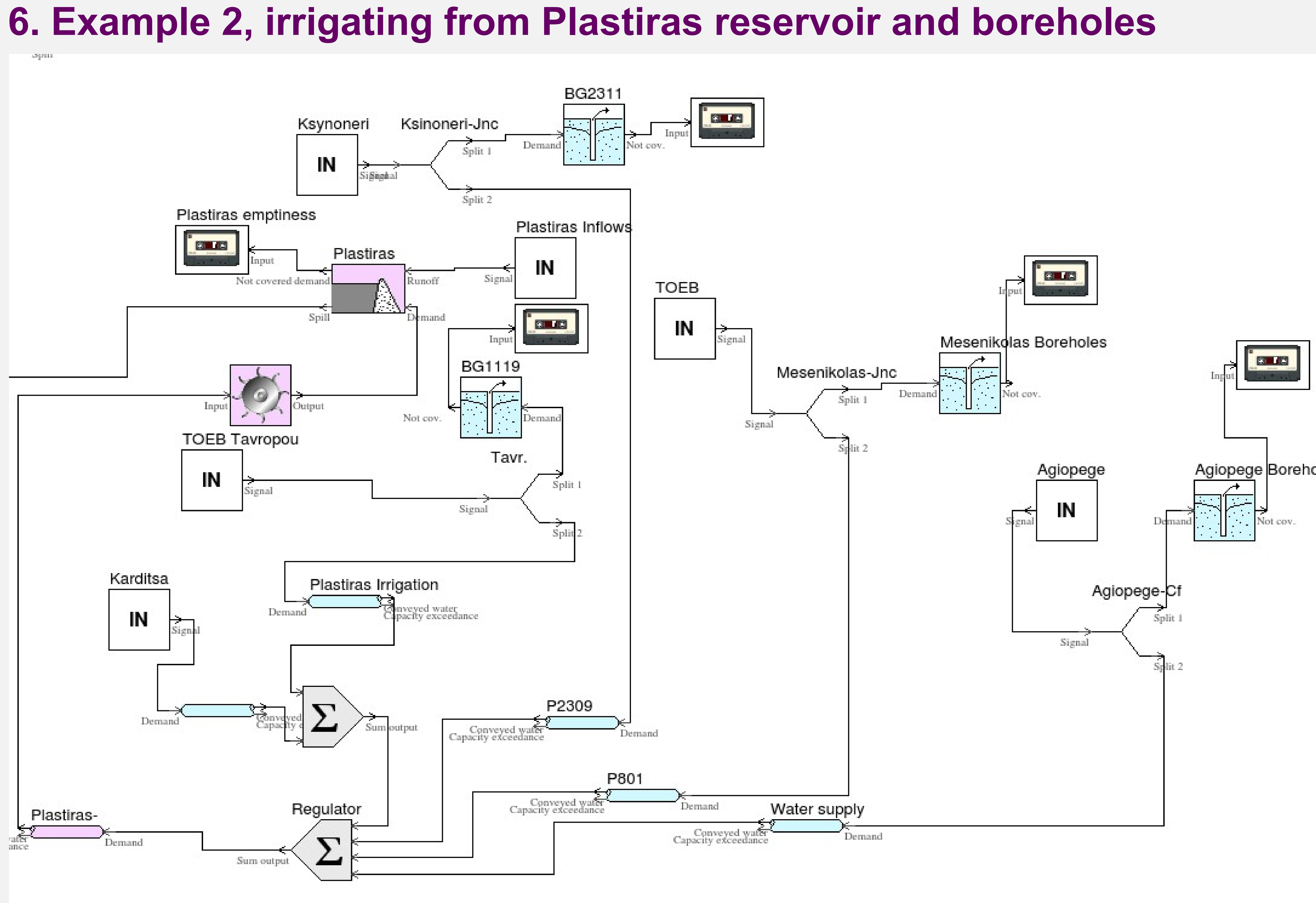
Distributing demand signals

Demand signals can be distributed to various resources using a "smart" junction component. A percentage *α* of the demand is diverged to one branch and the rest to the other branch The percentage *α* changes dynamically according to the available water inside reservoirs.

5. Example 1, cascade reservoirs Sykia, Kremasta, Kastraki



6. Example 2, irrigating from Plastiras reservoir and boreholes



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