Ph.D. in Information Technology:
DENARO
Thesis Defense

DEIB – Room PT1 – Building 20
July 28th, 2017 11.30 am

Ph.D. presentation and discussion:

Dr. Simona DENARO – XXIX Cycle
"Conflict Mitigation in Water Resources Systems by Informed Data-Driven Control and Financial Hedging Tools"
Advisor: Prof. **Andrea Castelletti**

Abstract:

Climate change and anthropogenic pressures are expected to reduce global freshwater availability and to exacerbate water crises in the near futures. Evidence of this emerging behavior has been observed worldwide, including traditionally flood sensitive regions, such as the Italian Alps, where intensive droughts have repeatedly challenged agricultural and hydropower production in the last decade. Given the low flexibility of traditional "hard path" solutions, such as structural and centralized actions, water resources systems performance is likely to degrade as extreme weather events and change in water demand regimes become increasingly evident. As a result, conflict in multi-agents river basins is expected to become a main issue.
Alternative to supply expansion, a cheaper, distributed and low impact "soft-path" can be undertaken. The core idea is to act on management measures in order to make a better use of the already existing infrastructures. "Soft-path" measures can improve the overall efficiency (or productivity) of the multi-sector water use by means of distributed and participatory management better informed decision making, and smart economics tools providing financial risk transfer during water crisis and extreme events. In this research, we focus on two particular areas of improvement: (i) better informed control strategies and (ii) novel financial hedging tools applications.
Nowadays, a large amount of information on water system boundary conditions is made available by abundant different sources ranging from ground stations to remote sensed products and citizen science virtual sensors. Nevertheless water managers still rely on very limited informative systems. Concurrently, the adoption of weather risk management mechanisms (e.g., index-based insurance contracts) in the negotiation process of conflicting water users has been little investigated. Yet it could provide the right amount of flexibility to generate win-win resolutions.
In this work we investigate both strategies and their effect on two complex multi-agents Alpine water systems characterized by conflict and challenging power distributions A first research path explored the potential of hydro-meteorological

data and coordination at the catchment scale in informing water resource systems operation. Results suggest a combination of seasonal snow data and information sharing can lead the overall system performance to a 20% improvement.
A second line of research was focused on financial tools application to foster cooperation in conflicting river basins. The analysis deployed two different applications. The first one evaluated the potential of weather derivatives as negotiation tools. Findings indicate index-based insurance contracts can offer cheaper solutions for redefining water rights and consistently shifting unfair trade-offs in power asymmetric water systems. The second application addressed the problem of extreme weather event insurability in shared river basins. The adoption of strategies that pool together different risks from competing users proved beneficial to both promoting insurance premium affordability by reducing premiums up to 7% and facilitating collaboration schemes at the catchment scale.