

An Indian-Australian research partnership

Project title

Multivariate statistical characterization of hydrological processes

Project number: IMURA0090

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Research Academy theme/s

List only the research academy theme/s that is relevant to the project

1. Advanced computational engineering, simulation and manufacture
2. Infrastructure engineering
3. Clean energy
- 4. Water**
5. Nanotechnology
6. Biotechnology and stem cell research

The research problem

Many of the processes in the hydrologic cycle are generally characterized by random phenomena intimately linked one to the other. It is fundamentally important to be able to relate the statistics of different random processes to define properly a physical phenomenon. Paradigmatic examples are represented by storm dynamics and droughts. In fact, different combinations of rainfall intensity and storm duration may lead to precipitation events with very different features (and very different consequences for both short and medium-term soil moisture), and an effective characterization of a drought requires the joint study of at least its duration and magnitude.

Project aims

The project aims at achieving a better characterization of the statistical properties of hydrological processes with the intent of improving the ability to forecast soil water availability at catchment scale, and the occurrence and duration of extreme events (e.g., droughts and floods).

Expected outcomes

Because the developed methods consider more than one factor in defining an event, new definitions of extremes and return periods can be derived, thereby making more efficient the solutions used to prevent or deal with such events. This will benefit water authorities in partitioning and delivering water for urban areas and irrigation, while maintaining an acceptable environmental flow. For example, forecasting of drought extent and duration will permit better decisions for water allocation, but also ensure that advanced warning can be given to primary producers, allowing them to plan their activities.

Which of the above Theme does this project address?

The project mainly deals with **water** related issues.

How will the project address the Goals of the above Themes?

The adoption of multivariate probabilistic models in hydrology has been limited by mathematical difficulties. The main problem is to generate joint laws consistent with the marginal distribution of each single variable. Recently, the derivation of multivariate joint distributions based on particular distributions called copulas, which are rather well known in financial statistics, have been used in hydrology, opening new routes in modelling return periods of multivariate events, especially extremes. The results may be verified using multivariate kernel density functions with proper band width.

Based on experimental data from India and Australia, we will use copulas to build probabilistic models of storm and drought occurrence. In modelling precipitation, we will relate storm frequency, intensity and duration, while for droughts we will analyse the relationship between intensity and duration, including frequency and magnitude as well.

Although the analysis will be focused on storm and drought, the method can be (and has already been) applied to other interesting applications, such as rainfall-river flow models (e.g., to predict floods and the relationship between peak flow and peak volume in rivers) and the link between temperature and water usage in cities.