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Rainfall nowcasting using a Neural Network based algorithm and small-catchment flood forecast in complex orography with a distributed hydrological model, implementing a Cellular Automata technique for drainage network extraction

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Hydrological modelling is becoming more and more needed for correctly simulating the hydrometeorological cycle and all the surface energy flux exchange when they are coupled with a meteorological model and alone when floods and drainage investigations have to be performed.

Spatially distributed hydrological models are able to account for the spatial variability of physical properties and for this aim they need an accurate representation of the internal drainage structure of the watershed.

Software that incorporates extraction algorithms that are more realistic from an hydrological point of view are needed better than GIS based software for overcoming problems like poor compatibility between commercial GIS software and research standard hydrological modelling packages or the expense associated with many conventional GIS packages.

The first steps that an extraction algorithm has to fulfil is to determinate the flow direction for each cell and remove in case there are, the singularities such as when a cell has not a defined flow direction because there are around cells with the same height.

In this paper we describe the CA2CHYM algorithm bases on Cellular Automata algorithm that is suitable for solving specific problems when the value in a point has to be determined by the values of neighbouring points.

The second step is to compute a flow accumulation matrix for determining the drainage network.

Once that the drainage network is defined, in this work a method for determining the stress for each point of the network in case of rain is also presented.

Often the problem arise to merge and downscale several rain measurements or model output field to a typical resolution of hydrological catchments. Few examples are present in literature but mainly for climate scale resolution whereas the rain model algorithm presented here deals with different real time rainfall data for creating a precipitation field suitable for the CETEMPS HYdrological Model (CHYM).

The rain gauge data, the satellite estimates and the MM5 model output field are combined using here as well a CA based algorithm. This algorithm allows to create a final rain field as a result of the merging of all the kind of data establishing a hierarchy among them. The method provides that the observed measurement will give always the predominant contribution to the closest grid point better than for example the MM5 forecasted value of the same grid point.

Satellite estimates are obtained with a non linear estimation algorithm based on a Artificial Neural Network (ANN) at hourly time. The NEREMIS (NEural Rainfall Estimation using Microwave and thermal Infrared Sensor) algorithm has been experimented in mid-latitude regions for instantaneously rainfall estimation using both infrared and microwave satellites measurements. NEREMIS calibrates the infrared measurements from geostationary satellites with the coincident microwave rainfall estimates from polar orbiting satellite and the calibration and validation is carried on in the European area.

Both the drainage network structure and the modelled rain field are used for computing a stress index in every point of the network. Once that it has been calibrated, such an index it is a first simple indication for detecting the probable flood risk areas in a real time operational use of the CHYM model.