Management and Impacts of Climate Change Programme GICC
CRP 1999

9/99 - Studying the potential impacts of climate change on the Rhône catchment in the perspective of their management

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Project objectives

The project aims to provide insights into foreseeable impacts on the French side of the Rhône watershed resulting from a climate change induced by a doubling of the CO_2 in the atmosphere (probable date 2050). The first phase focuses on climate scenarios and their hydrological consequences.

The global climate change likely to occur under the 2 x CO_2 scenario is evaluated using outputs from two general atmospheric circulation models. The obtained global atmospheric indications are disaggregated using the perturbation method to the more detailed scales needed for hydrological modelling. The resulting climatic forcings are applied to four hydrological models of the French side of the Rhône catchment and of tributaries of particular interest (the outputs from two of these models are analysed in more details). This gives indications on the effects pertaining to the major physical variables of the studied hydrosystems. In particular, the general hydrology of streams is closely studied, being regarded as a prerequisite for any investigation of hydrological and water-resource contingencies.

Building on these indications, we will attempt, in a second phase, to assess the impacts concerning various physical, biological and socio-economic aspects; interactions with groundwater; the qualitative and quantitative trends of vegetation, which give indications on its ability to adapt; altered relationships between water resources and irrigated crop systems; the response of fish communities to alterations of the water regime (in cooperation with the project submitted by M. Pont).

The research involved will also serve to express and if possible quantify the uncertainties of current knowledge on the subject. In this respect, the applicants make a point of employing a variety of models, both for global trend scenarios and for hydrological modelling.

Summary of achievements

The GICC-Rhône project is based on data collected for the Gewex-Rhône project. The latter project collected a reference atmospheric forcing over 1981-1998 with a tri-hourly time resolution and a 8-km spatial resolution, developed with the Safran system (CEN/CNRM). This forcing includes all the usual fields: air temperature, total precipitation, atmospheric radiation, solar radiation, wind speed, air specific humidity and potential evapotranspiration, the last deduced from the others.

Climate change is based on the following scenario: carbon dioxide (CO_2) increases yearly by 1% and is assumed to be responsible for all the climate changes; the target date is 2050 (when CO_2 will have doubled).

On the basis of a common climatic simulation providing a reference sea surface temperature (Hadley Centre), several atmospheric integrations of this scenario were collected - four at a low resolution, from an earlier project (LSPCR, Polcher – typical resolution 2.5° x 3.5 °) - and two (specific) new ones completed at a high resolution (LMD SECHIBA dx = 100 km; CNRM ISBA dx = 50 km).

Monthly large-scale anomalies were disaggregated using the perturbation method:

- computation of monthly anomalies deduced from a General Circulation Model (GCM) = GCM value modified climate – GCM present-time climate, interpolated on the Rhône grid;
- perturbation of the forcing: modified climate forcing = present-time forcing + interpolated anomaly.

Six scenarios have been developed by combining variables of the observed climate with the simulated anomalies concerning temperature and precipitation. These climate forcing scenarios are introduced as inputs into four different hydrological models of the French side of the Rhône watershed. Information is provided on each of these models. Their hydrological outputs are compared, and also compared to the current hydrological regime. Methods for the comparison of regimes and for the analysis of hydrology sensitivity to certain forcing variables have been designed or adjusted to fit our needs.

The clearest result obtained is that the first factor of uncertainty concerning future hydrology is the choice of atmospheric scenario. The dispersion between different hydrological models, although significant, so far remains less important. Progress has been announced in the quality of atmospheric scenarios – a progress that now remains to be matched by hydrological modelling…