Winter Seasonal Reservoir Inflow Forecasting in Spain

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Abstract

This poster shows a technique used to forecast reservoir inflows in the period December – January - February in Spain and its assessment.

A two steps forecasting technique is applied to obtain an ensemble of possible scenarios (reservoir inflows) that can be used in water allocation decision support models.

A set of verification scores has been computed to assess the system skill. It is shown that the skill depends on the reservoir's basin and the forecasted tercile. In most cases, the scores indicate a good level of skill. So, this SAI based forecasting system seems appropriate to forecast the reservoir inflows and help to improve the water management.

Introduction

In the past, seasonal forecasting at Spain has been characterized by a relatively low skill (Sánchez et al. (2014)). Nevertheless, new studies have been carried out that show new opportunity windows in this topic. One of them is reservoir inflow forecasting in winter using the observed Eurasian snow advanced index (SAI) as the only predictor.

Winter precipitation in Spain is very influenced by the North Atlantic Oscillation (NAO). But, in spite of some recent progress, the skill of the general circulation models on NAO seasonal forecasting is still limited.

On the other hand, Cohen & Jones (2011) propose an index, the Snow Advance Index (SAI). They have found that the October value of this index is highly correlated to the winter Artic Oscillation (AO) (very close related to NAO). With this result, Brands et al. (2012) show the correlation between the SAI in October and the winter precipitation in Spain.

Our seasonal forecasting system is based on this relations.

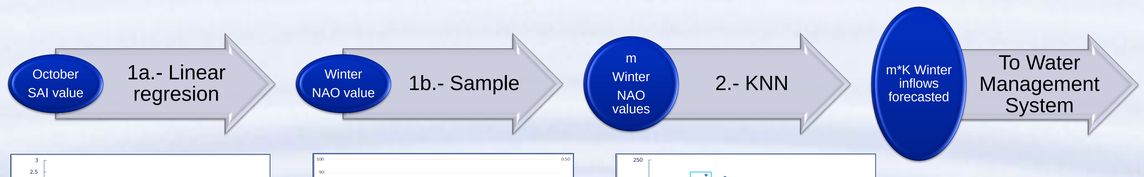
Data

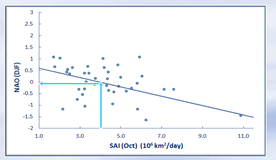
For the predictor variable, we use the daily and weekly versions of the Snow Advance Cover (SAI). These standardized indices measure the rate of increase of Eurasian snow cover in October, as described by the regression coefficient of the least squares fit of the daily/weekly Eurasian snow cover extension in a geographical domain covering 25º–60º N, 0º–180º E.

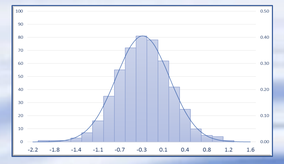
Four reservoirs from different basins have been selected to develop and asses the system: Cuerda del Pozo, Rosarito, Tranco de Beas and Ebro.

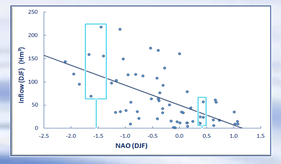
Methods

Making use of the correlations SAI – NAO and NAO – Reservoir Inflow, a two steps forecasting system has been implemented









First, a NAO single value is obtained from the observed SAI value and the correlation SAI – NAO through a simple linear regression.

Then a synthetic Gaussian distribution is used to get m sampled NAO values. The mean value of the distribution is determined by the single NAO value and the standard deviation is determined by the deviation of the cross-validation test on the linear correlation.

In this way we finally get an ensemble of m NAO forecasted values that tries to represent the uncertainty in the NAO forecasting.

At a second step, we use a KNN algorithm to obtain k inflow values from each of the NAO values and the correlation NAO – Inflow. This correlation depends on the reservoir itself. So we estimate the reservoir inflow forecasting uncertainty.

After some tests, a value of k=3 has been chosen as the optimal one.

As can be seen from the graphic, negatives NAO values produce more scattered inflow values.

In the end an ensemble forecast consisting of m*k historical inflow values has been produced.

Verification

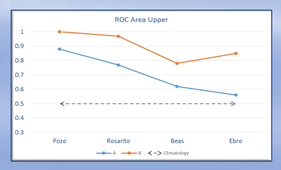
To assess the skill of the system, a cross-validation method has been used for 1999-2011 hindcast period.

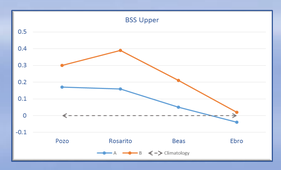
Two different forecasting systems has been evaluated:

A.- Based on the weekly SAI in Eurasia in October (the observations are made once a week). The available data start in 1973.

B.- Based on the daily SAI in Eurasia in October (the observations are taken every day). The available data start in 1999.

The selected period (1999-2011) is the common period with available data for the weekly SAI, the daily SAI and the reservoir inflow.





Conclusions

- The skill of the system depends on the reservoir. The correlation NAO-Inflow is very related to the location of the reservoir. The northern strip and the Mediterranean strip of Spain have low correlation values. Also, factors like the runoff, the different types of soil, underground water, control of the upstream waters,… affect the reservoir inflow.
- System B (daily SAI) is clearly better than system A (weekly SAI). Although the period is not very long, a skill assessment done on the weekly SAI for the period 1973-2011 has shown this to be slightly better than system A.
- The discrimination (ROC Area) is better in the upper tercile than in the lower one. The system outcome is an ensemble of forecasted reservoir inflows and then the different members are grouped in terciles. As the range of the upper tercile usually is much more wider than the other two terciles, it is easier to discriminate it. Probably choosing a kind of classification algorithm on a terciles system instead of a KNN in the second step the discrimination of the system could be improved.
- As for the Brier Skill Score, it summarizes the contributions of the reliability, resolution and uncertainty. It keeps better than the climatology except in the Ebro reservoir which is located in an low correlation area.

Final Considerations

In the frame of the EUPORIAS project case-study "Use of Seasonal Climate Forecast for Water Management in Spain" a complete water management system is being developed. The probabilistic seasonal forecast of the reservoir inflow is the input for SIMRISK, a reservoir management tool that simulate and analyse different possible scenarios. This tool produces a risk evaluation for the reservoir based on the initial condition, the forecasts and the historical demands.

The water managers, based on this evaluation can take different actions in advance to mitigate the risks.

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