



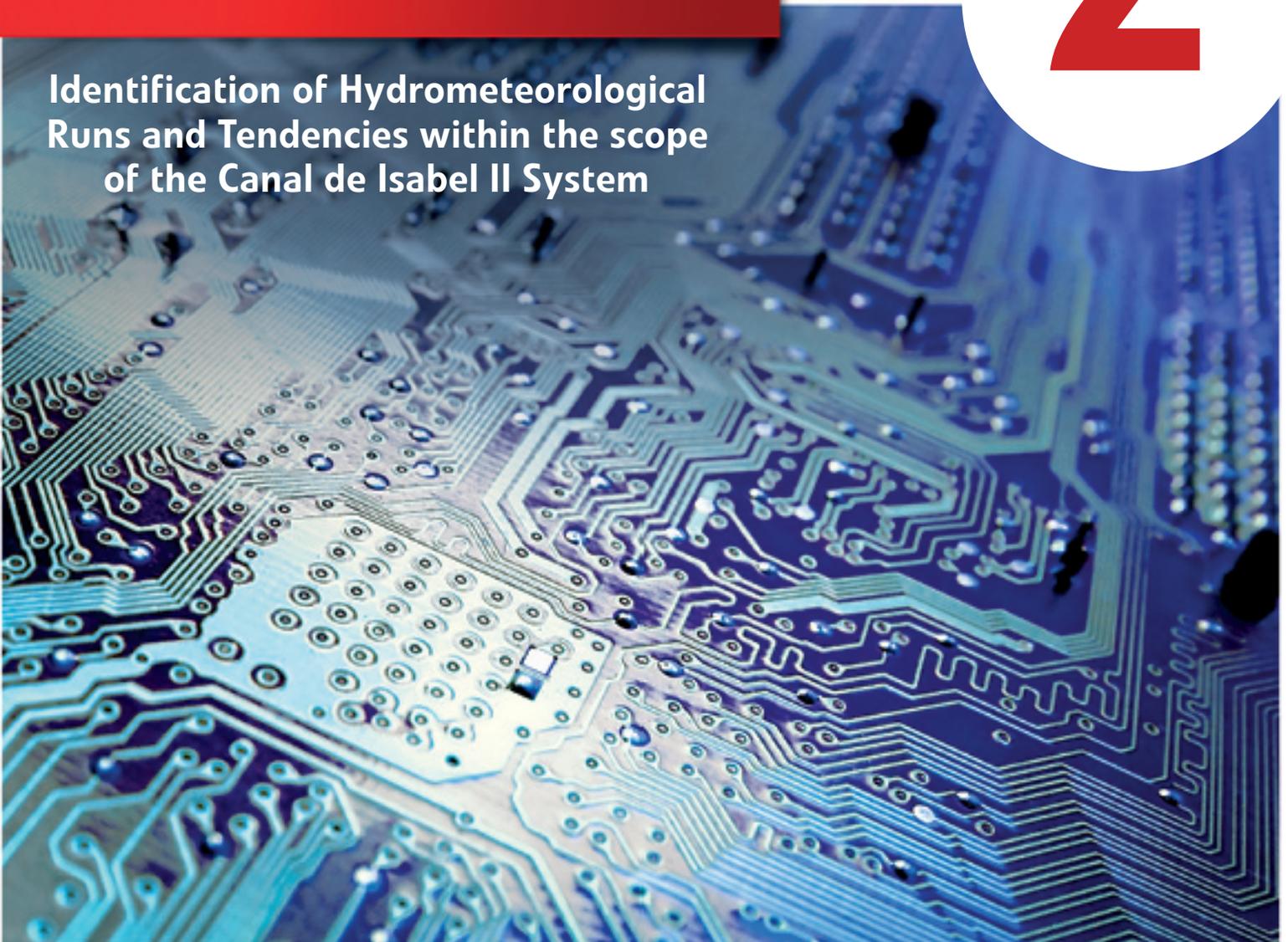
Canal de Isabel II

BOOKLETS

RESEARCH + DEVELOPMENT & INNOVATION

Identification of Hydrometeorological Runs and Tendencies within the scope of the Canal de Isabel II System

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Identification of Hydrometeorological
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Edition coordinated by: Subdirección de Comunicación y RR.PP.

ISBN: 978-84-933694-6-0



PRESENTATION



Canal de Isabel II's Research, Development & Innovation Booklets form part of the company's Knowledge Management Strategy and of the development involved in the Investigation, Development and Innovation Plan.

These Booklets represent an element for diffusion of projects and initiatives that are developed and sponsored by Canal de Isabel II for innovation in those areas related with water service in the urban environment.

A series of different problems that have been undertaken in each project are put forward in the Booklets, along with the results that have been obtained. The intention behind their diffusion by means of these publications is to share the experiences and knowledge that has been acquired with the entire water services sector, with the scientific community and with all those working on investigation and innovation tasks. What is pretended with the publication of these Booklets is to contribute to improvement and efficiency in water management and, consequently, in the quality of the service that is provided for the citizens.

Apart from its publication in printed format, the booklets will also be available on Canal de Isabel II's web site, into the Publications section.

TECHNICAL INVENTORY

Title of the Project	Identification of hydrometeorological runs and tendencies within the scope of the Canal de Isabel II system.
Line of Research	Assurance of strategic continuity of the service.
Units of Canal de Isabel II implied	Deputy Direction of Research, Development & Innovation.
External Partnership	Ecología y Tecnología del Medio Ambiente S.A.
Object and Justification of the Project	To know better the patterns of runoff flowing to reservoirs of Canal de Isabel II in medium term (monthly, seasonal and annual level). In particular, to identify patterns of non-random behavior, independent of the seasonal cycle, which is statistically quantifiable and possibly, able to be applied to the prognosis of medium term contributions and to the planning and management of droughts.
Contribution to the State of the Art	The statistical techniques on which the analysis has been based are conventional, although their systematic application to an ample set of series of contribution with the purpose of identifying and extracting the nonseasonal and non-random components can be considered novel.
Summary & relevant milestones of the project	The investigation has provided significant results for a quite relevant and representative hydrologic system of the central region of the Iberian Peninsula.
Summary of obtained results and outcomes	Knowledge supported in data, independent of the perspective of the operation on the cyclical persistence of the hydrological situations of shortage, nonseasonal behaviors and, actually, the relation between precedent contributions with the likely contributions in medium and long term.
Opened Lines of Research for the continuation of the project	<p>a) To take advantage of the relations observed between the hydrologic variables to improve the capacity of prognosis for future contributions to the reservoirs.</p> <p>b) Deepening in the knowledge of the apparently decreasing tendency in the spring contributions, observed in the 1940-2003 data.</p>

EXECUTIVE SUMMARY

The hydrometeorological reality of each water system consists of a series of cycles or runs of diverse duration and intensity in the precipitation regime of an area or in the behavior of the flows circulating through rivers, instance that occasionally is dramatically verified as is the case with severe droughts.

If we disregard the seasonal cycle, which from the very beginning has been incorporated in the design of an abstraction system such as Canal de Isabel II in its replenishment for the Community of Madrid, then it is worth asking if other cycles or phases, such as those arising during drought phenomena, obey to behavioral patterns that can be identified and characterized in quantitative fashion or if, on the contrary, they have a random nature (or with the available information, they are not distinguishable from random). The interest that the question poses is unquestionable: if said non-random behavior patterns were to actually exist, then knowledge about the same would allow us to advance the evolution of future contributions and, consequently, improve management of resources during situations of scarcity or other adverse situations

In general terms, the intention behind the research that has taken place is to answer the following question: is there any characteristic involved in the behavior of the contributions that cannot be satisfactorily explained with the combination of a seasonal cycle and a random component? Given that if any of these characteristics were to actually exist they would manifest themselves in quantifiable relations between the contributions corresponding to one or various periods and the contributions from one or various subsequent periods, with which the question that is being investigated can also be formulated as follows: are contributions corresponding to one period conditioned in any measure by contributions corresponding to previous periods?

The temporary level of the analysis that has been made corresponds to what we could call medium and long term: monthly, seasonal, annual and multiannual contributions. That is to say, the temporary level in which phenomena such as droughts are manifested.

The simplest way in which water conditions corresponding to one period can condition those of the following period is by persisting. If variations in the water variables take place in a temporary scale of greater duration than the period of analysis, then for example a drought situation in a period would tend to transfer over to the next period. Two types of persistence have been taken into account in this paper: rainfall persistence and hydrological persistence. The first refers to precipitations, while the second to hydrological conditions of the basin that influence in the response of the precipitations and in the production of the basic flows: edaphic moisture, level of aquifers, accumulation of snow, etc. The basis is the principle that persistence of the contributions may result from rainfall persistence, hydrological persistence or a combination of both.

The time series of runoff to basins feeding the Canal de Isabel II reservoirs during the periods 1940-41 to 2003-04 has represented the starting data for the study. Also, historical monthly accumulated precipitation data obtained from the National Meteorological Institute's Retiro station have been used as a precipitation reference.

Various statistical analysis techniques have been employed, all of which are well-known and habitually used, aimed at evaluating diverse hypothesis on the randomness of the water data series:

- a) Ratio of correlation and its statistical meaning, as a general measure of dependency between variables. This ratio has been used to evaluate the existence of a significant tendency in the series (correlation with the time variable), independence of the series (ratio of autocorrelation) and relations between precipitation and contribution and between contribution of a period with the previous period.
- b) Mann-Kendall tendency test, used to contrast the tendency in the series.
- c) Run test, employed to evaluate randomness of the formation of phases in the series.
- d) Autocorrelograms, applied to the annual series in order to identify multiannual cyclical behaviors.
- e) Table of contingencies, applied in the annual level to investigate possible relations between contributions from one year and those of the next.

The investigation that has taken place consisted in systematically applying the above-outlined techniques to the water series pertaining to the Canal de Isabel II's basin system and in the integration of the results they render. Thus knowledge has been generated that is in line with the questions put forward further above. The most relevant conclusions of the study are derived from this knowledge:

- a) Clear persistence of the contributions exists in the monthly level, which apparently does not correspond with the rainfall persistence (with the latter, if existing, being far weaker). Therefore, attributing persistence of the monthly contributions to what further above has been denominated hydrological persistence does appear to be plausible.
- b) Persistence of the contributions can also be observed in the seasonal level, although it is much weaker than in the monthly level and it is absent between summer and autumn. The latter can be attributed to the effect of the minimum stream flow in the variables responsible for water persistence.
- c) Apparently, in spring contributions there seems to be a certain decreasing and statistically significant tendency in the long term. However, the type of investigation that has been underway does not render a causal explanation for this observation; therefore, a reliable prediction of its possible future evolution cannot be made.
- d) It is impossible to reject the hypothesis that contributions from one water year are statistically independent from those corresponding to the previous year with the results obtained from the executed analysis. Expressed differently: no evidence has been found that allows us to state that, for example, there is more likelihood of a dry water year being followed by another dry year different to the probability that any year whatsoever would have.
- e) Likewise multiannual cyclical behaviors have not been detected, nor have any non-random elements been identified in the formation of dry year periods or humid year periods.
- f) Results (d) and (e) indicate that complete serial independence exists in the annual contributions. This conclusion is relevant for any prediction attempt over the annual contributions. Thus, what emerges is that knowledge about contributions in a water year provides no relevant information whatsoever about contributions in the following year. From another point of view it can also be said that the number of years elapsed as of the beginning of a multiannual drought in course provides no information about the number of dry years that still remain before the phase concludes.

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