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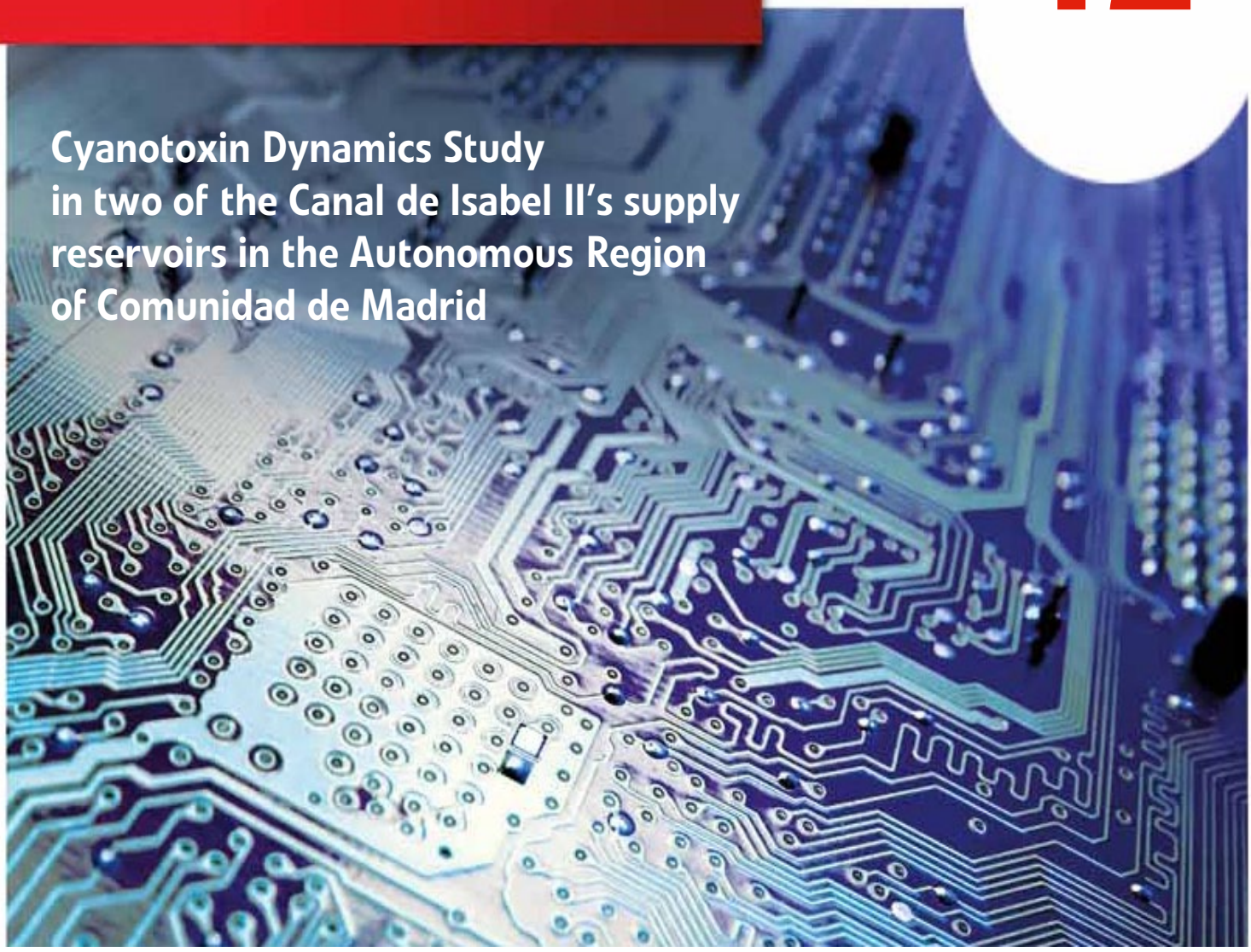

Cyanotoxin Dynamics Study in two of the Canal de Isabel II's supply reservoirs in the Autonomous Region of Comunidad de Madrid

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Introduction

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 Research, 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 aimed with the publication of these Booklets is to contribute to improvement and efficiency in water management and, consequently, in the quality of service that is provided to the citizens.

The R&D&I booklets published to date are as shown below by their titles in the following table.

Collection Number	Research, Development and Innovation Booklets published
1	Transferences of Water Rights between Urban and Agrarian Demands. The case of the Community of Madrid
2	Identification of Hydrometeorological Runs and Tendencies within the scope of the Canal de Isabel II system
3	Contribution of Canal de Isabel II to the International Demand Management Project (IDMF)
4	Micro-components and Explanatory Factors on Domestic Water Consumption in the Comunidad de Madrid
5	Virtual Water and Hydrological footprint in the Comunidad de Madrid
6	Study on the saving potential of water for residential uses in the Comunidad de Madrid
7	Potentials of efficiency in using dishwashers
8	Accuracy in the measurement of individual water consumption in the Madrid Region
9	Research project to define and assess the applicability of a Bioassay Test to determine the toxicity of water using Zebra Fish embryos
10	Water Use Efficiency in Gardening in the Region of Comunidad de Madrid
11	Remote Sensing Techniques and Geographical Information Systems for Assessing Water Demand for Outdoor Uses in the Comunidad de Madrid

Project Outline

Project title	Cyanotoxin Dynamics Study in two of the Canal de Isabel II's supply reservoirs in the Autonomous Region of Comunidad de Madrid
Research line	Drinking water and health
Canal de Isabel II units involved	• Water Quality Deputy Direction • R&D&I Deputy Direction
External participation	Universidad Autónoma de Madrid
Aim and justification of the project	Royal Decree 140/2003 concerning control over the drinking water supply governs the quantity of *Microcystine*, a toxin sometimes produced by cyanobacteria present in *cyanophycean algae* or *blue-green algae*, which could have cytotoxic, neurotoxic and hepatotoxic effects. Cyanotoxins constitute a risk to the water quality in the reservoirs. Therefore, it is essential to study the life vital mechanism of cyanobacteria so that the appearance, development and disappearance of blooms can be predicted, and with a view to learning about their latent states and associated toxicity.
State of the art contribution	The project is a breakthrough in obtaining knowledge about the life cycle of cyanobacterias and the cyanotoxins that they generate. The results yielded will be used to develop treatment, control and prediction strategies.
Project development summary and milestones	The following experiments were carried out in two of Canal de Isabel II's supply reservoirs; they were conducted from July to October 2007: • Sediment traps were installed, above the metalymnion and 3 metres above the reservoir bottom. An assessment was made of the scale of the sedimentation process affecting the cyanotoxins, as well the relevance of the toxin degradation phenomena, the consequences of its re-suspension, and the importance of its return to the water column. • The microcosmos test was used to assess the *Microcystines'* natural degradation capacity. With a view to this, the toxins were extracted during a toxic cyanobacteria blooming process and these toxins were brought into contact with the bacteria found in the water column. The filtered water was placed into microcosmos (15-litre capacity "cubitainers"), three of these exposed to the isolated toxin and the natural populations of bacteria, while two others operate, by way of control, with toxins, but having been sterilised, with a view to estimating other sources of toxin degradation (adsorption, UV radiation, and temperature).
Obtained results summary	The results of the study conducted in the two reservoirs not only revealed that the proportion of toxic cyanobacteria was low during the study year, but also the following: • It is suggested that the toxins could settle and be stored, in particle form, in the sediment, which would be conducive to them returning to the system during the course of re-suspension processes (for example, with the water flows in the reservoir). No significant differences have been observed in the degradation rates of the different chemical species of the cyanotoxins. • The particulated forms of the *Microcystines* are more resistant to degradation and predation. However, when the toxins are in solution form, a natural biodegradation process takes place, this occurring one week later in laboratory conditions. That process takes place slowly at first; for speeding up, in the second week, until all the *Microcystines* become completely degraded during this period.
Research lines open for continuing the work	• To study the toxic cyanobacteria inocula in the sediments and the processes that lead to their large-scale development. • To determine the role of bacteria capable of degrading the cyanotoxin *Microcystine* in reservoirs in the Autonomous Region of Comunidad de Madrid. .

Executive Summary

Cyanobacteria are algae that have the potential to produce toxins, and are subject to restrictions in water used for supply purposes in Spain, by virtue of Royal Decree 140/2003 to a value lower than 1 μg L^{-1} of *Microcystines*, this being the cyanobacteria most frequently found.

Very little is known about the effects, the quantification, the treatment and the life vital cycle dynamics of cyanobacteria, and this applies to their production mechanisms, the way they disperse in the water column, sedimentation and their disappearance due to bacteria degradation.

Canal de Isabel II has developed this research project, in collaboration with the Universidad Autónoma de Madrid, with a view to finding out more about cyanobacteria, so that it will be possible to predict the appearance of algal bloom, identify the latent states of the cyanobacteria, find out the sedimentation rates, study the toxicity involved and their degradation, and to develop the most suitable cyanobacteria prevention, control and treatment strategies for each particular point in time.

The following experiments were conducted between July and October 2007 in the Santillana and Valmayor supply reservoirs managed by Canal de Isabel II, in which was set:

- Analysis of the sedimentation rates of the toxins that are associated with cell remnants or cells in the process of degradation. By installing sediment traps, above the metalymnion and three metres from the bottom of the reservoir, an assessment was made of the scale of the sedimentation process affecting the cyanotoxins produced, as well the relevance of the toxin degradation phenomena; the consequences of their re-suspension and the importance of their return to the water column.

- Study of the biodegradation by bacteria of these compounds in the microcosmos. The microcosmos test was used to evaluate the Microcystines' natural degradation capacity. For that purpose, the toxins were extracted during a toxic cyanobacteria blooming process and these toxins were brought into contact with the bacteria found in the water column. The filtered water was placed into five 15-litre capacity "cubitainer" containers, three of which were exposed to the isolated toxin and the natural populations of bacteria, while the other two operated, by way of control, with toxins, but having been sterilised, with a view to estimating other sources of toxin degradation (adsorption, UV radiation, and temperature).

After one year, the sedimentation in the two reservoirs was analysed, and revealed that there was a low proportion of toxic cyanobacteria, mainly *Microcystines*. The cell and toxin degradation is minimal during the sedimentation process. One of the conclusions reached in the study was that the sediment can act as a toxin storage facility, gathering these toxins in particulated form, which is conducive to them rejoining the system when re-suspension processes occur, for example with the reservoir water-flow.

The study concerning biodegradation caused by natural bacteria showed that the particulated forms of the *Microcystines* are more resistant to degradation and predation. However, when the toxins are in solution form, a natural biodegradation process takes place, such under laboratory conditions, and does so in two phases; it takes place slowly at first, before speeding up in the second week, until all the *Microcystines* become completely degraded during this period. No significant differences have been observed in the degradation rates between the different chemical species of Cyanotoxins.

www.canalgestion.es/galeria_ficheros/compromiso-social/publicaciones/Cuaderno12_I+D+i.pdf

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