

EVALUATION OF WASTEWATER TREATMENT PLANTS OF THE PROVINCE OF LEÓN. THE ROLE OF GIS AS A TOOL FOR EFFICIENCY IMPROVEMENT AND TERRITORY MANAGEMENT

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Abstract

Legal and environmental requirements compel us to maintain a high quality on water resources. The current status of wastewater treatment plants and collecting lines must be evaluated and continuously checked. By using the advantages of geographic information systems, it could be possible to accurately determine the demand of infrastructures which optimize water pollution treatment, to select the most optimum systems for each particular case and to project economic programs and policies for covering all the necessities.

Introduction

The province of León is located at the northwest of Spain, combining flatter areas at the South with the steep relief of the Cantabrian Mountains in the North. It hence shows a large and complex hydrological network, composed by hundreds of small-medium streams and other important rivers, much of them protected by several figures (e.g. Nature Network 2000). According to official statistics (INE, Spain), the Province of León is structured in 211 municipalities which contain a total amount of 1428 localities. From all the municipalities, 178 account for less than 2000 inhabitants in their censuses, representing 84.4% of the total localities of the Province but only less than 25% of the entire population. Wastewater discharges derived from small populations (i.e. <2000 inhabitants), which represent the great majority of the Province, show special characteristics which might be considered when developing policy strategies and managing the treatment systems in order to undertaking requirements (Directive 91/271/EEC). Moreover, the European law (Directive 2000/60/EC) compel us to maintain a high quality on water resources.

In this context, for achieving the maintenance (or improving) the quality of the water resources of the Province of León, it results essential a rigorous and accurate knowledge of the current status of all wastewater treatment plants and collecting systems, developing also a method which allowed to continuously maintain or improve the information available. With this information, it could be possible to develop an efficient and locally-tailored planning for achieving the ecological and legal exigencies. In

this way, the Geographic Information Systems (GIS) represent simple and comprehensive tools for collecting information and maintain, in a spatially-explicit way, about wastewater treatment plants and collecting lines, as it has been shown in previous works (Gemitzi *et al.*, 2007; Kallali *et al.*, 2007; and Huffmeyer *et al.*, 2009).

Methods

Sampling data. Data about the collecting systems and wastewater treatment plants about all the localities of the Province, grouped by sub-regions and drainage basins, were recorded during two subsequent phases (De Luis Calabuig *et al.*, 2009). The sampling effort was high, collecting information about the systems themselves, about effluent and influent fluxes, population, economic activity, industry and other factors. The quality of the input data will condition the effectiveness and accuracy of the subsequent analysis undertaken with GIS tools. The accurate location (under X, Y coordinates in European Datum 1950, UTM projection 30N) of all water treatment pollution plants, as well as the dumping points, were determined by intensive fieldwork and gathered in graphic cards and digital databases.

Databases and Geographic Information System (GIS). Once the information about all localities had been gathered, it was homogenized and structured in a database which allowed doing easy queries as well as the connection with a GIS, giving a spatial dimension to the information.

Results and discussion

Population and economy. The population occupancy of the Province of León shows an extreme disperse pattern with an important seasonal variation in population size. There is not a meaningful industry activity, except some punctual cases (only 13% of the localities showed industry dumping, and among them only 27% were considered as dangerous for the aquatic ecosystems). In turn, livestock farming consists mainly in old and small exploitations inside town perimeters and connected to drainage networks.

Collecting lines. 95% of the localities of the province have collecting lines. Nevertheless, 79% of them do not separate water derived from rainfall and runoff from sewage, which significantly reduces the efficiency of the systems and frequently causes problems of maintenance and even major damages.

Wastewater treatment plants. Considering all the localities of the province of León, there were inventoried a total amount of 1678 water dumping points. In turn, these water dumping points occur sometimes within the treatment plants (indirect discharges, 78%) while in another occasions they

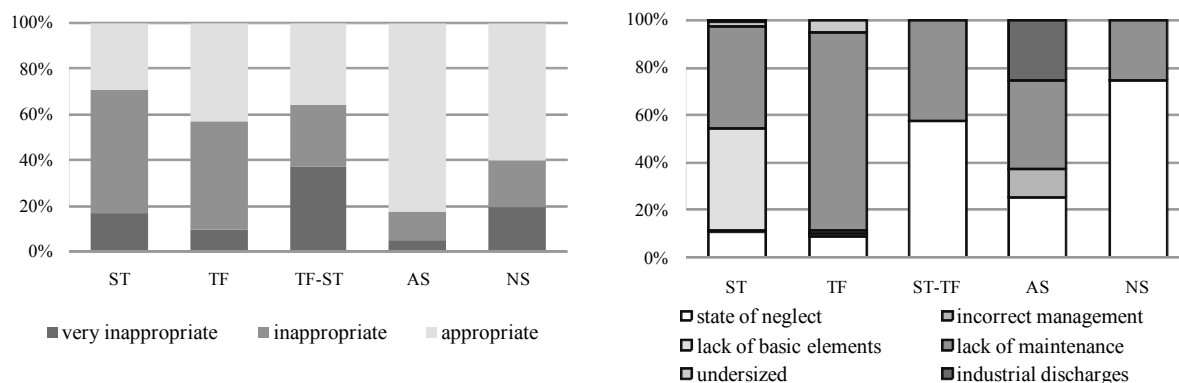


Figure 1. Quality of the sewage management service and main problems detected in the treatment systems. ST: septic tanks; TF: trickling filters; TF-ST: trickling filters with a secondary sedimentary tank; AS: activated sludge; NS: natural systems

occur directly in the receiver water streams without any treatment (direct discharges, 22%). There was also identified an important variability in the treatment systems, including septic and other septic tanks (ST, 62%), different types of trickling filters (TF, 30%), trickling filters with a secondary sedimentary tank (TF-ST, 4%), activated sludge (AS, 3%) and natural systems (NS, 1%).

Legal and environmental requirements. The quality of the sewage management service is considered not satisfactory in almost 70% of the localities. The percentages vary substantially depending upon the treatment system (see Figure 1). In general, there were found several problems as responsible of the non effective treatment of wastewater. The most important was the lack of maintenance (74% of the systems analyzed). Nevertheless, the state of conservations of the structures was acceptable in 50% of the cases, which led us to think that with just some minor improvements and not so much inversion, a substantially bigger number of plants in the Province could give an appropriate service of treatment to wastewater.

The inclusion of the whole database within a GIS allows to explore the data in a spatial basis, which represent a unique opportunity for determining those areas with the higher needs of improvement (i.e. protected areas, fragile riverine ecosystems, etc.) and/or increase the efficiency of the inversions (i.e. repair the plants with better accesses or cheaper needs). Moreover, the use of this GIS in sitting new wastewater treatment systems has revealed as a useful tool, since the GIS makes possible to study different variables, such as topography, climate, distance to cities and villages, slope, existence of environmental protected areas, in order to accept or reject a particular area within a region to locate a wastewater treatment system.

Conclusions

After the three stages of the study for evaluating the collecting lines and wastewater treatment plants of the province of León, all information has been gathered and included into an specific GIS, which allowed to manage and improve the efficiency of the systems.

Only the 78% of the dumping points showed wastewater treatment plants, which are characterized by the diversity of technologies applied, being dominant the septic tanks and other sedimentary tanks. The quality of the service is satisfactory for around 30% of the localities, while almost 70% showed non-satisfactory treatments of wastewater. Activated sludge and natural systems were the most efficient and showed the best results. The most important problem encountered was the lack of maintenance, followed by the abandonment and the bad technical design of the plants (dimension, volume and others). Although not all the plants work efficiently, around 50% of them showed a good state of conservation of their physical structures.

The application of GIS allow to characterize those areas with the higher priority for undertaking management actions or new constructions of wastewater plants, as well as to determine which systems are the most suitable ones for each particular location (considering all environmental factors which may drive their efficiency).

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