Example of management of water resources for agricultural irrigation

Carla Caroça

PhP in Geology, specializing in Hydrogeology by University of Lisbon, Science Faculty, Lisbon, Portugal

Abstract**—** *Water is a natural resource vital to life, economic development and social welfare. The National Water Plan resulting from the transposition of the Water Framework Directive, has as an objective: benefit the existing irrigated, with the aim of making more efficient use of water, in particular, with regard to reducing losses, storage, transport and distribution of water, its application in soil and the rationalization of consumption. [1]. Portugal, in Aveiro, between Nazaré and Alcobaça council, has an area with a simple irrigation system for irrigation, called Cela hydro-agricultural profit.*

Keywords**— irrigation, water, agriculture, Portugal, management.**

I. INTRODUCTION

Agriculture is one of the essential activities for the production of food and for the economic and social development of rural communities. The demand for irrigation water throughout the year, in quantity and quality, leads to the need for the construction of hydraulic structures with the objective of extracting and distributing water from the water resources to the cultivated areas. [2]

Portugal has as its environmental objective the socio-economic and environmental sustainability of water resources. One of the examples of the Water Resources Management Plan (PGRH), implemented in Portugal, is *Cela* Agricultural Instigation Work, which in Law-Decree number 86/2002 of April 6, from chapter XX – Concession, article 102nd, passed to write *Cela* Hidro-agricultural Profit, instead of Hidro-agricultural Instigation. This work, begun in 1940, continues to this day.

II. LOCATION

The *Cela* Hidro-agricultural Profit is located in the *Famalicão* Valley, covering part of the *Alcobaça* river and the alluvial lowlands of the basin bounded by the *Pescaria* and *Bárrio* mountains, in the parish of *Famalicão* of the municipality of *Nazaré* (104 ha) and in the parishes *Cela* and *Bárrio* in the municipality of *Alcobaça* (377 ha), in the district of *Leiria*, making a total area of 481ha. (**Fig. 1**)

The area where the Hydro-agricultural Profit is located corresponds to an alluvial plain basically constituted by holocenic formations composed of sediments transported by the waters and deposited in the basin, of very low dimensions and physiographically very flat. The terrain measures vary between 0 and 6 m. [3]

The most representative crops installed in the *Cela* Profit in recent years are horticulture, orchards and other crops with little representation. The average distribution of the crops is 65% of horticultural, 20% of orchard and 15% of other crops, being the one that consumes more water the horticultural ones. [4]

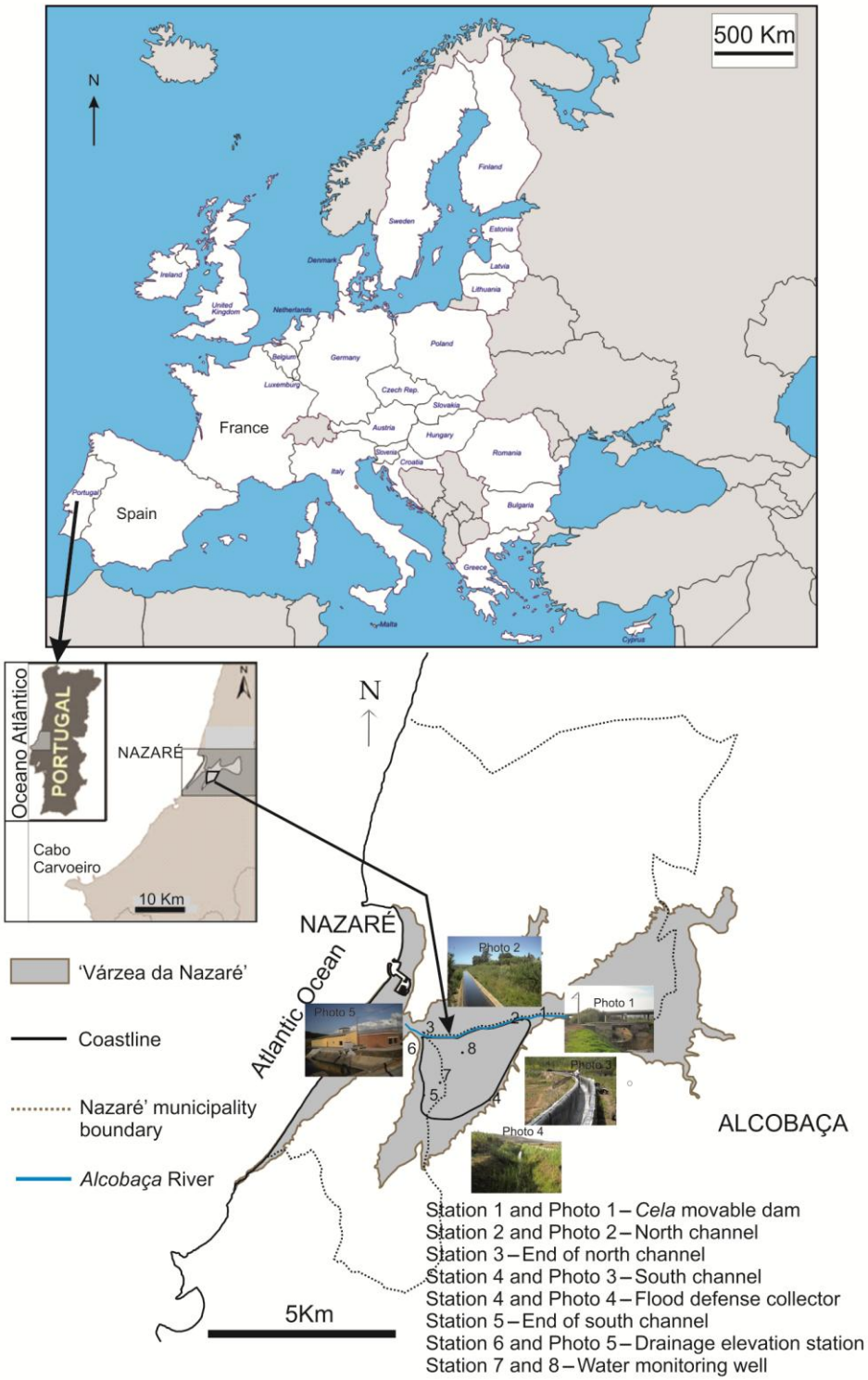

FIGURE 1 – CELA HYDRO-AGRICULTURAL PROFIT LOCATION. (*VÁRZEA DA NAZARÉ* IS THE AREA OCCUPIED BY THE OLD *PEDERNEIRA* LAGOON THAT SETTLED FROM THE 18TH CENTURY, AND IS FILLED WITH ALLUVIAL SEDIMENTS OF THE QUATERNARY.)

III. *CELA* HYDRO-AGRICULTURAL PROFIT

Hydro-agricultural works, using the definition of a work of hydroagricultural Instigation Work, are works of «use of public water for irrigation, watering or sealing, drainage and defense of land for agricultural purposes, adaptation to irrigated land benefited, irrigation improvement and the appropriate agrarian structuring» (Law-Decree number 269/82 of July 10). At the

moment it is defined as being «the set of hydro-agricultural infrastructure and its equipment, areas that were acquired and expropriated for its implantation, as well as other real estate identified in the respective regulation» (article 2nd, paragraph *a*, of Decree number 1473/2007 of 15 November).

The area of *Cela* Hydro-agriculture Profit consists of the following infrastructures:

- *Cela* movable dam (photo 1, station 1 in **Fig. 1**),
- Distributor channel of the *Alcobaça* River or main channel,
- Flood Waist Valve, also referred to as the Flood Defense Collector (around the perimeter of hydro-agricultural Profit),
- North and south elevated irrigation channels (also known as northern and southern collectors) (parallel to the flood defense collector and within the perimeter of the hydro-agricultural profit),
- Small beam dam (deactivate),
- Irrigation and drainage system integrating channels and irrigation ditch,
- Drainage elevation station (in this there are two buoys to measure the piezometer level, which is not registered due to lack of personnel and/or funding to allocate to the programmer a printer). (station 6 in **Fig. 1**).

The water intake of the *Alcobaça* river is made by means of a nozzle with a rectangular section equipped with an automatic damper provided by an electric automatism controlled by a mobile phone, [5], installed in the reservoir at Km 4, [4], without the need for pumping. The entrance is protected by a fixed metal grille, without cleaning grills. [5]. The maximum discharge at the outlet of the dam, according to the Association of Beneficiaries of *Cela* is variable according to the current of the river, hence it is difficult to estimate the cubic meters per hour. This flow will feed the main channel, *Paúl da Cela*, and at the end the surplus returns to the river *Alcobaça*. Along this route, the main channel is subdivided firstly by two irrigation channels, the north and the south. From these, there are several channels for patch of ground irrigation.

After watering, drain excess water in the patch of ground to avoid flooding. For this purpose, the elevation station located near the *VCI* of *Nazaré* (photo 5, station 6 in **Fig. 1**) is used to remove the water from the site with a maximum discharge (project horizon) of 0,222m^3/s to the *Alcobaça*. [4]

The management of the *Cela* Hydro-agricultural Profit was delivered to the *Cela* Beneficiaries Association based on a concession contract for the 'private use of the public water domain' for a period of 20 years, 'under the terms of article 69st of Law number 58/2005 of December 29, and in article 35st of Decree-Law number 226-A/2007 of May 31', made between *Administração de Recursos Hídricos (ARH) Tejo IP* and the *Direcção Geral da Agricultura e Desenvolvimento Rural (DGADR)*, in 2011.

Therefore, the Association has to fulfill certain obligations, such as:

- Maintain in perfect operation the infrastructures and the estates assigned to the concession;
- Facilitate water consumption for new users;
- Respect the precautionary measures of the competent authorities in flood periods;
- Informing any changes to the state of water captation that prevents its use in Agência Portuguesa do Ambiente (APA), I.P.;
- Comply with the provisions of article 78st of Decree-Law number 226-A/2007 of May 31 regarding the final destination of materials resulting from the cleaning of irrigation channels;
- Know and apply up-to-date national and international standards;
- Inform about changes in the type of crops and the fertilization system and phytopharmaceuticals used;
- To elaborate, define and present emergency prevention and mitigation measures in the face of various possible accidents in watering and in hydraulic infrastructures;

- Develop a monitoring plan about water resource used, fertilizers products and phytopharmaceuticals, and the patch of ground to be irrigated. [4]

In addition, the *Cela* Beneficiaries Association is subject to water resources tax, water utility tariffs and program contracts related to water resources management. [2]

IV. DISCUSSION

The Association initiated the payment of the water resources tax in 2010, but disagrees with this rate. Claiming that the use of water is done by closing a gate in the *Alcobaça* river bed and proceeding to its distribution by trenches and by cement aerial channels. It considers that the calculation formula in the law does not apply to the situation of this irrigation system based on gravity, without pressure, and there being no alternative to this payment suggested the existence of three counters. One at the water entrance of the *Alcobaça* river and the other two at the exits of the north channel and the south channel, in the discharges to the flood defense collector. The difference between the outlet value for the flood defense collector and the value of the water intake in the perimeter would give an approximate value of the discharge consumed, taking into account that not all water is used, since there are loss of around 30%, due to the occurrence of infiltrations and evaporations along the course.

The Continent Rural Development Program 2014-2020, version 1, dated 28 October 1983, prepared by the Sea and Agricultural Ministry in the politics planning Cabinet, includes *Cela* Hydro-agricultural Profit in the Priority Intervention of 'Sub-Action 2 – Improvement of the existing irrigation efficiency'. To 'improve and update the existing hydro-agriculture utilization in order to reduce losses in water transport and distribution, to promote storage reinforcement and more efficient techniques in conjunction with more energy-efficient solutions and the introduction of new technologies'. According to this program, the modernization of older profits will have an impact on productivity and water management, introducing water and energy savings, and investment in this area should focus in particular on:

- Introduction of water conduction and distribution systems leading to the reduction of unused water fractions;
- Modernization and automation of equipment already installed;
- Rehabilitation of installed infrastructures in order to improve the efficiency of their management and exploration, reducing water losses;
- Promotion and installation of new technologies, namely in water and irrigation management, such as automation, telemanagement, remote monitoring and geographic information systems and water quality monitoring.

The introduction of more efficient water supply and distribution systems presupposes the minimization of impacts on the environment, preservation of the water lines and natural values present, water monitoring, landscape integration and water management, as inseparable from the sustainability of public irrigation. Likewise, the modernization of water pumping and energy production equipment associated with the management of hydro-agricultural profits aims at increasing the energy efficiency of these profits, with consequent environmental gains, in particular in terms of reducing consumption of fossil fuels and reduction of greenhouse gas emissions. [6]

V. CONCLUSION

The Water Law (Law number 58/2005, of 29 December, altered for Law-decree number 130/2012 of 22 June) and the Water Framework Directive (WFD) (transposed Directive 2000/60/EC of the European Parliament and of the Council of 23 October) do not mention hydro-agricultural works, but rather, hydraulic infrastructures. Hydraulic infrastructures are 'works or assemblies of works, installations or equipment installed on a fixed basis in beds or banks intended to allow the use of water for the purposes of the general interest' (article 4st, paragraph *ee*, Law-decree number 1301/2012 of 22 June). They require the expropriation of small patch of ground for the placement of primary and secondary pipelines, lift stations, dams, reservoirs and other hydraulic infrastructures. (Example: *Cova da Beira* Hydraulic Infrastructures). [7]. These are more expensive works than the works of hydro-agricultural Profit. As the Water Law and the WFD did not repeal Law-decree number 269/82 of 10 July, nor its alterations, this "remains as the set of standards and reference principles for hydro-agricultural profits and areas benefited" [8], changed to Law-decree number 86/2002 of April 6, and this one, in turn, was changed to Law-decree number 169/2005 of September 26. [2]

The author considers the "hydro-agricultural profit works" (Law-decree number 86/2002 of 6 April, based on article 102nd) useful and which should be considered in agricultural activities as current practices, not only for better irrigation efficiency and production of agricultural products, but also for the management and preservation of water resources throughout the year. However, if other entities responsible for water resources (*Agência Portuguesa do Ambiente, IP* and Autarquias) do not comply with the requirements of the legislation on the preservation of the environment and the quality of water for human consumption and irrigation, such as: non-control on the introduction of wastewater into water lines and soil and the lack of cleaning and reprofiling of water lines, agricultural production is impaired.

Good planning and management of water resources is achieved when the various public and private entities, professionals, researchers and students work together and/or share informations.

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