

AQUIFER PROJECT: “Innovative instruments for an integrated management of groundwater in a context of an increasing scarcity of hydrological resources”

Deliverable 2.4.2

Experimental design of adaptation plans to water scarcity

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1. INTRODUCTION

Groundwater bodies are increasingly being used to obtain water, either for agricultural and livestock activities or for the production of drinking water. With the increasing consumption of water from aquifers, it is important to have as much knowledge as possible about them.

The need for more information on aquifers, their monitoring networks and sustainable management led to the creation of the Aquifer project. The Aquifer project aims to "capitalize on, test, disseminate and transfer innovative practices for the preservation, monitoring and integrated management of aquifers, to assist them in making decisions regarding the management of groundwater resources, improve technology transfer to local actors, create new synergies and develop common tools in a context of scarce water resources and environmental threats."

What sets this project apart from others is the fact that it studies both the water quality and the water quantity existing in groundwater bodies, through the study of aquifer recharge management and the use of monitoring network and hydrological modeling. Another point to highlight is the creation of a website open to the public that helps decision making on good agricultural practices that prevent the degradation of aquifers and increase their water quality and quantity.

To make this project as complete as possible, several national and international entities joined forces: Centro Nacional do Instituto Geológico e Mineiro de Espanha (IGME), Instituto Superior de Agronomia da Universidade de Lisboa (ISA-UL), AR - ÁGUAS DO RIBATEJO, E.I.M., S.A., Comunitat d'Usuaris d'Aigües del Delta del Llobregat (CUADLL), Aqua-Valley, Serviço Nacional de Geologia, BRGM, Parceria Portuguesa para a Água (PPA), Catalan Water Partnership (CWP) and Comunidade de Regantes do Campo de Cartagena (CRCC)

In order for each entity to give its best contribution, different groups of activities were created, and later distributed among the different partners. The first group of activities aims to obtain a pilot aquifer monitoring network and a hydrogeological database. The second group is

focused on hydrogeological modeling, aquifer recharge and on defining innovative solutions for water resources management. The third group is responsible for creating a decision support network for groundwater management and for exploring the limitations and difficulties of combined use. Finally, the last group defines innovative practices for aquifer management in situations of scarcity and to create a transnational website with all this information available.

This activity belongs to the second group of activities. The main objective is to understand the importance of agricultural associations related with preservation of ground water bodies. In Portugal, the main job of agricultural associations is helping the farmer taking decisions and suggest the best way to do them.

The biggest concern of these associations is the water consumption and efficient irrigation, so all the measures promoted are directed to those aspects. These measures are in different categories: soil type, weather, crop, irrigation system, water management and equipment efficiency.

2. MEASURES SUGGESTED BY AGRICULTURAL ASSOCIATIONS

2.1. Measures related with irrigation systems.

For the farmer to have an efficient irrigation system, he needs to have an idea of what his water consumption is going to be. The water consumption will vary with the area, the irrigation method, the chosen crop, the irrigation management, the weather and the soil type.

After considering all the factors, he needs to determine what is going to be his highest flow and his average flow. To determine the highest flow (Q) he can use this formula:

$$Q = K \frac{E_t A T}{E_a T_1}$$

Q = Flow (L/s)

Et = Highest consumption of water by the crop (mm/day)

A = irrigation area (ha)

T = Time between irrigations (days)

Ea = Efficiency

T1 = Watering time per cycle (days);

K = Constant (0,116 for the metric system)

This formula includes all the essential parameters to choose the right equipment for an irrigation system. However, to determine some of these parameters, such as: the frequency of irrigation, the time of operation and the efficiency, you need to consider different aspects such as: the soil, the weather, the crop and which watering system you are going to use.

Equipment efficiency

The 3 most efficient irrigation systems are: fixed sprinkler, moving sprinkler (pivot) and drip irrigation. These systems have different efficiencies and different coverage area percentages. When choosing an irrigation system you have to consider it's efficiency, crop, area and cost.

The two main factors that you have to consider in the different irrigation systems are the watering uniformity and application rate.

In general, the sprinkler systems (fixed and pivot) have less watering uniformity than the drip irrigation. But the watering uniformity depends a lot on the maintenance that the equipment has. Knowing exactly the amount of water that comes out of each sprinkler or drip point, makes it possible to adjust and have an efficient watering system.

The application rate is the amount of water irrigated per hour and varies a lot with the irrigation systems. The fixed sprinklers and drip irrigation have an application rate a lot smaller than the pivot. But the pivot is less likely to cause superficial runoff than the other two. Usually the sprinkler systems have a low runoff but a bigger probability of water lost caused by the wind and high temperatures.

2.2. Measures related with soil type, weather and crop

Soil Type

Being the weather and the soil type, two very important aspects to consider when choosing your irrigation system, they need to be properly characterized.

Different soil types have different qualities for an efficient irrigation. Aspects as granulometry, thickness, usable water capacity, infiltration, drainage problems, erosion risks can cause different water consumption.

Aspects as the soil capacity to retain water and the granulometry influences the superficial and underground runoff. This means that if on a soil with low infiltration capacity a high irrigation rate is used this will result in a big water lost to superficial runoff. On the other

hand, if the soil has a high infiltration capacity and a low capacity to retain water a high irrigation rate is used, there will be a higher water lost to underground runoff.

A good soil sample analysis is essential to determine all the aspects mentioned and calculate the amount of water needed. When the irrigation is not adjusted to the soil type, the water loss could be intense and the system can become very inefficient.

Another important aspect that influences especially the superficial runoff is the slope. With higher slopes, the percentage of water lost in superficial runoff is more likely to be high.

Weather

The weather is another factor that needs to be taken into account.

When implementing an irrigation system, we need to have an idea of the kind of weather you are expecting to get, mainly focusing on when are the wet and dry seasons and the average amount of rain.

In Portugal a map with the humidity levels, based on the relation between precipitation and evapotranspiration, is available to the public.

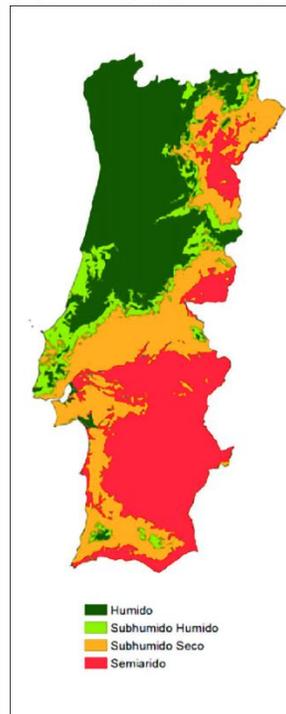


FIGURE 1: MAP OF THE ARIDITY INDEX IN PORTUGAL

With the map in figure 1, you can have an idea of the kind of weather you are expecting to get. If you want to get more information about the weather, you can also collect data from the last couple of years in the website SNIRH.pt

On a daily basis, we also have to consider the weather to decide when and how much water you will use for irrigation. The most important factors to consider are the temperature and the wind speed. Watering efficiency gets worse as weather conditions reach temperatures above 30°C and wind speeds above 3,5 - 4 m/s.

The irrigation system type that you choose has a big influence on the water loss. The weather has less influence on drip irrigation systems than on sprinkler systems.

The weather conditions can reduce the efficiency of the irrigation system if not taken into account as they reduce the watering uniformity and application rate, due to evaporation and drift cause by wind.

Crop

The crop you choose to grow has a big influence on the water consumption. Different crops have different water necessities and on different time frames.

Another aspect that varies from crop to crop is the evapotranspiration. A crop that, with the heat, has a high evapotranspiration, has a higher water consumption, which requires a different irrigation management.

3. FINAL CONSIDERATIONS

- We know that we have an efficient irrigation system and a good water management when we take into account all the factors that influence the water consumption and water losses.
- An efficient irrigation system is the key for a good quality groundwater and profit for the owner.
- A good soil evaluation can tell us the soil usable water capacity and estimate the water losses.
- A good weather data analysis will give us an idea of the water received by precipitation and the water loss due to high temperatures and wind.
- The study of the different irrigation systems tells us which one is more adequate considering our crop, area, weather conditions and soil type.
- After analyzing all the aspects mentioned above, we need to think what the right watering time is and how regularly we have to water.
- If we consider all these aspects, we will have an efficient irrigation system.
- The best way to preserve the ground water masses is by reducing the water consumption and underground runoff, because along with the water, other products are lixiviated such as: nutrients, insecticides, pesticides and so on.
- An efficient irrigation system is the key for a good quality groundwater and profit for the owner.