

The Use of Precision Agriculture for Improving the Water Economics of Farms and the Need for Agricultural Advisory [†]

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Abstract: The rational management of water, which is determined by the Framework Directive 2000/60/EC of the EU, is a contractual obligation of the Agricultural Sector of Cyprus, both towards the European Union and the next generations of Cypriot citizens. To make decisions about sustainable water use and improve water use, it is necessary to understand the water use of crops in different water-use areas. Especially in large water projects in Cyprus, there must be a good way to determine the water use of crops so that the correct use of crops can be ensured, thus eliminating problems such as a lack of new information about the crop area and agricultural evaporation, Demand, and water. In most projects, water is managed and supplied based on historical data, and current information is available to determine water demand and availability for large areas. This paper also adds, apart from the clear positive effect of remote sensing and new technologies in crop irrigation, to the emerging need for advisory services for the diffusion of innovation to Cypriot farmers since the estimation of crop water requirements is part of estimating the carbon footprint under the project CARBONICA (EU Funded) for carbon farming.

Keywords: technoeconomic analysis; irrigation water; earth observation; SEBAL method; advisory services



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1. Introduction

Prolonged drought, dry conditions, and poor irrigation and water supply management result in a significant reduction in water reserves and resources [1]). Irrigation water reductions are based on studies of percentage reductions in the required volume of irrigation water and crop responses to these reductions. The required irrigation volume for each crop is calculated based on the evapotranspiration (ET) of each crop, which has been empirically found (Epan) in the past [2]. However, the need for an accurate measurement of ET today remains imperative and is an integral element in the decision-making of Water Policy Bodies. The continuous decrease in rainfall in Cyprus [3,4] (Cyprus Meteorological Services, 2020/2021) in recent decades has contributed to an increase in irrigation and, therefore, the volumes of water consumed in agriculture. However, the reckless use of irrigation water combined with reduced rainfall caused a serious blow to the storage of water in Cyprus [5].

2. Methods

ETc forecasts based on remote sensing are almost universally used due to the following advantages of remote sensing: abundant raw data, low cost, and weather forecasting. It is worth noting that Landsat 7 ETM+ and 8 OLI images cover almost the entire island of

Cyprus, and their resolution is good for hydrological studies. The study area is in the village of Mandria in the Paphos Region (west of Cyprus), which is the main agricultural area of the Paphos Region and absorbs the largest amount of water (26%) in the water supply system of Cyprus. Remote sensing techniques have been applied to estimate the accurate irrigation volumes per crop and finally compared to the empirical values that farmers are already using.

3. Results and Discussions

To produce these results, evapotranspiration maps were created where users can see the needs of their crops on a daily or even monthly basis (Figure 1). These maps are essentially the satellite images of the area, which were converted into maps using the SEBAL algorithm [6] after its application in the ERDAS Imagine software (version 16).

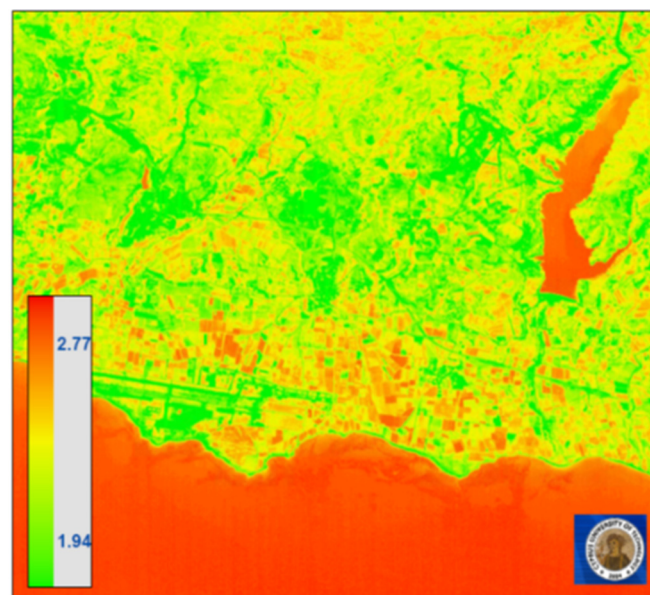


Figure 1. Example of a crop evapotranspiration map creation in Cyprus.

Table 1 shows the results of the project for the crops under investigation. The aim was to create an irrigation plan from which the producer would know the required irrigation volumes. It is noted that the results of this project, in terms of evapotranspiration, are given in mm/day, which, however, are easily converted to m³/ha/month for comparison purposes with previous research data referred to in the “Norm Input Output Data for the main crop and livestock enterprises of Cyprus” [7], which are listed in that format. The specific manual (Norm) published by the Agricultural Research Institute is the only technical and economic database in Cyprus for issues related to agricultural crops.

Table 1. Irrigation needs (m³/ha/month) for specific crops in Cyprus.

Crop	J	F	M	A	M	J	J	A	S	O	N	D	Total
Potatoes	-	-	-	-	-	-	450	850	1200	1550	1300	-	5330
Groundnuts	-	-	-	-	-	-	620	1450	1650	300	-	-	4020
Beans	-	-	-	-	-	-	450	850	1200	990	-	-	3490
Peas	-	-	200	800	480	-	-	-	-	-	-	-	1480

The research data of this project were converted into irrigation costs after multiplying with the cost of irrigation water, which amounts to EUR 0.17/ton (Table 2). So, the project data are now comparable to the data mentioned in the Norm. This study focuses on the cost of irrigation, which appears to be a major expense for producers today. More specifically,

the cost of irrigation for the crops amounts to 19%, 25%, 23%, and 5% of the variable costs, respectively, and to 12%, 19%, 17%, and 4% of the total costs, respectively. It is, therefore, indisputable that the cost of irrigation contributes to a reduction in the profit of the producer since it can contribute 20% to the formation of the cost of cultivation. A reduction in the cost of irrigation has positive inductive effects on the producer’s profit, which is the final demand for producer–entrepreneurs.

Table 2. Percentage of marginal cost and profit in irrigation expenses.

Irrigation Cost as for	Potatoes	Beans	Groundnuts	Peas
Variable Cost (before)%	0.19	0.25	0.23	0.05
Total Cost (before)%	0.13	0.15	0.14	0.03
Variable Cost (after)%	0.12	0.19	0.17	0.04
Total Cost (after)%	0.08	0.11	0.10	0.02
Profit increase%	1.29	1.20	2.23	1.05

4. Conclusions

It is clear from the new data produced by this research project that the producer’s profit increases. In addition to the benefit of the producer, however, at the microeconomic level, there are also social benefits. The use of satellite remote sensing in the field of irrigation and water resources management can contribute at a microeconomic level to the maximization of the producer’s profit. The reduction in irrigation costs, using the optimal amounts of water for the needs of the crops, contributes dynamically to the profit margin of the producer while, at the same time, having a positive effect on the storage of surface water resources stored in the dams. All these positive research results fade out unless there is a proper advisory service that disseminates this knowledge. Although the Ministry of Agriculture, Rural Development and Environment in Cyprus has undertaken a great effort to establish an efficient system for agricultural knowledge and innovation (AKIS) to promote innovation in the agri-food sector, it should be improved by becoming even more integrated and powerful providing farmers better access to education and training programs.

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