Introducing Kiwifruit Water Footprint into a Traceability IT System

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Abstract

Efficient use of water resources is connected to sustainable agricultural practices. Water Footprint (WF) has been largely employed for more than ten years as a useful tool for planning efficient water and nutrient management strategies at various spatial levels. Greek kiwifruit production is constantly growing especially during the last decade, and the plain of Arta (NW Greece), is among the hotspots regarding kiwifruit culture in Greece. The irrigation water requirements of the crop in that area are high, while fertilisers are usually provided to the crop via fertigation methods. In this framework an innovative web application was developed in collaboration with Kolios Fruit S.A., a major exporter of agricultural products, which is based in Arta. The application is used to handle data during the full range of cultivation practices of kiwifruit (pruning, irrigation, fertigation, plant protection, harvest etc.), along with data from soil analysis, weather conditions, fruit quality analysis and yield. A component of the that application calculates the WF. During the testing of the application the average cultivation WF of kiwifruit at the plain of Arta was found equal to 335,47 m^3 tn^{-1}. The application provides to farmers, agriculturalists, processors, traders, consumers etc., traceability information regarding kiwifruit cropping practices as well as information regarding the WF of the fruits.

Keywords

Agricultural practices, efficient water use, environmental labeling

1. Introduction

As water scarcity is listed among the major global risks and agriculture is the most significant water user in many countries, efficient use of water resources is connected to sustainable agricultural practices. Water Footprint (WF), an index that accounts for the amount of water used along a part or the full supply chain of a product, has been largely employed for more than ten years as a useful tool for planning efficient water and nutrient management strategies at various spatial levels. Greek kiwifruit production is constantly growing, especially during the last decade.

The 9,500 hectares of kiwifruit fields rank the country as the 3rd top global producer. The plain of Arta (NW Greece) is among the hotspots regarding kiwifruit culture in Greece. The irrigation water requirements of the crop in that area are high, while fertilisers are usually provided to the crop via fertigation methods.

WF could connect water and cultivation inputs management of kiwifruit cultivation in a single index. In this framework an innovative web application, which includes calculation of cultivation WF, was developed by the University of Ioannina in collaboration with Kolios Fruit S.A., a major exporter of agricultural

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products, which is based in Arta. The application was tested for the case of kiwifruit cultivation in the plain of Arta.

2. Description and Main Features of the Application

The web application is designed to handle data regarding the full range of cultivation practices of kiwifruit (pruning, irrigation, fertigation, plant protection, harvest etc.), along with data from soil analysis, weather conditions, fruit quality analysis and yield. The cultivation WF is calculated taking into account the green, blue and grey components of the index. The application provides to farmers, agriculturalists, processors, traders, consumers etc., traceability information regarding kiwifruit cropping practices as well as information regarding the WF of the fruits.

The application is consisted by two main components: the data gathering part used for the traceability of kiwi and the data mining used for generating various statistics regarding the kiwifruit and the farms. In the first component, farmers, agriculturalists and traders are responsible for gathering data from every stage of the traceability chain. The farmers and agriculturalists gather and store data regarding their cultivation practices and their harvest through the application. Those data are stored in the database through a Restful API service, and they are accessible by interesting parties (**Figure 1**). To enhance the user experience, standard information such as commonly used fertilizers and plant protection products are already stored in the database and are accessed via a simple dropdown menu from the user. At the end of each harvest period agriculturalists perform chemical analysis on the kiwifruit that determines the quality of the product. To complete the traceability chain of the kiwifruit, traders are responsible for recording the shipment of the product. The traceability applications provide the ability to the traders to quickly perform a forward trace recall in case of an emergency.

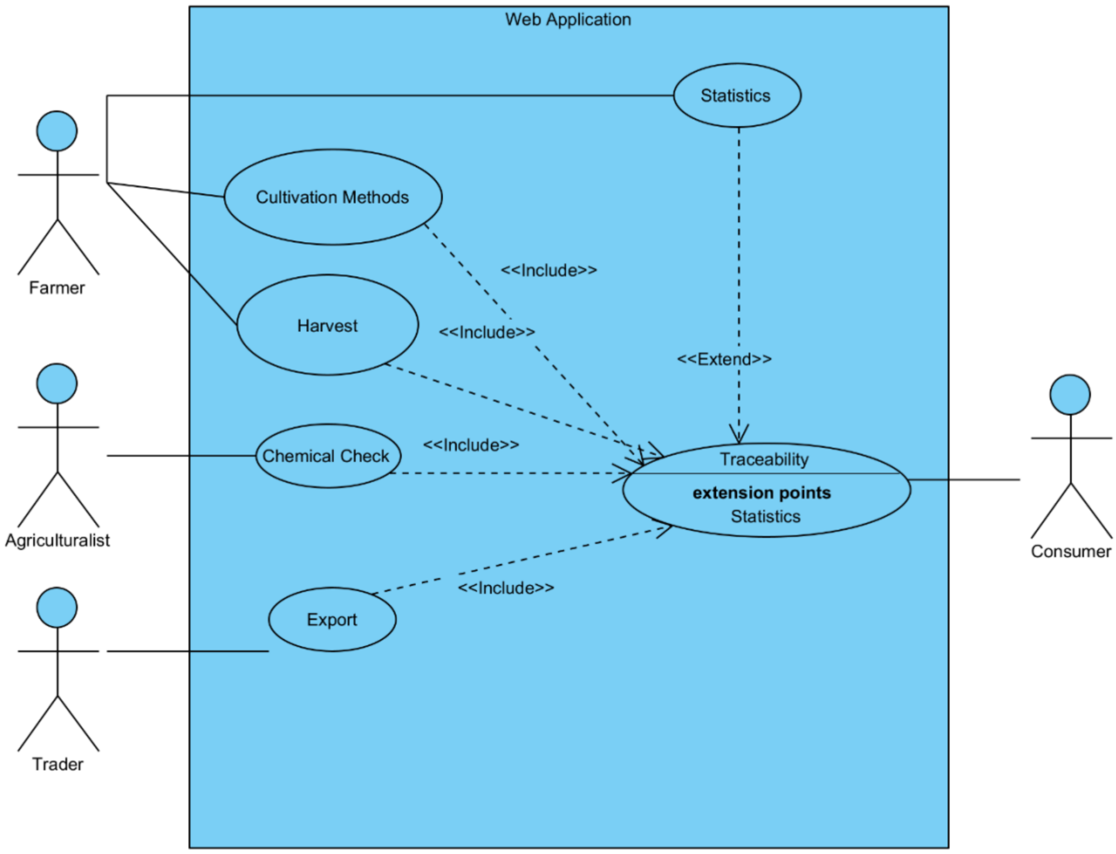

Figure 1: Data gathering and dissemination flow chart

In the second component, various elaborate algorithms are used to calculate the green, blue and grey components of WF. To begin with, the application, on a daily basis, calculates and stores the crop evapotraspiration (ET_c) to the database by using crucial data from local agro-meteorological stations. The calculation of ET_c is made using the methodology proposed by Allen et al. [1]. The meteorological data are gathered by accessing the API of Enhydris, a database system that stores meteorological data from all around Europe [2]. It also provides an API to allow users to retrieve data from any meteorological station stored in their database. An agro= meteorological station is assigned to each farm stored in the database based on their proximity, calculated according to the Haversine formula. At the end of the year, several algorithms are executed by the system to calculate the green, blue and grey components of the WF (**Figure 2**). The WF was calculated according to the methodology proposed by WFN [3].

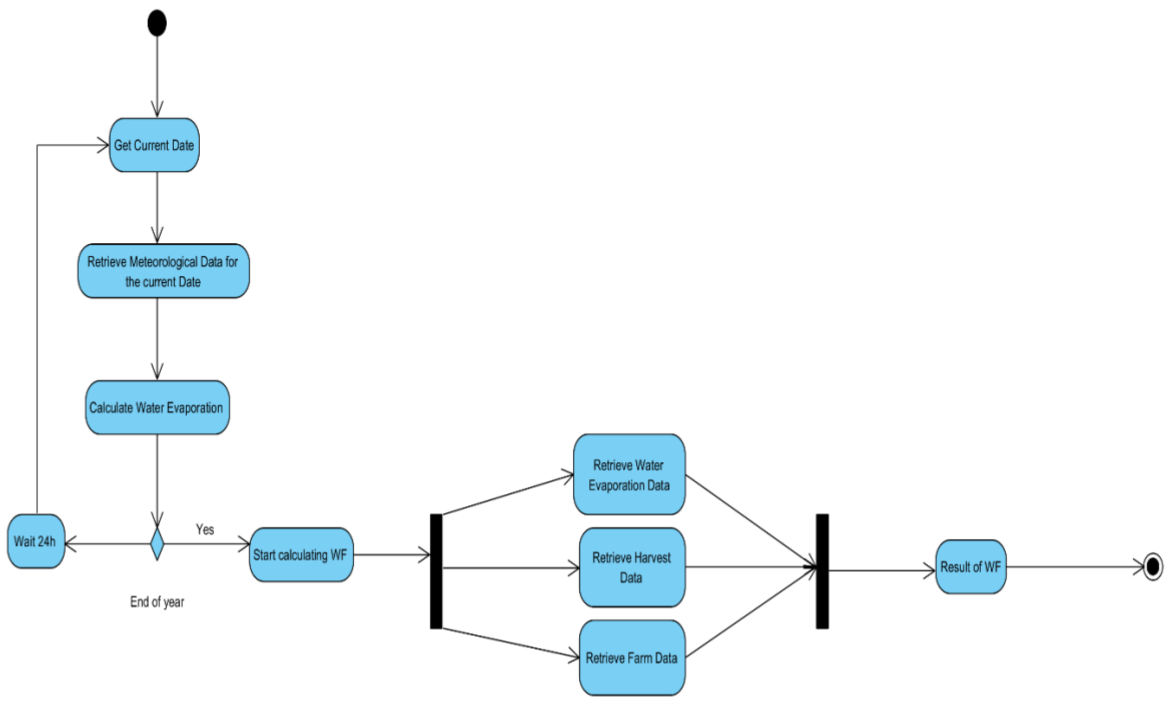

Figure 2: Calculation procedure for Water Footprint

Those data are available to the farmers and also as a marketing tool to allow customers be aware that the product and the applied cultivation techniques are eco-friendly. In addition to the WF through the application, farmers can find statistics generated by data mining algorithms. Those statistics take into consideration the cultivation practices performed in the farm, the location of the farm, and the chemical results of the kiwifruit to create a correlation between them and provide suggestions to the farmers to increase the efficiency and quality of their products.

3. Results Regarding Kiwifruit Water Footprint

During the test period of the application, it was found that the average cultivation WF of kiwifruit in orchards supervised by Kolios Fruit S.A. in the Arta plain is equal to 335,47 m^3 tn^{-1}.

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