Chapter 8
Support Irrigation Water Management of Cereals Using Optical Remote Sensing and Modeling in a Semi-Arid Region

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ABSTRACT

Irrigated agriculture is an important strategic sector for Morocco, contributing to food security and employment. Nowadays, irrigation scheme managers shall ensure that water is optimally used. The main objective was to support the irrigation monitoring and management of wheat in the irrigated perimeter using optical remote sensing and crop modeling. The potential of spectral indices derived from SPOT-5 images was explored for quantifying and mapping surface water content changes at large scale. Indices were computed using the reflectance in red, near infrared, and shortwave infrared bands. A field crop model (AquaCrop) was adjusted and tested to simulate the grain yield and the temporal evolution of soil moisture status. This research aimed at providing a scientific and technical approach to assist policymakers and stakeholders to improve monitoring irrigation and mitigating wheat water stress at field and irrigation perimeter levels in semi-arid areas. The approach could lead to operational management tools for an efficient irrigation at field and regional levels.

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GENERAL CONTEXT

Irrigated areas produce more than half of all foodstuffs in the world and therefore contribute significantly to food security. This activity, however, consumes about 72% of available water resources (Geerts & Raes, 2009; Seckler, Barker, & Amarasinghe, 1999). In Morocco, water availability is one of the main limiting factors in achieving good yields. Irrigated agriculture occupies only 15% of the cultivated area (about 1.5 million ha) in the country, but accounts for about 45% of the agricultural Gross Domestic Product and 75% of agricultural exports, depending on the season. This contribution is greater during dry seasons when production in rainfed areas is severely affected (MAPM, 2012). The challenge for stakeholders and managers in the irrigated perimeter is to increase production, control water management and rationalize irrigation. In order to save water and help farmers meet this challenge, they are given technical supervision and coaching, as well as subsidies for irrigation equipment, and legislation governing the mobilization and rational use of water resources has been enacted (Conseil Supérieur de l'Eau et du Climat, Law No. 10-95) (Hayat Lionboui, Benabdelouahab, Hasib, & Boulli, 2016).

WATER RESOURCE MANAGEMENT IN THE STUDY AREA

The study area is located in central Morocco, between the Atlantic coast in the north-west and the Atlas Mountains in the south-east (32°23´ north latitude; 6°31´west longitude; 445 m above sea level), within the irrigation perimeter of the Tadla region. The area is characterized by a semi-arid climate: the annual average temperature is about 19°C, with large inter-seasonal variation. The average cropping season precipitation is about 300 mm (average over the 1970-2010 period), with significant inter-annual variation ranging from 130 to 600 mm.

The area is characterized by a semi-arid climate; the annual average temperature is about 19°C, with large inter-seasonal variation (maximum = 38°C in August and minimum = 3.5°C in January). The average annual precipitation is about 300 mm (average over the 1970-2010 period), with significant inter-annual variation (from 130 mm to 600 mm). The irrigated area covers 100,000 hectares (ha) and is characterized by a flat topography. Durum wheat is one of the main crops in this perimeter (12% of total cultivated area).

Created in the 1940s, the Tadla irrigated perimeter was among the first large irrigation schemes in the country. It is on a plain in central Morocco (32°23´ N latitude; 6°31´ W longitude; 445 m above sea level) that covers about 100,000 hectares (ha) and is characterized by a flat topography. The plain has a semi-arid climate, with about 300 mm average annual precipitation over the 1970-2010 period and a high inter-annual variation, ranging from 130 to 600 mm over the same period.

The Tadla irrigated perimeter is divided into two sub-schemes by the Oum-Er-Rbia river, which flows from the Middle-Atlas Mountains (east) to the Atlantic Ocean (west) (Figure 1).

The irrigation water used in the Tadla perimeter comes mainly from surface water (87.1% of the total amount of irrigation water consumed in 2009/2010). Two dams, Ahmed-Al-Hansali (capacity of 750 million m^3) and Bin-El-Ouidane (1.5 billion m^3), supply irrigation water to the Tadla perimeter, in addition to groundwater pumping (Hayat Lionboui, Benabdelouahab, Elame, Hasib, & Boulli, 2016).

The groundwater depth in the area varies from 31 to 117 m (Bouchaou et al., 2009; Najine et al., 2006). The over-exploitation of groundwater has led to reduced piezometric levels (FAO, 2011). The proportion of groundwater, however, has increased in recent years due to frequent droughts. Groundwater