Chapter 1 Crop Production System Zones: Environmental Indices

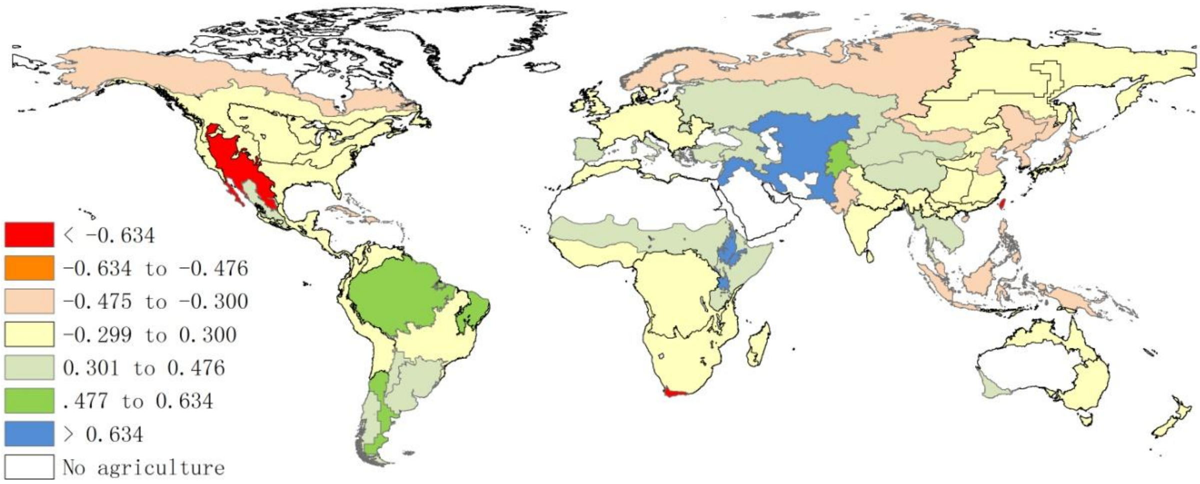
Values and trends for key environmental factors—rainfall, temperature, and radiation—can be used to capture some of the basic global environmental changes that are currently taking place. In this chapter three relevant indicators for rainfall (accumulated rainfall), temperature (temperature accumulation), and radiation (accumulated photosynthetically active radiation (PAR)) are presented for each of sixty Crop Production System Zones (CPSZ). These zones are defined based on prevailing ecological conditions, which are associated with typical climate and cropping patterns. By limiting the total number of zones, use of the CPSZs provides a meaningful yet manageable approach to agricultural monitoring of diverse agricultural areas. While large units are not necessarily exposed to the same environmental factors, they nevertheless provide a convenient approach for qualitative impact assessments. Further detail on the CPSZs is provided in annex A. (For more information on the Environmental Indices, see section 6.3.1).

The three environmental factors basically represent the supply of water (rainfall), heat and light (temperature and radiation). All three are measured as environmental indices, defined over the crop growing areas only and covering the whole period from October 2012 to September 2013. The three indices also use a spatial weighting approach that gives a high weight to areas with high primary production potential, thus in essence measuring "agricultural rainfall," "agricultural temperature," and "agricultural radiation." Selected results for the environmental indices for the CPSZ are presented in this chapter, while detailed information is provided in the figures and tables in annex B. The tables in the annex provide several derived statistics, such as time trends and a comparison with the recent twelve-year average (2001-12) and the most recent five years (2008-12).

Naturally, the three indices are inter-related in several ways. The first inter-relation regards major geographic variations, which are well known, such as high temperatures in tropical areas. The second covers correlations between variables within the CPSZs. For instance, temperature and PAR vary in parallel. This is particularly well marked in the American continent (U.S. cotton belt and Mexican coastal plains), most of South America, and in Asia, Gansu-Xinjiang and the North China plain, along with adjacent areas in Korea and Japan. Rainfall and PAR as well as rainfall and temperature vary in opposite directions.

Figure 1.1 illustrates global temperature trends. Only few areas show a significant trend towards increasing temperatures (in blue), including the Eastern African Highlands, parts of western Asia, and some areas in South America, most notably the Brazilian Nordeste. Marked decreasing trends (in red) affect parts of the western United States and Mexico, South Africa, and Taiwan. The observation is in line with the current apparent "global warming slow-down," which is receiving a lot of attention in the scientific literature and in the media (2) (3) (4).

Figure 1.1 Global temperature trends



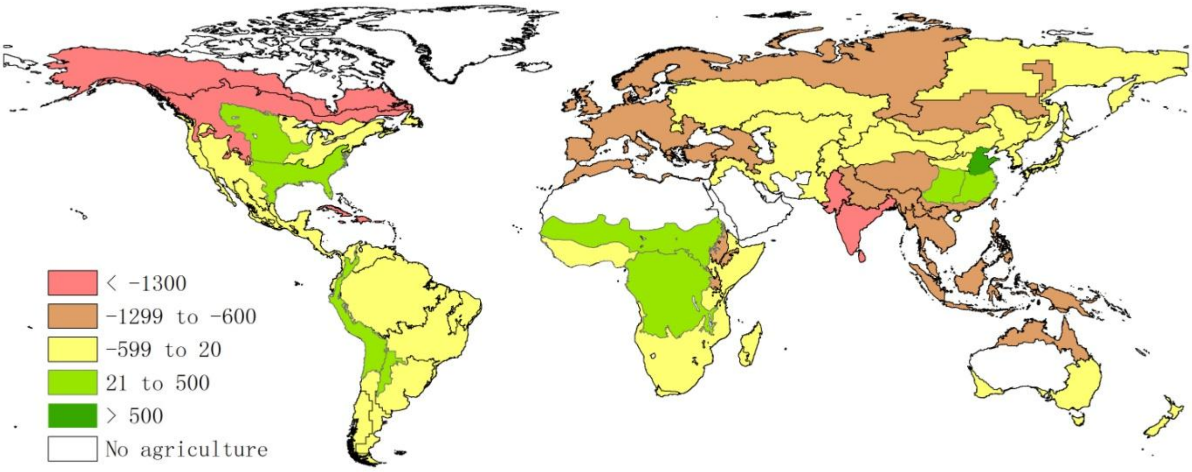
Note: The Intensity of the temperature trend is expressed as the coefficient of correlation of the time trend line. Values larger than |0.476| are significant below p<0.05 and those larger than |0.634| are significant below p<=-.01. For non-significant trends, only the direction of the change is shown by the color coding.

For temperature, most of the northern hemisphere experienced average conditions, with some areas undergoing below average conditions over the period from October 2012 to September 2013. The same region was affected by below average conditions when only the early months of 2013 are included (see among others section 4.2). The southern hemisphere was generally warmer than the last five years. Exceptions to the above-mentioned patterns include (i) an area extending from Mongolia to Punjab, southern India and Sri Lanka (but skipping Gansu-Xinjiang) with below average temperatures; (ii) the eastern United States, also with below average temperatures, and (iii) three areas in the southern hemisphere: south Madagascar and South Cape in South Africa, and south-west Southern Cone in South America (see also figure B.2a).

In another example of global short-term changes, figure 1.2 compares the current season with the recent five years for PAR. Because PAR very directly relates to both rainfall (negatively) and temperature (positively), it is a key parameter. Importantly, the comparison of 2013 PAR with the five-year average (figure 1.2) differs only little from the comparison of 2013 PAR with the twelve-year average (figure B.3b in annex B). Most of Eurasia experienced less than average PAR conditions, which was particularly the case in Southern Asia, including Bangladesh, Punjab and Gujarat. The same observation applies to the Caribbean islands. Particularly favorable PAR conditions affected central Africa, north-western South America, the U.S. cotton belt and the Mexican coastal plain, as well as the northern Great Plains. In Asia, the south-west and the lower Yangtze regions and in particular the North China plain received ample PAR in 2013.

In Africa, the broader Sahel region similarly benefited from favorable PAR conditions. The Sahel usually is a water-stressed region where—consistent with the observation that PAR and rainfall are negatively related—more sunshine typically means less rainfall. As shown in figures B.1a (rainfall) and B.3a (PAR) in annex B, this was not the case this season.

Figure 1.2 Accumulated PAR (W/m^2) for October 2012-September 2013, compared with five-year average



CropWatch results further show that several regions suffered a significant shortage of rainfall (figure 1.3). These include northern South America and Central America, the south-west Southern Cone in South America, central eastern Asia (Japan and Korea), and north Australia (annex B, table B.1 and figure B.1). Rainfall was abundant in Madagascar, the U.S. cotton belt and the Mexican coastal plain, as well as in the southern region in China (see also section 4.2.1). Among the areas with favorable but less abundant precipitation, the region from the Ukraine to central Asia (Kazakhstan) can be singled out.

In the interpretation of the environmental indices, it is important to consider they cover a whole calendar year and impacts often depend on weather conditions during a specific time of the year. As a result, the annual indices presented are more meaningful for areas with one clear growing season only (see section 3.2, cropping intensity), for instance the Sahel. Where a winter crop and a non-irrigated summer crop are cultivated (as in most of Europe), the interpretation of the index requires additional attention data narrowing down the spatial and temporal window. For example, figure 1.3 shows the April to September rainfall anomaly. Unusually wet summer conditions occurred in the region of Mongolia, Pamir and surroundings while wet winter months occurred in Madagascar, North Australia and south-west South America. A negative departure from the recent mean occurred in the area from Punjab to Gujarat.

Figure 1.3 Accumulated rainfall index anomaly, April to September 2013 (percent)