

Annex B. Quick reference to CropWatch indicators, spatial units and methodologies

The following sections give a brief overview of CropWatch indicators and spatial units, along with a description of the CropWatch production estimation methodology. For more information about CropWatch methodologies, visit CropWatch online at www.cropwatch.com.cn.

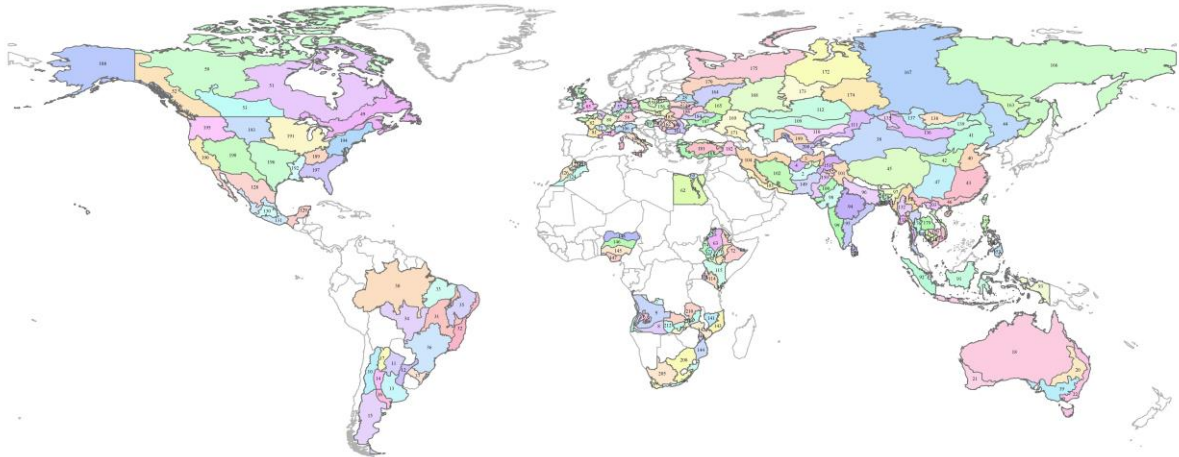
Agroecological zones for 42 key countries

Overview

212 agroecological zones for the 42 key countries across the globe

Description

42 key agricultural countries are divided into 212 agro-ecological zones based on cropping systems, climatic zones, and topographic conditions. Each country is considered separately. A limited number of regions (e.g., region 001, region 027, and region 127) are not relevant for the crops currently monitored by CropWatch but are included to allow for more complete coverage of the 42 key countries. Some regions are more relevant for rangeland and livestock monitoring, which is also essential for food security.



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|---|--|---|--|
| 001. Central region with sparse vegetation | 054. East-German lake and highland sparse crop area | 107. Islands | 160. Central mixed farming and pasture Carpathian hills |
| 002. Dry region | 055. Central wheat zone of Saxony and Thuringia | 108. Western Italy | 161. Eastern and southern maize wheat and sugarbeet plains |
| 003. Mixed dry farming and irrigated cultivation region | 056. Wheat zone of Schleswig-Holstein and the Baltic coast | 109. Central non-agriculture region | 162. Western and central maize wheat and sugarbeet plateau |
| 004. Mixed dry farming and grazing region | 057. Wild wheat and sugarbeets zone of the north-west | 110. South zone | 163. Iaur and Primorsky Krai |
| 005. Arid Zone | 058. Basium Plateau | 111. Eastern plateau and southeastern zone | 164. Central Basia |
| 006. Central Plateau | 059. Western sparse crop area of the Rhinish massif | 112. Northern zone | 165. Central black soils area |
| 007. Humid zone | 060. Nile Delta and Mediterranean coastal strip | 113. Coast | 166. Eastern Siberia |
| 008. Semi-Arid Zone | 061. Nile Valley | 114. Highland agriculture zone | 167. Middle Siberia |
| 009. Sub-humid zone | 062. Desert | 115. Northern rangelands | 168. Middle Volga |
| 010. Andes | 063. Central-northern maize-teff highlands | 116. South-west | 169. Northern Caucasus |
| 011. Chaco | 064. Eastern arid area | 117. Teller-sap | 170. Northwest Region including Novgorod |
| 012. Mesopotamia | 065. Great Rift region | 118. Whong valley between Tonic-up and Vietnam border | 171. South Caucasian |
| 013. Humid Pampas | 066. Northern Arid area | 119. Northern plain and northeast | 172. Subarctic region |
| 014. Pampas hills | 067. North-western cereal-root-sesame lowlands | 120. Southwest Hillly region | 173. Iral and setser Volga region |
| 015. Arid part of Patagonia | 068. North-western sesame irrigated lowlands | 121. Dry Zone | 174. Western Siberia |
| 016. Dry Pampas | 069. North-western semi-arid lowlands | 122. Intermediate Zone | 175. West subarctic region |
| 017. Subtropical highlands | 070. South-eastern mixed maize zone | 123. Wet zone | 176. Central double and triple-cropped rice lowlands |
| 018. Arid and semi-arid zone | 071. South-eastern Wendebo highlands | 124. Desert | 177. South-eastern horticulture area |
| 019. Southeastern wheat area | 072. Semi-arid pastoral areas | 125. Sub-humid northern highlands | 178. Western and southern hill areas |
| 020. Subhumid subtropical zone | 073. South-western coffee-onset highlands | 126. Karna semiarid zones | 179. Single-cropped rice north-eastern region |
| 021. Southwestern wheat area | 074. Eastern mixed maize zone | 127. Karna subhumid zones | 180. Black Sea region |
| 022. Wet temperate and subtropical zone | 075. Mixed Central dry zone | 128. Arid and semi-arid regions | 181. Central Anatolia region |
| 023. Coastal region | 076. Alpes region | 129. Humid tropics with summer rainfall | 182. Eastern Anatolia region |
| 024. Gangetic plain | 077. Mediterranean zone | 130. Sub-humid temperate region with summer rains | 183. Wurnars Agen Mediterranean lowland region |
| 025. Hills | 078. Northern barley zone | 131. Sub-humid hot tropics with summer rains | 184. Central wheat area |
| 026. Siberet basin | 079. Waize, barley and livestock zone along the English Chomel | 132. Central plain | 185. Eastern Carpathian hills |
| 027. Center | 080. Rapessed zone of eastern France | 133. Delta and southern-coast | 186. Northern wheat area |
| 028. North | 081. Southwest maize zone | 134. Hills | 187. Southern wheat and maize area |
| 029. South-west | 082. Mixed maize, barley and rapessed zone from the Centre to the Atlantic Ocean | 135. Altai | 188. Alaska and Hawaii |
| 030. Amazonas | 083. North England, Wales and North Ireland sparse crops area | 136. Gobi Desert | 189. Blue Grass region |
| 031. Central Savanna | 084. Barley area in Scotland | 137. Bangal Khussgal Region | 190. California |
| 032. Coast | 085. South English mixed wheat and Barley zone | 138. Selenge-Onon Region | 191. Corn Belt |
| 033. Northeastern mixed forest and farmland | 086. Central Hungary | 139. Central and Eastern Steppe | 192. Lower Mississippi |
| 034. Mato Grosso | 087. Puzeta | 140. Bazi basin | 193. Northern Plains |
| 035. Nordeste | 088. North Hungary | 141. Northern high altitude areas | 194. North-eastern areas |
| 036. Parana basin | 089. Transdambia | 142. Low Zambesia River basin | 195. Northwest |
| 037. Southern subtropical rangelands | 090. Java | 143. Northern coast | 196. Southern Plains |
| 038. Gusu-Xinjiang | 091. Kalimantan and Sulawesi | 144. Southern region | 197. Southeast |
| 039. Heifun | 092. Sumatra | 145. Derived sorasmo zone | 198. Southeast |
| 040. Huang Haihai | 093. West Pupas | 146. Gulsoun savanna | 199. Central region with sparse crops |
| 041. Inner Mongolia | 094. Beccum Plateau | 147. Humid forest zone | 200. Eastern hilly cereals zone |
| 042. Loess region | 095. Eastern coastal region | 148. Soadano-Sahelian zone | 201. Aral Sea cotton zone |
| 043. Lower Yangtze rregion | 096. Gangetic plain | 149. Belochistan | 202. Central coastal areas from Thanh Hoa to Khanh Hoa |
| 044. North East China | 097. Assam and north-western regions | 150. Lower Indus basin in south Punjab and Sind | 203. Northern zone with Red river Delta |
| 045. Qinghai-Tibet | 098. Agriculture areas in Rajasthan and Gujarat | 151. Northern highlands | 204. Southern zone with Yekong Delta |
| 046. Southern China | 099. Western coastal region | 152. Northern Punjab | 205. Arid and desert zones |
| 047. South-West China | 100. North-western dry region | 153. Forest islands | 206. Humid Cape Fold mountains |
| 048. China Taiwan | 101. Western Himalayan region | 154. Nagros and central Visayas Islands | 207. Mediterranean zone |
| 049. Saint Lawrence basin | 102. Central and Eastern wasteland region | 155. Northern lowlands of Mindano to western Visayas | 208. Dry Highveld and Bushveld maize areas |
| 050. Arctic | 103. Arid Red Sea coastal low hills and plains | 156. Central rye and potatoes area | 209. Luangwa Zambesi rift valley |
| 051. Hudson Bay | 104. Semi-arid to subtropical western and northern hills | 157. Northern oats and potatoes areas | 210. Northern high rainfall zone |
| 052. Western Canada | 105. East coast | 158. Northern-central wheat and sugarbeet area | 211. Central-eastern and southern plateau |
| 053. Prairies | 106. Po Valley | 159. Southern wheat and sugarbeet area | 212. Western semi-arid plain |

CropWatch indicators

The CropWatch indicators are designed to assess the condition of crops and the environment in which they grow and develop; the indicators—RAIN (for rainfall), TEMP (temperature), and RADPAR (photosynthetically active radiation, PAR)—are not identical to the weather variables, but instead are value-added indicators computed only over crop growing areas (thus for example excluding deserts and rangelands) and spatially weighted according to the agricultural production potential, with marginal areas

receiving less weight than productive ones. The indicators are expressed using the usual physical units (e.g., mm for rainfall) and were thoroughly tested for their coherence over space and time. CWSU are the CropWatch Spatial Units, including MRUs, MPZ, and countries (including first-level administrative districts in select large countries). For all indicators, high values indicate "good" or "positive."

INDICATOR			
BIOMSS			
Biomass accumulation potential			
Crop/ Ground and satellite	Grams dry matter/m ² , pixel or CWSU	An estimate of biomass that could potentially be accumulated over the reference period given the prevailing rainfall and temperature conditions.	Biomass is presented as maps by pixels, maps showing average pixels values over CropWatch spatial units (CWSU), or tables giving average values for the CWSU. Values are compared to the average value for the last five years (2014-2018), with departures expressed in percentage.
CALF			
Cropped arable land and cropped arable land fraction			
Crop/ Satellite	[0,1] number, pixel or CWSU average	The area of cropped arable land as fraction of total (cropped and uncropped) arable land. Whether a pixel is cropped or not is decided based on NDVI twice a month. (For each four-month reporting period, each pixel thus has 8 cropped/ uncropped values).	The value shown in tables is the maximum value of the 8 values available for each pixel; maps show an area as cropped if at least one of the 8 observations is categorized as "cropped." Uncropped means that no crops were detected over the whole reporting period. Values are compared to the average value for the last five years (2014-2018), with departures expressed in percentage.
CROPPING INTENSITY			
Cropping intensity index			
Crop/ Satellite	0, 1, 2, or 3; Number of crops growing over a year for each pixel	Cropping intensity index describes the extent to which arable land is used over a year. It is the ratio of the total crop area of all planting seasons in a year to the total area of arable land.	Cropping intensity is presented as maps by pixels or spatial average pixels values for MPZs, 42 countries, and 7 regions for China. Values are compared to the average of the previous five years, with departures expressed in percentage.
NDVI			
Normalized Difference Vegetation Index			
Crop/ Satellite	[0.12-0.90] number, pixel or CWSU average	An estimate of the density of living green biomass.	NDVI is shown as average profiles over time at the national level (cropland only) in crop condition development graphs, compared with previous year and recent five-year average (2014-2018), and as spatial patterns compared to the average showing the time profiles, where they occur, and the percentage of pixels concerned by each profile.
RADPAR			
CropWatch indicator for Photosynthetically Active Radiation (PAR), based on pixel based PAR			
Weather /Satellite	W/m ² , CWSU	The spatial average (for a CWSU) of PAR accumulation over agricultural pixels, weighted by the production potential.	RADPAR is shown as the percent departure of the RADPAR value for the reporting period compared to the recent fifteen-year average (2004-2018), per CWSU. For the MPZs, regular PAR is shown as typical time profiles over the spatial unit, with a map showing where the profiles occur and the percentage of pixels concerned by each profile.
RAIN			
CropWatch indicator for rainfall, based on pixel-based rainfall			
Weather /Ground	Liters/m ² , CWSU	The spatial average (for a CWSU) of rainfall accumulation over agricultural	RAIN is shown as the percent departure of the RAIN value for the reporting period, compared to

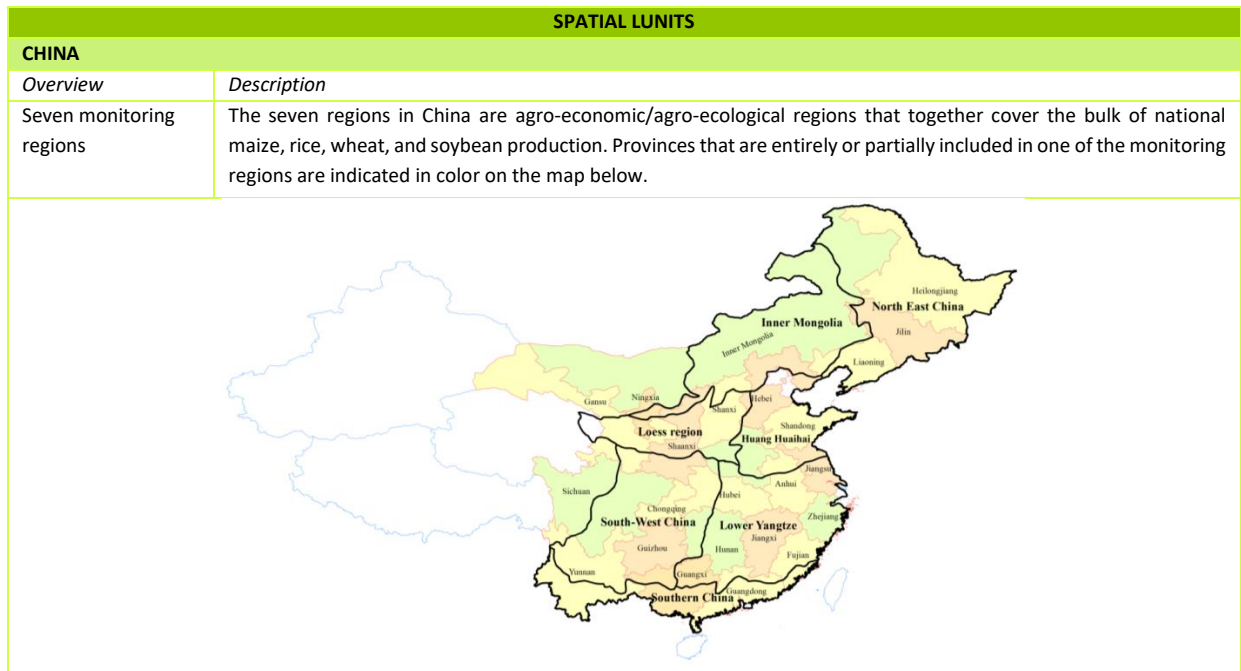
INDICATOR			
and satellite		pixels, weighted by the production potential.	the recent fifteen-year average (2004-18), per CWSU. For the MPZs, regular rainfall is shown as typical time profiles over the spatial unit, with a map showing where the profiles occur and the percentage of pixels concerned by each profile.
TEMP			
CropWatch indicator for air temperature, based on pixel-based temperature			
Weather /Ground	°C, CWSU	The spatial average (for a CWSU) of the temperature time average over agricultural pixels, weighted by the production potential.	TEMP is shown as the departure of the average TEMP value (in degrees Centigrade) over the reporting period compared with the average of the recent fifteen years (2004-18), per CWSU. For the MPZs, regular temperature is illustrated as typical time profiles over the spatial unit, with a map showing where the profiles occur and the percentage of pixels concerned by each profile.
VCIx			
Maximum vegetation condition index			
Crop/ Satellite	Number, pixel to CWSU	Vegetation condition of the current season compared with historical data. Values usually are [0, 1], where 0 is "NDVI as bad as the worst recent year" and 1 is "NDVI as good as the best recent year." Values can exceed the range if the current year is the best or the worst.	VCIx is based on NDVI and two VCI values are computed every month. VCIx is the highest VCI value recorded for every pixel over the reporting period. A low value of VCIx means that no VCI value was high over the reporting period. A high value means that at least one VCI value was high. VCI is shown as pixel-based maps and as average value by CWSU.
VHI			
Vegetation health index			
Crop/ Satellite	Number, pixel to CWSU	The average of VCI and the temperature condition index (TCI), with TCI defined like VCI but for temperature. VHI is based on the assumption that "high temperature is bad" (due to moisture stress), but ignores the fact that low temperature may be equally "bad" (crops develop and grow slowly, or even suffer from frost).	Low VHI values indicate unusually poor crop condition, but high values, when due to low temperature, may be difficult to interpret. VHI is shown as typical time profiles over Major Production Zones (MPZ), where they occur, and the percentage of pixels concerned by each profile.
VHIn			
Minimum Vegetation health index			
Crop/ Satellite	Number, pixel to CWSU	VHIn is the lowest VHI value for every pixel over the reporting period. Values usually are [0, 100]. Normally, values lower than 35 indicate poor crop condition.	Low VHIn values indicate the occurrence of water stress in the monitoring period, often combined with lower than average rainfall. The spatial/time resolution of CropWatch VHIn is 16km/week for MPZs and 1km/dekad for China.

Note: Type is either "Weather" or "Crop"; source specifies if the indicator is obtained from ground data, satellite readings, or a combination; units: in the case of ratios, no unit is used; scale is either pixels or large scale CropWatch spatial units (CWSU). Many indicators are computed for pixels but represented in the CropWatch bulletin at the CWSU scale.

CropWatch spatial units (CWSU)

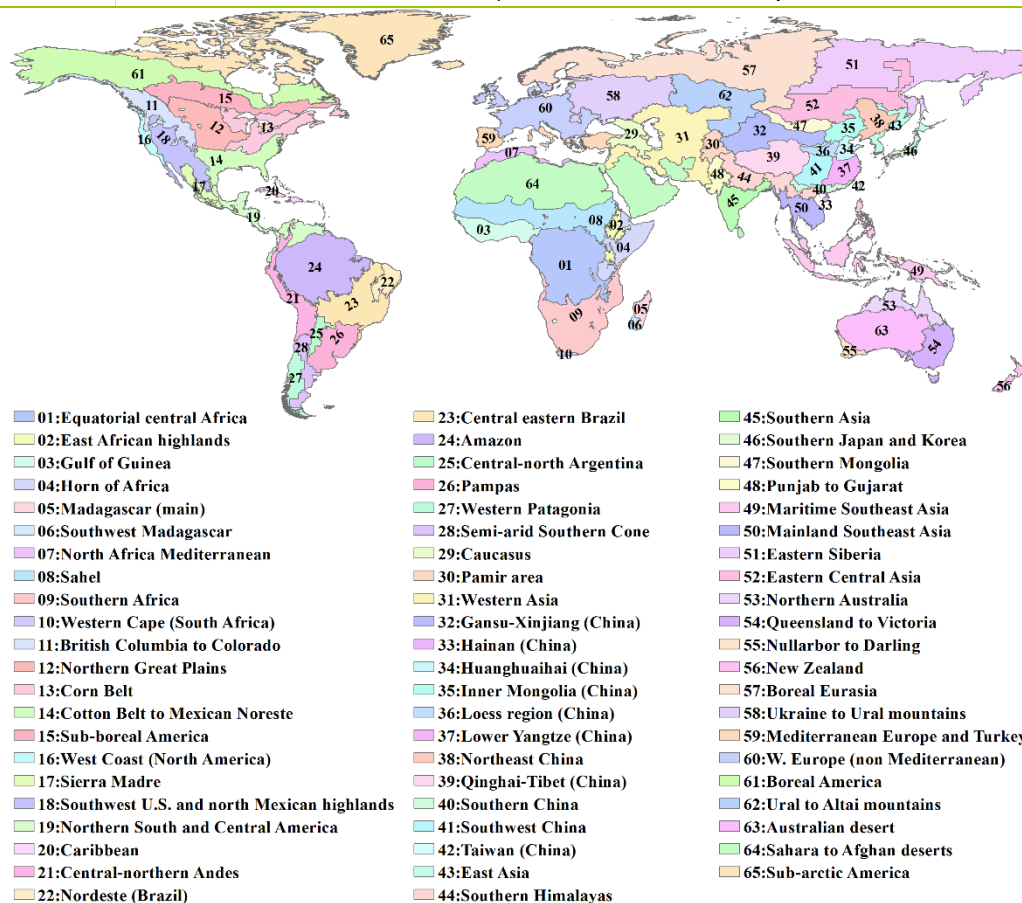
CropWatch analyses are applied to four kinds of CropWatch spatial units (CWSU): Countries, China, Major Production Zones (MPZ), and global crop Monitoring and Reporting Units (MRU). The tables below

summarize the key aspects of each spatial unit and show their relation to each other. For more details about these spatial units and their boundaries, see the CropWatch bulletin online resources.



Global Monitoring and Reporting Unit (MRU)

Overview	Description
65 agro-ecological/agro-economic units across the world	MRUs are reasonably homogeneous agro-ecological/agro-economic units spanning the globe, selected to capture major variations in worldwide farming and crops patterns while at the same time providing a manageable (limited) number of spatial units to be used as the basis for the analysis of environmental factors affecting crops. Unit numbers and names are shown in the figure below. A limited number of units (e.g., MRU-63 to 65) are not relevant for the crops currently monitored by CropWatch but are included to allow for more complete coverage of global production. Additional information about the MRUs is provided online under www.cropwatch.com.cn .



Production estimation methodology

The main concept of the CropWatch methodology for estimating production is the calculation of current year production based on information about last year's production and the variations in crop yield and cultivated area compared with the previous year. The equation for production estimation is as follows:

$$Production_i = Production_{i-1} * (1 + \Delta Yield_i) * (1 + \Delta Area_i)$$

Where i is the current year, $\Delta Yield_i$ and $\Delta Area_i$ are the variations in crop yield and cultivated area compared with the previous year; the values of $\Delta Yield_i$ and $\Delta Area_i$ can be above or below zero.

For the 42 countries monitored by CropWatch, yield variation for each crop is calibrated against NDVI time series, using the following equation:

$$\Delta Yield_i = f(NDVI_i, NDVI_{i-1})$$

Where $NDVI_i$ and $NDVI_{i-1}$ are taken from the time series of the spatial average of NDVI over the crop specific mask for the current year and the previous year. For NDVI values that correspond to periods after the current monitoring period, average NDVI values of the previous five years are used as an average expectation. $\Delta Yield_i$ is calculated by regression against average or peak NDVI (whichever yields the best regression), considering the crop phenology of each crop for each individual country.

A different method is used for areas. For China, CropWatch combines remote-sensing based estimates of the crop planting proportion (cropped area to arable land) with a crop type proportion (specific type area to total cropped area). The planting proportion is estimated based on an unsupervised classification of high resolution satellite images from HJ-1 CCD and GF-1 images. The crop-type proportion for China is obtained by the GVG instrument from field transects. The area of a specific crop is computed by multiplying farmland area, planting proportion, and crop-type proportion of the crop.

To estimate crop area for wheat, soybean, maize, and rice outside China, CropWatch relies on the regression of crop area against cropped arable land fraction of each individual country (paying due attention to phenology):

$$Area_i = a + b * CALF_i$$

where a and b are the coefficients generated by linear regression with area from FAOSTAT or national sources and CALF the Cropped Arable Land Fraction from CropWatch estimates. $\Delta Area_i$ can then be calculated from the area of current and the previous years.

The production for "other countries" (outside the 31 CropWatch monitored countries) was estimated as the linear trend projection for 2017 of aggregated FAOSTAT data (using aggregated world production minus the sum of production by the 31 CropWatch monitored countries).