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**CropWatch Online Resources:** This bulletin along with additional resources is also available on the CropWatch Website at <http://www.cropwatch.com.cn>.

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 *Note:* CropWatch resources, background materials and additional data are available online at [www.cropwatch.com.cn](http://www.cropwatch.com.cn).

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## Abbreviations

5YA	Five-year average, the average for the four-month period for July-October from 2011 to 2015; one of the standard reference periods.
15YA	Fifteen-year average, the average for the four-month period from July-October from 2001 to 2015; one of the standard reference periods and typically referred to as “average.”
BIOMSS	CropWatch agroclimatic indicator for biomass production potential
BOM	Australian Bureau of Meteorology
CALF	Cropped Arable Land Fraction
CAS	Chinese Academy of Sciences
CI	Cropping Intensity
CWAI	CropWatch Agroclimatic Indicator
CWSU	CropWatch Spatial Units
DM	Dry matter
EC/JRC	European Commission Joint Research Centre
ENSO	El Niño Southern Oscillation
FAO	Food and Agriculture Organization of the United Nations
GAUL	Global Administrative Units Layer
GVG	GPS, Video, and GIS data
ha	hectare
kcal	kilocalorie
MPZ	Major Production Zone
MRU	Monitoring and Reporting Unit
NDVI	Normalized Difference Vegetation Index
OISST	Optimum Interpolation Sea Surface Temperature
PAR	Photosynthetically active radiation
PET	Potential Evapotranspiration
RADI	CAS Institute of Remote Sensing and Digital Earth
RADPAR	CropWatch PAR agroclimatic indicator
RAIN	CropWatch rainfall agroclimatic indicator
SOI	Southern Oscillation Index
TEMP	CropWatch air temperature agroclimatic indicator
Ton	Thousand kilograms
VCIx	CropWatch maximum Vegetation Condition Index
VHI	CropWatch Vegetation Health Index
VHIn	CropWatch minimum Vegetation Health Index
W/m <sup>2</sup>	Watt per square meter

## Bulletin overview and reporting period

This CropWatch bulletin presents a global overview of crop stage and condition between July 1 and October 31 2016, which is referred to as the “July-October” period. The bulletin is the 103<sup>rd</sup> such publication issued by the CropWatch group at the Institute of Remote Sensing and Digital Earth (RADI) at the Chinese Academy of Sciences, Beijing.

### CropWatch analyses and indicators

CropWatch analyses are based mostly on several standard as well as new ground-based and remote sensing indicators, following a hierarchical approach. The analyses cover large global zones; major producing countries of maize, rice, wheat, and soybean; and detailed assessments of Chinese regions. In parallel to an increasing spatial precision of the analyses, indicators become more focused on agriculture as the analyses zoom in to smaller spatial units.

CropWatch uses two sets of indicators: (i) agroclimatic indicators—RAIN, TEMP, and RADPAR, which describe weather factors; and (ii) agronomic indicators—BIOMSS, VHIn, CALF, VCIx, and Cropping Intensity, describing crop condition and development. Importantly, the indicators RAIN, TEMP, RADPAR, and BIOMSS do not directly describe the weather variables rain, temperature, radiation, or biomass, but rather they are spatial averages over agricultural areas, which are weighted according to the local crop production potential. For each reporting period, the bulletin reports on the *departures* for all eight indicators, which (with the exception of TEMP) are expressed in relative terms as a percentage change compared to the average value for that indicator for the last five or fifteen years (depending on the indicator). For more details on the CropWatch indicators and spatial units used for the analysis, please see the quick reference guide in Annex C, as well as online resources and publications posted at [www.cropwatch.com.cn](http://www.cropwatch.com.cn).

This bulletin is organized as follows:

Chapter	Spatial coverage	Key indicators
<b>Chapter 1</b>	World, using Monitoring and Reporting Units (MRU), 65 large, agro-ecologically homogeneous units covering the globe	RAIN, TEMP, RADPAR, BIOMSS
<b>Chapter 2</b>	Major Production Zones (MPZ), six regions that contribute most to global food production	As above, plus CALF, VCIx, VHIn, and Cropping Intensity
<b>Chapter 3</b>	30 key countries (main producers and exporters)	As above plus NDVI and GVG survey
<b>Chapter 4</b>	China	As above plus high resolution images
<b>Chapter 5</b>	Production outlook, crop growth in the Middle East, and an update on El Niño.	
<b>Online Resources</b>	<a href="http://www.cropwatch.com.cn">www.cropwatch.com.cn</a>	

### Regular updates and online resources

The bulletin is released quarterly in both English and Chinese. To sign up for the mailing list, please e-mail [cropwatch@radi.ac.cn](mailto:cropwatch@radi.ac.cn) or visit CropWatch online at [www.cropwatch.com.cn](http://www.cropwatch.com.cn). Visit the CropWatch Website for additional resources and background materials about methodology, country agricultural profiles, and country long-term trends.

## Executive summary

The current CropWatch bulletin is prepared jointly by several institutes of the Chinese Academy of Sciences (CAS) under the overall coordination of the Digital Agriculture Division of the Institute of Remote Sensing and Digital Earth (RADI). The bulletin is based mainly on geophysical data and models and focuses on crops that have been harvested in 2016 or were still growing between July and October, to be harvested later this year. The bulletin is global and comprehensive; it covers prevailing weather conditions in all countries and pays special attention to thirty major agricultural countries and China (the “30+1” countries) where crop condition, size of cultivated areas, and global food production is assessed with specific agronomic indicators. Together, the “30+1” make up at least 80% of the production and exports of maize, rice, wheat, and soybean. The bulletin also includes specific sections on global production, as well as pests and diseases, trade, and prices in China.

### Global agroclimatic patterns

Weather is the major single factor behind the variability of global food production. The current reporting period from July to October included several large, coherent areas with weather conditions favorable or unfavorable to crop production.

#### *Areas with excess precipitation*

Several major areas with excess precipitation over the reporting period included:

- *The Sahelian region*, covering the usually semi-arid Sahelian region of northern Africa (Senegal to north Sudan), extending east into the Arabian Peninsula.
- *Western Russia to northern-central Europe and Greece*, including several regions that received precipitation amounts that are beneficial to the early crop stages of their beginning winter crop season.
- *Central and southern Asia*, where—not unlike the previous season—vast expanses of land in and around central and southern Asia recorded abundant precipitation compared to average (+67%). The area includes more than 30 countries and large sub-national units; temperature was systematically below average (-0.4°C) and so was radiation (-5%). The area extends east as far as Shanxi and Hebei provinces in China (+44% and +46%), Tajikistan and Kyrgyzstan (+143% and +196%, with about normal temperature and sunshine) and several regions in Kazakhstan. The contiguous regions of Jambyl in southern-central Kazakhstan, Kyrgyzstan, and the Xinjiang Uygur autonomous region of China are at the core of the high precipitation area: Xinjiang experienced an increase in precipitation of 224% over the average, while Kazakhstan increased its cropped arable land fraction by a spectacular 23 percentage points.
- *Eastern Asia to central-eastern Australia*, probably resulting from the fading El Niño that affects Southeast Asia and Oceania alike.
- *Northern United States and Canada*, where some areas recorded more than double the average precipitation (such as in Iowa, Minnesota, South Dakota and Montana).

#### *Areas with a deficit in precipitation*

In contrast, many other areas experienced a deficit in precipitation compared to average. Notable among them are:

- *Thirty countries from Sweden and Germany to Great Britain to Morocco, Iran, and Afghanistan, and the Black Sea countries*, where on average the deficit reaches 34%; the largest water stress occurred in the eastern Mediterranean while northern and north-western Europe were less

affected. Nevertheless, both France and Germany list a decrease in cropping intensity (-8% and -16%, respectively), and so did the Ukraine (-18%), where winter crops have now been planted and where prospects will need to be improved by winter rainfall.

- *Russia*, with two patches of deficit precipitation: one centered around the Perm oblast and east of it, the other around the Tomsk oblast.
- *Eastern Asia*, with three Chinese provinces (Henan, Chongqing, and Shandong), Japan, the Republic of Korea, and the Democratic People's Republic of Korea. In the latter country, the current deficit (-45%) follows another drought year.
- *The Indian states of Tamil Nadu, Kerala, and Karnataka, as well Sri Lanka*, all suffering an average precipitation deficit of 50%.
- *Eastern and Southern Africa*, specifically fourteen countries south of Ethiopia and Uganda, Zambia, and Namibia. In eastern Africa, crops are currently growing at the higher elevations, while southern Africa is just planting after a severe drought year that affected much of the region in 2015. Zambia reduced the cropped arable land fraction by 10 percentage points compared to the recent five-year average.
- *Southern Oceania and Western Australia; the southern United States; as well as the "Southern cone" of South America*, three unrelated patches of deficit precipitation. In the Southern Cone, this covers Chile, Uruguay, and nine provinces in Argentina.

### **Global crop production in 2016**

CropWatch put the total output of the crops produced during 2016 at 2,460 million tons of major grains and 316 million tons of soybeans. The major grains are made up almost exactly by 40% maize (995 million tons; a 1.2% increase over 2015), 30% rice (as paddy, 736 million tons and down 0.8%), and 30% wheat (730 million tons; up 1.2%).

*Major cereal producers.* For the three major cereal producers, China's output reached 520 million tons, while those for the United States and India were 435 million and 261 million tons respectively. Neither China nor India performed well in 2016 due to the poor environmental conditions. In China, while maize stagnates and both rice and wheat production drop 1%, for the first time in over a decade the production of soybean is up by a non-negligible 2%. In India, only rice is up by 1% compared to 2015; soybean is on par with 2015, while maize is down 1% and wheat as much as 6%, one of the largest decreases of all countries monitored by CropWatch. In the United States, on the other hand, while wheat remains stable, the output of all other major commodities increases significantly, with soybean up 3%, and both maize and rice improving at least 5% over last year's output.

*Rice.* The early 2016 rice crops did poorly in a number of Asian countries because of the prevailing El Niño drought in Southeast Asia that was reported on in detail in the February and May 2016 CropWatch bulletins. The list includes Cambodia (rice -10% compared to 2015), Myanmar (-8%), Bangladesh and Vietnam (both -6%), and Pakistan (-3%).

*Maize.* Maize production increased in Iran (+9%) as well as in a group of countries in Central Asia that benefited from unusually favorable rain for the second consecutive year, as mentioned in the agroclimatic overview above.

*Wheat.* The most spectacular drop in wheat production occurred in Turkey (-17%), followed by some major producers and exporters such as India (-6%), Argentina (-4%), and France and the United Kingdom (both -3%). Large increases are those of Australia (+14%) and Iran (+15%), a country that did well for most crops after a run of mediocre years.

*Soybean.* For soybean, Egypt, Iran, Canada, and—one of the largest producers—Argentina all underwent a drop of 1%. Brazil increased production by 2%, while both Russia and the United States improved by 3%.

The current bulletin also assesses domestic production of the major exporters and importers, which is likely to affect trade patterns. The major importers have generally increased their domestic output, with the notable exceptions of rice (resulting from a 1% production drop in China) and wheat, with Turkey—mentioned above—estimated to have lost 17% of production compared with 2015. Exporters did generally well with a marked increase in wheat availability among the major exporters (+8.0%), resulting from the excellent performance of Canada and Australia. The reduced rice availability for the top exporters (-0.6%) results from the poor performance of several countries, including Pakistan (-3%), Vietnam (-6%), and Brazil (-7%). On the contrary, rice availability has increased in Australia (+14%) and the United States (+6%). The most noteworthy variations among maize exporters include mainly the large drop of production in Brazil (-12%).

### **China**

In China, all crops for 2016 have now been harvested, and the total production is put by CropWatch at 200.4 million tons for maize (same as 2015), 200.5 million tons for rice (-1% compared to 2015), 118.6 million tons for wheat (-1%), and 13.3 million tons for soybean (+2%). For summer crops, CropWatch puts the total (including maize, single rice, late rice, spring wheat, soybean, minor cereals, and tubers) at 414.3 million tons, a marginal decrease (-0.4%) from 2015. The total annual food production (including cereals, tubers, and legumes) reaches 570 million tons, a drop of 1.0% (5.9 million tons) compared with last year.

The government's recent decision to end the procurement of maize at a guaranteed minimum purchasing prices resulted in farmers shifting to other crops. This year's maize area, however, was only 0.8% below 2015, with the most significant decreases occurring in Inner Mongolia and Heilongjiang provinces. Increases are listed for Liaoning (+4%) and Yunnan (+5% due to yield increase).

For soybean, as already mentioned above, 2016 witnessed a reversal of a decade-long downward trend in production. The largest increases occurred in Inner Mongolia (+23% resulting from an increase in planted area just above 26%). The drop in rice production was brought about mainly from decreases in early rice (-3%) and late rice (-2%) due to shrinking planted areas. Some areas nevertheless increased their rice production, including Jilin (+12%), Liaoning (+9%), and Yunnan (+6%).

To a large extent, the listed variations can also be ascribed to environmental conditions that were favorable to pests and weakened crops, making them vulnerable to rice planthoppers (which damaged 14.7 million hectares) and rice sheath blight that took a toll on a slightly smaller area (13.3 million hectares). The variations in production will affect prices and trade; specific sections of the CropWatch bulletin provide details.

## Chapter 1. Global agroclimatic patterns

*Chapter 1 describes the CropWatch agroclimatic indicators (CWAIs) for rainfall (RAIN), temperature (TEMP), and radiation (RADPAR), along with the agronomic indicator for potential biomass (BIOMSS) for sixty-five global Monitoring and Reporting Units (MRU). Rainfall, temperature, and radiation indicators are compared to their average value for the same period over the last fifteen years (called the “average”), while BIOMSS is compared to the indicator’s average of the recent five years. Indicator values for all MRUs are included in Annex A table A.1. For more information about the MRUs and indicators, please see Annex C and online CropWatch resources at [www.cropwatch.com.cn](http://www.cropwatch.com.cn).*

### 1.1 Overview

#### Rainfall

In many ways, the current reporting period from July to October 2016 displays some global patterns that were already noticed in the previous CropWatch bulletins, notably above-average rainfall in a large area including semi-arid sub-Saharan Africa and extending across the Arabian Peninsula to central Asia. This pattern has been ongoing for more than one year now. The largest excesses are those that occurred in the Asian part of the region, especially Southern Mongolia (MRU-47, RAIN +201%), Gansu-Xinjiang (MRU-32, +175%), and Inner Mongolia (MRU-35, +56%). As these areas already normally receive fair amounts in the July-October period, increases are significant. Smaller, but still marked excesses in the range from 25% to 30% occurred—from lower to higher increases—in Eastern Central Asia (MRU-52), the Chinese islands of Taiwan (MRU-42), Hainan (MRU-33), and the Lower Yangtze region (MRU-37) where precipitation reached 673 mm (168 mm/month on average and 33% above average). Further west, increases are also reported for western Asia (MRU-31, +28%), Punjab to Gujarat (MRU-48, +33%), and the Pamir Area (MRU-30, +35%) where the precipitation is welcome during the present pre-rabi crop season. Finally, at the western end of the area, increases also include a region from the Sahara to Afghan deserts (MRU-64, +41%) leading to Gulf of Guinea countries (MRU-03, +11%) and across the Sahel (MRU-08) where the excess of 15%, while modest, has nevertheless benefited the end of the semi-arid crop areas in western and northern-central Africa.

Other notable rainfall excesses included Maritime South-east Asia (MRU-49), which recorded an increase of precipitation over average reaching 25%, while northern Australia (MRU-53) recorded a large positive departure that more than doubled the average (+127%).

In North America, the pattern of large excesses in the northernmost areas (which are of limited relevance for crops) also continued this year. The excess also affected British Columbia to Colorado (MRU-11, +40%), the West Coast (MRU-16, +45%), and particularly the northern Great Plains (MRU-12, with rainfall nearly double the average: +97%).

In South America, the Brazilian Nordeste (MRU-22) is the only area that recorded a precipitation excess (+26%).

Precipitation deficits reproduced recent patterns in east and southern Africa, including in the East African Highlands (MRU-02, -24%); the Horn of Africa (MRU-04, -40%) and Southwest Madagascar (MRU-06, also -40%); and Southern Africa (MRU-09, -11%) and Western Cape (MRU-10, -58%). Water reserves are low

from the previous season's drought throughout the region, but the current agricultural season is just starting in the south.

In South America, dry conditions affect some areas where cattle plays a larger role than crops, such as Western Patagonia (MRU-27, -36%).

The previous CropWatch bulletin stressed the Korean and the Moroccan drought. North Africa-Mediterranean (MRU-07) is currently suffering a RAIN deficit (-14%) that extends into Western Europe (MRU-60, also -14%) but intensifies in the east of the region in Mediterranean Europe and Turkey (MRU-59, -26%) and the Caucasus (MRU-29, also at -26%). The eastern Asian areas (MRU-43, i.e. the Republic of Korea, Democratic People's Republic of Korea, and the Primorsky area of Russia and Northern Japan) and MRU-46 (Southern Japan) experienced deficits of 28% and 14%, respectively.

In both New Zealand (MRU-56) and Nullarbor to Darling (MRU-55) the RAIN deficit reached between 50% and 60%.

### Temperature

Low temperature anomalies were generally rare this reporting period and they usually concerned only isolated MRUs. The largest area, in terms of the number of adjacent MRUs affected, occurred in Australia where the center and south of the continent (MRU-55, Nullarbor to Darling, to MRU-54, Queensland to Victoria) experienced cool spring condition with CropWatch TEMP anomalies ranging from -0.5°C in the east to -1.5°C in the west. In east and southern Africa, low temperature affected the Horn of Africa (MRU-04, TEMP -0.7°C) and the two Malagasy MRUs (MRU-5, -0.7°C and MRU-6, -1.0°C). Next are two adjacent areas in South America: Central-north Argentina (MRU-25, -1.2°C) and the Pampas (MRU-26, -0.7°C). Also worth mentioning is the Caucasus (MRU-29) with -0.7°C, before finally listing some positive anomalies in southern Japan and the southern tip of the Korean peninsula (MRU-46, +1.9°C) as well as northern Australia (MRU-53) with a +1.5°C departure.

### Radiation

With RADPAR, some well-marked spatial patterns exist again, with excess radiation in the tropical and equatorial parts of the American continent and Africa: +3.1% in the Amazon (MRU-24), +4.3% in northern South and Central America (MRU-19), as well as +4.8% in the central-northern Andes (MRU-21), a significant value for a sunshine departure over a large area. The largest departure occurred in equatorial central Africa (MRU-01, +7%) covering essentially the Congo basin, with the adjacent Horn of Africa (MRU-4) recording a 4.2% positive RADPAR departure.

Negative RADPAR departures in agriculturally important locations concern basically all of Oceania, maritime Southeast Asia, and the whole Asian continent east of the latitude of MRU-48 (Punjab to Gujarat), with the exception of Qinghai-Tibet (MRU-39). This includes, among others, the following, in decreasing order of deficit: the lower Yangtze in China (MRU-37, RADPAR -7.9%), New Zealand (MRU-56, -7.4%), Queensland to Victoria (MRU-54, -7.3%), northern Australia (MRU-53, -5.4%), Taiwan (MRU-42, -5.0%), and Punjab to Gujarat (-4.9% in MRU-48).

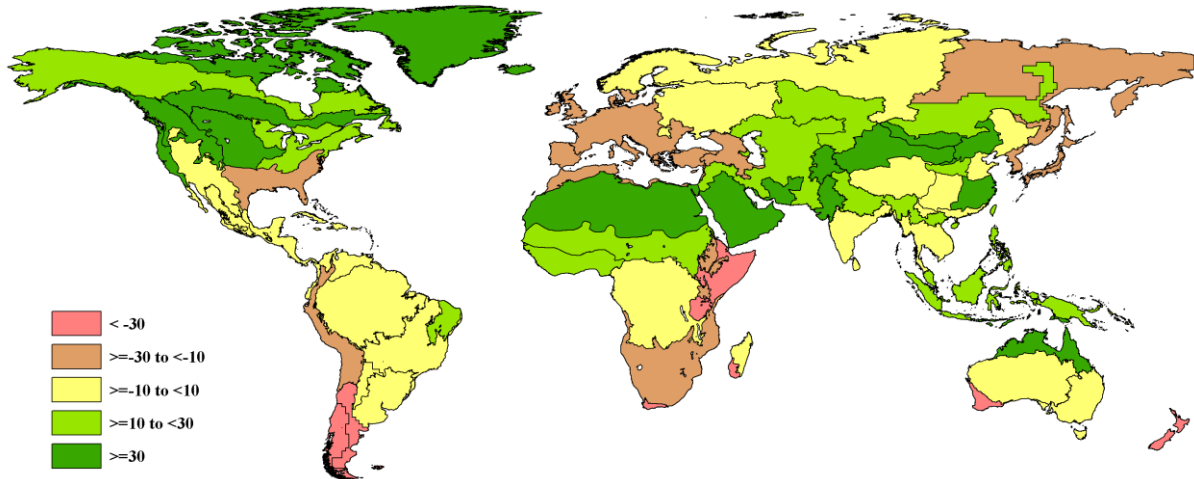
### Combinations of anomalies

For the reporting period, generally, little coherence existed between RAIN and other environmental variables, except BIOMSS, which is directly influenced by water availability. At the scale of MRUs, a reasonably good negative correlation between large excesses of rainfall and sunshine (RADPAR) is visible, mostly in Southern Mongolia (MRU-47, RAIN +201% and RADPAR -2.9%), Gansu-Xinjiang (MRU-32, +175%, -3.4%), Northern Australia (MRU-53, +127%, -5.4%) and the northern Great Plains in the United States

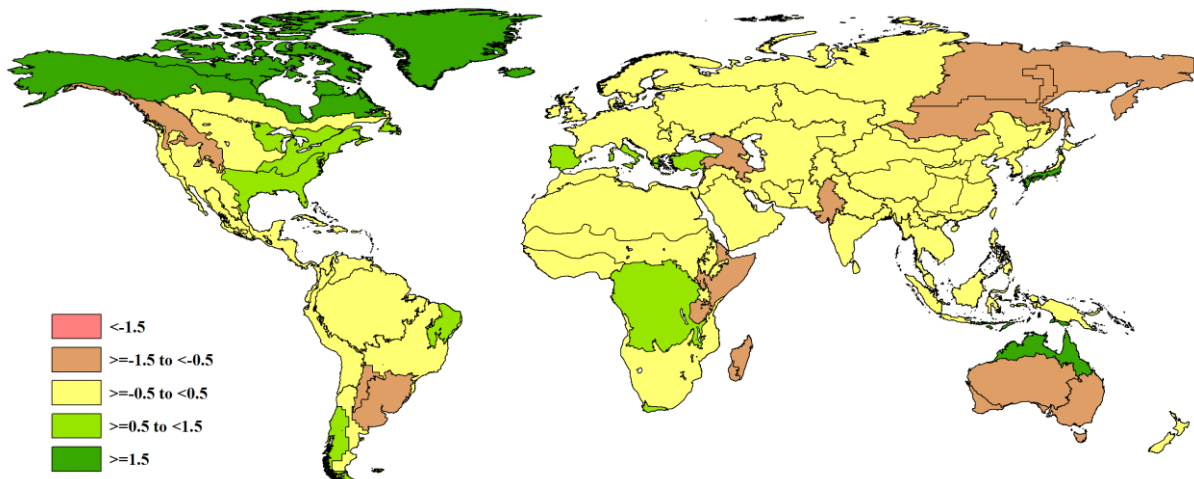
(MRU-12, +97% and -4.6%). (This correlation is more marked at finer spatial resolution, see section 3.1). In the four areas, BIOMSS departure were respectively: +97%, +132%, +89%, and +58%.

While quite some MRUs experienced a “double anomaly”—for example excess RAIN and RADPAR—only few “triple anomalies” are seen. One, however, is in MRU-04, the Horn of Africa, which suffered from drought (RAIN, -41%) combined with low temperature (-0.7°C), and, paradoxically, abundant RADPAR (+4.3%). Another, northern Australia (MRU-53), on the contrary recorded abundant rainfall (+127%), high temperature (+1.5°C), and a shortage of sunshine (RADPAR -5.4%).

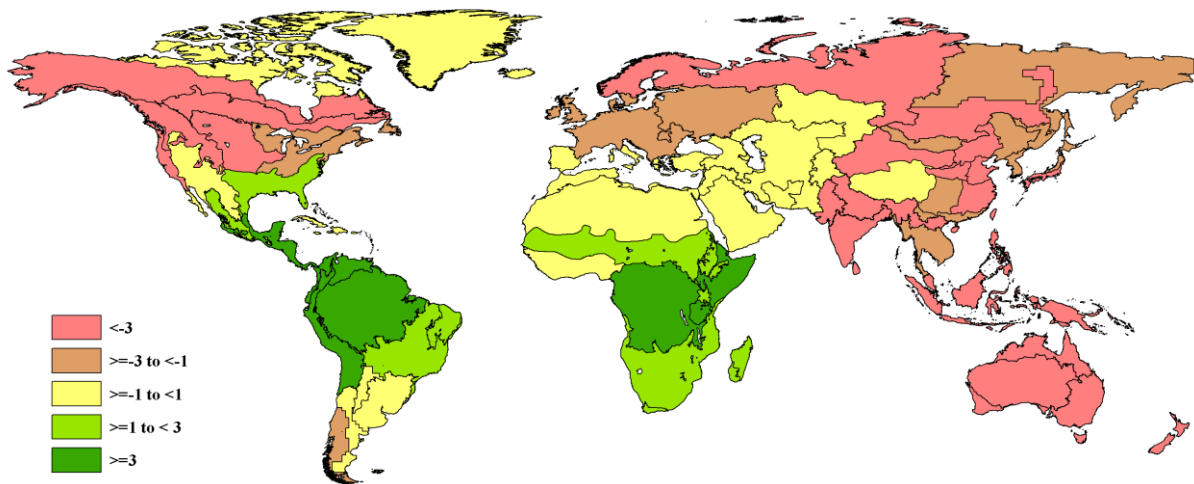
**Figure 1.1. Global map of July-October 2016 rainfall anomaly (as indicated by the RAIN indicator) by MRU, departure from 15YA (percentage)**



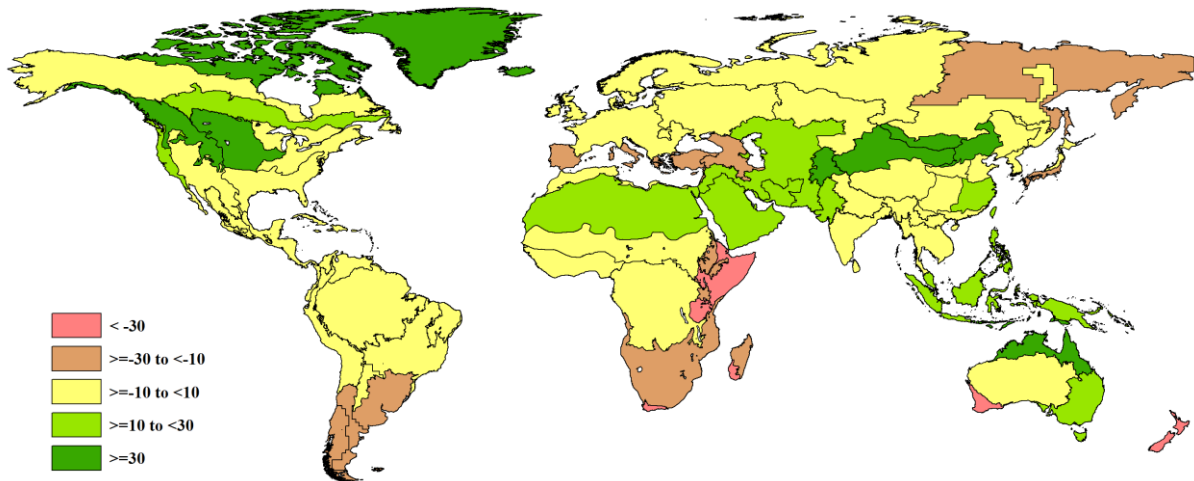
**Figure 1.2. Global map of July-October 2016 temperature anomaly (as indicated by the TEMP indicator) by MRU, departure from 15YA (degrees Celsius)**



**Figure 1.3. Global map of July-October 2016 PAR anomaly (as indicated by the RADPAR indicator) by MRU, departure from 15YA (percentage)**



**Figure 1.4. Global map of July-October 2016 biomass accumulation (BIOMSS) by MRU, departure from 5YA (percentage)**



## Chapter 2. Crop and environmental conditions in major production zones

Chapter 2 presents the same indicators—RAIN, TEMP, RADPAR, and BIOMSS—used in Chapter 1, and combines them with the agronomic indicators—cropped arable land fraction (CALF), maximum vegetation condition index (VCI), minimum vegetation health index (VHI), and cropping intensity—to describe crop condition in six Major Production Zones (MPZ) across all continents. For more information about these zones and methodologies used, see the quick reference guide in Annex C as well as the CropWatch bulletin online resources at [www.cropwatch.com.cn](http://www.cropwatch.com.cn).

### 2.1 Overview

Tables 2.1 and 2.2 present an overview of the agroclimatic (table 2.1) and agronomic (table 2.2) indicators for each of the six MPZs, comparing the indicators to their fifteen and five-year averages.

**Table 2.1. July-October 2016 agroclimatic indicators by Major Production Zone, current value and departure from 15YA**

	RAIN		TEMP		RADPAR	
	Current (mm)	Departure from 15YA (%)	Current (°C)	Departure from 15YA (°C)	Current (MJ/m <sup>2</sup> )	Departure from 15YA (%)
West Africa	925	11	26.2	-0.4	1004	0
South America	340	-5	19.4	-0.5	1010	1
North America	474	30	21.0	0.5	1075	-2
South and SE Asia	1153	12	27.2	-0.3	905	-4
Western Europe	209	-25	16.6	0.3	914	0
C. Europe and W. Russia	230	-1	15.3	-0.5	826	-2

Note: Departures are expressed in relative terms (percentage) for all variables, except for temperature, for which absolute departure in degrees Celsius is given. Zero means no change from the average value; relative departures are calculated as  $(C-R)/R \times 100$ , with C=current value and R=reference value, which is the fifteen-year average (15YA) for the same period (July-October) for 2001-2015.

**Table 2.2. July-October 2016 agronomic indicators by Major Production Zone, current season values and departure from 5YA**

	BIOMSS (gDM/m <sup>2</sup> )		CALF (Cropped arable land fraction)		Maximum VCI Intensity	Cropping Intensity	
	Current	Departure from 5YA (%)	Current	Departure from 5YA (% points)	Current	Current (%)	Departure from 5YA (%)
West Africa	1997	3	97	1	0.93	127	-1
South America	917	-8	91	3	0.79	169	1
North America	1395	25	94	3	0.92	128	4
S. and SE Asia	1908	3	95	0	0.93	157	-6
Western Europe	863	-18	91	0	0.81	115	-10
Central Europe and W Russia	939	-3	98	3	0.89	101	-2

Note: See note for table 2.1, with reference value R defined as the five-year average (5YA) for July-October 2011-2015.

### 2.2 West Africa

Sorghum and millet are important staples in the northern, semi-arid (Sahelian) part of this MPZ. They are replaced in southern areas by more water demanding crops, especially in the west where high elevations

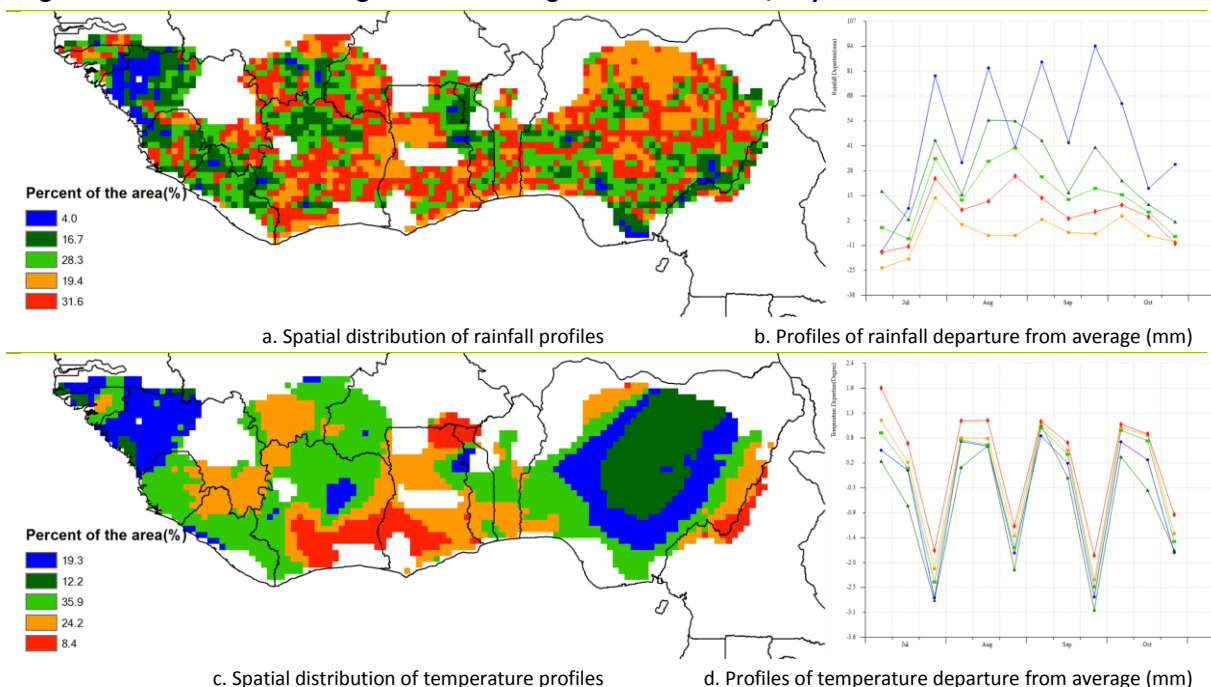
result in abundant precipitation. The reporting period corresponds to the main harvesting season throughout the region, especially for maize, sorghum, millet, and yams. In the west (Guinea to Liberia), rice plays an important part; the harvest has started and will extend into December, sometimes January. In the areas that tend to record bimodal rainfall (southern Côte d'Ivoire to Nigeria), the first maize crop is usually harvested from October, while the second is less advanced and will be harvested in 2017. Cassava, the main staple in the region is also still growing. The cropping intensity map clearly shows areas where two crops were cultivated along the Atlantic Ocean. For the whole MPZ, the cropping intensity reached 125%, slightly below average.

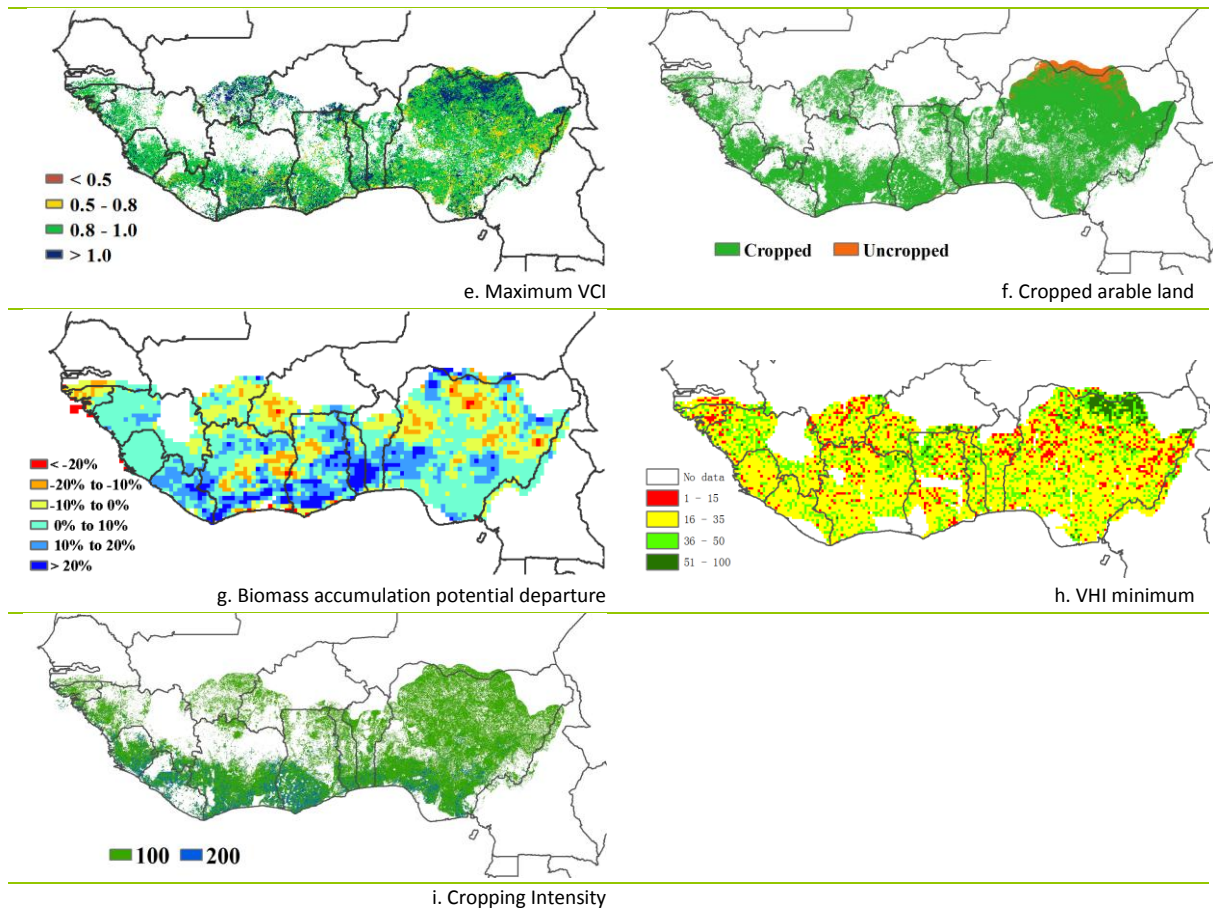
As a whole, the MPZ recorded above average rainfall (RAIN, +11%) and close to average temperature and sunshine, which resulted in a slight increase of the biomass production potential. The west of the region, which normally records between 1000 and 1500 mm rainfall over the current reporting period, enjoyed a significant increase of precipitation between 11% (Sierra Leone) and 18% (Guinea), as well as a decrease in sunshine (-1% in Liberia to -5% in Guinea Bissau). The rainfall in this area increased the Niger discharge for the benefit of the Sahel. In the center and east (Côte d'Ivoire to Nigeria) precipitation departures reached between +4% (Benin) and +14% (Togo) over average, and RADPAR was average or above average (0 to +2%). For the MPZ as a whole, the cropped arable land fraction reached 97%, an increase of 1 percentage point that can be assigned to favorable rain.

The spatial rainfall departure patterns confirm that the highlands of the western part of the MPZ (4% of crop lands) did very well. Most areas (76.6%) had a peak of above average rainfall (+20% to 50%) centered around August. The interaction of rainfall and temperature patterns resulted in the largest positive biomass production potential departures being concentrated in the southern areas, which corresponds to the areas that cultivate two maize crops, of which the first did well. No areas had NDVI that dropped significantly below average; the area where VHI was highest corresponds to the Sahelian part of Nigeria.

Altogether, conditions were close to average, with abundant but not excessive precipitation well distributed in time. CropWatch indicators depict a coherent situation with all crops doing well, including those to be harvested later this year and in early 2017 (second maize crop and cassava).

**Figure 2.1. West Africa MPZ: Agroclimatic and agronomic indicators, July-October 2016**





Note: For more information about the indicators, see Annex C.

### 2.3 North America

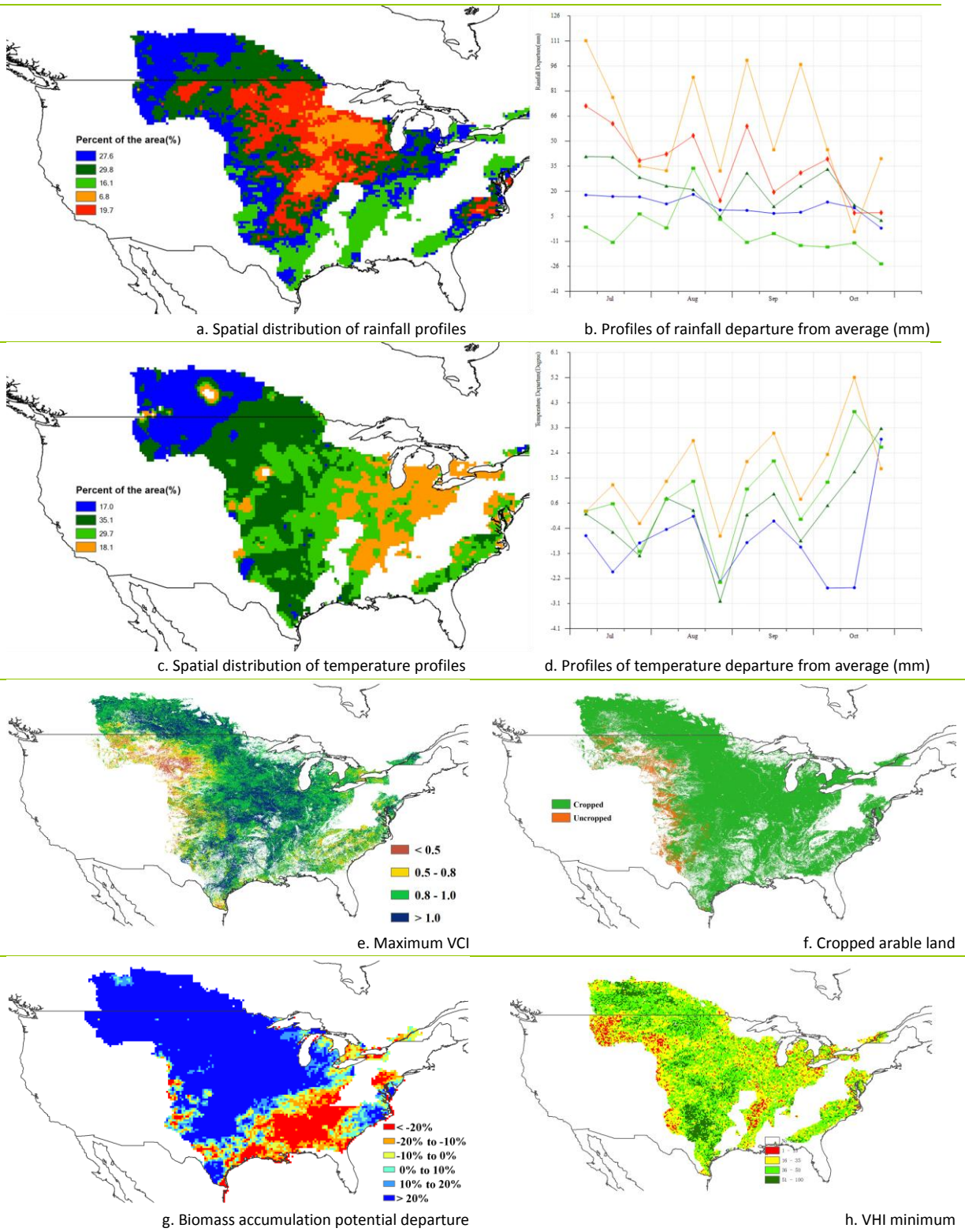
The current monitoring period from July to October 2016 covers the growth and harvesting season of summer crops. CropWatch agroclimatic and agronomic indicators indicate above average crop condition in the North American MPZ.

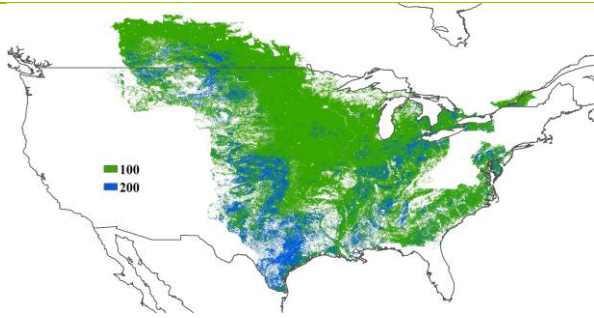
During the monitoring period, most of the MPZ enjoyed sufficient precipitation and normal temperature, which was beneficial to crop growth. The agroclimatic indicators show that RAIN was 30% above average, TEMP 0.3°C above, and RADPAR just 2% below. Abundant rainfall fell over the major crop production zones, including the Corn Belt (RAIN, +19%), northern Great Plains (+97%), British Columbia to Colorado (+41%), and the West Coast (+45%), which provided an adequate soil water supply for the growth of maize, soybean, and spring wheat. Especially after mid-September, above average temperature was very conducive to crop harvest.

Agronomic indicators confirm the generally above-average crop condition in the MPZ. Compared to the average of the past five years, accumulated biomass potential (BIOMSS) increased significantly by 25%. Two distinct BIOMSS patterns are observed: values of 20% above average occurred in the northwestern regions (Corn Belt and northern Great Plains), while the southeast shows negative values, with some even beyond -20%. Good crop condition is confirmed by a high average VCIx value (0.92) in the southern Canadian Prairies and northern Great Plains, as well as in the Corn Belt where VCIx even exceeded 1, indicating very favorable crop condition. According to the CropWatch CALF indicator over the whole monitoring period, 94% of arable lands were cropped, which is 3 percentage points above average. At the same time, cropping intensity significantly increased (+4%).

Considering the performance of the zone’s agroclimatic and agronomic indicators, good summer crop production can be expected for the North American MPZ.

**Figure 2.2. North America MPZ: Agroclimatic and agronomic indicators, July-October 2016**





i. Cropping Intensity

Note: For more information about the indicators, see Annex C.

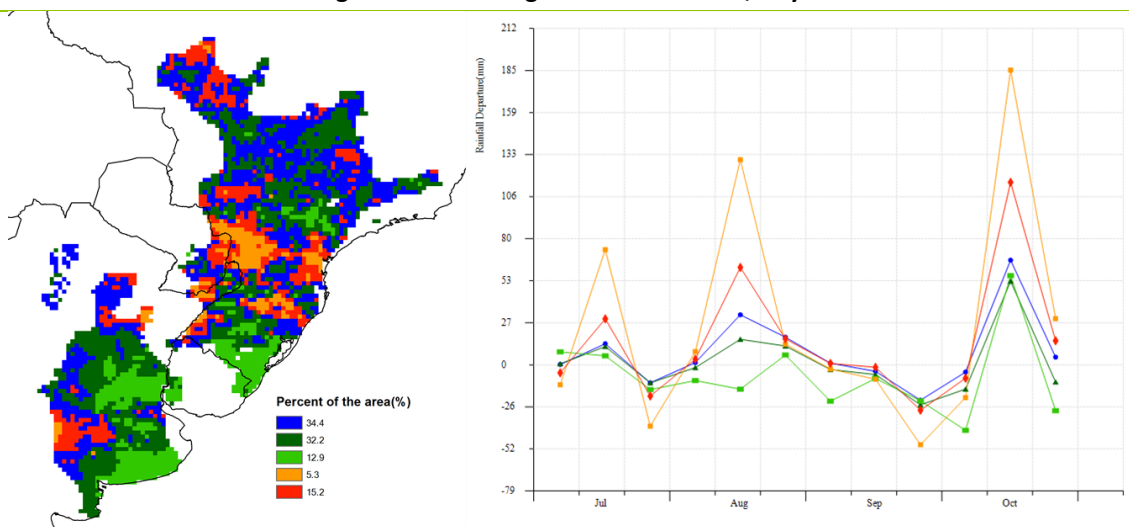
## 2.4 South America

This reporting period essentially covers the growing period of winter crops. Main crops are in the vegetative stages (maize) or at the beginning of planting (soybean). Figure 2.3 summarizes the CropWatch agroclimatic and agronomic indicators.

In general, RAIN was below average, with some variability among areas: negative departures in the Pampas, Patagonia, and semi-arid and Andean regions, and increments in northeast Brazil, the Amazon, and central-north Argentina. Increases in TEMP over average were more consistent among areas. Potential growth estimated through the BIOMSS indicator points at reductions in areas with a higher degree of RAIN deficit, while indicating increments in most areas with high RAIN. Maximum VCI highlights the variability of crop condition in the region. Despite the reductions in RAIN, Argentina shows in general higher maximum VCI values than Brazil, probably related to a higher retention of soil water from the previous season's rains (with strong El Niño effect) over temperate areas. Low VCI values occur locally in areas such as in the south of Buenos Aires province (Argentina) and Rio Grande do Sul and Paraná states (Brazil); they are associated with negative anomalies in precipitation. Low VHI values are observed for these areas, as well as in the northern areas of Brazil. BIOMSS reductions for the Pampas and Rio Grande do Sul due to lower rainfall do not always result in reductions in the vegetation health index (VHI), probably also due to the soil water retention from the extremely wet last season. For the central Pampas, changes in crop proportions from last year could also explain the high VHI values observed.

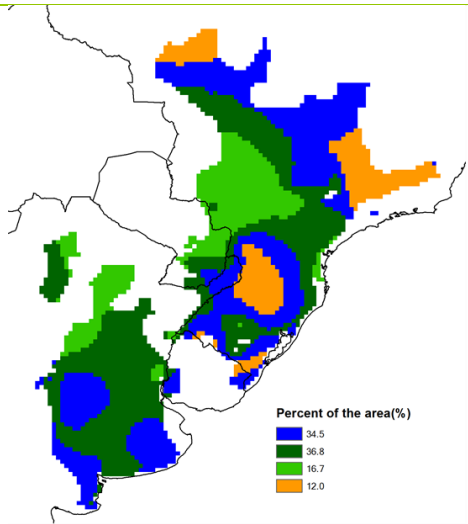
Overall, conditions are average to favorable for crops in the South America MPZ.

Figure 2.3. South America MPZ: Agroclimatic and agronomic indicators, July-October 2016

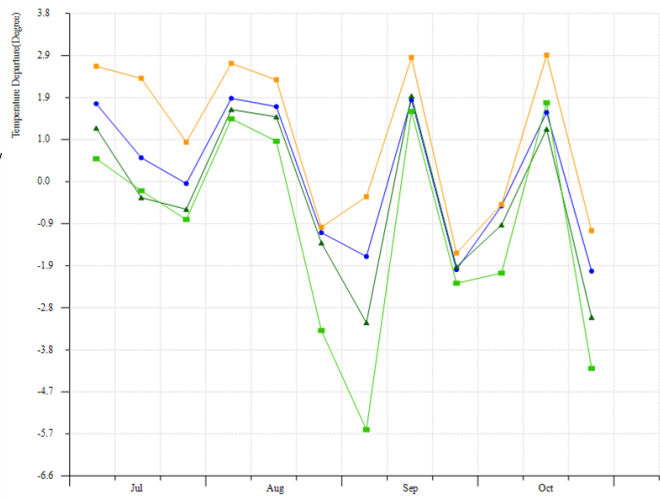


a. Spatial distribution of rainfall profiles

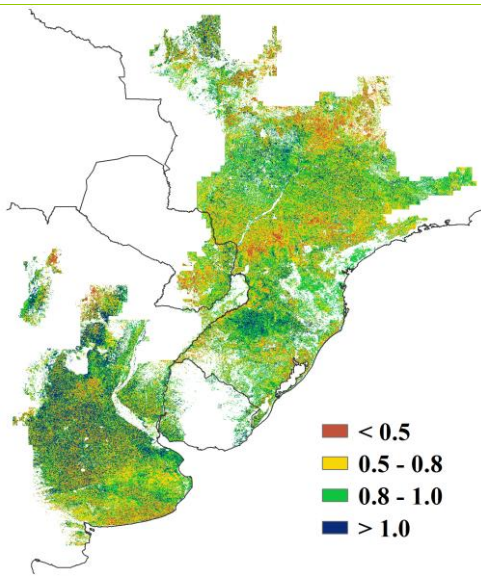
b. Profiles of rainfall departure from average (mm)



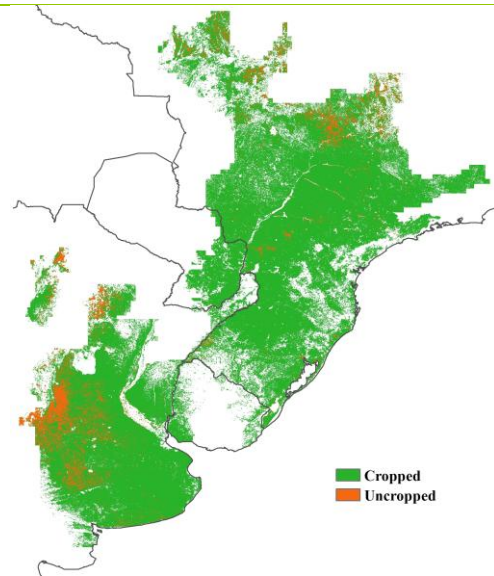
c. Spatial distribution of temperature profiles



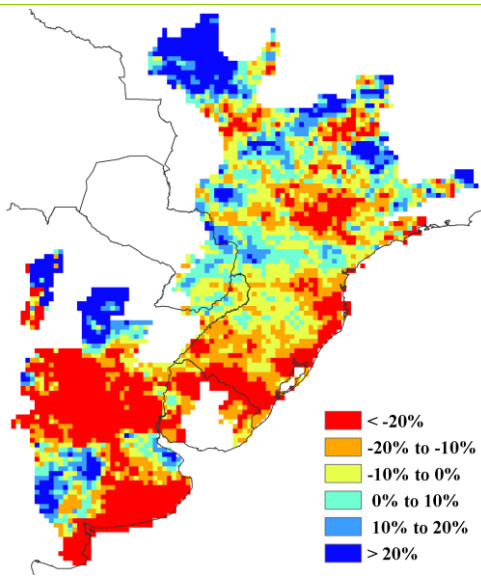
d. Profiles of temperature departure from average (mm)



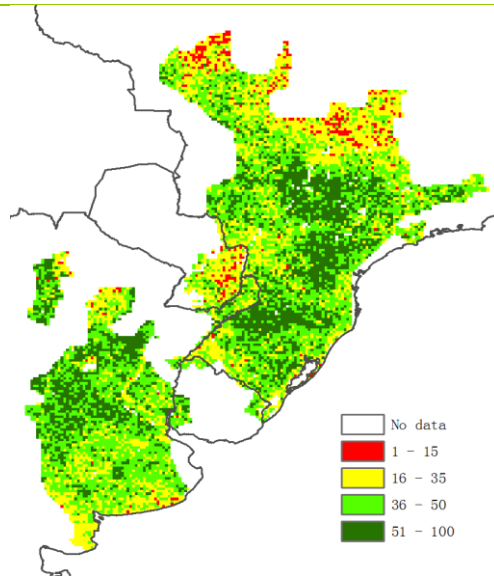
e. Maximum VCI



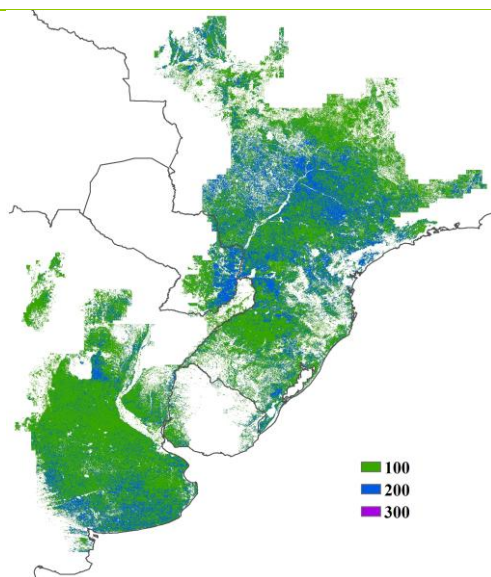
f. Cropped arable land



g. Biomass accumulation potential departure



h. VHI minimum



i. Cropping Intensity

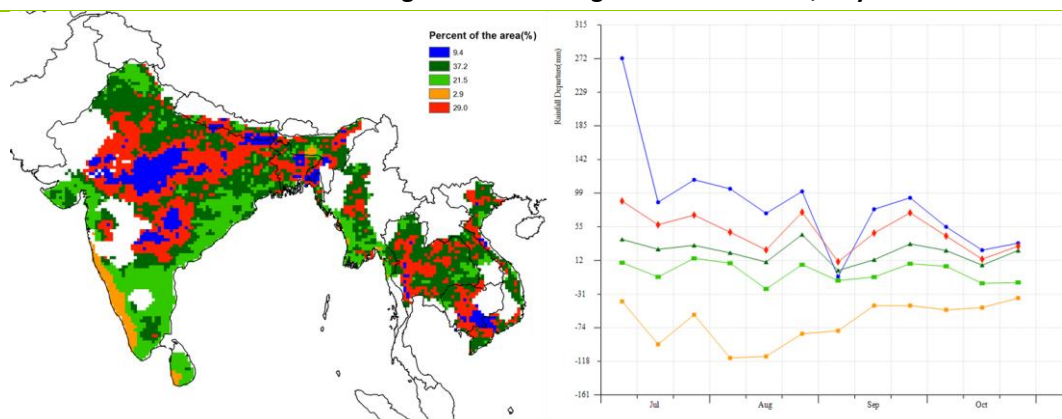
Note: For more information about the indicators, see Annex C.

## 2.5 South and Southeast Asia

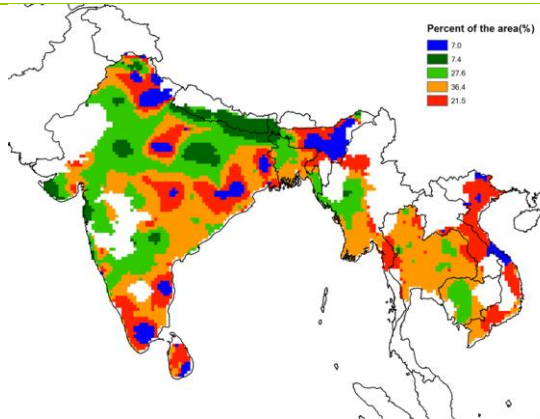
The reporting period is the planting and growing season of rice and maize. As per CropWatch agroclimatic indicators, the crop condition for the MPZ is average. During the monitoring period rainfall (RAIN) was 12% above average, with increases in Thailand (+9.4%) and Cambodia (+29%), Bangladesh (+19%), India (+12%), and Vietnam (+12%). The excess rainfall in these areas caused floods and damaged crops. While the biomass accumulation potential (BIOMSS) increased by 3%—probably due to the excess rainfall, temperature remained average. The photosynthetically active radiation (RADPAR) dropped 4% as compared to average. Meanwhile, maximum VCI values ranged from 0.5 to 1, pointing at average to favorable crop condition. In southern India and in some parts of Vietnam, however, maximum VCI values remained below 0.5, indicating poor crop condition. No change was observed in the region's fraction of cropped arable land (CALF), which was 95% during the monitoring period. The non-cropped areas are distributed mainly in the Indian state of Tamil Nadu, Haryana, and in southern Vietnam. The cropping intensity of the MPZ was 157%, 6% below average. Low values of VHI minimum were recorded in parts of Vietnam, the Indian state of Tamil Nadu, Karnataka, Kerala, Orissa, and Punjab, pointing to water stress in these areas linked to deficit rainfall.

Overall the crop condition is average in the MPZ as a whole, in spite of severe floods in India, Myanmar, Bangladesh, Vietnam and Thailand.

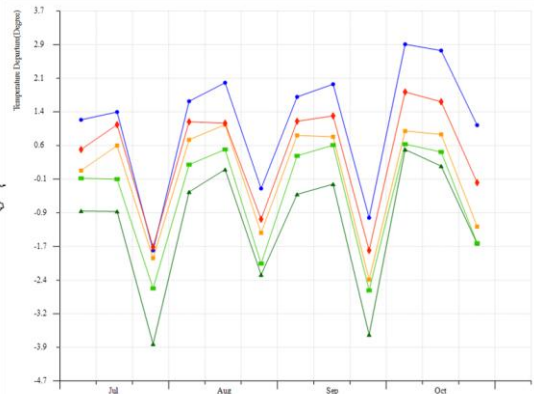
Figure 2.4. South and Southeast Asia MPZ: Agroclimatic and agronomic indicators, July-October 2016



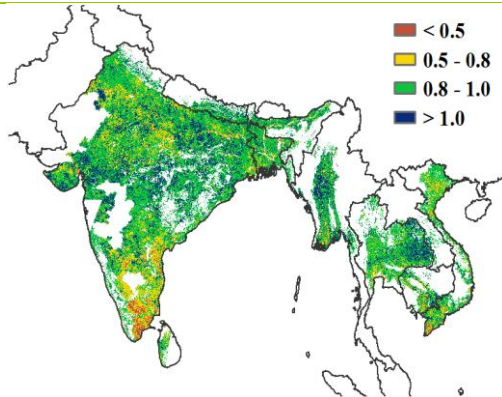
a. Spatial distribution of rainfall profiles



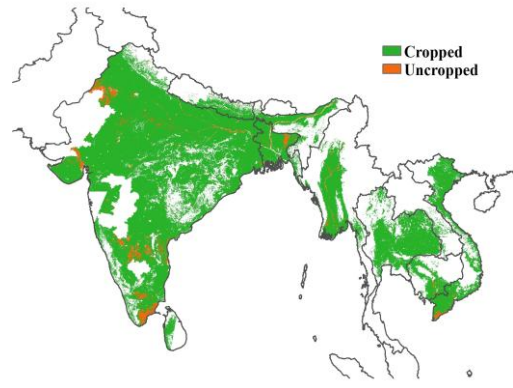
b. Profiles of rainfall departure from average (mm)



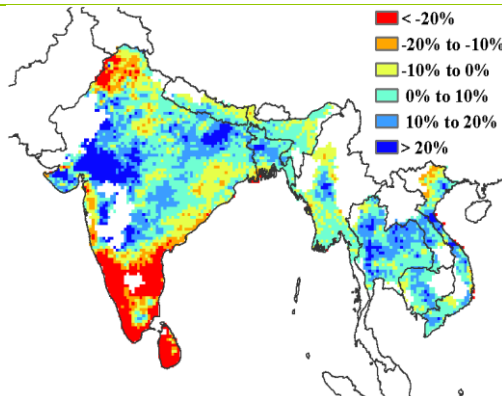
c. Spatial distribution of temperature profiles



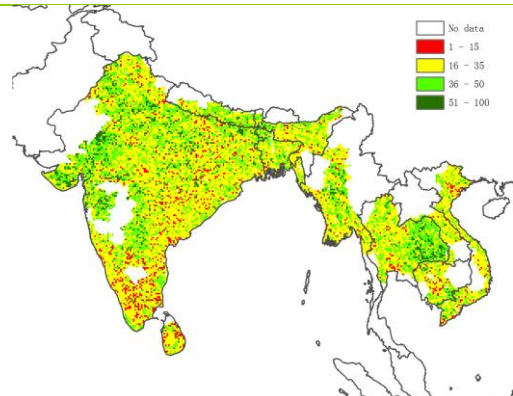
d. Profiles of temperature departure from average (mm)



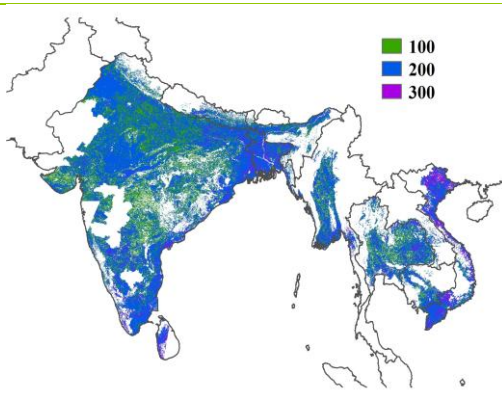
e. Maximum VCI



f. Cropped arable land



g. Biomass accumulation potential departure



h. VHI minimum

i. Cropping Intensity

Note: For more information about the indicators, see Annex C.

## 2.6 Western Europe

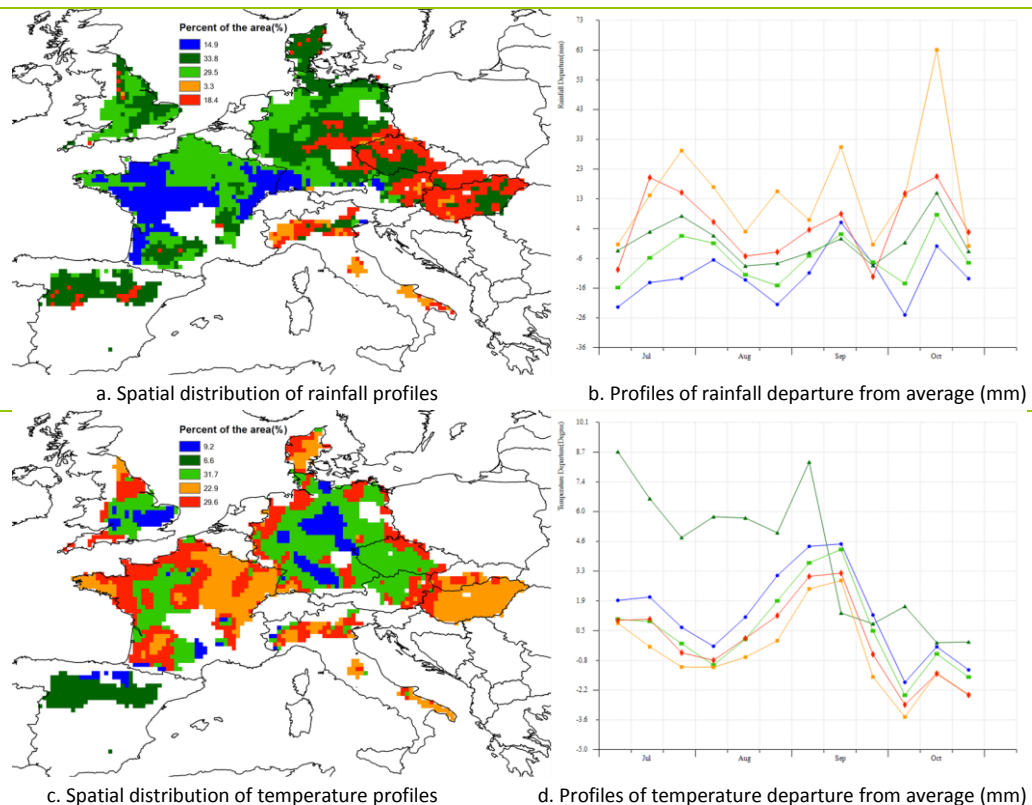
Crop condition was below average in most parts of the continental Western European MPZ, based on the integration of agroclimatic and agronomic indicators.

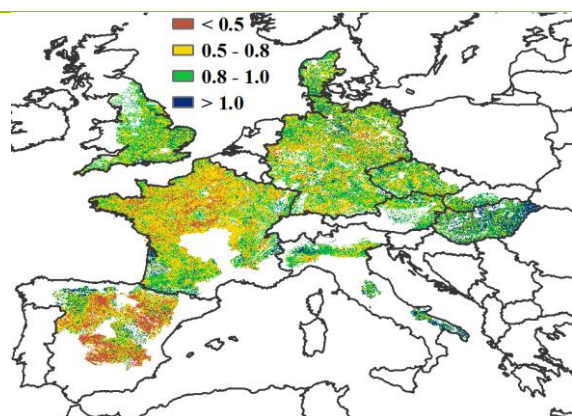
Total precipitation was 25% below average, but with exceptional positive departures over most of Germany, Hungary, Austria, the Czech Republic, Denmark, Italy, Spain, the southern part of northern France, and the east of the United Kingdom in late July and early September and during the second half of October. The west and east of France suffered a precipitation shortfall in late August. Temperature showed an increase of 0.3°C over average and radiation was about average. Below average temperatures were observed in most parts of Western Europe after early September except for Spain. In August, a heat wave that occurred across the whole of Europe was felt mostly in Germany, France, Italy, Belgium, Austria, and Switzerland; in parts of Spain temperatures approached 40 degrees from June to middle August, a historical record. The unfavorable climatic conditions (low rain and high temperature) were not beneficial for late crop development and maturation.

Due to the rainfall deficit, the biomass accumulation potential, BIOMSS, was 18% below the recent five-year average. The spatial distribution of BIOMSS shows that the lowest values (-20% and below) occur over most of France, Spain, northern Germany, the United Kingdom, and Denmark. The values for minimum VHI confirm the water deficit in those regions over the last four months. In contrast, BIOMSS in most other regions was 10% above average. According to the VCIx map, crop condition was below average in most of Spain, France, and Germany, compared with other regions in the MPZ. Average VCIx for the MPZ was 0.81. Cropping intensity (115%) was down 10% compared with the five-year-average and only 91% of the arable land was cropped across the MPZ. Most uncropped arable land was concentrated in Spain throughout this reporting period.

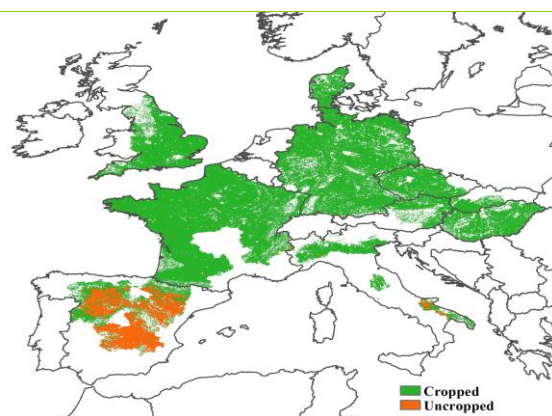
Generally, the condition of summer crops in the MPZ was below average and more rain will be needed to ensure adequate soil moisture supply for the ongoing winter crop season.

**Figure 2.5. Western Europe MPZ: Agroclimatic and agronomic indicators, July-October 2016**

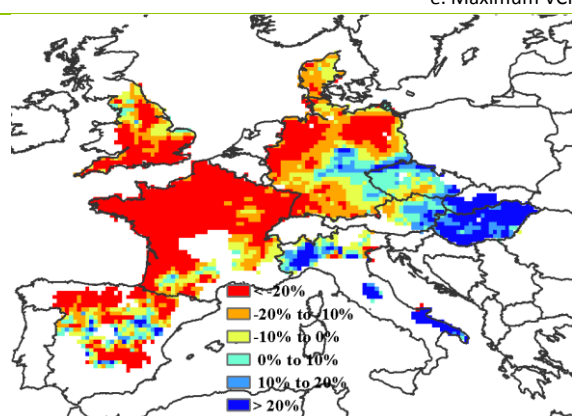




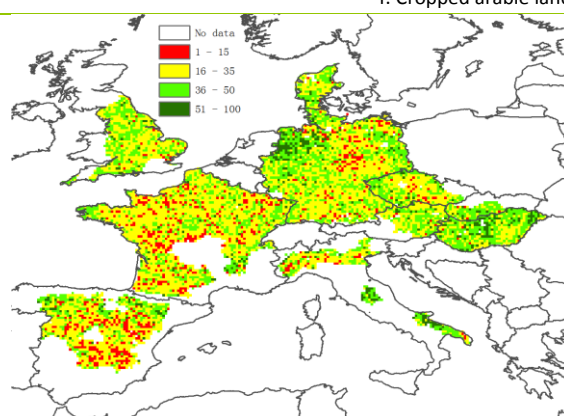
e. Maximum VCI



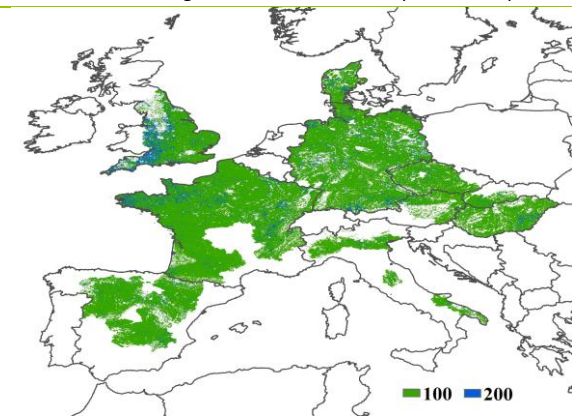
f. Cropped arable land



g. Biomass accumulation potential departure



h. VHI minimum



i. Cropping Intensity

Note: For more information about the indicators, see Annex C.

## 2.7 Central Europe to Western Russia

The overall average agroclimatic variables over the MPZ (RAIN, -1%; TEMP, -0.5°C; and RADPAR, -2%) hide a situation made up by spatially contrasted situations.

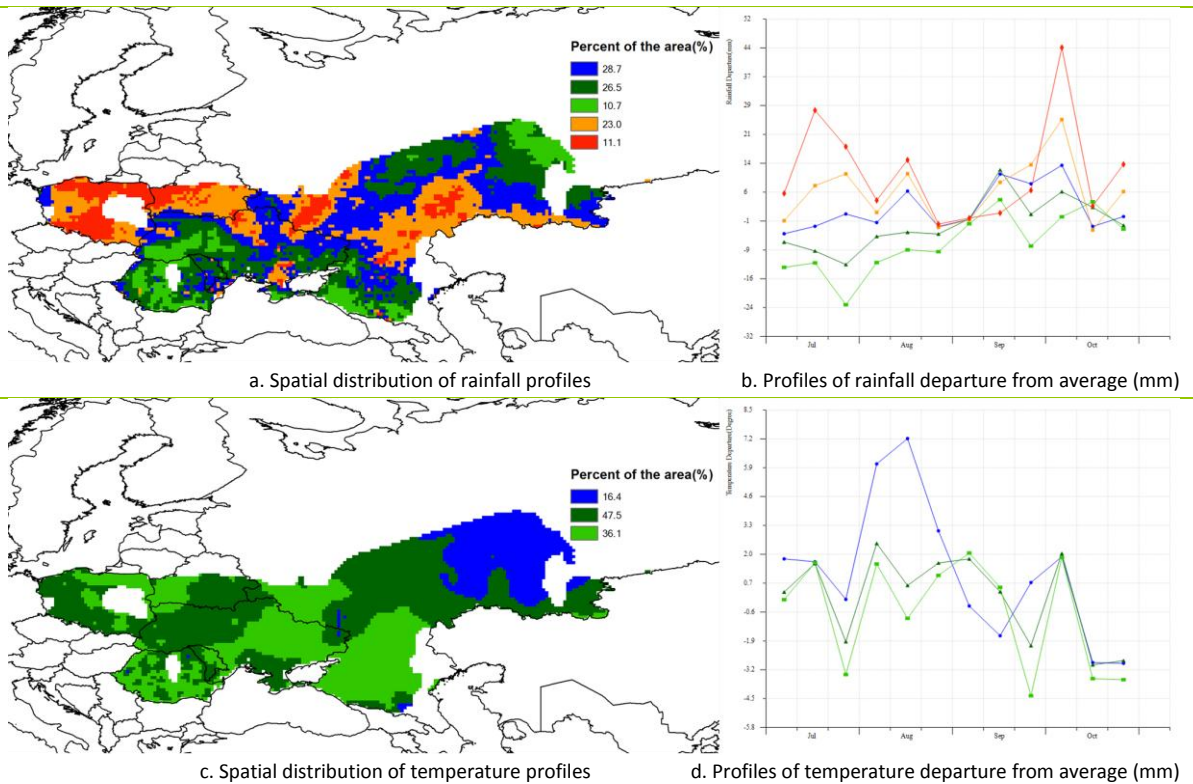
Unfavorable rainfall affected about 37.2% of the MPZ during July and August, especially in Romania (RAIN, -27%), southwest Ukraine (Lviv to Vinnytsia oblasts) and southern Russia (from the kray of Krasnodar to the Kabardino balkariya republic). The largest deficits occurred in the two republics of Ingushetiya (-42%), Adigeya (-39%), and the kray of Krasnodar (-32%). Favorable precipitation with peaks in July and October was recorded on a large band crossing the continent from Poland (+28%) in the west to the Russian oblasts of Samarskaya (+7%) and Saratovska (+29%), with maxima in the oblast of Leningrad (+48%) and the republic of Karelya (+47%). Temperature was generally low, with two colder periods in July and in September. The coldest area was the already-mentioned Adigeya republic with an average drop of 1.8°C

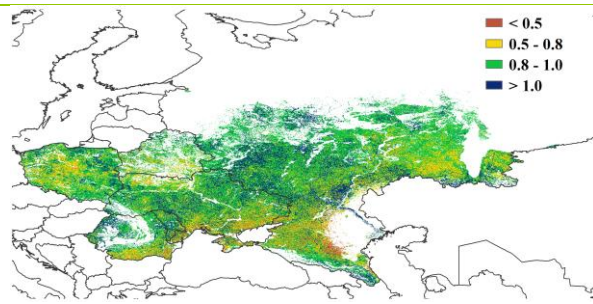
over the reporting period. The only area with significantly higher than average temperature occurred in the northeast of the MPZ around and between the oblasts of Kirov (+0.5°C over the reporting period) and Perm (+1.3°C) where the temperature departure peak exceeded 7°C in early August for two consecutive dekads.

The resulting biomass production potential (BIOMSS, -3% on average for the MPZ), which is relevant mostly for summer crops, directly results from the agroclimate: a positive departure in Poland (+21%, decreasing in the west), northwest Belarus (+8% nationwide) and adjacent areas in Russia (oblast of Smolensk, +17%), as well as in the oblasts in the east of the MPZ mentioned for their high precipitation. Low values occur in the southern areas. The pattern is largely confirmed by the VCIx values: high in Poland and Belarus and intermediate in Ukraine and Romania where a mix of favorable and unfavorable situations occurs.

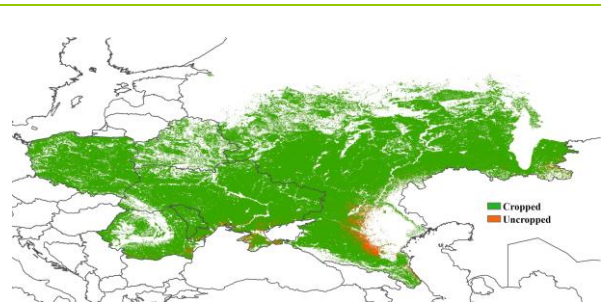
Uncropped arable land occurs mostly in the Caucasus (Stavropol kray), which is also characterized by clusters of unfavorable VHI<sub>n</sub> and low VCI<sub>x</sub>. Considering all indicators—including CALF (98% on average, an increase of 3 percentage points over average), the rather high average VCI<sub>x</sub> (0.89 on average; 0.9 in Poland, Ukraine and Russia), and the cropping intensity (101%, 2% below average)—mixed but about average conditions are estimated to prevail over the MPZ, with below average conditions in the southernmost areas where the outcome of the current winter crops season will crucially depend on winter precipitation.

**Figure 2.6. Central Europe-Western Russia MPZ: Agroclimatic and agronomic indicators, July-October 2016**

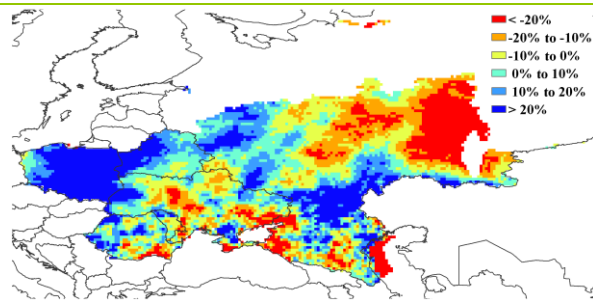




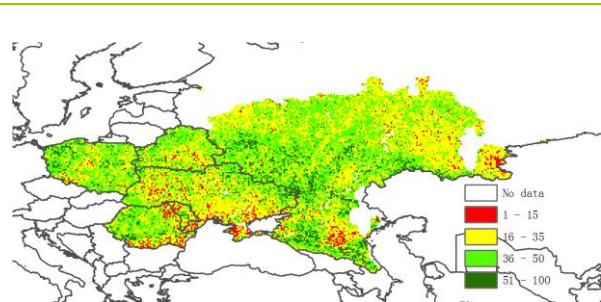
e. Maximum VCI



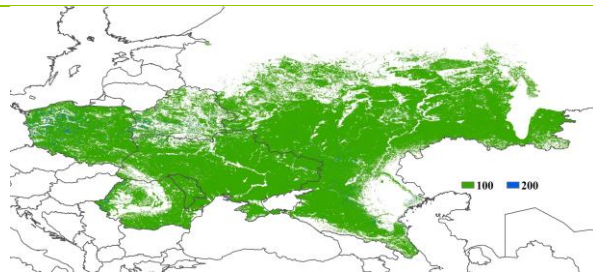
f. Cropped arable land



g. Biomass accumulation potential departure



h. VHI minimum



i. Cropping Intensity

Note: For more information about the indicators, see Annex C.

## Chapter 3. Main producing and exporting countries

*Building on the global patterns presented in previous chapters, this chapter assesses the situation of crops in 30 key countries that represent the global major producers and exporters or otherwise are of global or CropWatch relevance. In addition, the overview section (3.1) pays attention to all countries worldwide, to provide some spatial and thematic detail to the overall features described in section 1.1. In section 3.2, the CropWatch monitored countries are presented, and for each country maps are included illustrating NDVI-based crop condition development graphs, maximum VCI, and spatial NDVI patterns with associated NDVI profiles. Additional detail on the agroclimatic and BIOMSS indicators, in particular for some of the larger countries, is included in Annex A, tables A.2-A.11. Annex B includes 2016 production estimates for Argentina, Australia, Brazil, Canada, and the United States.*

### 3.1 Overview

As mentioned in Chapter 1, some agroclimatic patterns emerge at the MRU level that are of global relevance. In this Chapter, analyses are more specific, for all countries and in particular for the 30 countries that make up the bulk of food production and trade (especially exports). For those 30 countries, analyses will also cover sub-national situations and agro-ecological zones. (A more detailed analysis for China is provided separately in Chapter 4.)

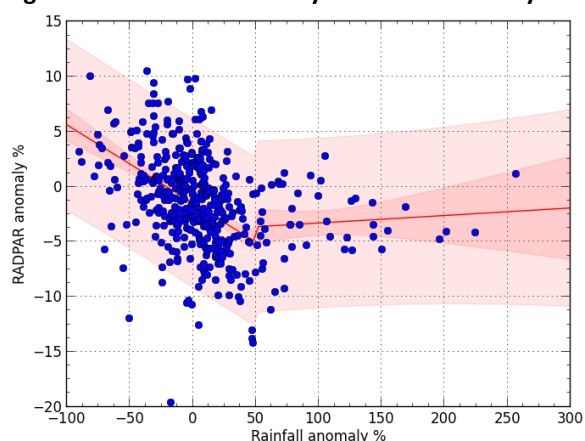
As a result of global atmospheric dynamics, agroclimatic variables are usually correlated; for instance rainfall and temperature may correlate as a result of normally abundant precipitation in equatorial areas. Other well-known examples include temperature and sunshine (positive correlation) as well rainfall and sunshine (negative correlation). Those “climatological patterns” are mostly zonal, but they are subjected to variations according to the prevailing climate and season; the link between temperature and rainfall, for example, is much weaker in tropical areas than in temperate ones.<sup>1</sup> Despite these frequent correlations, however, it is much less common that *departures* from the reference value (in this case the fifteen-year average used by CropWatch for RAIN, TEMP, and RADPAR) follow coherent patterns at the global scale. For the current July-October 2016 reporting period, however, there is a very significant correlation between rainfall anomalies and RADPAR anomalies across the 439 polygons that make up figures 3.2 (rainfall), 3.3 (temperature), 3.4 (PAR), as well as 3.5 (biomass).

The spatial departure patterns between rainfall and RADPAR are very visible<sup>2</sup> (compare figures 3.2 and 3.4); in fact, the coefficient of correlation reaches  $r = -0.33$  for  $n = 439$ . The correlation is high ( $R = 0.16$ ) for rainfall anomalies below +40% (including negative ones) but levels off for higher departures (figure 3.1). This means that, particularly for rainfall deficit areas, the global patterns of anomalies roughly coincide for rainfall and RADPAR.

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<sup>1</sup> This was discussed in some detail in a recent CropWatch publication: <https://link.springer.com/article/10.1007%2Fs00484-016-1199-7>.

<sup>2</sup> The same patterns are also very visible for rainfall and BIOMSS, but this is a direct consequence of the methodology used to derive BIOMSS from rainfall and temperature (BIOMSS anomaly % Vs. rain anomaly %:  $r = 0.91$ ; BIOMSS anomaly % Vs. rain anomaly %:  $r = -0.08$ ).

**Figure 3.1. RADPAR anomaly vs rainfall anomaly**

Note: The RADPAR anomaly vs rainfall anomaly is best modelled as a piecewise linear regression with DOF=435 (number of points is 439 countries and sub-country units) with a breakpoint at a rainfall anomaly of +50% ( $r=0.44$ ).

### Areas with excess precipitation

#### *Africa: Sahelian region*

Abundant precipitation benefited the end of the cropping season in the semi-arid West African Sahel, where Mauritania recorded in excess of 800 mm of rainfall over the reporting period (and thus almost throughout the rainy season), corresponding to 100% excess. Other countries with favorable rainfall include Niger (+39% of well-distributed precipitation), Mali, Burkina Faso, and Senegal, as well as the western Gulf of Guinea from Liberia to Guinea Bissau, which all experienced close to 20% positive rainfall departures. The region experienced radiation moderately below the reference values (RADPAR, -2%) and slight negative temperature departures (TEMP, -0.4°C). The expected potential biomass increase (BIOMSS) is nevertheless depressed by the temperature and reaches +9%.

#### *Asia: Arabian Peninsula*

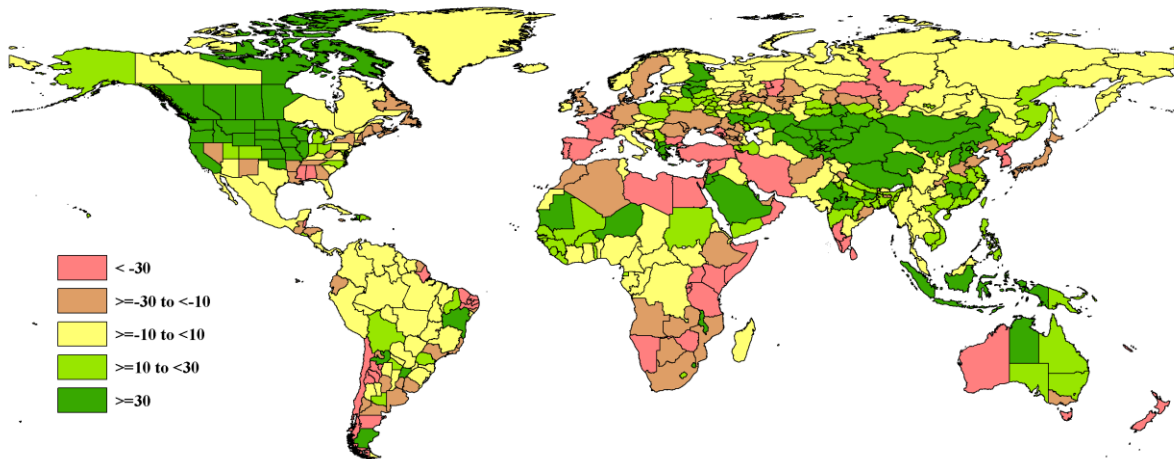
Chad, in the center of the Sahelian area (RAIN, +8%) provides the transition to North Sudan (RAIN, +28%) and the Arabian Peninsula where several countries also recorded unusually favorable rainfall: Jordan (+73%), Saudi Arabia (+100%), and Qatar (+257%). The three countries normally record low rainfall amounts (20 to 50 mm over the reporting period) but, considering prevailing aridity conditions over the Middle-East, the amounts are nevertheless significant ecologically and agronomically, mostly so for Jordan.

#### *Europe: eastern Europe to western Russia*

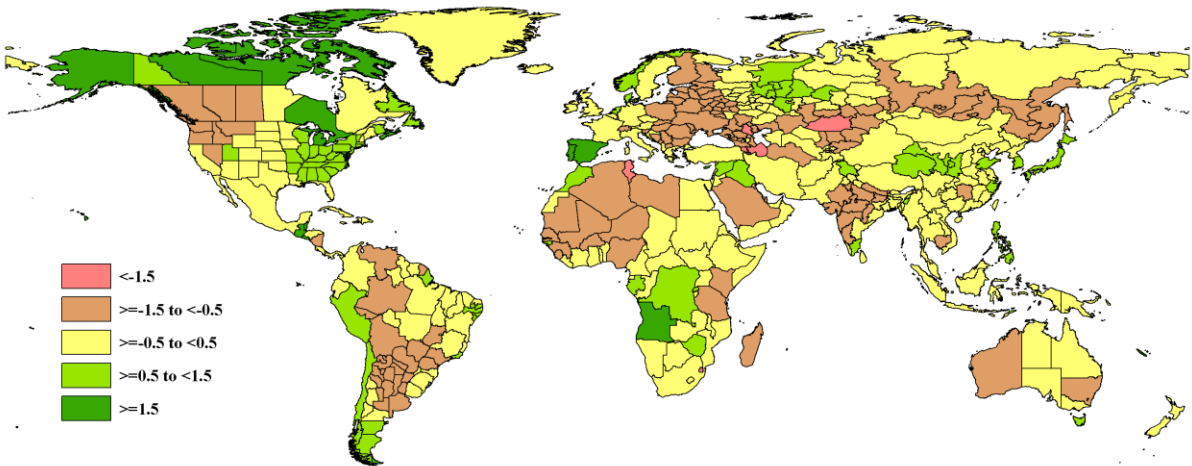
Several regions from western Russia to northern-central Europe and Greece received precipitation amounts that are beneficial to the early crop stages of the beginning winter crop season in the area. Precipitation was 28% above average with both relatively low sunshine and temperature (RADPAR, -5%; TEMP, -0.8°C). The resulting biomass production potential departure is 14%.

The region encompasses the areas between Karelya and the oblast of Pskov (RAIN, +32% to +48%) in the north, extending south to the Belgorod oblast with excesses between 20% and 30% and west as far as Poland (+27%) and Slovakia (+13%) across Belarus (+23%) and Lithuania (+20%). To the south of this area, after skipping Hungary (+4%), more significant positive rainfall departures again occurred in Serbia (+11%), and especially in Albania (+40%), Macedonia (+57%), and Greece (+77%).

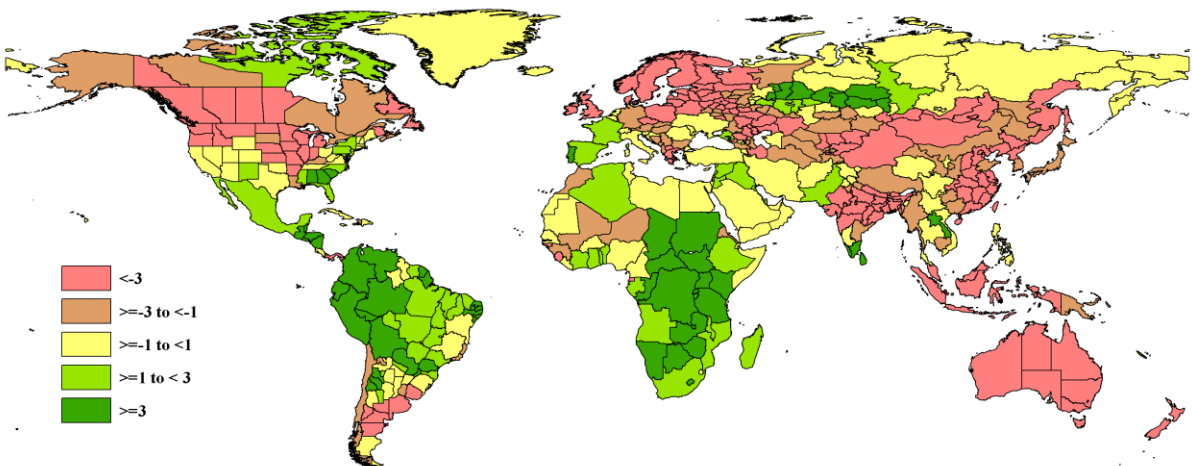
**Figure 3.2. Global map of July-October 2016 rainfall (RAIN) by country and sub-national areas, departure from 15YA (percentage)**



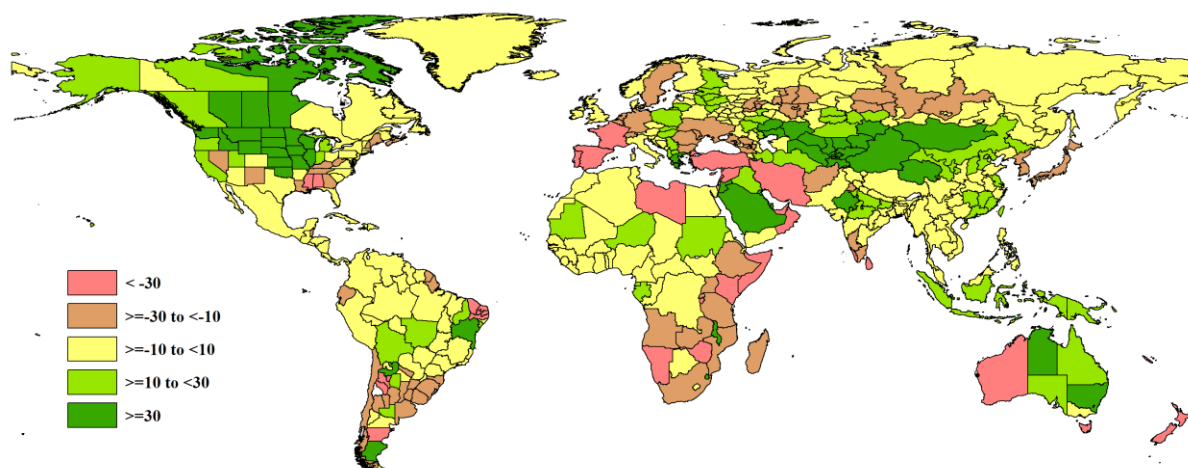
**Figure 3.3. Global map of July-October 2016 temperature (TEMP) by country and sub-national areas, departure from 15YA (degrees)**



**Figure 3.4. Global map of July-October 2016 PAR (RADPAR) by country and sub-national areas, departure from 15YA (percentage)**



**Figure 3.5. Global map of July-October 2016 biomass (BIOMSS) by country and sub-national areas, departure from 15YA (percentage)**



*Europe to Asia: southern Russia to China*

Not unlike the previous season, vast expanses of land in and around central and southern Asia recorded abundant precipitation when expressed against the average of the recent fifteen years (+67%). The area includes more than 30 countries and sub-national units illustrated in figure 3.2 (rainfall by national and subnational boundaries). With very few exceptions (Nagaland and Qinghai), temperature was systematically below average (-0.4°C) and so was radiation (-5%). The BIOMSS indicator increased by 41%. Radiation was particularly low in the southern part of the northern-central Indian peninsula. Overall, this large area with abundant precipitation is bounded by the following regions:

- In the west: the southern Russian oblasts of Volgograd (+33% rainfall) and Saratov (+29%), as well as the western region in Kazakhstan (Zapadno-Kazakhstanskaya oblast, +51%). All experienced a drop in RADPAR in the order of 5%. Temperatures were 0.5°C to 1.0°C below average.
- In the north: the Pavlodar region of northeast Kazakhstan with +39% precipitation, about average RADPAR, and below average temperature (-0.8°C).
- In the east: Mongolia and the Chinese region of Inner Mongolia with +53% and +37% precipitation, respectively, and average TEMP and RADPAR.
- In the southeast: the Chinese provinces of Qinghai (+84%) and Xizang (+36%).
- In the south: the Indian states of Bihar (+38%), Madhya Pradesh (+62%), and Rajasthan (+79%). The drop in sunshine was significant and reaches -10%, -11%, and -5%, respectively.
- In the southwest: Uzbekistan with +169% of precipitation but otherwise average conditions.

The large area also includes the following administrative units, which all experienced precipitation close to or in excess of +45%: Shanxi and Hebei provinces in China (+44% and +46%), Tajikistan and Kyrgyzstan (+143% and +196%, with about normal TEMP and RADPAR), and several regions in Kazakhstan. They include the Aktubinsk oblast (RAIN, +54%), the eastern region—Vostochno-kkazachstanskaya oblast—with +79% precipitation, the Kyzylorda region at +129% precipitation, Yujno Kazakhstanskaya oblast at +143%, and the Jambyl region with precipitation up 201% and a 1.2°C drop in temperature. The largest excess over average was recorded in the Xinjiang Uygur region of western China with 410 mm of rain, corresponding to an increase of 224% over the average of the recent years. Sunshine (RADPAR) fell below average significantly or very significantly in southern Asia (Maharashtra and Chhattisgarh (-8%), Uttar Pradesh (-7%), and Nepal and Bangladesh (-6%).

The contiguous regions of Jambyl in southern-central Kazakhstan, Kyrgyzstan, and the Xinjiang Uygur autonomous region of China are at the core of the high precipitation area. Kazakhstan increased the

cropped arable land fraction by a spectacular 23 percentage points, followed by Uzbekistan with +20 percentage points.

*Asia and Oceania: eastern Asia to central-eastern Australia*

In this region, the excess precipitation is minor compared with the previous one, but nevertheless useful for the winter crop areas in southeastern China and Southeast Asia, and the spring crops in Oceania. The region approximately reaches from Jiangxu, Anhui, and Hubei provinces in China to all of maritime Southeast Asia and the eastern half of Australia except Victoria and Tasmania. The average precipitation excess in the region is 36% with a correlated drop in RADPAR of 4% and close to average temperature. The largest precipitation increases over average occurs in Indonesia (+36%), Hunan, and Jiangxi provinces in China (+42 and +45%, respectively), the Northern Territory in Australia where 114 mm represents more than a doubling of average rainfall amounts (+123%), and Timor Leste (+144%).

*America: northern United States and Canada*

A large contiguous area of above-average precipitation extends from British Columbia to Manitoba to Ohio to California, excluding Nevada. The average precipitation excess amounts to 67% with below average sunshine (RADPAR, -4%) and a biomass production potential increase of 42% above average. Rainfall was particularly abundant over Nebraska (+85%) and Wisconsin (+90%), with other states even recording rainfall more than double the average, from 107% in Kansas to 150% in North Dakota, with values increasing from Iowa (+109%) through Minnesota and South Dakota to Montana (+127%). The lowest precipitation excesses in Ohio (+11%), Michigan (+19%), and Indiana (+27%) were associated with the largest positive temperature anomalies (1.4°C, 1.5°C and 1.0°C, respectively). The largest RADPAR deficits occurred in Illinois (-7%), Washington State (-8%), British Columbia, and Manitoba (both provinces at -9%).

**Deficit precipitation areas**

*Europe, the Mediterranean and western Asia*

The large rainfall deficit area (-34% on average) covers 30 countries from Sweden and Germany to Great Britain to Morocco, Iran and Afghanistan, and the Black Sea countries. Other variables were average but the BIOMSS potential dropped 26% below average. The largest deficits occur in the eastern Mediterranean (Lebanon -87%, Syria -65%, and Turkey -42%, where precipitation is normally low over the reporting period) while northern and north-western Europe is less affected. Nevertheless, both France and Germany list a decrease in cropping intensity (-8% and -16%, respectively) that can be due to reduced rainfall. The same applies to Ukraine (cropping intensity down 18%) and Morocco, which suffered a bad drought in 2014/15 and recorded 66 mm, a weak -16% departure from average. Winter crops have now been planted in the region and prospects remain generally favorable.

*Russia*

The area under consideration includes the oblasts of Perm and Tomsk, the Komi-Permyak okrug, and the Krasnodar kray as the area with the largest precipitation deficit (RAIN, -34%, -31%, -31%, and -32%, respectively). It extends west to the Nizhni Novgorod oblast and the Republic of Mordovia where the deficit decreases to about 15%. The deficits need to be compared against actual values, which were close to 200 mm—sufficient for farm operations and early stages of winter crops. The region had average temperature (+0.2°C), +3% RADPAR, and a BIOMSS expectation departure of -16%.

*Eastern Asia*

This particular rain deficit area encompasses three Chinese provinces (Henan, Chongqing, and Shandong), Japan, the Republic of Korea, and the Democratic People's Republic of Korea. The average rainfall deficit is moderate (-19%) with a +3% increase in radiation (RADPAR). The area deserves mentioning because the most severe deficit occurs in the Korean DPR with RAIN at -45%, a drop from 650 mm to 350 mm or about 3 mm/day. This is very close to the evaporation values in the local lowlands and thus potentially the beginning of another drought year.

*Southern India*

The Indian states of Tamil Nadu, Kerala, and Karnataka, as well as Sri Lanka suffered an average precipitation deficit of 50% (-31% in Tamil Nadu to -62% in Kerala). It is likely that, due to high potential evapotranspiration (PET) values, the rainfall deficit has created some stress for rainfed crops in the presence of above-average sunshine (+4%).

*Southern Oceania and Western Australia*

The average rainfall deficit was 50% on average in Tasmania (-69%), New-Zealand (-55%), and Western Australia (-52%), and Victoria (-24%). The region also had a marked reduction in RADPAR (-6%).

*Eastern and Southern Africa*

The area under consideration covers fourteen countries south of Ethiopia and Uganda, Zambia, and Namibia. Crops are currently growing at the higher elevations in eastern Africa while southern Africa is just planting after a severe drought year that affected much of the region. The average rainfall deficit reaches 33% with just above average temperature and RADPAR up 4% compared with average. The resulting biomass production potential is down 30%. The driest countries in relative terms include Somalia (-78%) and Kenya (-43%), while the situation is more favorable in Zambia (-15%) and South Africa (-12%). The latter country reduces the cropped arable land fraction by 10% over the average of the previous five years. It is worth mentioning that Tanzania, which suffered very little compared with the drought areas to its north and south in 2015/16, is now recording a RAIN deficit of 31% with +4% RADPAR. Several countries in the region report large positive sunshine anomalies of 8% (Uganda and Rwanda) and 11% (Burundi).

*Southern United States*

The area includes a group of states in the west (Mississippi, Alabama, Tennessee, Georgia, Louisiana, and Arkansas), as well as two isolated states: Nevada and New Mexico. The average precipitation deficit reaches 24% with a slight positive temperature anomaly (TEMP, +0.5°C) but close to average sunshine (-1%). The deficit is most severe in Mississippi (-41%) and Alabama (-36%), while it does not exceed 30% in the remaining states. The largest sunshine anomalies occurred in Alabama (+5%) and Georgia (+8%).

*South America: Southern cone*

The drought (RAIN, -41%) in this region affected an area that includes Chile and Uruguay as well as nine provinces in Argentina, especially Chubut (-64%), Tucuman (-54%), and La Rioja (-48%). Both temperature and radiation were slightly below average.

*Other areas of concern*

Some small or isolated areas are listed in this section, starting with part of the Brazilian Nordeste where Paraíba, Ceará, and Rio Grande do Norte all report a RAIN deficit between 70% and 75%. However, considering their very low average precipitation and the time of the year, this is not alarming.

Figure 3.3 shows that few areas with below average TEMP experienced abnormally low temperatures (< 1.5°C). These include:

- The region between the Black and the Caspian Sea: Armenia (-2.5°C), the Adyghe Autonomous Oblast (-1.8°C), Azerbaijan (-1.8°C), and the Kalmyk republic (-1.6°C).
- Tunisia (-1.7°C)
- The Karaganda region in Kazakhstan (-1.5°C)
- Sikkim (-1.5°C)

**Table 3.1. CropWatch agroclimatic and agronomic indicators for July-October 2016, departure from 5YA and 15YA**

Country	Agroclimatic Indicators				Agronomic Indicators		
	Departure from 15YA (2001-2015)				Departure from 5YA (2011-2015)		Current
	RAIN (%)	TEMP (°C)	RADPAR (%)	BIOMSS (%)	CALF (%)	Cropping Intensity (%)	Maximum VCI
Argentina	-7	-0.8	-1	-14	16	-15	0.9
Australia	-2	-0.5	-7	7	13	-4	1.0
Bangladesh	19	-0.5	-6	6	1	2	0.9
Brazil	1	-0.2	2	0	-3	3	0.8
Cambodia	30	-0.6	-2	8	0	-7	0.9
Canada	24	0.1	-6	25	1	3	1.0
China	14	0.0	-4	11	0	-5	0.9
Egypt	-31	-0.4	0	-6	-1	-2	0.7
Ethiopia	-21	-0.3	2	-13	0	-1	0.9
France	-41	-0.2	3	-35	0	-8	0.7
Germany	-23	0.2	-2	-16	0		0.9
India	12	-0.4	-6	3	1	-5	0.9
Indonesia	36	0.2	-5	21	0	0	1.0
Iran	-39	-0.5	1	-42	3	4	0.6
Kazakhstan	56	-0.8	-2	34	23	-1	1.0
Mexico	-9	-0.2	2	-6	5	3	0.9
Myanmar	-1	-0.1	-2	0	0	5	1.0
Nigeria	8	-0.6	0	4	1	-2	0.9
Pakistan	6	-0.3	2	3	0	-11	0.7
Philippines	11	0.8	-1	2	0	-4	1.0
Poland	28	-0.6	-6	21	0	-6	0.9
Romania	-27	-0.8	-1	-17	-1	0	0.9
Russia	-1	-0.4	-2	-3	3	-1	0.9
S. Africa	-12	0.3	2	-13	-10	-1	0.7
Thailand	9	-0.2	0	7	0	-12	1.0
Turkey	-43	0.1	0	-37	2	2	0.7
United Kingdom	-12	0.4	-4	-9	0	15	0.9
Ukraine	-14	-0.6	0	-12	2	-18	0.9
United States	23	0.5	-1	18	2	2	0.9
Uzbekistan	169	-0.5	-2	133	20	0	0.9
Vietnam	13	0.3	0	1	0	3	0.9

### 3.2 Country analysis

This section presents CropWatch results for each of thirty key countries (China is addressed in Chapter 4). The maps refer to crop growing areas only and include (a) Crop condition development graph based on NDVI average over crop areas, comparing the July-October 2016 period to the previous season and the five-year average (5YA) and maximum; (b) Maximum VCI (over arable land mask) for July-October 2016 by pixel; (c) Spatial NDVI patterns up to October 2016 according to local cropping patterns and compared to the 5YA; and (d) NDVI profiles associated with the spatial pattern under (c). See also Annex A, tables A.2-A.11, and Annex B, tables B.1-B.5, for additional information about indicator values and production estimates by country. Country agricultural profiles are posted on [www.cropwatch.com.cn](http://www.cropwatch.com.cn).

**Figures 3.6-3.35. Crop condition for individual countries July-October 2016**

ARG AUS BGD BRA CAN DEU EGY ETH FRA GBR IDN IND IRN KAZ KHM MEX MMR NGA PAK PHL POL ROU RUS THA TUR UKR USA UZB VNM ZAF

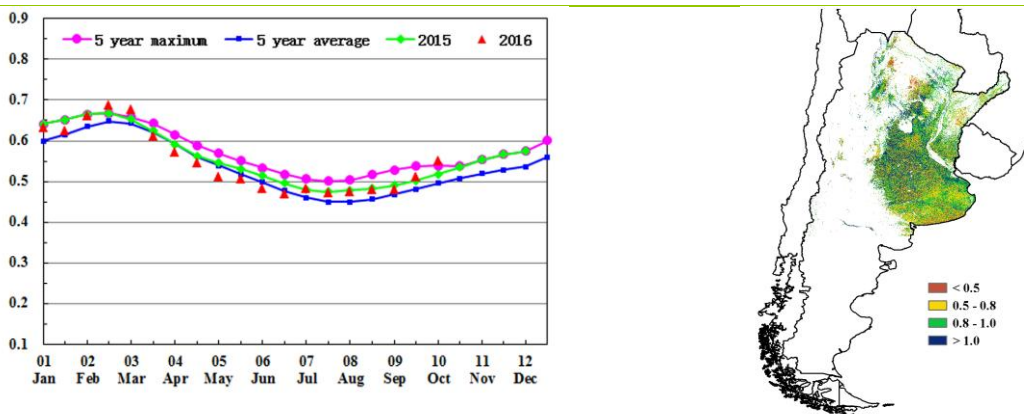
# [ARG] Argentina

At the end of current reporting period (July-October), wheat is beginning to be harvested in the north of the country; the planting of early maize is almost completed and soybean planting is beginning. Predictions of harvested areas show an increment for wheat and maize and a slight reduction in soybean associated with reductions in both export taxes and regulations for maize and wheat.

For RAIN, a moderate decrease (-7% compared to the 15YA) was observed, while in general TEMP and RADPAR were close to average. Reductions in the RAIN indicator could be due to neutral or La Niña conditions, in a change from the strong El Niño that affected the southern hemisphere summer; this can also explain the 14% reduction in potential biomass (BIOMSS), a reduction that was stronger in the Pampas than in north Argentina. The top three agricultural producing provinces—Buenos Aires, Cordoba, and Santa Fe—experienced rainfall shortages that reached 29%, 27%, and 9%, respectively. NDVI profiles for the reporting period are higher than average, and for the last month (the maize planting period) they are also higher than last year's in spite of the poorer RAIN conditions. Abundant soil water retention from the last campaign could explain this behavior. In addition, changes in crop proportions could generate or add to NDVI anomalies because of the different planting dates of wheat, maize, and soybean in the Pampas. Maximum VCI showed high values (larger than 0.8) for most of the area, possibly reflecting the soil water retention and the higher proportion of wheat and maize crops in especially the central Pampas.

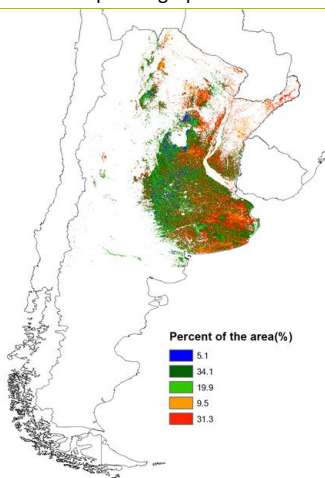
Overall, the agro-climatic conditions in Argentina are average; more rainfall is needed for the crops that have just been sown and those at their early growing stages, especially in the major agricultural regions. (See also section 5.1 and table B.1 in Annex B for production estimates for maize and soybean.)

Figure 3.6. Argentina crop condition, July-October 2016

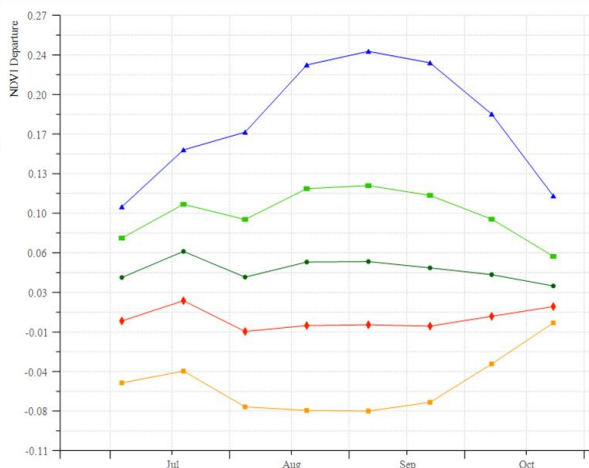


(a) Crop condition development graph based on NDVI

(b) Maximum VCI



(c) Spatial NDVI patterns compared to 5YA



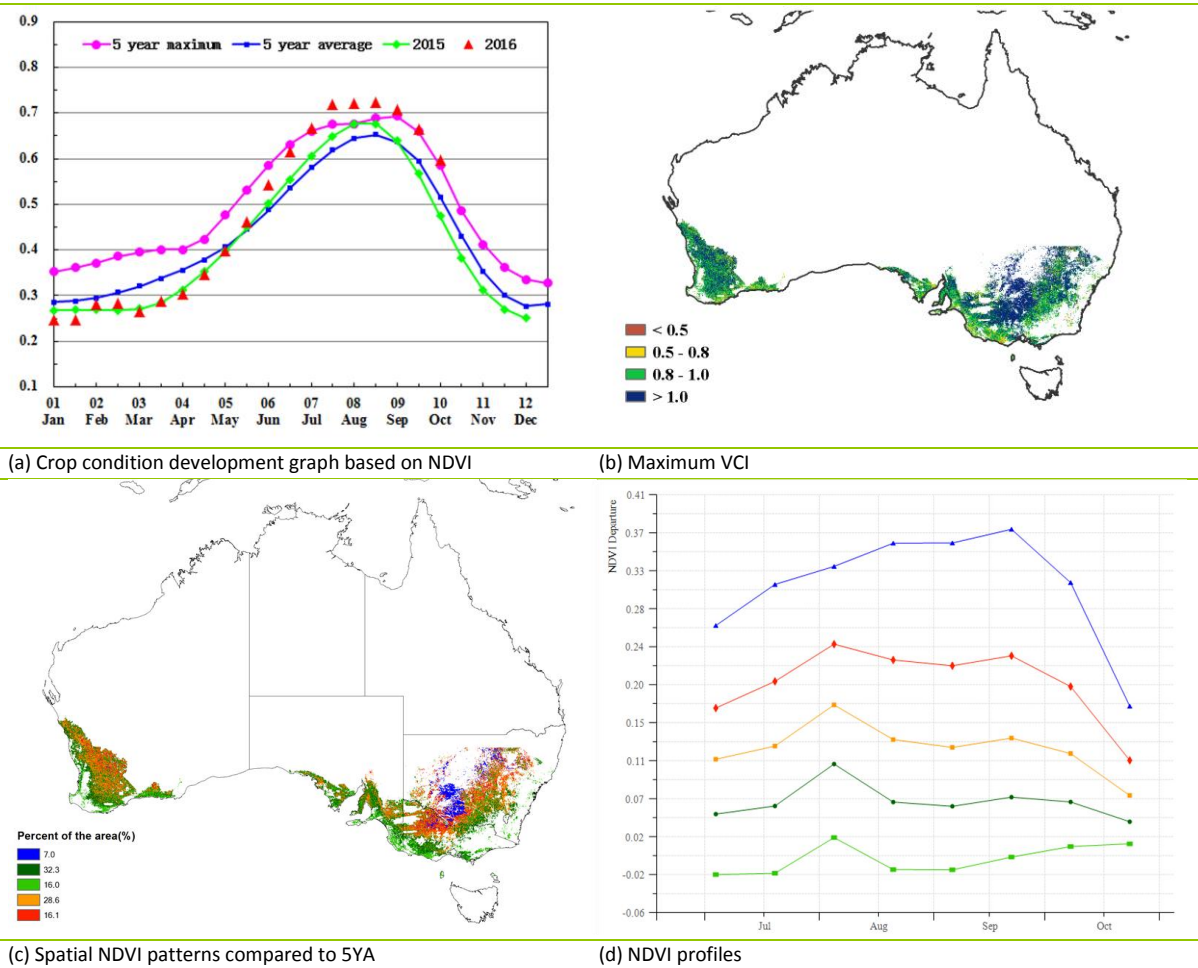
(d) NDVI profiles

# [AUS] Australia

Compared to the average of the last five years, Australia showed very favorable condition during this monitoring period, which was the main growing season for winter wheat and barley. The agroclimatic conditions were about average (RAIN, -1.5%; TEMP, -0.5°C) except for a significant drop in sunshine (RADPAR, -7%). The spatial NDVI patterns show that in New South Wales, most of Victoria, South Australia, and Western Australia (together covering 84% of the arable land), winter wheat and barley condition was above average throughout the reporting period with a maximum VCI in the range of 0.8 to 1.0 and above. Crop condition was slightly below average only in some parts of southern Victoria, southeastern South Australia, and southern and western West Australia (16% of the arable land). This analysis is consistent with the national crop condition development graphs that show that winter wheat and barley, on the whole, grew well in July, exceeding the five year maximum value in July and August and staying close to it in September and October.

With also an increase in CALF (13 percentage points), CropWatch estimates that the production of summer crops in Australia will increase by 25%. For global production estimates, see section 5.1. CropWatch estimates for wheat production in Australia are listed in table B.2 in Annex B.

Figure 3.7. Australia crop condition, July-October 2016

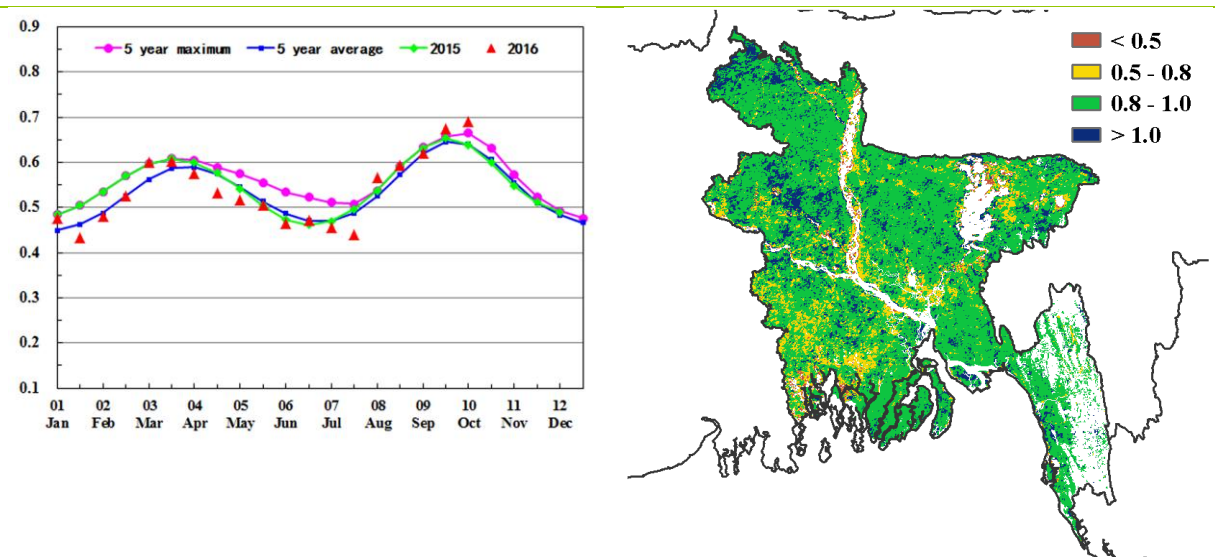


ARG AUS **BGD** BRA CAN DEU EGY ETH FRA GBR IDN IND IRN KAZ KHM MEX MMR NGA PAK PHL POL ROU RUS THA TUR UKR USA UZB VNM ZAF

# [BGD] Bangladesh

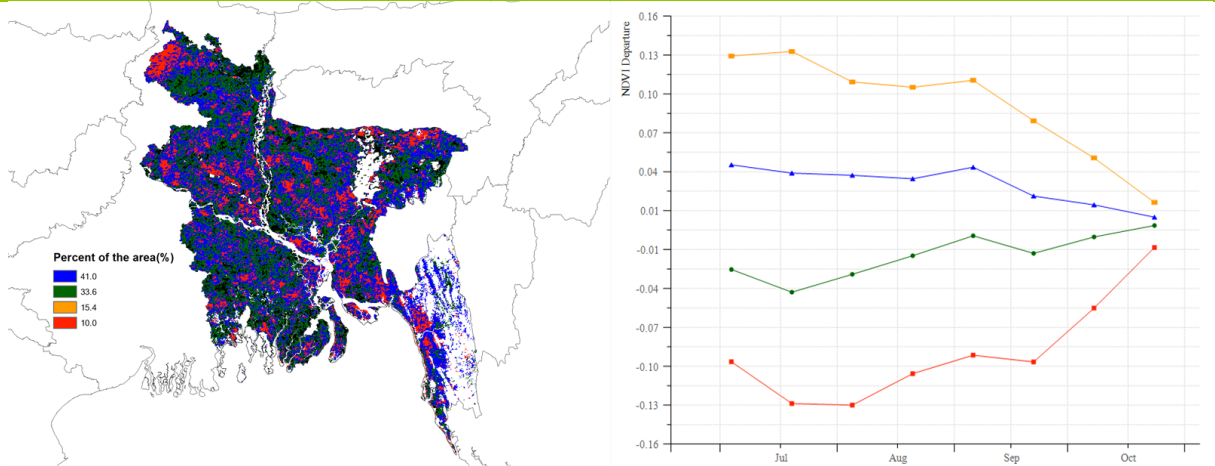
The reporting period corresponds to the growing of Aus and planting of Aman rice. As per CropWatch indicators, overall crop condition was above average during the reporting period. However, excess rainfall (19% above average) caused flooding in Madaripur, Rangpur, Rajbari, Manikganj, Kurigram, Faridpur and Tangali districts and damaged the standing crops. The overall biomass accumulation potential (BIOMSS) increased by 6% above the five-year average while photosynthetically active radiation (RADPAR) remained low (-6%) and temperature (TEMP) was average. Compared to the previous five-year average, the crop arable land fraction (CALF) increased by 1 percentage point. The national NDVI profile remained comparable with the previous five-year average values. Over the whole country the maximum VCI ranged from 0.5 to 0.9, indicating average crop condition. Spatial NDVI profiles of the country steadily progressed during the monitoring period except in the Sylhet region where a sharp drop was noticed in August. Overall, above average output is expected due to favorable conditions of rainfall, biomass accumulation, arable land fraction, as well as temperature.

Figure 3.8. Bangladesh crop condition, July-October 2016



(a) Crop condition development graph based on NDVI

(b) Maximum VCI



(c) Spatial NDVI patterns compared to 5YA

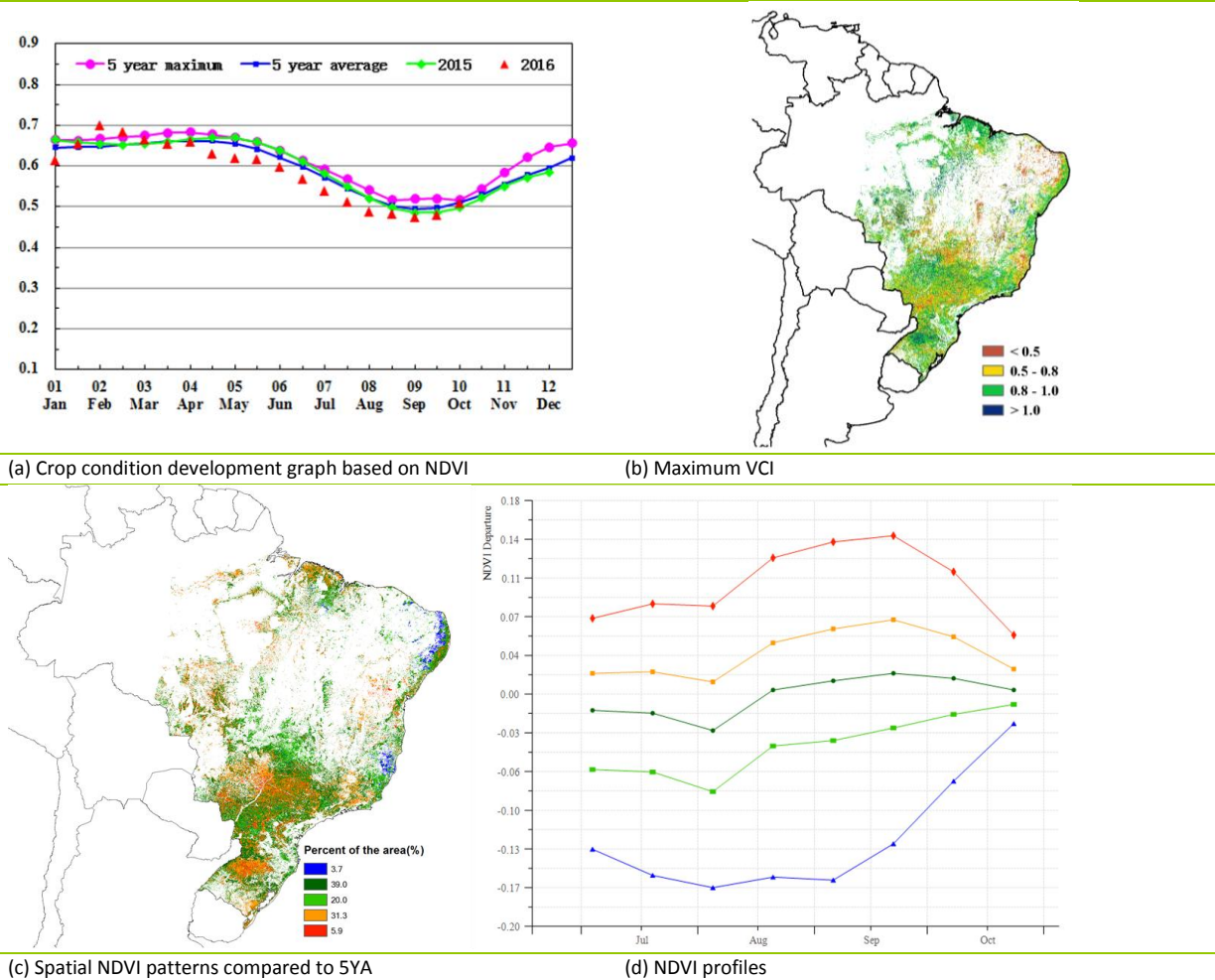
(d) NDVI profiles

# [BRA] Brazil

Generally, crop condition in Brazil was comparable to the five-year average. Over the reporting period, winter wheat has reached maturity and harvesting will be concluded by the end of November. The harvest of the second maize crop was completed and maize in central-east Brazil was approaching maturity. "Normal" agro-climatic conditions were observed for the nation as a whole according to the CWAls: RAIN (+1%), TEMP (+0°C) and RADPAR (+2%). However, climatic condition varied greatly from state to state. As shown in figure a, below average rainfall mainly occurred in Rio Grande do Sul and central Brazil. Statistically, among the major agricultural states, Mato Grosso and Parana are the only two states that received above average rainfall (+6% and +12% respectively). Rainfall in Mato Grosso do Sul and Santa Catarina was average, while other major agricultural states suffered from 10% or more water shortage. Considering that temperature and radiation were generally average, the below average BIOMSS mainly resulted from water deficit.

Agronomic indicators consistently show average crop condition. As indicated by the maximum VCI map, the indicator was below 0.5 in central Brazil due to unfavorable rainfall. Spatial NDVI patterns and the corresponding NDVI departure profiles also confirm that below average NDVI mainly occurred in Goias and Central Brazil where almost no rainfall was observed for two months before early August. Above average NDVI in southern Brazil from August to October indicates a favorable outlook for wheat production. CropWatch revised the wheat production to 7545 ktons, 8% up from the previous harvest season. Since this latest monitoring period is out of the soybean, rice, and maize growing season for most parts of Brazil, CropWatch keeps the production estimates for those three crops at the same level as the previous forecast. See also section 5.1 for production estimates, as well as table B.3 in Annex B.

Figure 3.9. Brazil crop condition, July-October 2016



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# [CAN] Canada

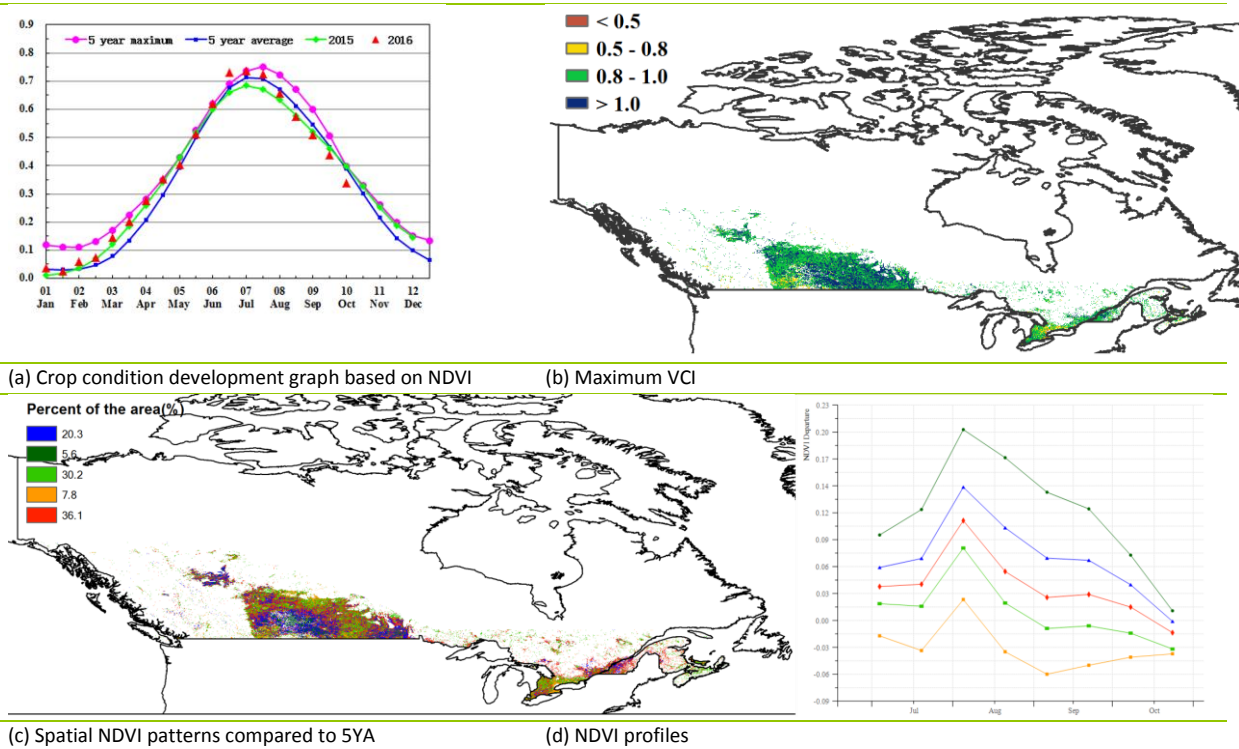
In Canada, the monitoring period covered the harvesting stages of winter wheat, barley, oats, and spring wheat, as well as the growth and harvest stages of maize and soybeans. In general, the condition of crops was above the average of the previous five year period.

The dry weather of 2015 gave way to wet conditions this year. Compared to average, rainfall (RAIN) was up 23.8%, temperature (TEMP) was about normal, while sunshine (RADPAR) exhibited a 6% negative departure. Abundant rainfall was recorded in Alberta (+50%), Manitoba (+73%), and Saskatchewan (+66%), benefiting greatly the growth of wheat and other crops. While close to normal rainfall fell in the maize producing provinces, including Ontario (+5%) and Quebec (-4%), moderate to severe droughts were recorded in July to September from Toronto to Ottawa.

Good crop condition is confirmed by the NDVI profiles and related spatial NDVI patterns in the key growing period from the end of June to September: 80% to 90% of the agricultural regions of Canada showed a positive departure compared with the previous five years. Favorable crop condition as identified by VCIx (0.9) occurred especially in the southern part of Saskatchewan and Manitoba, where the indicator even rose above 1. The significant increase of accumulated biomass potential (BIOMASS) also identified good crop condition in Alberta (+37%), Manitoba (+47%), and Saskatchewan (+48%), while average crop condition was recorded in Ontario (+6%) and Quebec (-3%). The cropped arable land fraction (CALF) indicator and cropping intensity also showed a positive trend, with slightly above average conditions (+1% and + 3%, respectively).

CropWatch currently projects wheat production in Canada for 2016 to be up 8% over last year (see section 5.1 and table B.4 in Annex B).

Figure 3.10. Canada crop condition, July-October 2016



# [DEU] Germany

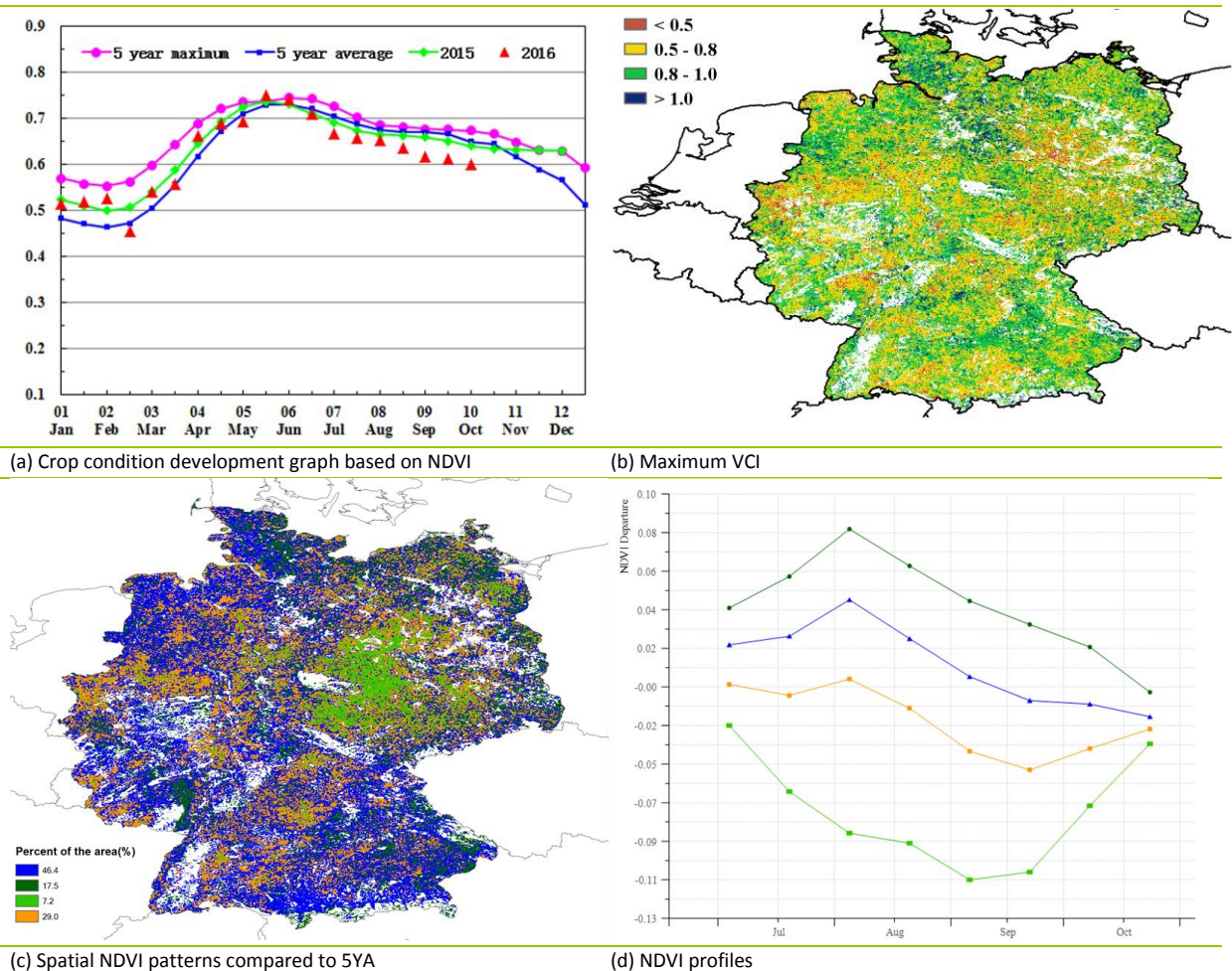
In Germany total precipitation was 23% below average over the period of analysis. From the middle of August rainfall (RAIN) deficits were recorded all over the country. Temperature and radiation were close to average (TEMP, 0.1°C and RADPAR, -2%) but biomass (BIOMSS) was 16% below the recent five-year average.

Nationwide, the NDVI development curve was below both normal and last year's values. In August and September, crops in over 35% of the country were in poor condition, with the notable exceptions of the northern regions. Dry conditions especially affected the central area from Nordrhein-Westfalen in the west to Saxony-Anhalt (where conditions were particularly poor) and southern regions of the country. Crop conditions assessed on the basis of NDVI are confirmed by VCIx values, which in the same regions did not exceed 0.5.

All over the country in October precipitation totals were close to average and well distributed. They boosted winter crop emergence and early development, especially in regions with scarce rainfalls in September. The NDVI spatial profiles indicate current crop condition slightly below average at this point.

Long lasting rainfall deficits during the reporting period benefited the ripening of summer crops but hampered sowing activities and the emergence of winter crops.

**Figure 3.11. Germany crop condition, July-October 2016**



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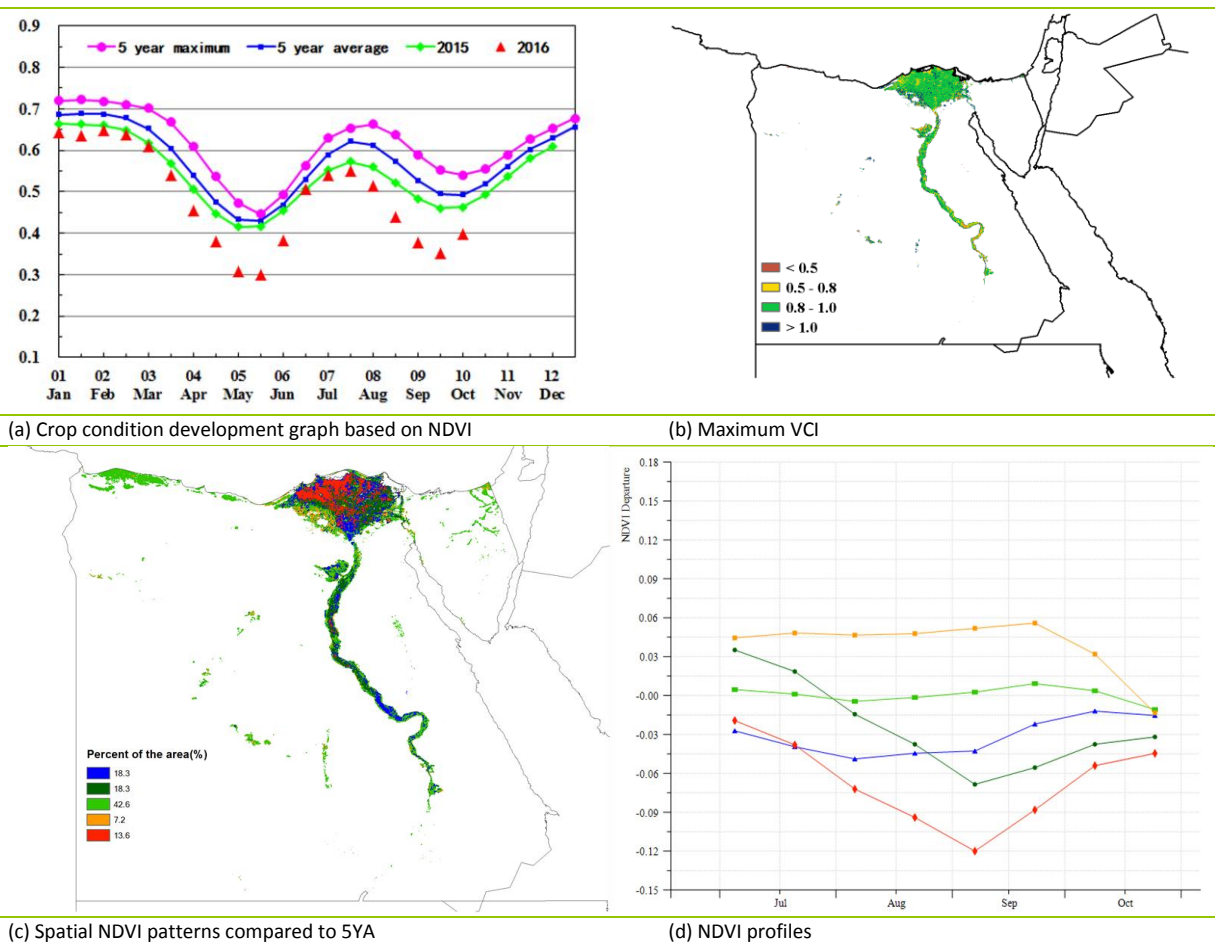
# [EGY] Egypt

The July-October monitoring period covers the growing stage of rice and maize and the harvest of wheat and barley crops. Generally, crop condition was unfavorable when compared with the previous five-year average. Compared to average, all agroclimatic indicators were about average (rainfall was -31% below average, but since the expected amount is less than 10 mm, the shortage is meaningless), as were temperature (-0.5°C) and biomass (-6%). It is stressed that, since the bulk of crops is irrigated, rainfall is not a crucial variable in Egypt. Among the agronomic indicators, CALF was 1 percentage point below average and the cropping intensity decreased 2%; VCIx was moderate.

The spatial NDVI pattern and clusters indicate that crop growth was generally below the recent five-year average. Only 7.2% of the cropped area, located in the southern Beheira provinces, displayed relatively good growing condition, while 13.6% (located in northern Beheira, Kafrel-Sheikh, Gharbia, and Monufia provinces in the north of the country) showed decidedly inferior condition.

In general, crop condition is assessed as below average.

Figure 3.12. Egypt crop condition, July-October 2016

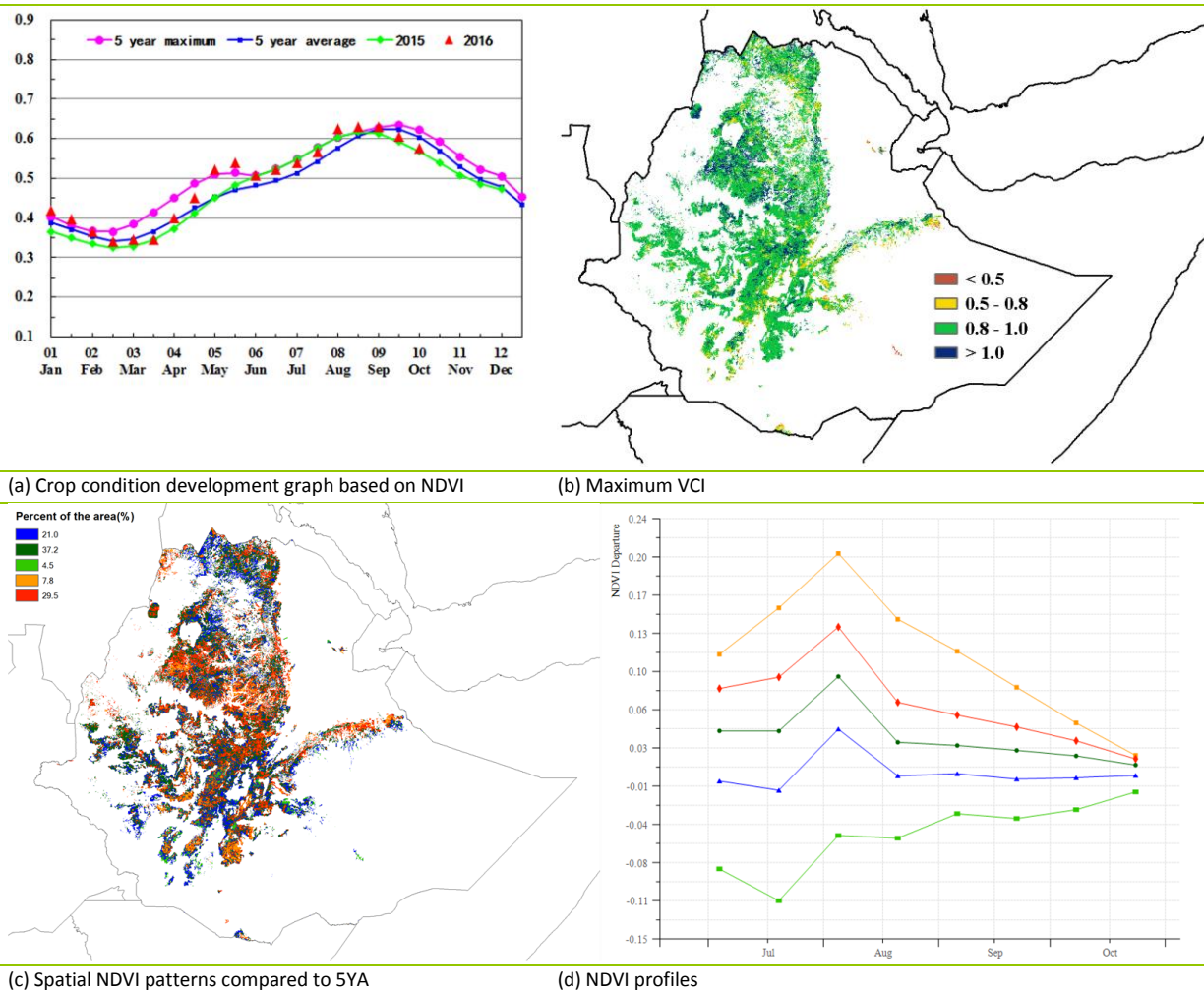


# [ETH] Ethiopia

During the period from July to October, the condition of crops in the country was generally favorable, with temperatures not differing much from the average. The prevailing RADPAR slightly (though not significantly) increased by 2%, while rainfall (RAIN) dropped 21% below average. For crops to be harvested in December, this coincides with a reduction of 13% in the biomass production potential BIOMSS. Crops, such as wheat, harvested around August may not have been affected much by these conditions in most parts of Tigray, Amhara, and Oromia. The maximum VCI was generally fair in the central and northern parts of the country, which include Amhara, Oromia, and North Wollo. Only few areas such as northeast SNPP and far-east Oromia showed high maximum VCI.

The spatial NDVI clusters and profiles reflected a pattern similar to the previous growing season. Crop development was slow and slightly below average between September and October in Tigray, where the growing season ends around September. Because Amhara, the major teff and wheat producing area, has a growing season up to October, an average production output is anticipated there. About 4.5% of the country (in southern parts of SNPP and Oromia) experienced unfavorable conditions, which lead to locally poor crop condition. Overall, average crop conditions are prevailing in the country.

**Figure 3.13. Ethiopia crop condition, July-October 2016**



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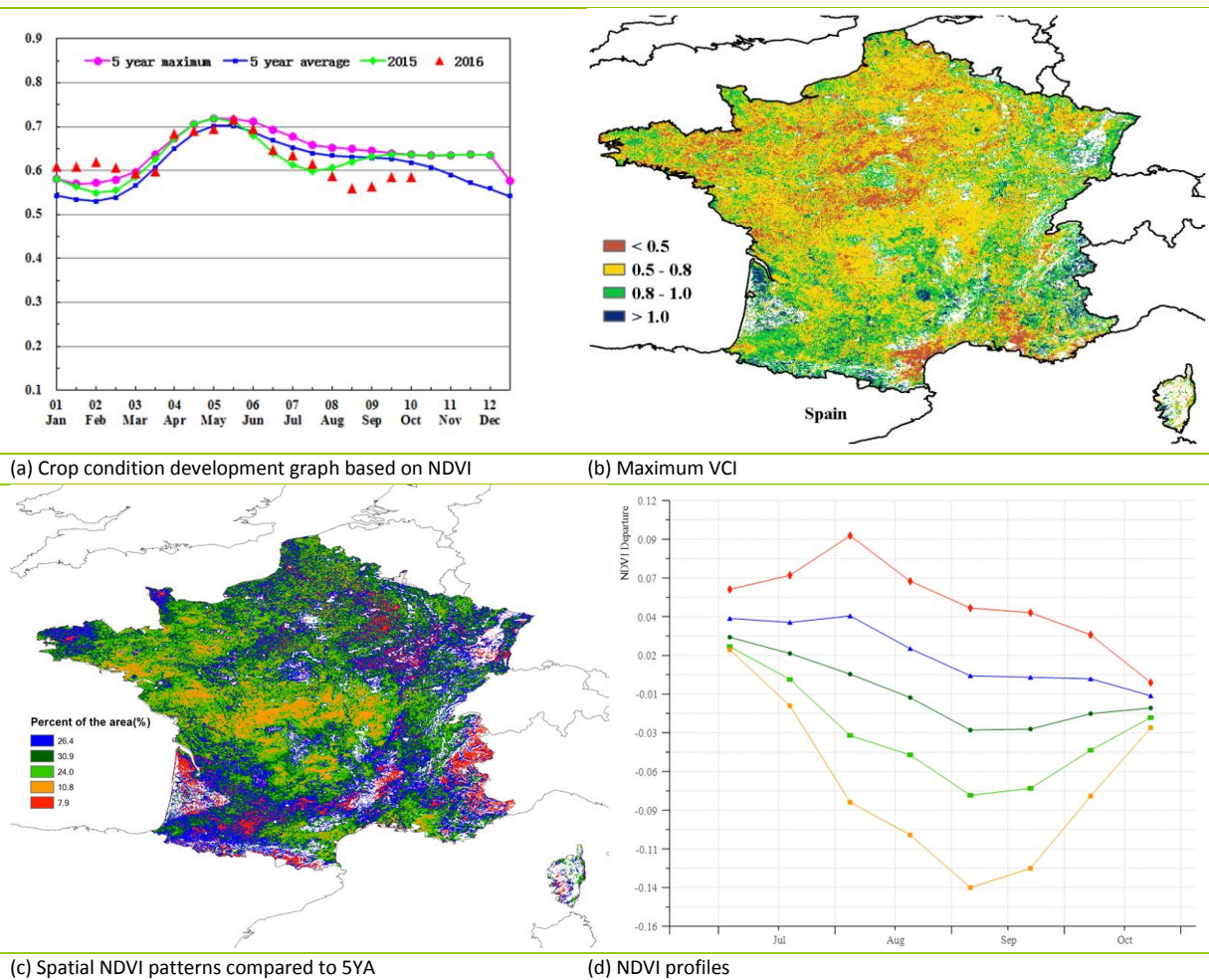
## [FRA] France

In France, the reporting period covers important phenological phases for sugar beet (storage organs development and sugar accumulation) and maize (grain filling and ripening), as well as early development stages of winter crops sown in September-October. At the national level, total precipitation was significantly below the fifteen-year average (-41%), while temperature (-0.3°C) and radiation (+3%) showed only slight departures. Rainfall was very scarce within the whole reporting period. An exception was recorded in the middle of October with 10 days with above-average rainfall. The biomass production potential dropped 35% below the recent five-year average. NDVI was continuously below average from the end of June, with highest negative departures at the end of August and early September.

Negative NDVI departures actually occurred over the majority of agricultural areas, especially in the wide belt from the northwest (Bretagne) across the center to the east. Significantly below average NDVI occurred in 35% of agricultural areas starting in July. The worst crop conditions, affecting 10.8% of arable land, were observed especially in the central regions (south of Centre, Bourgogne, Limousin and Auvergne), northwest (Haute-Normandie), and western areas (Pays de la Loire and Poitou-Charentes). At the scale of the whole country, the VCIx amounts to 0.74, significantly below its average value for the past five years. The lowest values (<0.5) of this indicator are observed in the same regions with the least favorable crop conditions according to NDVI. This leads to a lower than usual expectation for maize and sugar beet.

In the second ten-day period of October, higher than average rainfall was favorable for emergence and early development of winter crops. The drought that caused the production of rainfed summer crops to be below average also led to a delay of winter crop sowing. Their output in 2017 will depend critically on winter rains.

Figure 3.14. France crop condition, July-October 2016



# [GBR] United Kingdom

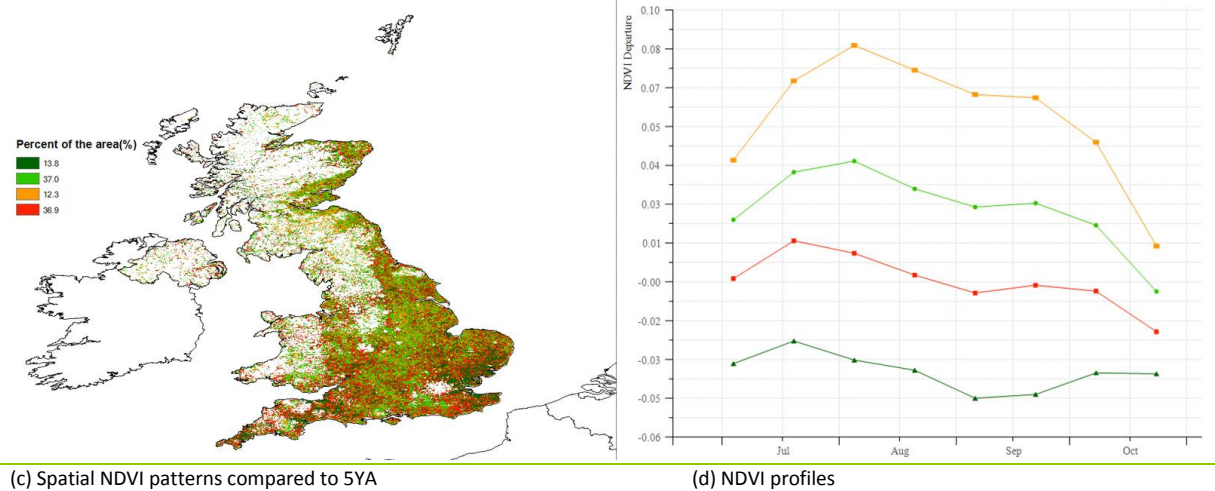
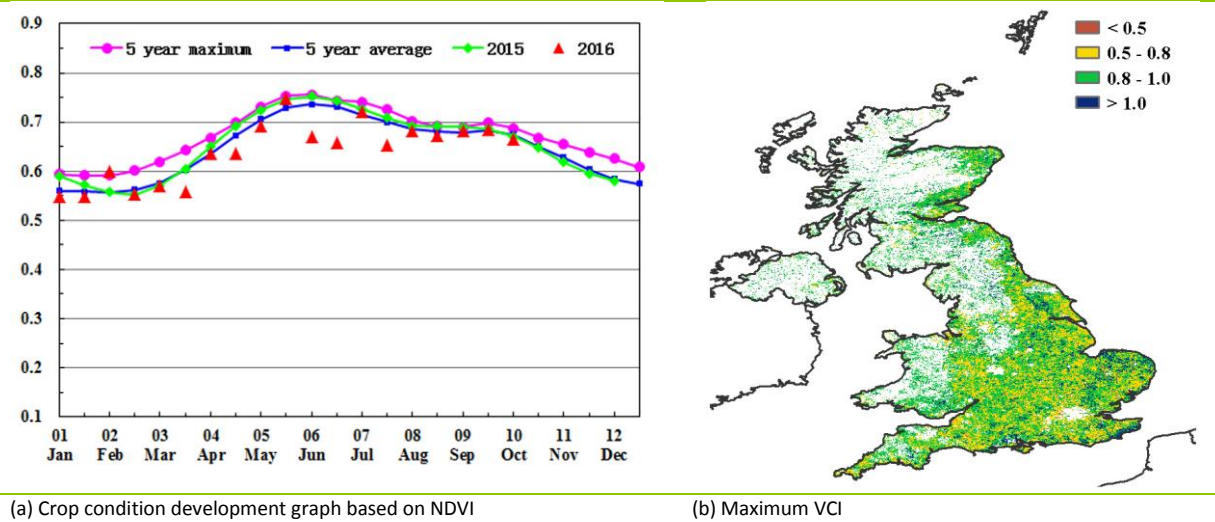
In the beginning of the monitoring period, negative departures from average were recorded for both precipitation and the agronomic indicators. These then continued in the south and southeast of the country, where long periods with rainfall scarcity (RAIN at -30% comparing to the fifteen-year average) and higher than average temperatures were recorded for July-September.

Across the monitoring period, NDVI profiles indicate worse than average crop condition for 13.8% of the total area, located mainly in the above mentioned regions. This could negatively affect yield of spring barley grown in the south of the country. Although maximum Vegetation Condition Index (VCI) values varied across the country, they were all above 0.5, with a national value of 0.91.

At the national level, precipitation was 12% below the fifteen-year average, whereas temperature (TEMP, +0.4°C) and radiation (RADPAR, +4%) were above average. In July and August, crop condition development (as indicated by the NDVI patterns) was clearly below the five-year average and last year's values as a result of rainfall deficit and higher than usual temperatures. A biomass reduction of 9% compared to the five-year average is foreseen, which could affect also tuber crops and grasslands.

Summer crop condition was generally good, but more moisture will be needed for winter crops.

**Figure 3.15. United Kingdom crop condition, July-October 2016**



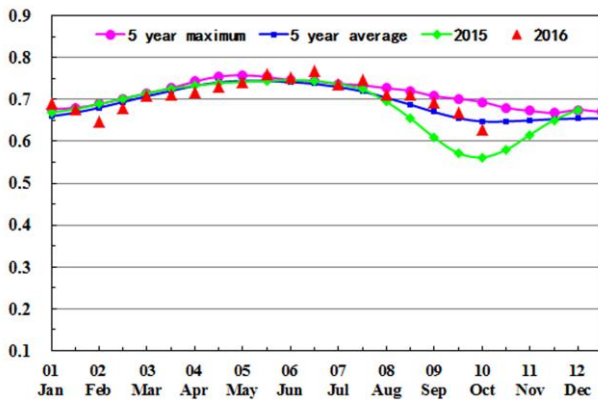
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# [IDN] Indonesia

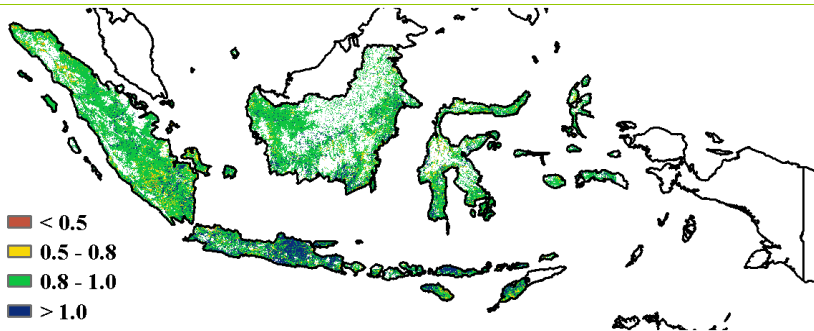
In Indonesia, the dry season maize and rice crops were entering their generative or early ripening stages over the monitoring period. Crops generally showed good condition from August to October. Precipitation was significantly above average (RAIN, +36%), resulting from the fading El Niño. Consistent with the increase in rainfall, radiation (RADPAR) displayed a decrease of 5% while the biomass accumulation potential (BIOMSS) increased significantly by 21% compared with the recent five-year average. The national average NDVI curve follows a profile similar to the recent five-year average. Contrasting NDVI clusters are observed with mostly above average conditions on the island of Java in August.

Altogether, CropWatch estimates that normal yields can be expected for this season's crops.

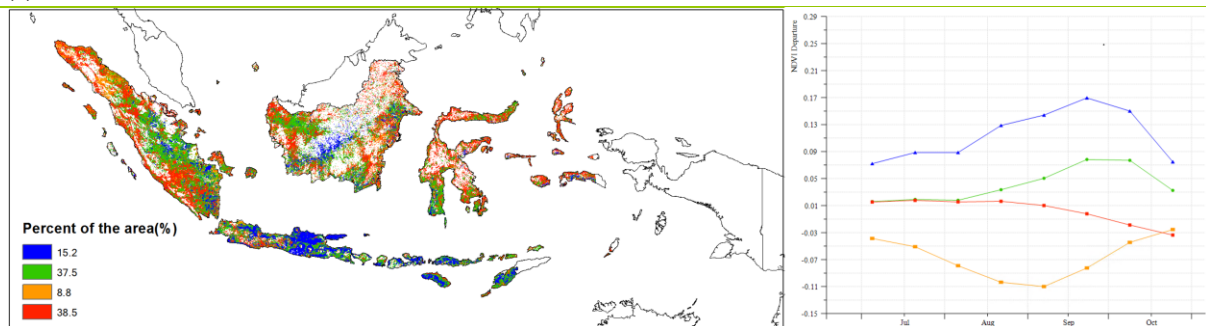
**Figure 3.16. Indonesia crop condition, July-October 2016**



(a) Crop condition development graph based on NDVI



(b) Maximum VCI



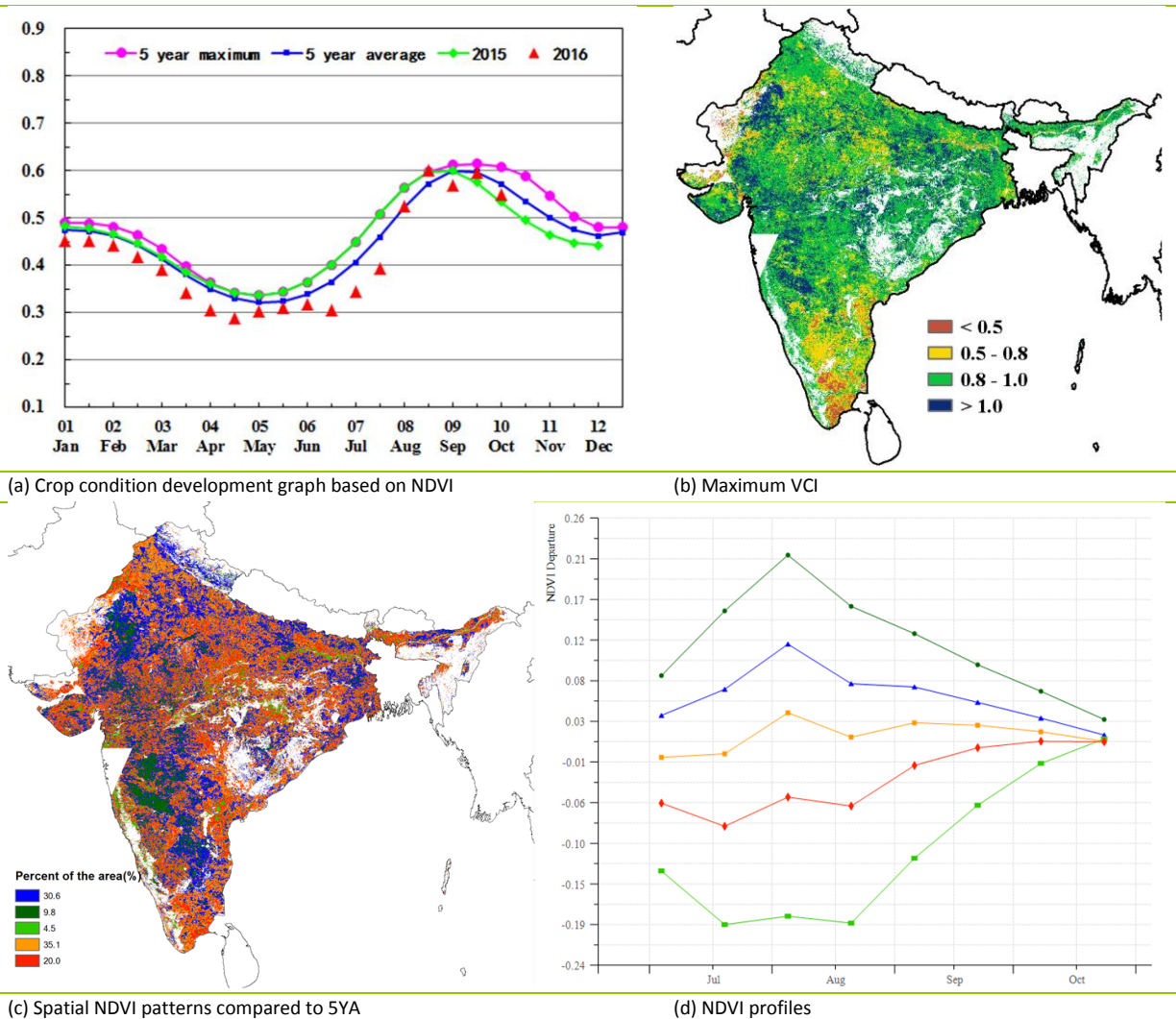
(c) Spatial NDVI patterns compared to 5YA

(d) NDVI profiles

# [IND] India

The current monitoring period corresponds to the rainfed kharif season crops. Over the last four months, crop condition was below average for the country. Excess rainfall (RAIN, +12%), primarily in Andhra Pradesh (+9%), Bihar (+38%), Rajasthan (+79%), Uttar Pradesh (+29%), and Madhya Pradesh (+62%), caused flooding and damaged the crops. Temperature (TEMP) remained average, while photosynthetically active radiation (RADPAR) decreased by 6%. The crop condition development was below the previous five-year average, while the national NDVI profiles remained average. In Tamil Nadu, Andhra Pradesh, Gujarat, and Karnataka, the maximum VCI value stayed below 0.5, indicating poor crop condition. The cropped arable land fraction (CALF) increased by 1 percentage point as compared to the five-year average while the biomass accumulation potential (BIOMSS) rose 3%. Overall, as per Crop Watch indicators, crop condition was below average and a reduced output is expected, due mainly to the damage caused by the recent floods.

**Figure 3.17. India crop condition, July-October 2016**



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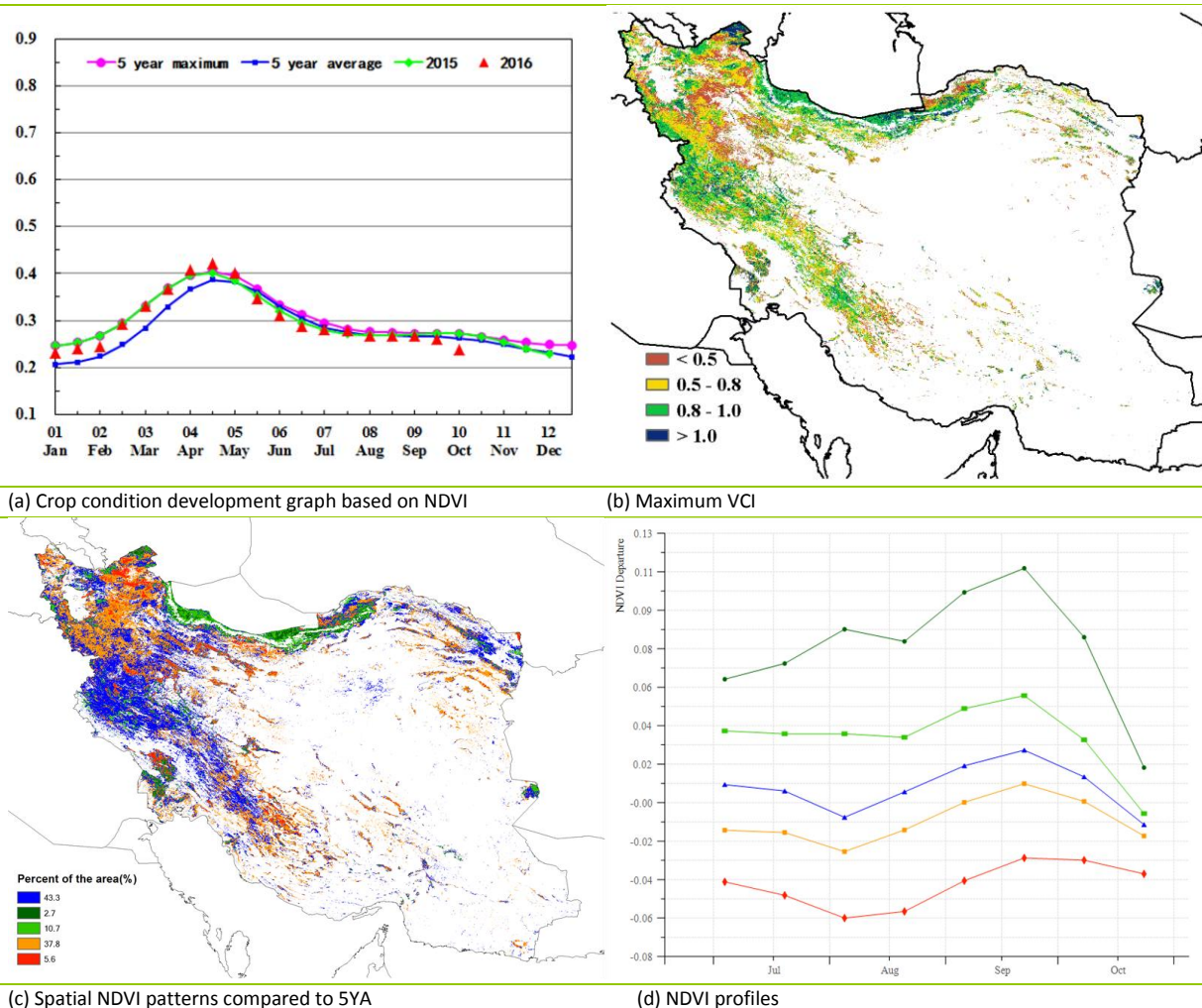
# [IRN] Iran

Crop condition was generally close to or below average from July to October 2016 in Iran. The summer crops (potatoes and rice) were harvested in September, while winter wheat and barley started to be sown in the same month. Accumulated rainfall (RAIN, -39%) was below average over the last four months, while temperature (-0.5°C) was slightly below and RADPAR (+1%) close to average. CropWatch agro-climatic indices for the current season indicate unfavorable weather conditions for crop growth, which is confirmed by the significant decrease of the BIOMSS indicator by 42%. Compared to the five-year average, the national average of VCIx for this monitoring period was 0.6, and CALF increased by 3 percentage points. The cropping intensity (+4%) above the five-year average indicates higher crop land utilization in 2016.

According to the national crop condition development graphs, the major rice producing areas (Mazandaran and Gilan provinces in the central-north region) experienced favorable conditions, while in most of the northwestern region, crop condition was below average for the entire monitoring period. Crop condition in the central-western region, such as in Kermanshah, Llam, and surrounding provinces, was above average except during early August and at the end of October.

Overall, the production of rice in Iran is expected to be above average, while the outlook for other summer crops is just fair.

**Figure 3.18. Iran crop condition, July-October 2016**



# [KAZ] Kazakhstan

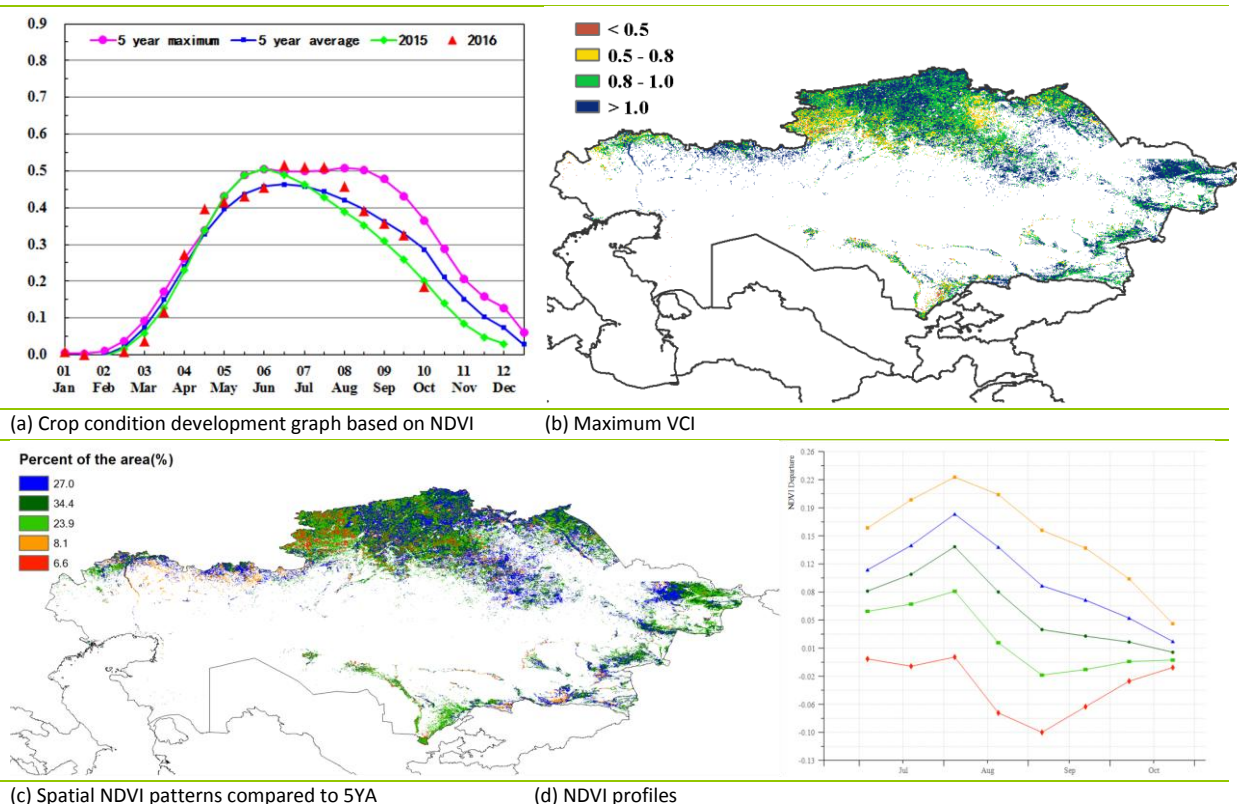
During the reporting period, weather conditions were generally favorable for growth and harvesting of spring crops. The CropWatch agroclimatic indicators show that rainfall (RAIN) was well above average (+56%), temperature (TEMP) below (-0.8°C), and radiation (RADPAR) slightly below (-2%). BIOMSS is expected to increase by 34% compared to the five-year average.

Spatial NDVI patterns and profiles show that in August crop condition was below the five-year average in 30.5% of the agricultural areas. In all other areas it was significantly above average (locally even very significantly, up to 0.2 NDVI units), due to the abundant rainfall. Since then, NDVI departures from average decreased continuously, returning to average conditions at the end of October. This created favorable conditions for farm operations and winter crops emergence and early tillering. The national average of the VCIx (1.00) was above average conditions, and the arable land fraction increased by 23% compared to its five-year average.

The most favorable conditions of crops occurred in northern areas (northeast of Kustanayskaya, Severo-kazachstanskaya and the north of Pavlodarskaya oblasts) as well as in the east of kazakhstan (Vostochno-kazachstanskaya oblast). The agroclimatic indicators show favorable condition in the northern part, with a 36% increase of rainfall and a 24% increase of biomass compared with the fifteen-year average.

According to the crop condition development graph, overall crop condition was average from the end of August. Thanks to precipitation well-distributed in time (with a drier than usual August and close to average September) the output of summer crops is bound to increase. In 2016, wheat production is expected to amount to 7 million tons, up 100,000 tons from the previous year.

Figure 3.19. Kazakhstan crop condition, July-October 2016



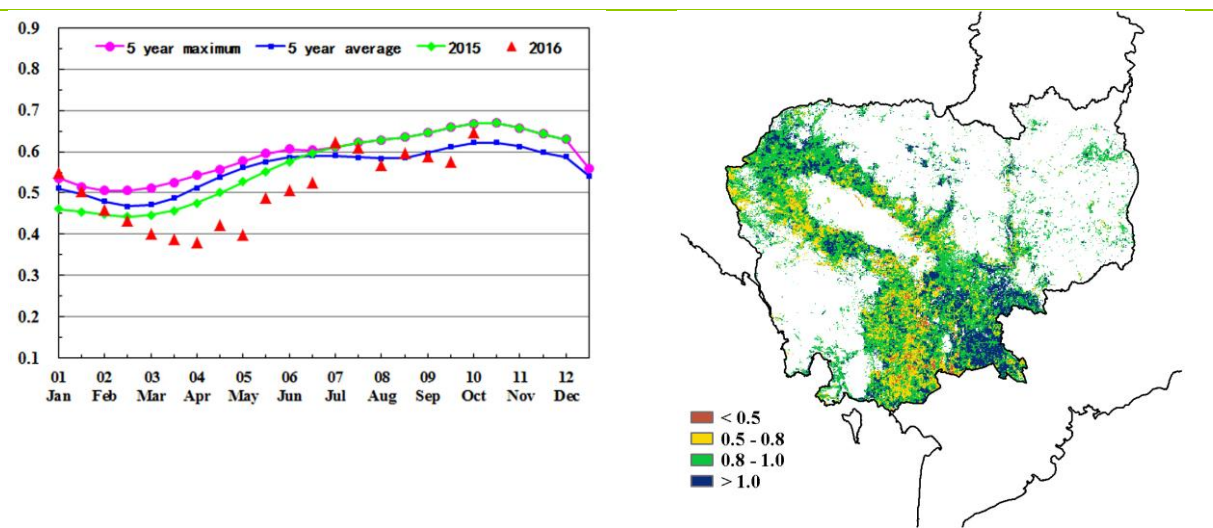
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# [KHM] Cambodia

Crops in Cambodia displayed around average conditions over the reporting period, which coincides with the planting of the main paddy crop. Overall, rainfall was higher than average (+29.5%) over much of the country, with cloudiness causing a 2% drop in RADPAR. The biomass accumulation potential increased 8%.

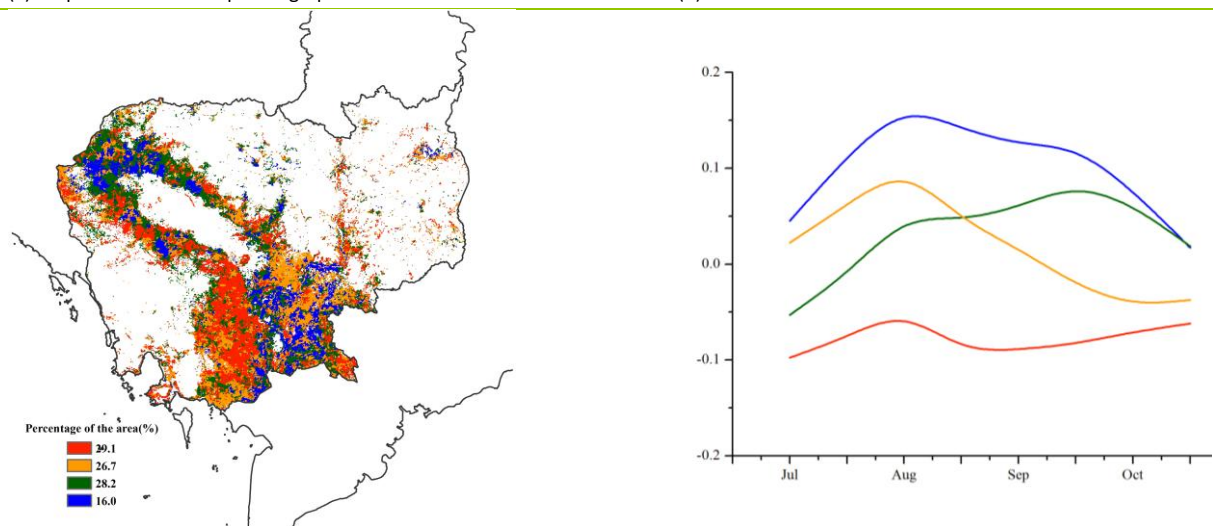
Overall crop condition, which was better than average during mid-July, changed to average in the two months that followed. In the area of south Tonle Sap (29.1% of the cropland in the whole country), crop conditions were below average over the entire period. The maximum VCI of this area (0.5-0.8) confirms the low NDVI. With the exception of this area, however, nearly half of the country experienced near average crop condition. Limited patches in southeast and northwest Tonle Sap performed better than average, for instance in Kampong Chan, Prey Veng, and Svay Rieng. Overall crop prospects for the country are at the same level as recent years.

**Figure 3.20. Cambodia crop condition, July-October 2016**



(a) Crop condition development graph based on NDVI

(b) Maximum VCI



(c) Spatial NDVI patterns compared to 5YA

(d) NDVI profiles

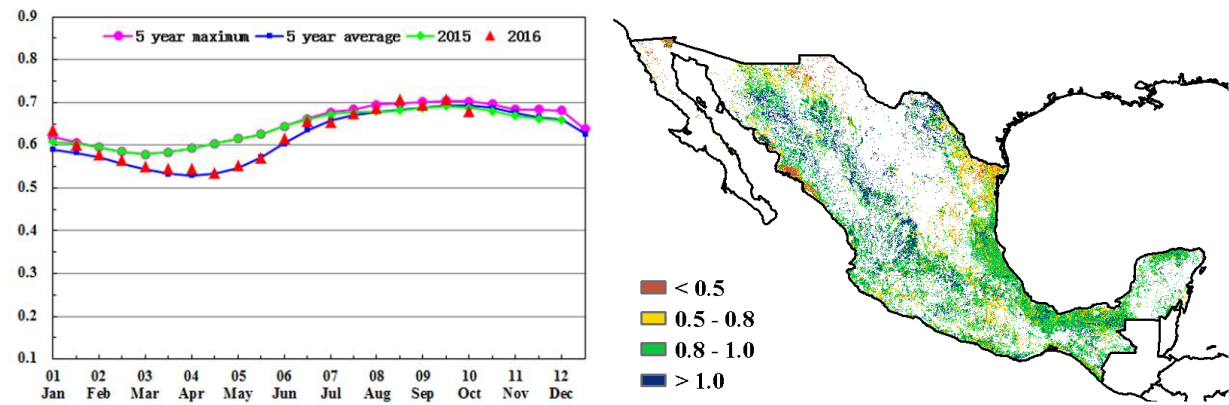
# [MEX] Mexico

During this monitoring period, maize and sorghum (spring to summer) were still growing, while rice (spring to summer) was being harvested. Overall, crop condition was average according to the crop condition development graph based on NDVI.

The CropWatch agroclimatic indicators show that rainfall and temperature separately dropped below average by 9% and 0.2°C while RADPAR increased by 2%. Consequently, BIOMSS was below average by 6%. In contrast, CALF and cropping intensity increased respectively by 5% and 3%. The map of spatial patterns for maximum VCI show that high values (larger than 0.5) of this indicator are widespread, while low values occur only in western Sinaloa, northern Chihuahua and Tamaulipas provinces. According to the graph for spatial NDVI patterns and NDVI profiles, crop condition was above average in 68.9% of planted areas, mainly in Veracruz, Tabasco, Coahuila, Guanajuato, and Jalisco. On the contrary, crops in western Sinaloa, southwestern and northern Sonora, and northern Chihuahua and Tamaulipas (accounting for about 31% of all cropland), experienced below or close to average crop condition, a pattern also confirmed by maximum VCI.

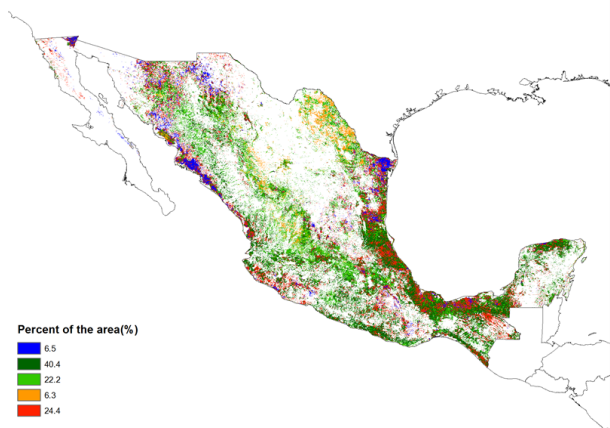
Altogether, crop yields for this season in Mexico are expected to be above average.

**Figure 3.21. Mexico crop condition, July-October 2016**

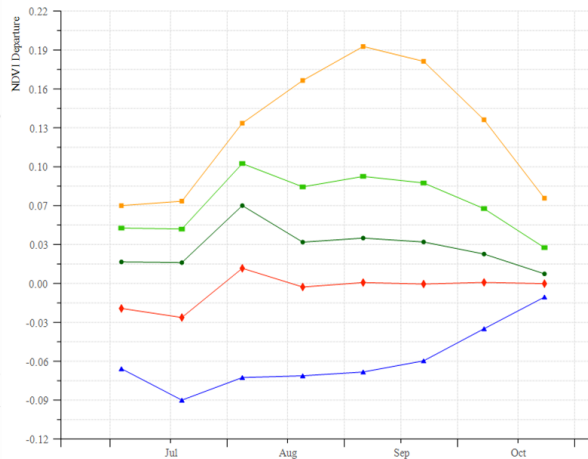


(a) Crop condition development graph based on NDVI

(b) Maximum VCI



(c) Spatial NDVI patterns compared to 5YA



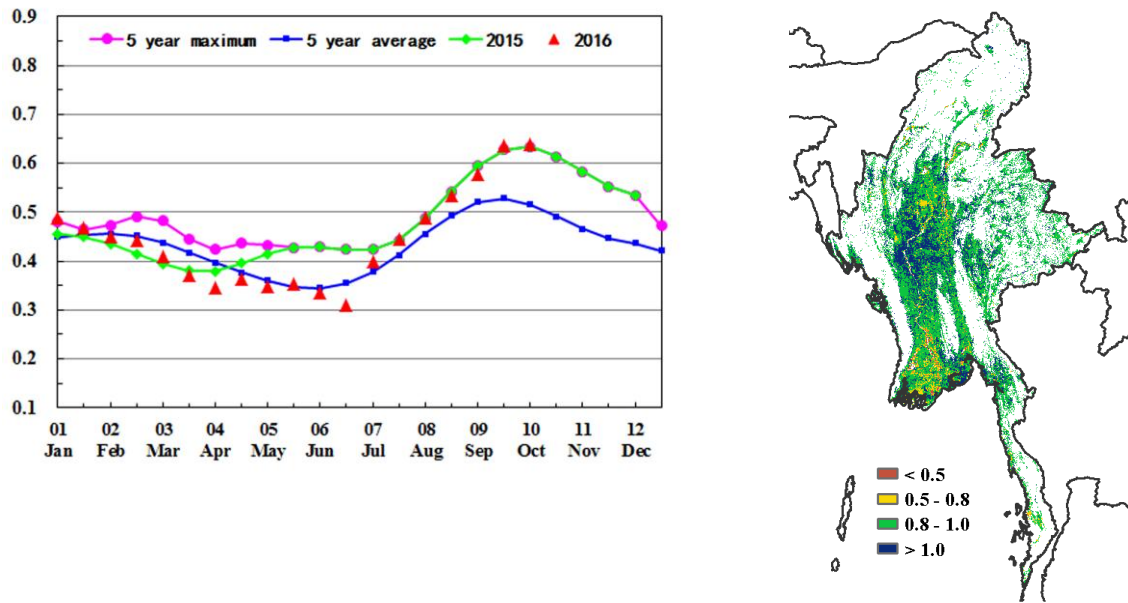
(d) NDVI profiles

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# [MMR] Myanmar

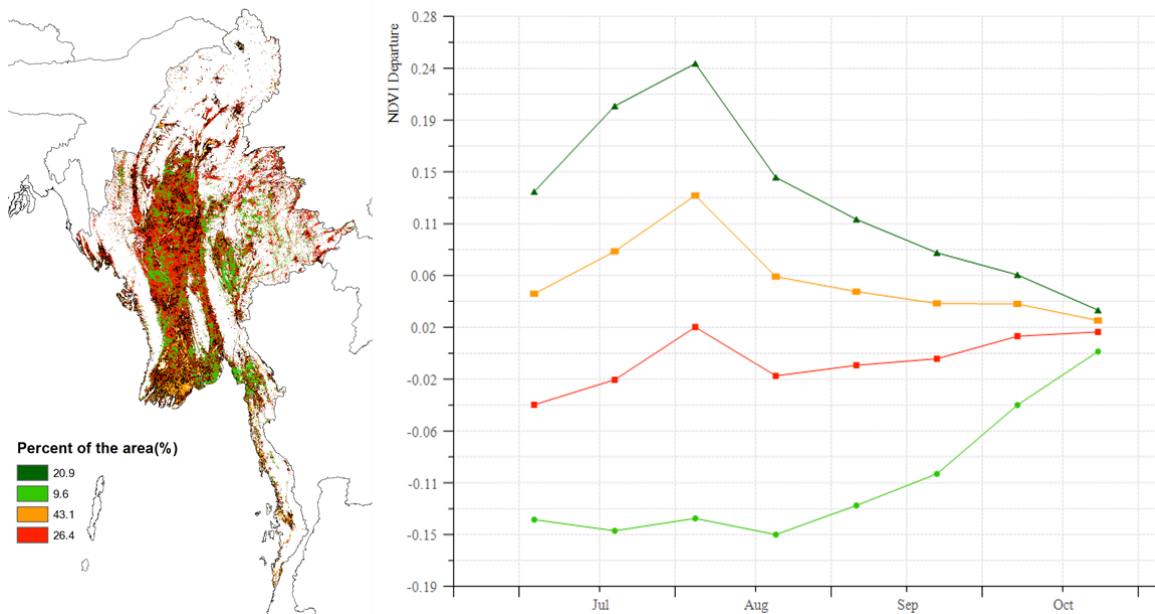
The reporting period covers the mid-cycle stages of the main rice crop (which accounts for 85% of annual production) as well as the harvest of potatoes, which started the last week of September. It also covers the sowing of winter wheat and maize in September. The CropWatch agroclimatic and agronomic indicators show average rainfall (RAIN, -1%), TEMP (-0.1°C), radiation (RADPAR -2%), and biomass accumulation potential (BIOMSS). The national NDVI profile values were slightly above average from early July to October in the whole country. In the central part of the country (that is, Mandalay and Magway regions), VCIx exceeded 1.0 while only some small patches in the Delta (Ayeyawaddy and Yangon divisions) show VCIx below 0.5. Other areas enjoyed a "normal" VCIx between 0.8 and 1.0. The crops that suffered damage due to flooding are expected to recover, resulting in a slight increase in paddy production. Overall, CropWatch assesses the crop condition and production outlook for the country as average.

Figure 3.22. Myanmar crop condition, July-October 2016



(a) Crop condition development graph based on NDVI

(b) Maximum VCI



(c) Spatial NDVI patterns compared to 5YA

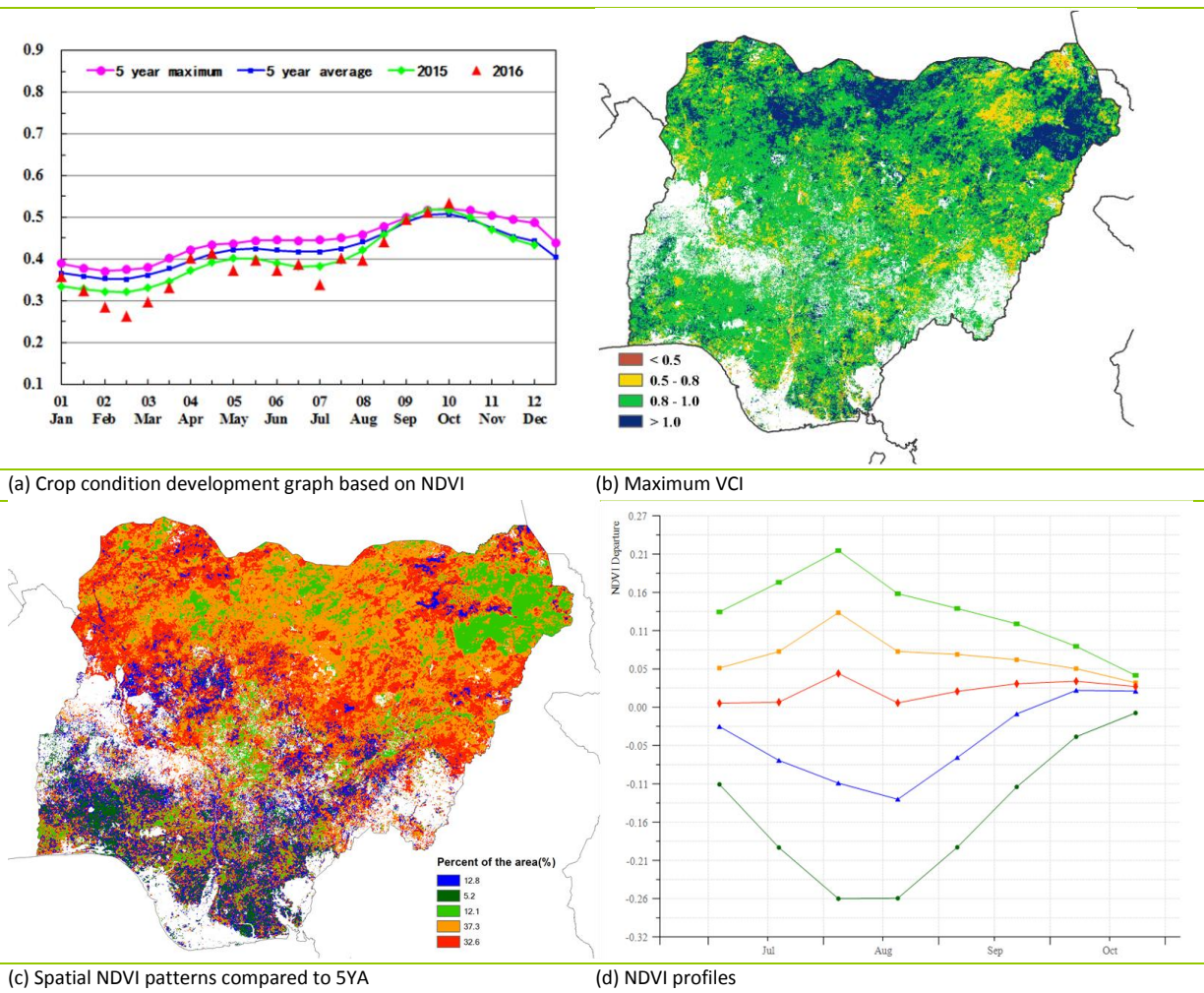
(d) NDVI profiles

# [NGA] Nigeria

Between July and October, Nigerian farmers were harvesting their maize, rice, sorghum and yam crops, while the second maize crop, irrigated rice, and cassava were growing. Temperature and RADPAR were average, while rainfall showed a slight increase (RAIN, +8%), which resulted in a minor rise in the biomass production potential (BIOMSS, +4%).

The crop development based on NDVI shows that conditions changed from below average and below the previous year in July to higher than the recent five-year maximum in October. Contrary to the previous year, when the north Sahelian region was characterized by unsatisfactory VCIx, during the current monitoring period the region showed favorable development compared to the average in Borno, Jigawa, western Katsina, and eastern Zanfana. The spatial NDVI patterns and clusters indicate that crop condition was generally above average over much of the country, except in some central areas (12.8% of croplands) and especially in the south (5.2% of area).

**Figure 3.23. Nigeria crop condition, July-October 2016**



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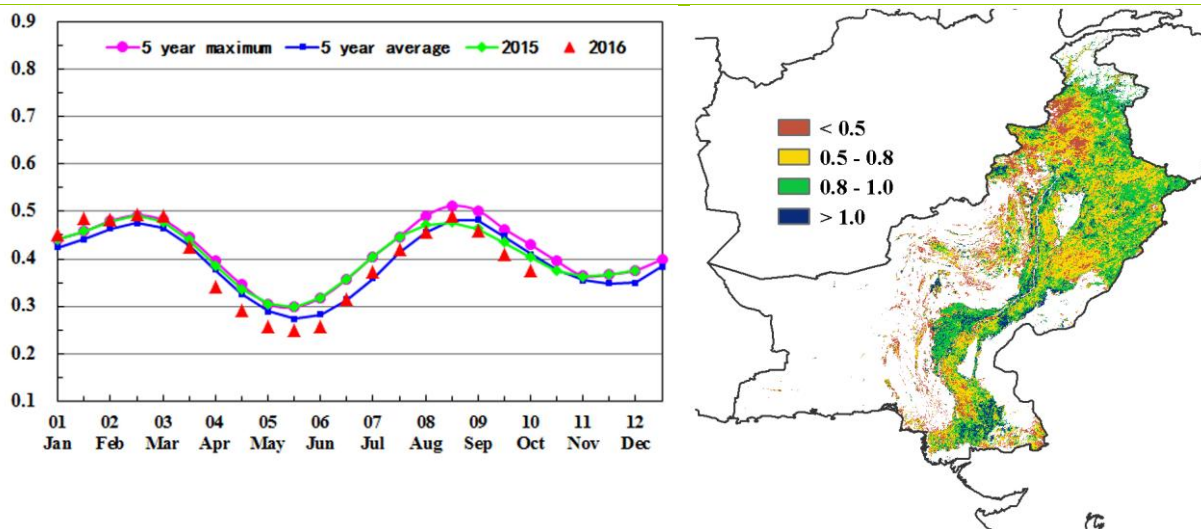
# [PAK] Pakistan

This monitoring period covers the growing and harvesting stages of summer (kharif) maize and rice, as well as the sowing of winter barley and wheat. Crop condition was generally unfavorable from July to October. Compared with average, RAIN and RADPAR showed some increase (+6% and +2% respectively), while TEMP was average (-0.3°C). BIOMSS increased by just 3% compared to the recent five-year average. The national average of VCIx (0.70) was above average, the fraction of cropped arable land (CALF) was unchanged, and cropping intensity decreased by 11% compared to average.

As shown by the crop condition development graph, crops condition varied between below average and average in this period. According to the spatial NDVI patterns and profiles, 73% of the cropped areas were above average throughout the period, while 21.9% was just below, and 4.9% below average but recovering in October (affecting central Khyber Pakhtunkhwa, Punjab, and some areas of Sindh).

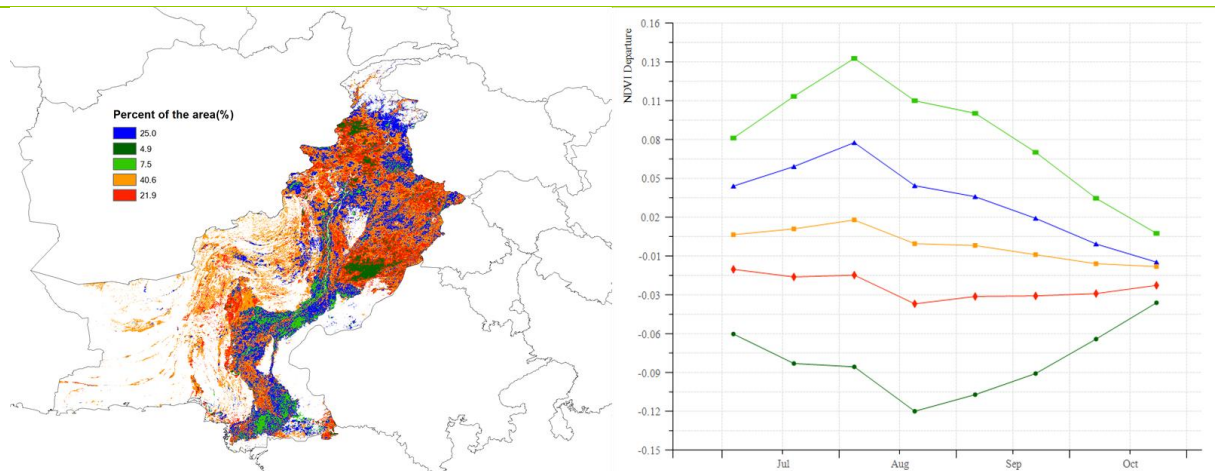
Altogether, crop condition for Pakistan is estimated to be average.

Figure 3.24. Pakistan crop condition, July-October 2016



(a) Crop condition development graph based on NDVI

(b) Maximum VCI



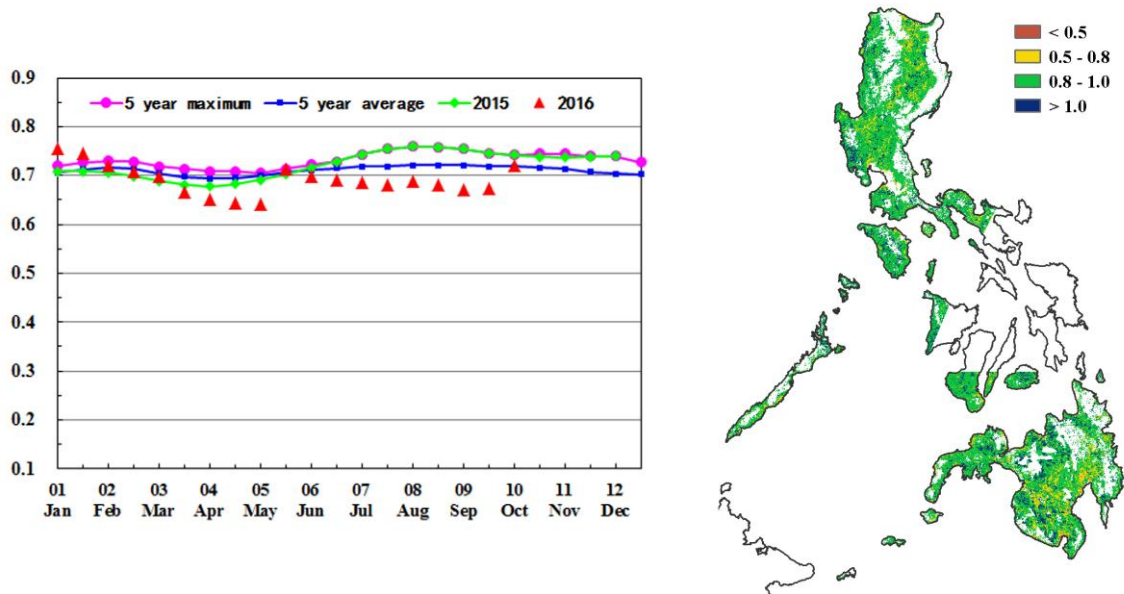
(c) Spatial NDVI patterns compared to 5YA

(d) NDVI profiles

# [PHL] The Philippines

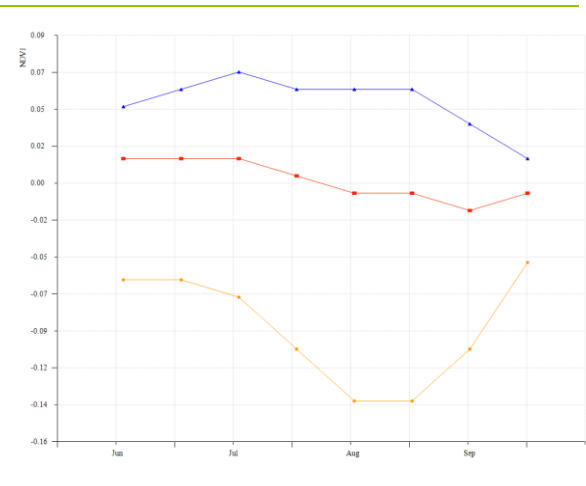
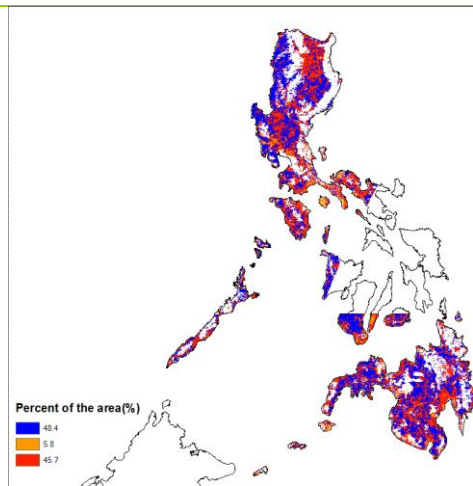
The crops in the Philippines generally showed unfavorable condition between August and October according to the NDVI profiles. Harvesting of the main season paddy crop is currently underway. Nationwide, rainfall (RAIN) was 11% above average, accompanied by increased temperature (0.8°C) and about average radiation (RADPAR, -1%). The biomass accumulation potential (BIOMSS) shows a slight increase of 2%, while the cropping intensity decreased by 4% compared with the average. Typhoon Sarika flooded some crops in Luzon during mid-October, but the impact on crops is limited according to the NDVI cluster map, which shows that the VCIx values for most areas are above average. As the main crops have entered into the harvest period, the extreme weather in the monitoring period will not have much impact on the yield.

Figure 3.25. Philippines crop condition, July-October 2016



(a) Crop condition development graph based on NDVI

(b) Maximum VCI



(c) Spatial NDVI patterns compared to 5YA

(d) NDVI profiles

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# [POL] Poland

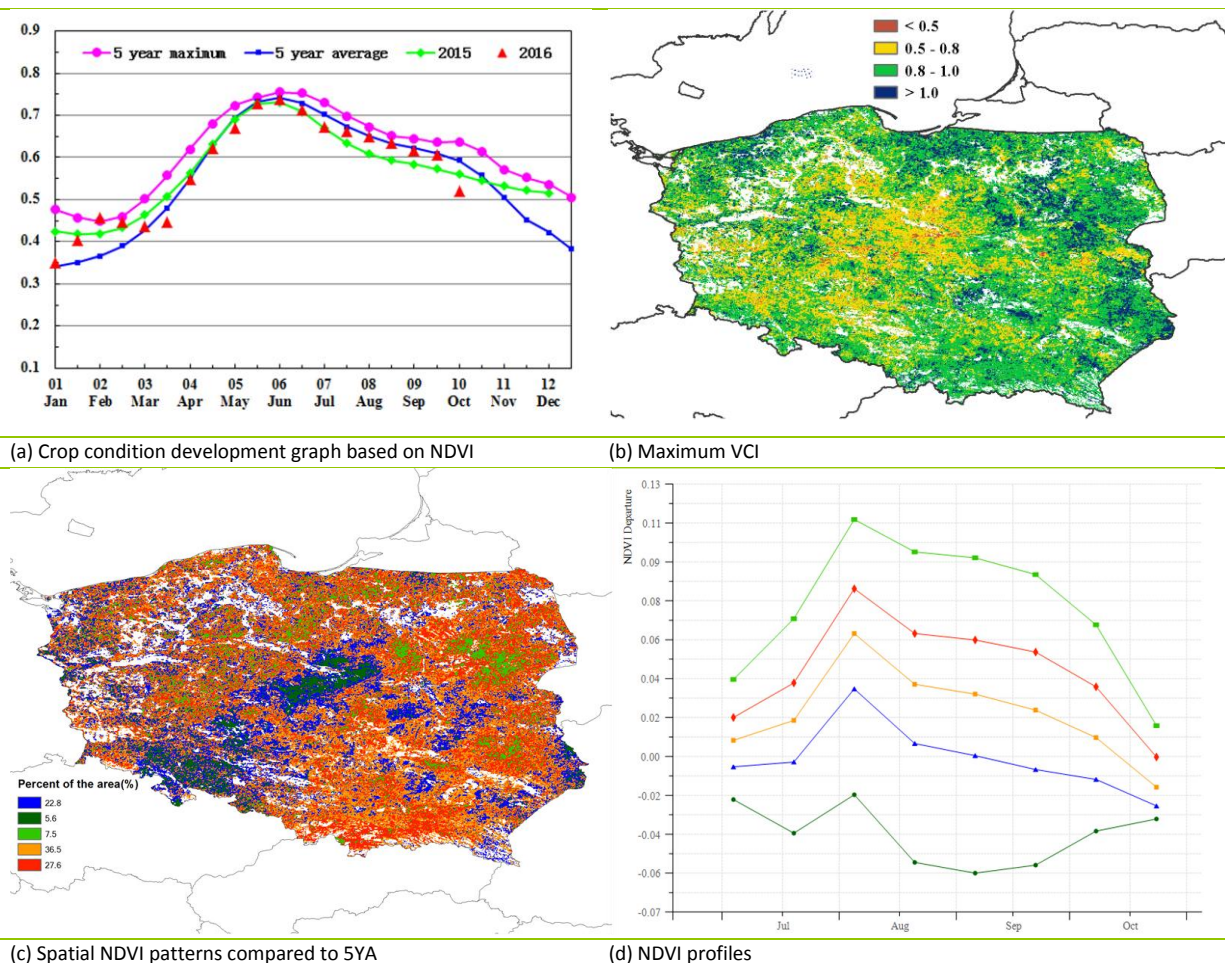
In Poland, meteorological conditions were variable during the reporting period. In July, precipitation totals were above average, locally reaching the fifteen-year maximum in the second ten-day period of the month. The precipitation hampered the cereal harvest in the majority of areas. Dry conditions prevailed from the middle of August until the end of September, and some areas recorded no rain at all in September. This weather benefited sugar beet and maize maturity and final yield. Due to unusually dry soils, winter crops sowing was postponed in central and south-western areas. Abundant precipitation in October was favorable for the emergence and early development of winter crops but caused inundations on heavy soils.

In August, NDVI values below the five-year average occurred on about 6% of agricultural land. Due to scarce rainfall in September, the area of less than average crop condition has increased. In Wielkopolskie and Kujawsko-Pomorskie regions, crop condition indicators presented mixed patterns, below or above the average; the higher than average patterns could indicate a production surplus due to irrigation. The least favorable crop condition occurred in the center, south-west, and west of the country, confirmed by low VCIx; these regions experienced the strongest rainfall deficits in late summer. In the eastern part of the country crop condition was better than average.

Overall, at the national scale, precipitation presents a positive departure of 28% over average for the reporting period, whereas negative departures concern temperature (-0.7°C) and radiation (-6%). Weather conditions were most favorable in the eastern part of the country, as confirmed by higher than average VCIx and a biomass potential increase of 21%.

Altogether, the production of the Polish crops is foreseen as average.

Figure 3.26. Poland crop condition, July-October 2016



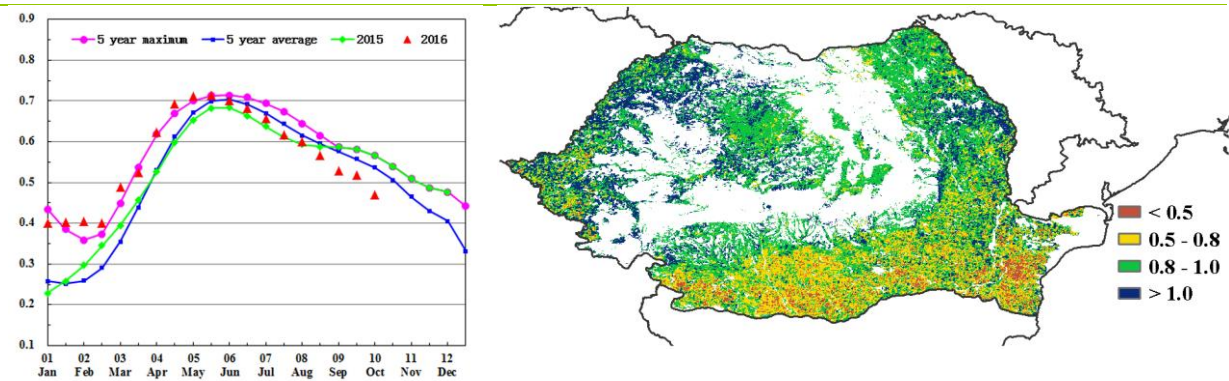
# [ROU] Romania

In Romania, July to October precipitation was below average by 27%. The country suffered a long period with very scarce rainfall, which was broken in mid-September but with a significant decrease in temperatures (TEMP, -0.9°C). The prolonged drought followed by a cold period was unfavorable for sowing and early development of winter rape seed and then cereals. Potential biomass accumulation is currently predicted 17% below the average of the recent five years.

In August about 30% of agricultural land suffered worse than average crop condition. The area along the southern border of the country, covering 9.6% of the agricultural area, experienced particularly negative departures from the five-year average, with maximum VCIs between 0.5 and 0.8, and often below 0.5; this concerns the Sud-Vest Oltenia region (including Dolj and Olt counties) through the Sud-Muntenia region (Teleorman County) to the Sud-Est region (Constanta County).

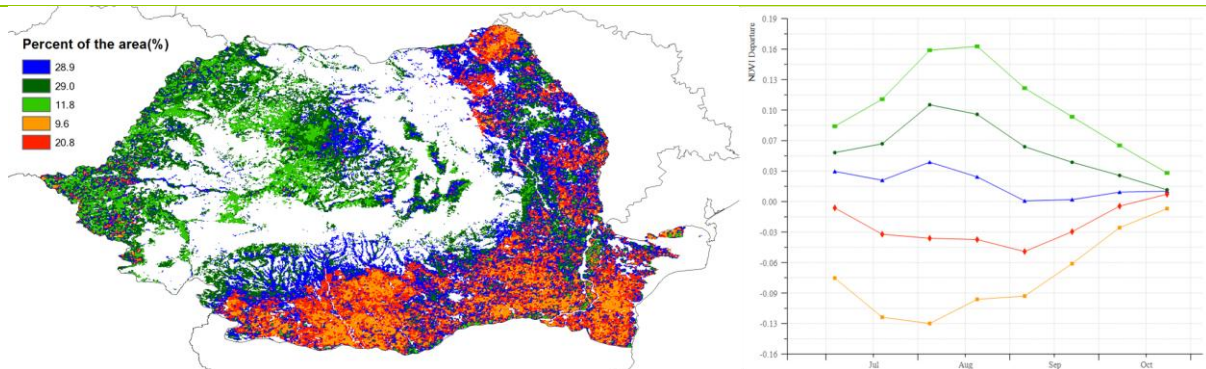
According to the NDVI profiles, crop condition since August was continuously below average as a consequence of unfavorable weather. In the south and southeast, NDVI was below the average of the last five years, whereas in the Carpatian region and the western part of the country the profiles were above the average. The overall maximum VCI was 0.86, indicating close to average summer crops production; colder than usual meteorological conditions could have caused a slowdown of the development of winter crop seedlings.

**Figure 3.27. Romania crop condition, July-October 2016**



(a) Crop condition development graph based on NDVI

(b) Maximum VCI



(c) Spatial NDVI patterns compared to 5YA

(d) NDVI profiles

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# [RUS] Russia

Nationwide agroclimatic indicators were close to average, with somewhat lower temperature (TEMP, -0.4°C) and slightly worse biomass accumulation (BIOMSS, -3%). Crop condition development, based on NDVI, was also near the average and slightly better than last year.

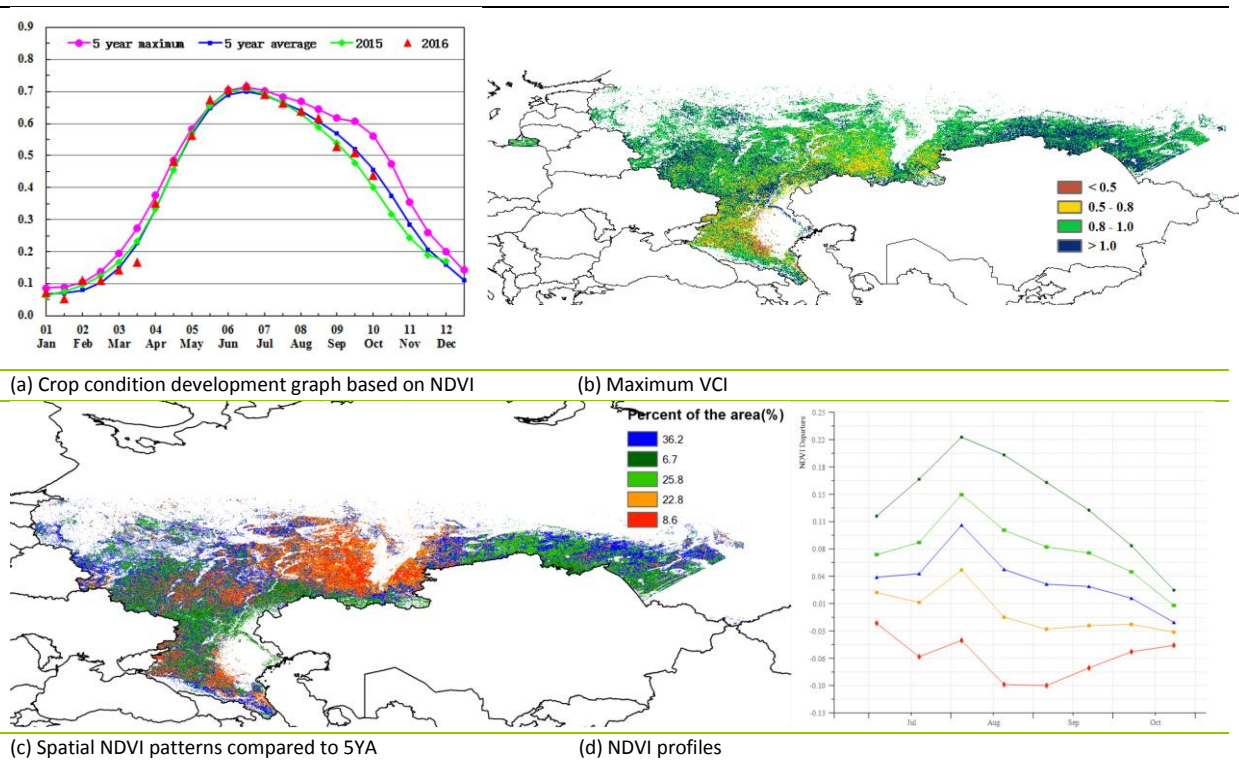
The central region presents positive prospects for biomass production (4%) due to a precipitation surplus (RAIN, +10%), even though in the end of the reporting period lower than usual temperature was recorded (-0.6°C in general).

The Volga and Southern Ural regions, also very important producers, experienced precipitation deficits (-11%) with moderate temperature excess, especially in the Ural area (+0.5°C), which reduced biomass expectation in both regions (-9%). A BIOMSS reduction due to both low rain and low temperature affected the northern Caucasus, neighboring areas to the north, as well as an area near the Black Sea, with negative departures from average as large as 25%.

Spatial NDVI profiles, confirmed by maximum VCI <0.8, show that from June onward crop condition for about 9% of the total area was worse than the five-year average. This applies to the southwest and Volga regions toward the Urals and may result in below average expectation both for cereals harvested in August and summer crops.

Overall crop production in Russia is foreseen to be close to average levels and early development of winter crops presents better perspectives than last year.

**Figure 3.28. Russia crop condition, July-October 2016**



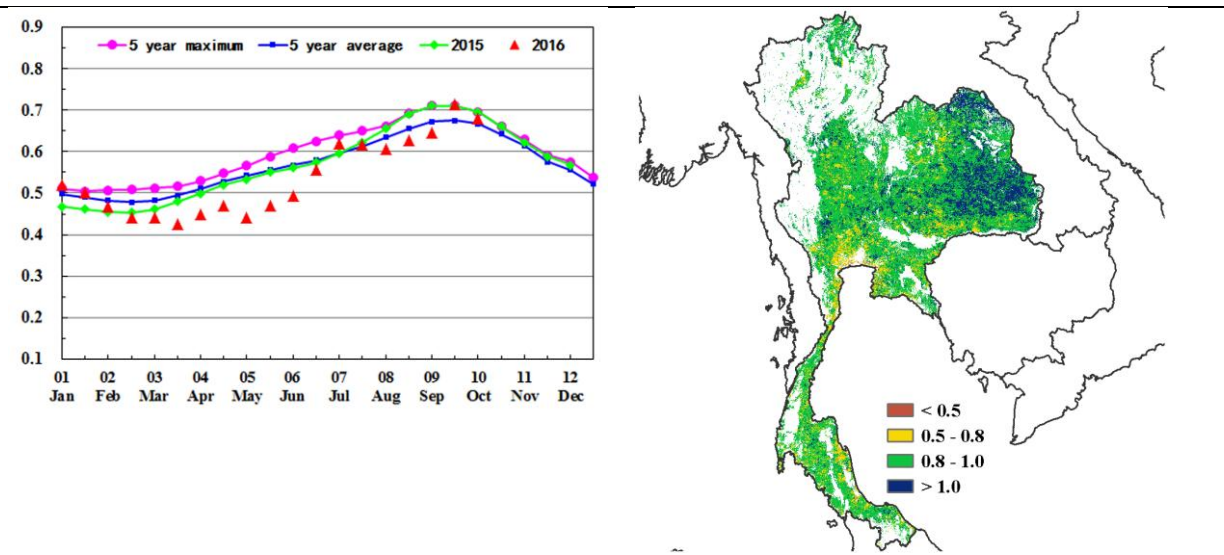
# [THA] Thailand

The reporting period covers the end of the monsoon season in Thailand. Maize harvesting was completed in September, while it started in October for the main paddy crop and in September for sorghum. The CropWatch agroclimatic and agronomic indicators show average conditions for TEMP and RADPAR, while a small increase in rainfall (RAIN, +9%) resulted in a rise of the biomass accumulation potential (BIOMSS, +7%) compared to the previous five-year average.

The national NDVI values were slightly below average from early July to September, then increased above average and followed the five-year maximum at the end of September before returning to average values. In the eastern provinces (Nong Khai, Bueng Kan, Udon Thani, Sakon Nakhon, Mukdahan, Kalasin, Maha-Sarakham, Roi Et, Yasothan, Amnatcharoen, Ubon Ratchathani, Surin Sisaket, and Khan Kaen) VCIx exceeded 1. VCIx dropped below 0.5, indicating generally poor conditions in Samut Prakan, Bangkok, Nonthaburi, Samut Sakhon, Samut Songkharm, Nakhon Pathom, Pathum Thani, Phatthalung Trang, Nakhon Si Thammarat, and Songkhla provinces.

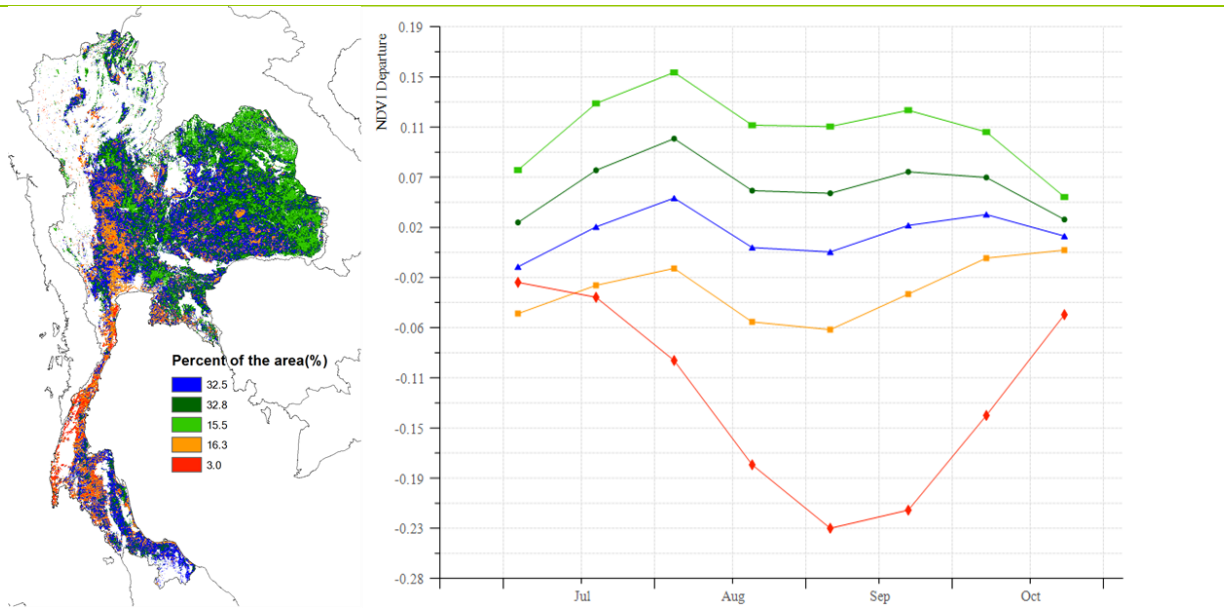
Due to normal rainfall, the crop production will be above average.

**Figure 3.29. Thailand crop condition, July-October 2016**



(a) Crop condition development graph based on NDVI

(b) Maximum VCI



(c) Spatial NDVI patterns compared to 5YA

(d) NDVI profiles

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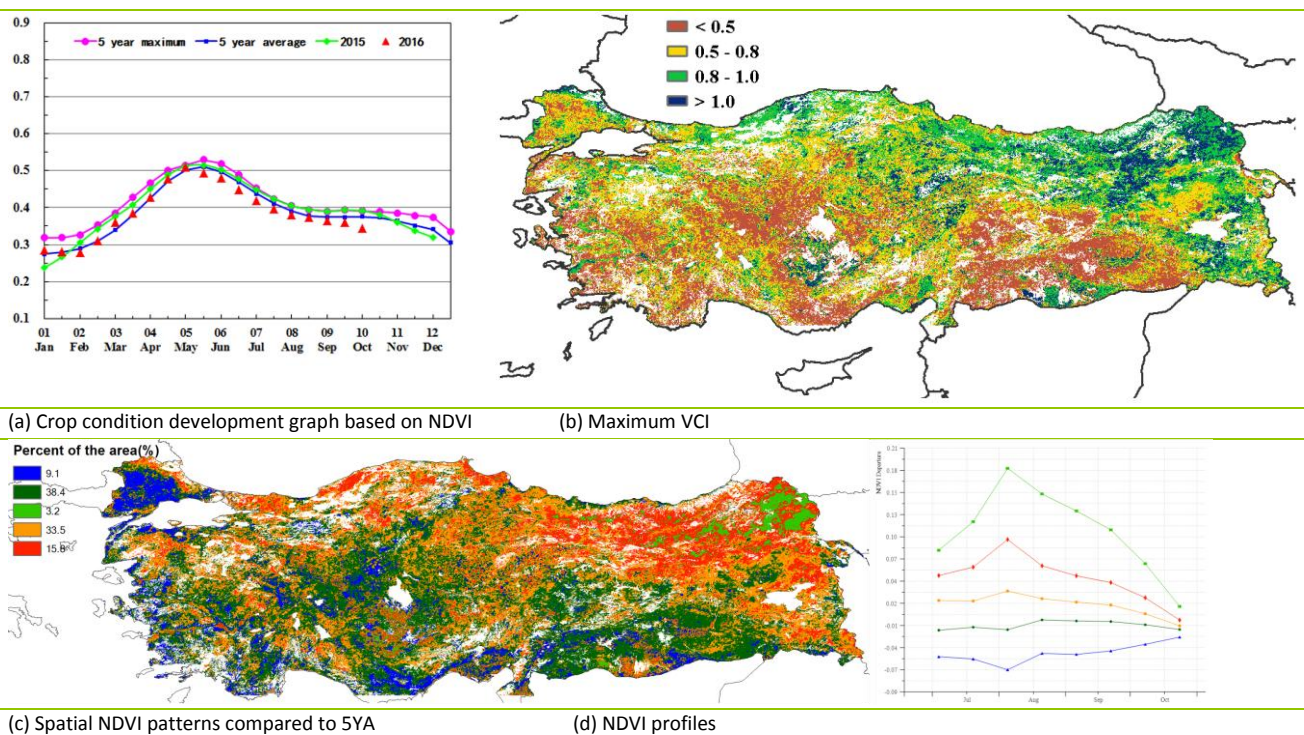
# [TUR] Turkey

Major agricultural regions in Turkey suffered rainfall shortages within the reporting period. At the national scale precipitation totals were 43% below the fifteen-year average. Temperature and radiation were near to average, with the exception of the southeast of the country, which was warmer than usual by 0.7°C. The maximum VCI (0.72) was below average and the cropped arable land fraction (CALF) increased by 2 percentage points compared to the five-year average. Nationwide, NDVI was below last year's values and slightly below the five-year average; NDVI dropped significantly in October. In general, biomass production is expected to be much lower than the five-year average (BIOMSS, -37%).

The areas (9.1% of arable land) that experienced the most unfavorable conditions, especially during the summer months, occur in the northwest (the European part of the country), in the Aegean region, and in Central Anatolia and the south (Mediterranean region). This spatial pattern is confirmed by low maximum VCI values (<0.5). Barley and maize are the crops most affected as they were at grain filling and ripening phases during the reporting period. The coastal area of the Black Sea and the northeast (spring barley cultivation area) presented rather favorable conditions, which appear clearly in the maximum VCI map with pixels above 0.8.

In general, the production outlook is below last year's and the five-year average due to unfavorable weather conditions.

**Figure 3.30. Turkey crop condition, July-October 2016**



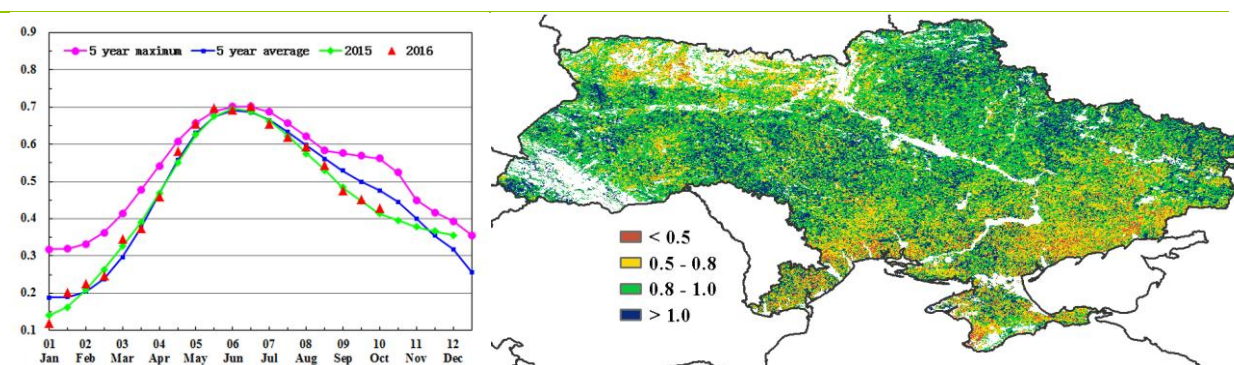
# [UKR] Ukraine

In Ukraine during the reporting period both precipitation and temperature were below average (respectively -13% and -0.6°C), negatively affecting the biomass production potential (-12%). Across all the important agricultural regions similar departures from the average were recorded. In July and mid-August close to average precipitation prevailed, but throughout September a rainfall deficit persisted over most of the country. A precipitation surplus was recorded in the beginning of October, a period that was preceded and followed by dekads with temperature lower than the average.

At the national scale, NDVI indicated worsening crop conditions from July, being below the five-year average and similar to the last year's values. Spatial NDVI patterns show that about 8% of the agricultural area in the country presented significantly below average NDVI from the beginning of the reporting period until the middle of September. This concerns mainly the western Ukraine (Ternopil and Khmelnytskyi oblasts) and the south and east (Donetsk Oblast). The VCIx values indicate crop conditions in the south and east (more pixels with VCIx <0.5) are worse than in the western part of the country. In central and northeastern parts, both NDVI and VCIx (>1.0) indicate good crop conditions.

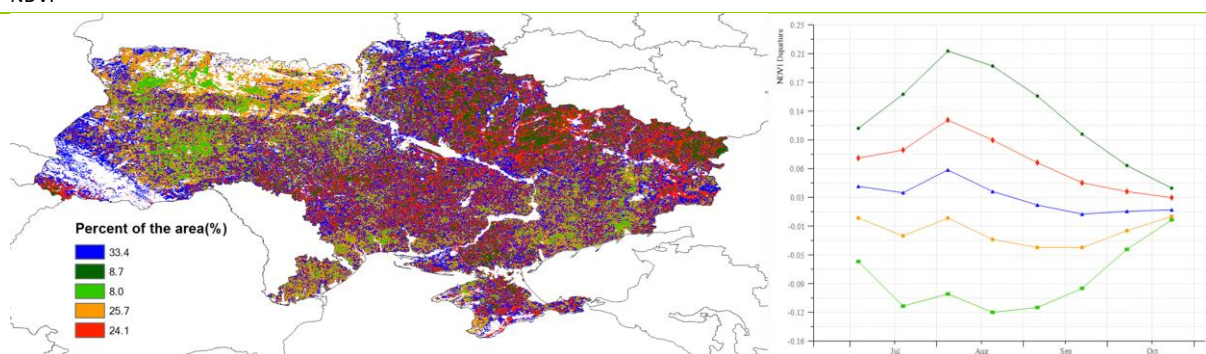
The weather conditions may negatively affect spring cereals and maize production in non-irrigated areas in the south of the Ukraine.

**Figure 3.31. Ukraine crop condition, July-October 2016**



(a) Crop condition development graph based on NDVI

(b) Maximum VCI



(c) Spatial NDVI patterns compared to 5YA

(d) NDVI profiles

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# [USA] United States

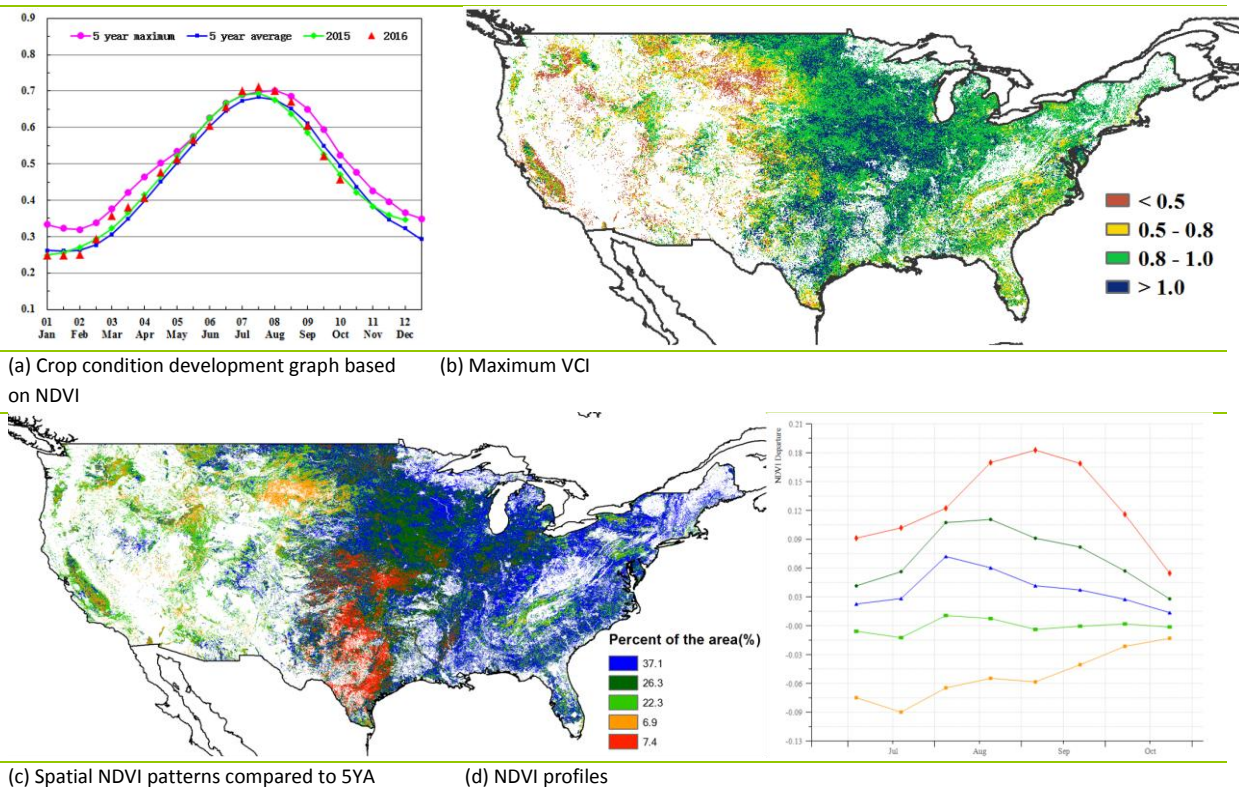
CropWatch agroclimatic and agronomic indicators show above average crop condition in the United States, especially maize, soybeans, and rice, which were growing during this monitoring period from July to October, 2016.

The prevailing weather was warm and wet with precipitation 23% above average, and close to average temperature (+ 0.5°C) and RADPAR (-1%). Abundant rainfall was recorded in the northern Great Plains, including North Dakota (RAIN, +150%), South Dakota (+126%), Nebraska (+85%), Kansas (+107%), and Montana (+127%), benefiting the growth of wheat, soybean, and maize. In the Corn Belt, maize and soybeans enjoyed favorable soil moisture availability in Iowa (RAIN, + 109%), Illinois (+56%), Missouri (+59%), Minnesota (+121%), Wisconsin (+90%), Indiana (+27%), Michigan (+19%), and Ohio (+12%). According to the Federal Emergency Management Agency (FEMA), torrential rainfall in August caused floods in Louisiana. In Arkansas, a major rice producer, 13% below average rainfall occurred, but with little impact because of sufficient inflow from the Mississippi river. Temperature was above or close to average in most areas including major maize and soybean states (Illinois, +0.9°C; Iowa, +0.5°C), major rice states (Arkansas, +0.6°C), the major spring wheat state (North Dakota, -0.2°C), and major winter wheat producers (Kansas, +0.2°C).

Favorable crop condition is confirmed by the CropWatch agronomic indicators, all compared to the average of the recent five years. Biomass showed an 18% positive departure, CALF was 2% above, and cropping intensity also increased by 2%. The VCIx was 0.92, and in the northern Great Plains and Corn Belt VCIx even exceeded 1. As shown by the spatial NDVI patterns and NDVI profiles, the positive NDVI departure covered almost the entire country, including the central and western Corn Belt, Great Plains, and lower Mississippi River, indicating just limited damage to the crops from heavy rainfall.

Overall, CropWatch puts the current year's output as a 5% increase for maize compared with 2015, as well as increases for rice (+6%) and soybeans (+3%). For wheat, an output similar to 2015 is projected (0%). (See section 5.1 and tables 5.1 and B.5 for production estimates.)

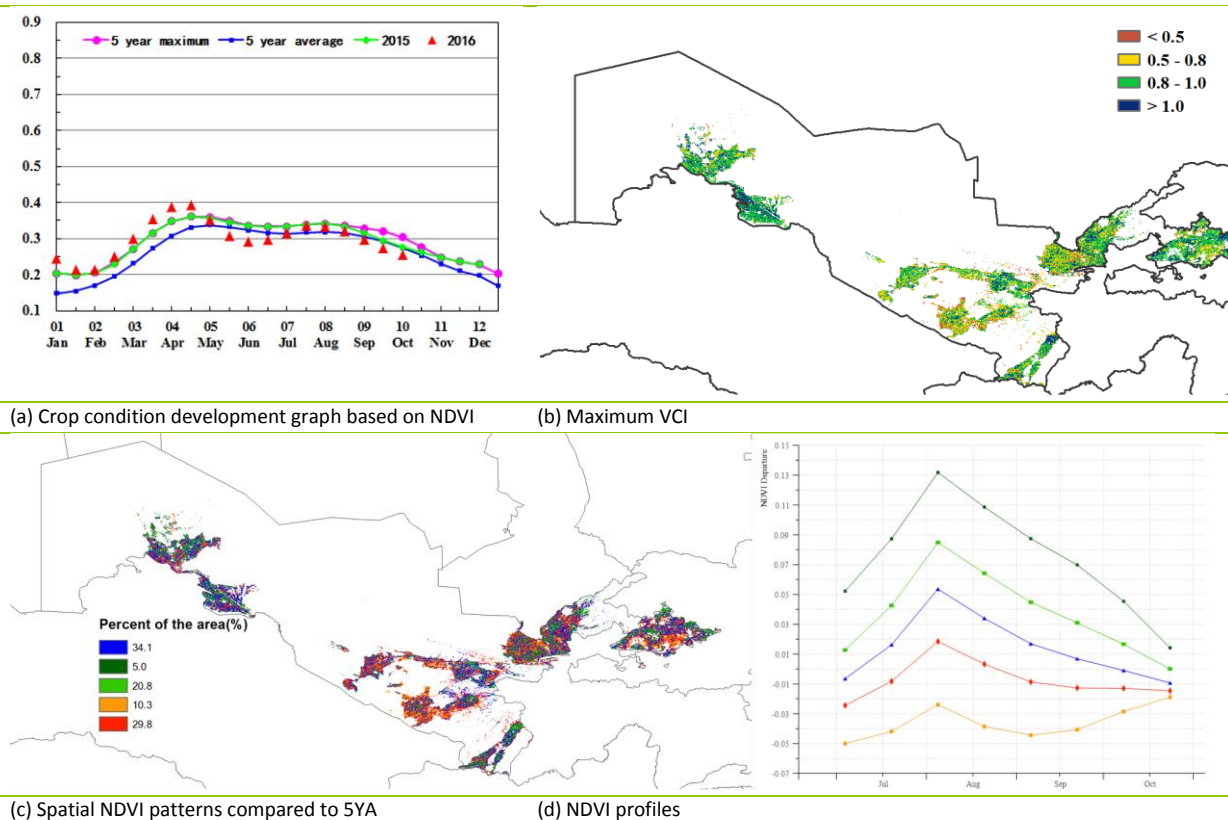
**Figure 3.32. United States crop condition, July-October 2016**



# [UZB] Uzbekistan

The reporting period covers the harvest of maize and cotton (which is mostly cultivated in the Aral sea area) and the sowing of winter wheat, the country's most important cereal crop, mainly in the east. As shown in the crop condition development graph, NDVI was below average from late August to October. Spatial NDVI patterns, however, show that crop condition was persistently below average only in 10.8% of the arable land. The national average of the VCIx was 0.90, and the arable land fraction (CALF) increased by a whopping 20 percentage points compared to the five-year average. This is due to the combined effect of RAIN (+169% over average), and close to normal TEMP (-0.5°C) and RADPAR (-2%). The resulting biomass production potential BIOMSS rose +133% above the average of the previous five-years. Crop condition was favorable, with good conditions for growth further supported by sufficient soil moisture for the forthcoming wheat crop.

**Figure 3.33. Uzbekistan crop condition, July-October 2016**



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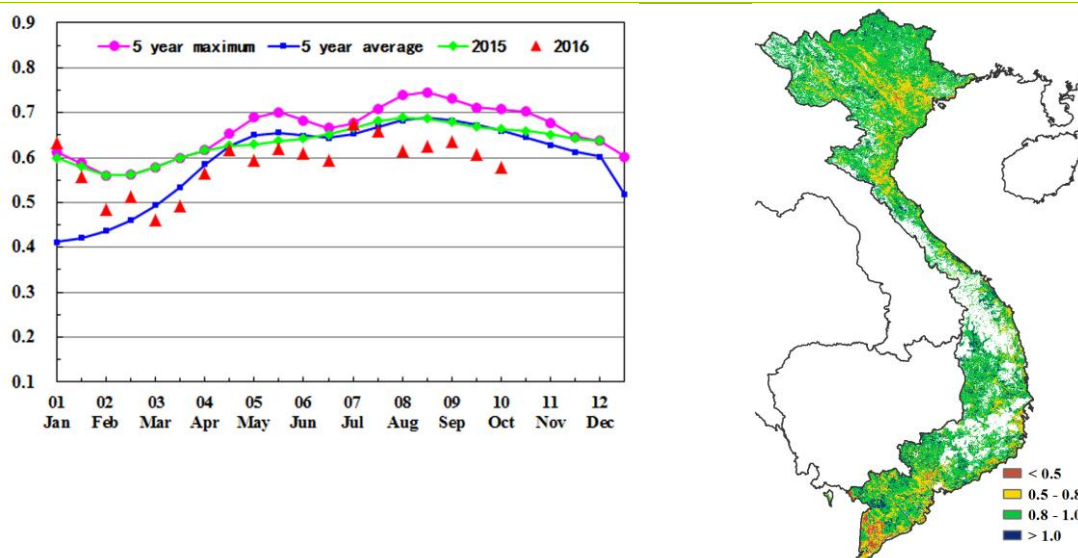
# [VNM] Vietnam

The harvesting period of summer and autumn rice has been completed, while the 10<sup>th</sup> month rice was still growing in mid-October. The crop condition from July to October was lower than the recent five-year average. For the period under consideration, most CropWatch agroclimatic and agronomic indicators show conditions near the average (RADPAR, 0%; TEMP, +0.3°C; and BIOMSS, +1%) or above (RAIN, +12.5%).

Spatial NDVI profiles show that the crop condition was lower than average in the country as a whole. Generally, areas in the north fare better than central and southern locations. According to spatial NDVI patterns, about 11.4% of the croplands recorded consistently low NDVI, especially in the center of the country (Gia Lai and Binh Dinh), the north (Nghe An), the Red river basin and delta (Hanoi, Yen Bai), and especially the south (Ho Chi Minh, Long Anh and Tien Giang and, south of the delta, Bac Lieu). These conditions are confirmed by VCIx values between 0.5 and 0.8.

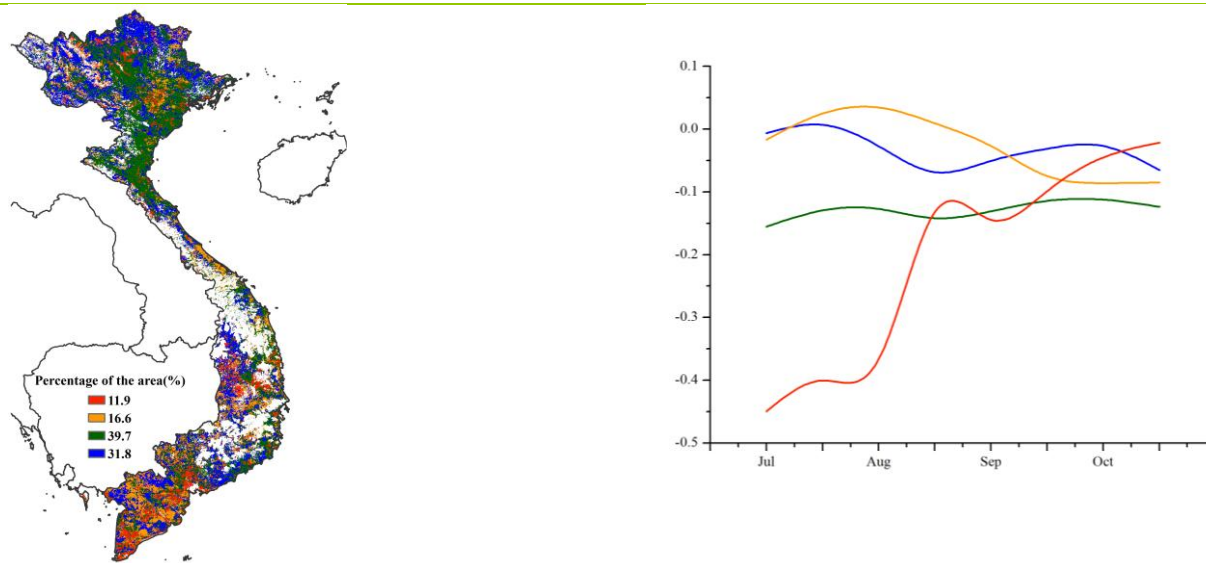
NDVI profiles show that crop condition was above average in nearly 50% of the major rice plantation area, mainly (as already mentioned) the north (Lao Cai and Lang Son), with VCIx ranging between 0.8 and 1.0. Based on CropWatch indicators, the crop situation in Vietnam is considered to be close to but below average.

Figure 3.34. Vietnam crop condition, July-October 2016



(a) Crop condition development graph based on NDVI

(b) Maximum VCI



(c) Spatial NDVI patterns compared to 5YA

(d) NDVI profiles

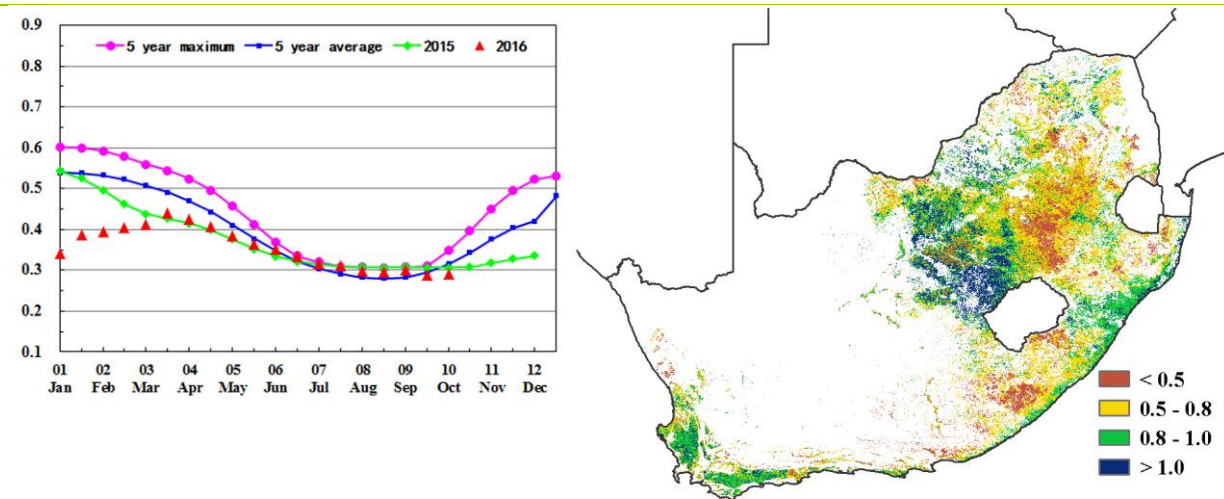
# [ZAF] South Africa

Compared to the last five years, crop condition in South Africa showed an above average level between July and August, but below average in the two months after—a period getting close to the harvesting time for wheat and barley. Additionally, agronomic indicators show a 12% reduction in rainfall (RAIN) compared to average, while temperature (TEMP) increased by a very significant 2.9°C. Despite a radiation (RADPAR) increase of 2%, the biomass production potential (BIOMSS) fell 13% compared to the five-year average.

Most parts of Orange Free State and North West Province showed quite low maximum VCI. In contrast, the Mediterranean southern coastal areas—major growing areas of most winter crops, showed relatively good maximum VCI between 0.8-1.0. The spatial NDVI clusters and profiles further show high values in Kwa-Zulu Natal and the southwestern and eastern cape which are citrus producing areas, indicating a fairly good overall production.

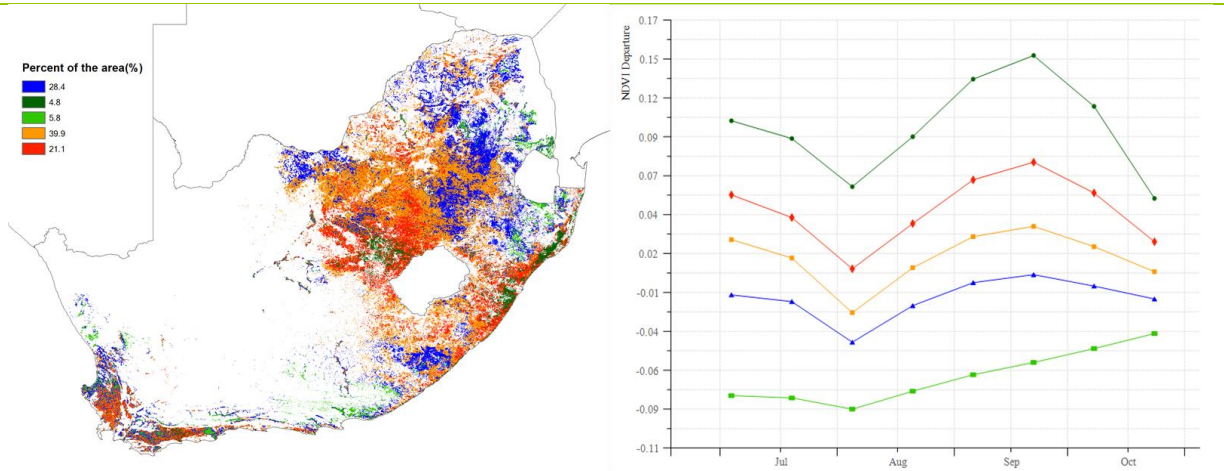
Since the growing period is just about starting in the western half of the country, no specific assessment can be made currently about the forthcoming 2015/16 maize crop.

**Figure 3.35. South Africa crop condition, July-October 2016**



(a) Crop condition development graph based on NDVI

(b) Maximum VCI



(c) Spatial NDVI patterns compared to 5YA

(d) NDVI profiles

## Chapter 4. China

Chapter 4 presents a detailed analysis for China, focusing on the seven most productive agro-ecological regions of the east and south. After a brief overview of the agroclimatic and agronomic conditions over the monitoring period (section 4.1), section 4.2 presents an update on CropWatch estimates for 2016 crop production in China. Section 4.3 reports on ongoing pest and diseases monitoring, while the next two sections focus on domestic prices (4.4) and grain and soybean imports and exports for the country (4.5). Finally, an analysis for individual regions is provided in section 4.6. Additional information on the agroclimatic indicators for agriculturally important Chinese provinces are listed in table A.11 in Annex A.

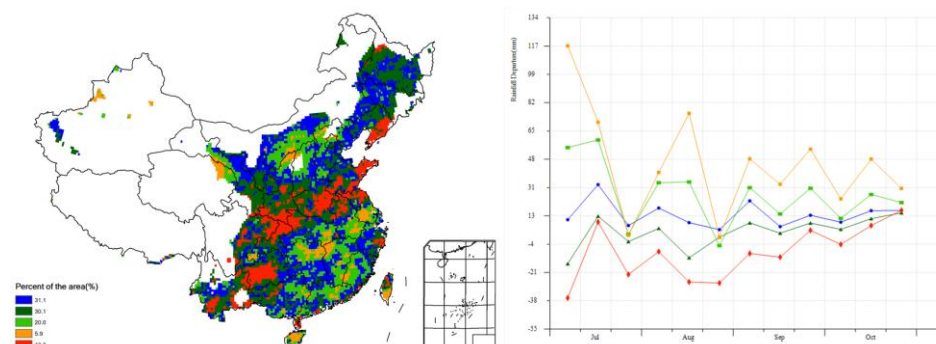
### 4.1 Overview

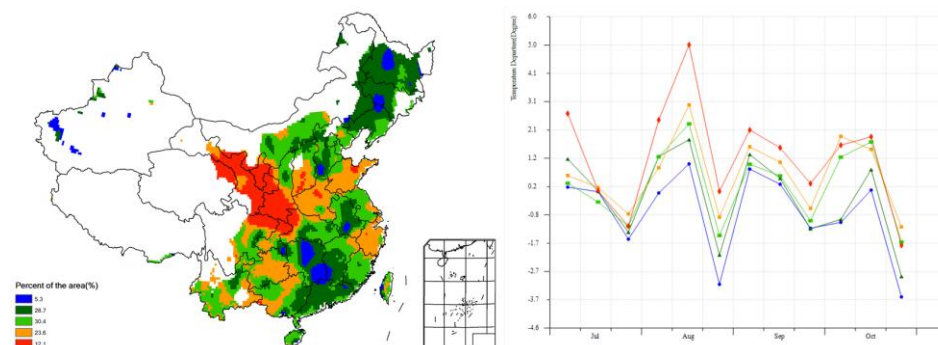
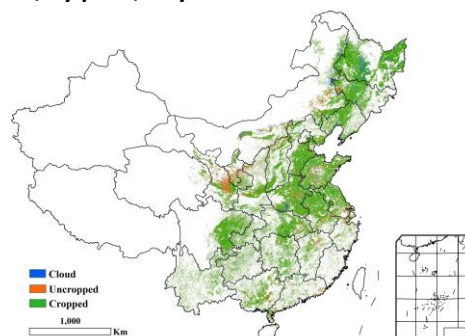
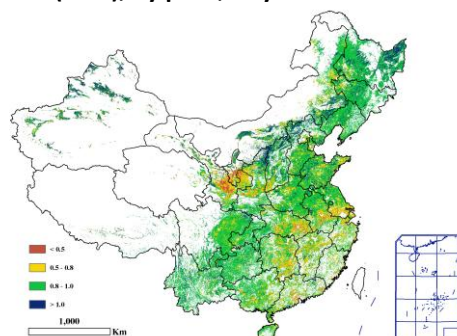
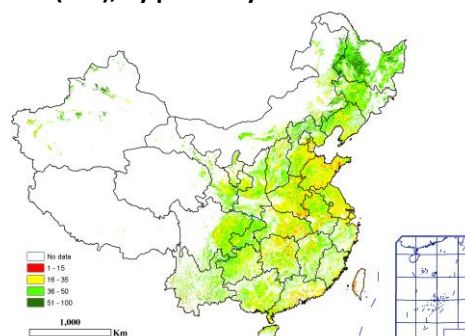
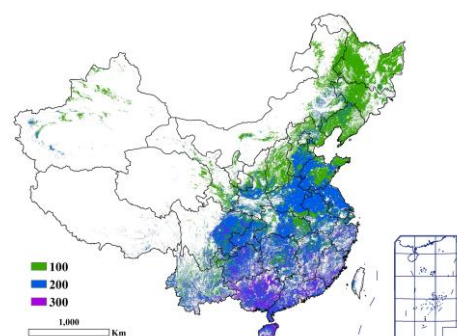
Overall, China enjoyed crop conditions similar to last year's. At the national scale, the conditions that prevailed during the monitoring period (TEMP,  $-0.1^{\circ}\text{C}$  and RADPAR,  $-4\%$ ) were largely average. Together with favorable rainfall (RAIN,  $+14\%$ ) they resulted in above average potential biomass (BIOMSS,  $+11\%$ ). TEMP was close to average everywhere, with the largest—but still moderate—departures occurring in the Loess region ( $+0.3^{\circ}\text{C}$ ) and in Northeast China ( $-0.4^{\circ}\text{C}$ ). RAIN was much higher than expected in the Inner Mongolia region ( $+57\%$ ), while the Lower Yangtze region and the Loess region respectively recorded increases of  $+33\%$  and  $+14\%$ . At the provincial level, high precipitation was reported from Hebei ( $+46\%$ ) and Jiangxi ( $+46\%$ ). Almost all of the major agricultural areas of China suffered from low temperatures during late-July and late-October and also low rainfall in October. Figures 4.1-4.6 and table 4.1 illustrate the distribution of the various CropWatch indicators.

**Table 4.1. CropWatch agroclimatic and agronomic indicators for China, July-October 2016, departure from 5YA and 15YA**

Region	Agroclimatic indicators			Agronomic indicators			
	Departure from 15YA (2001-2015)			Departure from 5YA (2011-2015)		Current	
	RAIN (%)	TEMP ( $^{\circ}\text{C}$ )	RADPAR (%)	BIOMSS (%)	CALF (%)	Cropping Intensity (%)	Maximum VCI
Huanghuaihai	-5	0.1	-4	1	0	-2	1.34
Inner Mongolia	57	-0.3	-3	33	3	0	0.91
Loess region	14	0.4	-3	7	-5	-4	0.94
Lower Yangtze	33	-0.1	-8	16	-1	5	0.80
Northeast China	-1	-0.4	-2	4	0	-1	0.98
Southern China	9	0.0	-3	7	-1	-1	0.59
Southwest China	-3	0.1	-1	-5	-	-9	0.89

**Figure 4.1. China spatial distribution of rainfall profiles, July-October 2016**



**Figure 4.2. China spatial distribution of temperature profiles, July-October 2016****Figure 4.3. China cropped and uncropped arable land, by pixel, July-October 2016****Figure 4.4. China maximum Vegetation Condition Index (VCIx), by pixel, July-October 2016****Figure 4.5. China minimum Vegetation Health Index (VHI), by pixel July-October 2016****Figure 4.6. China Cropping Intensity, July-October 2016**

High VCIx values occurred mostly in China's southwest and in the Northeast region. Low VCIx values affected central and southeast China, particularly the center of Ningxia and the east of Gansu province. Crop condition in the northeast was above average, although agroclimatic conditions were just average. At the regional and provincial scales, BIOMSS was above average in the seven regions, especially in the Lower Yangtze (+16%) and Inner Mongolia (+33%) regions. At the provincial level, the highest values occurred in Fujian (+29%), Jiangxi (+25%), and Inner Mongolia (+29%). Low BIOMSS was only recorded for southwest China (-5%).

During the monitoring period, the cropped arable land fraction (CALF) overall remained stable in comparison with last year. For two of the seven monitored regions, CALF was about equal to the five-year average, while slightly negative values were recorded for the Lower Yangtze region and Southern China (-1%). In the Loess region, CALF decreased by 5%, indicating that less arable land was cultivated. The cropped arable land was mainly distributed in the center of Gansu and Shandong, east of Henan and Inner Mongolia. Cropping intensity increased by 5% in the Lower Yangtze region, but was average in Inner Mongolia; it decreased in the other five regions. Cropping intensity showed that single crops were mainly confined to Northeast China; double crops were located in the center of the country, while the three-

season crops can only be grown in Southern China. Finally, the minimum VHI values indicate that almost all provinces in central and eastern China suffered from water stress, including southeast Henan, central Jiangsu, central Shanxi, and the east of Shandong (figure 4.6).

## 4.2 China's crop production

The harvest of maize, rice, wheat, and soybean in China was completed by the end of October. Based on the latest remote sensing and field sampling data, the revised CropWatch estimate of China's production is listed in table 4.2. For rice, a more detailed production estimate is presented in table 4.3, taking into account complex regional patterns.

**Table 4.2. China's maize, rice, wheat, and soybean production (thousand tons) in 2016 and percentage change from 2015 by province**

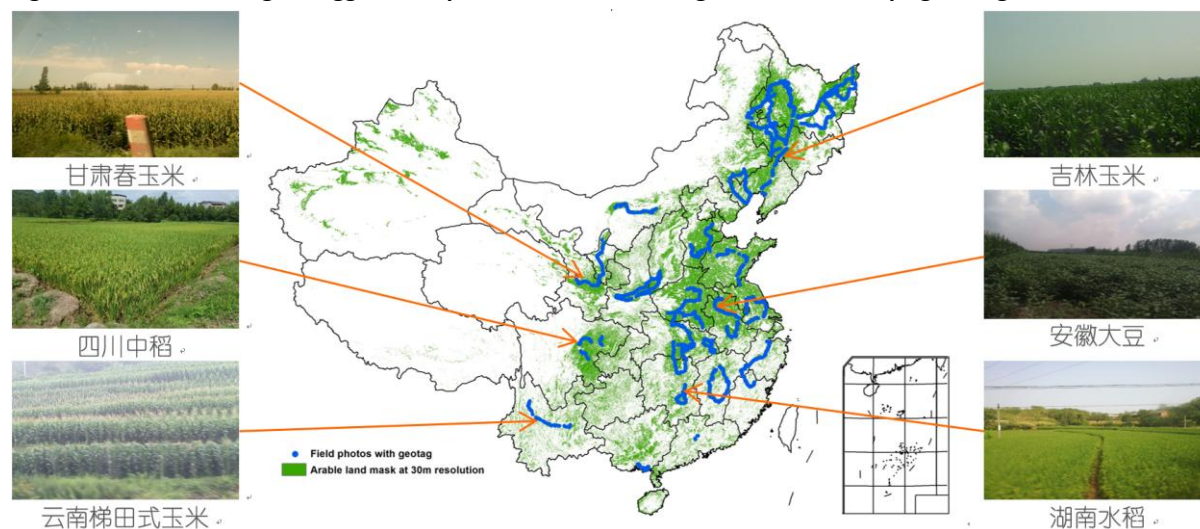
	Maize		Rice		Wheat		Soybean	
	2016	Δ(%)	2016	Δ(%)	2016	Δ(%)	2016	Δ(%)
Anhui	3608	0	16689	-4	11340	2	1092	-1
Chongqing	2103	-3	4733	-3	1110	-1		
Fujian			2873	0				
Gansu	4795	0			2562	-3		
Guangdong			10999	0				
Guangxi			11287	0				
Guizhou	5105	3	5404	4				
Hebei	17944	4			10832	0	186	3
Heilongjiang	27195	-2	20923	3	452	4	4594	0
Henan	16808	0	3852	-2	25160	-3	788	2
Hubei			15453	-3	4330	0		
Hunan			24709	-3				
Inner Mongolia	16206	-7			2056	10	1019	23
Jiangsu	2186	-3	16610	-2	9729	1	781	-1
Jiangxi			16751	-4				
Jilin	24324	2	5670	12			706	5
Liaoning	15707	4	4409	-9			420	-18
Ningxia	1719	0	553	2	788	1		
Shaanxi	3428	-6	1017	-3	4011	1		
Shandong	19217	2			21893	-4	698	3
Shanxi	8666	-1			2132	1	167	-4
Sichuan	7212	0	14937	0	4646	-1		
Xinjiang	6727	1						
Yunnan	6135	5	5642	6				
Zhejiang			6252	-3				
Sub total	189085	0	188763	-1	101041	-1	10451	1
<b>Other provinces*</b>	<b>11276</b>	<b>-8</b>	<b>11769</b>	<b>2</b>	<b>17550</b>	<b>1</b>	<b>2836</b>	<b>4</b>
<b>China*</b>	<b>200361</b>	<b>0</b>	<b>200532</b>	<b>-1</b>	<b>118591</b>	<b>-1</b>	<b>13287</b>	<b>2</b>

Note: \* Production of Taiwan province is not included.

*Maize.* For maize, the Chinese government's recent decision to end procurement of the crop at a guaranteed minimum purchasing prices is resulting in farmers shifting to other, more suitable crops in regions where maize cultivation is marginal due to soil or climatic conditions. The policy, however, has not resulted in much change in terms of national total maize planted area. According to an area estimation based on an integration of 16 meter resolution remote sensing imagery and big data analysis techniques for the 40 thousand field photos collected nationwide (See figure 4.7), this year's maize area was only 0.8% below 2015, with the most significant decreases occurring in Inner Mongolia and Heilongjiang provinces (areas shrinking by respectively 222 and 103 thousand hectares, or 7% and 2% compared to 2015). Maize production for other major provinces (maize production above 1500 ktons) increased as a result of favorable agroclimatic conditions; in particular, production in Liaoning is up 4% over 2015, recovering from last year's severe drought. Other significant changes in production are also observed in Shaanxi (-6%, mainly due to the decreased planted area) and Yunnan (+5%, due to yield

increase). At the national level, maize production is estimated at 200.4 million tons, a marginal decrease compared with 2015.

**Figure 4.7. Location of geo-tagged field photos collected during the summer crops growing season**



*Soybean.* CropWatch revised its estimates for soybean yield, putting it slightly above the previous forecast. With the increased planted area, soybean production is set to 13,287 ktons, up 2% from last year and up 147 ktons compared to the August forecast. The most significant increase occurred in Inner Mongolia (a 23% increase) where the planted area increased 26.5% over 2015. Interestingly, while the average yield in Liaoning recovered by 7% from the drought year in 2015, production still decreased by 18% due to the smaller planted area.

*Rice.* CropWatch now puts the total rice production for China at 200.5 million tons, a 1% decrease from last year, with a marginal change in single rice production and 3% and 2% decreases of early rice and late rice production, respectively. Due to the excessive rainfall in some areas and below average RADPAR, pest and diseases impacts are more severe than during both an average year and 2015. Abundant rainfall coupled with storms and typhoons also lead to localized flooding that damaged rice fields in central and southern China. Fortunately, the unfavorable conditions were not widespread and their impacts remained limited for national single rice production. The 2% decrease in late rice production was mainly due to the decrease in planted area compared with 2015, in line with the trend to convert double cropping to single rice cropping. Significant changes in rice production are also observed for rice in Jilin, Liaoning, and Yunnan (+12%, -9%, and +6%, respectively), with those changes in production resulting mainly from the variation in planted area compared with 2015.

*Wheat.* Because the wheat harvest in China for 2016 was already completed before the start of the current reporting period, CropWatch estimates for wheat remain unchanged at 118.6 million tons.

Overall, CropWatch puts the total 2016 output of summer crops (including maize, single rice, late rice, spring wheat, soybean, minor cereals, and tubers) at 414.3 million tons, a marginal decrease (-0.4%) from 2015. The total annual crop production (including cereals, tubers, and legumes) is 570.3 million tons, a 1.0% drop or 5.9 million tons less compared with 2015. Detailed information of seasonal aggregated production by province is listed in table 4.4.

**Table 4.3. China, 2016 single rice, early rice and late rice production (thousand tons) and percentage change from 2015 by province**

	Early rice		Single rice		Late rice	
	2016	Δ(%)	2016	Δ(%)	2016	Δ(%)
Anhui	1782	-3	13195	-4	1712	-4
Chongqing			4733	-3		
Fujian	1712	-1			1160	1
Guangdong	5224	-2			5775	1
Guangxi	5418	-3			5869	3
Guizhou			5404	4		
Heilongjiang			20923	3		
Henan			3852	-2		
Hubei	2273	-2	10481	-4	2699	-4
Hunan	8243	0	8194	-4	8272	-4
Jiangsu			16610	-2		
Jiangxi	7284	-1	2721	-5	6746	-6
Jilin			5670	12		
Liaoning			4409	-9		
Ningxia			553	2		
Shaanxi			1017	-3		
Sichuan			14937	0		
Yunnan			5642	6		
Zhejiang	791	-4	4625	-3	836	-6
Sub total	32728	-1	122965	-1	33068	-2
<b>Other provinces*</b>	<b>1359</b>	<b>-30</b>	<b>8538</b>	<b>11</b>	<b>1874</b>	<b>0</b>
<b>China*</b>	<b>34087</b>	<b>-3</b>	<b>131503</b>	<b>0</b>	<b>34942</b>	<b>-2</b>

Note: \* production of Taiwan province is not included.

**Table 4.4. Aggregate crop production (thousand tons) per harvest season for major agricultural provinces, China 2016**

	Winter crops		Early rice		Summer crops		Total(#)	
	2016	Δ(%)	2016	Δ(%)	2016	Δ(%)	2016	Δ(%)
Anhui	12044	2	1782	-3	20252	-3	34078	-1
Chongqing	2249	-3			8181	-3	10430	-3
Fujian			1712	-1	4234	1	5946	0
Gansu	3002	-2			5928	0	8930	-1
Guangdong			5224	-2	7531	1	12755	0
Guangxi			5418	-3	10423	3	15841	1
Guizhou					12347	3	12347	3
Hebei	10825	-1			18129	4	28954	2
Heilongjiang					53791	0	53791	0
Henan	25305	-3			26110	0	51415	-2
Hubei	5875	0	2273	-2	18196	-4	26344	-3
Hunan			8243	0	19109	-4	27352	-3
Inner Mongolia					21424	-4	21424	-4
Jiangsu	9971	-1			21012	-2	30983	-2
Jiangxi			7284	-1	9692	-6	16977	-4
Jilin					30700	3	30700	3
Liaoning					20537	1	20537	1
Ningxia					3094	0	3094	0
Shaanxi	4085	-7			6218	-5	10303	-6
Shandong	22252	-4			21226	2	43478	-1
Shanxi	2218	2			9147	-1	11365	-1
Sichuan	5541	-2			26768	0	32309	0
Yunnan					14382	6	14382	6
Zhejiang			791	-4	6363	-3	7155	-3
Sub total	103367	-2.0	32727	-1.4	394794	-0.2	530890	-0.6
<b>Other provinces*</b>	<b>18613</b>	<b>-6.6</b>	<b>1359</b>	<b>-30.0</b>	<b>19455</b>	<b>-3.0</b>	<b>39427</b>	<b>-5.9</b>
<b>China*</b>	<b>121980</b>	<b>-2.7</b>	<b>34086</b>	<b>-3.0</b>	<b>414249</b>	<b>-0.4</b>	<b>570317</b>	<b>-1.0</b>

Note: \* Production of Taiwan province is not included. # Crops are sorted into winter crops (sown before winter the previous year), early rice (sown in late spring and harvested in summer), and summer crops (sown in summer and harvested in autumn). Total annual crop production is the sum of the winter crops, early rice, and summer crops production.

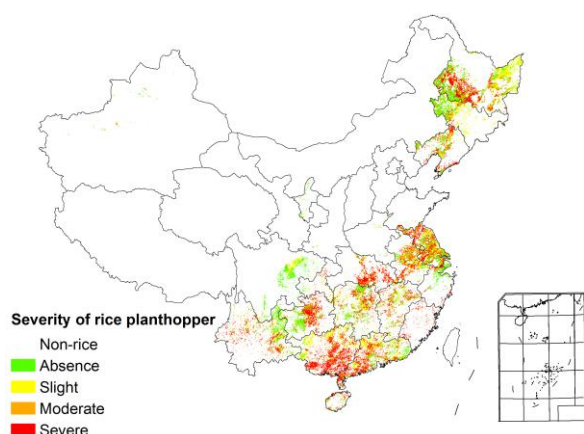
### 4.3 Pests and diseases monitoring

The impact of pests and diseases was relatively severe during mid to late September 2016 in the main rice regions of China. In Huanghuaihai and Northeast China, double cropped late rice was mainly in its booting and heading stages, while in Southwest China and the Lower Yangtze River regions single cropped late rice was in heading and filling stages. Typhoon Meranti brought heavy rainstorms to the rice regions of Huanghuaihai, Southern China, and the Lower Yangtze. As a result, from mid to late September habitat conditions were conducive to the migration of planthoppers and rice leaf rollers, as well as to the dispersal of sheath blight.

#### Rice planthopper

The distribution of rice planthopper in mid to late September is shown in figure 4.8 and table 4.5. The total area affected has reached 14.7 million hectares, with the pest severely occurring in most of Jiangsu, central Anhui, central Hubei, most of Fujian, most of Guangdong, and most of Guangxi. Moderate attacks occurred in central Hunan, central Yunnan, and eastern Guizhou, most of Jiangxi, western Heilongjiang, and central Liaoning.

**Figure 4.8. Distribution of rice planthopper in China (mid to late September 2016)**

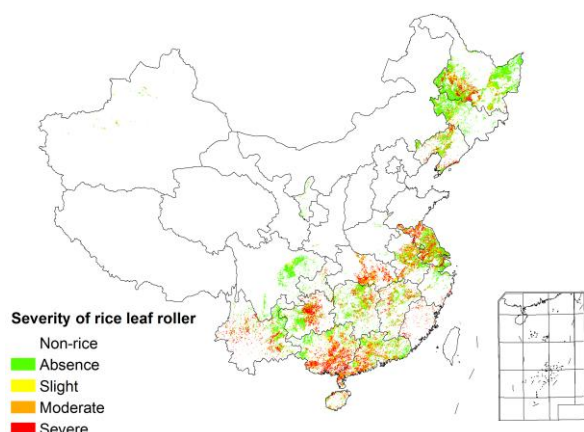


**Table 4.5. Occurrence and affected area for the rice planthopper in China (mid to late September 2016)**

Region	Occurrence ratio in % of the cultivated area				Total area/ thousand hectares
	Absence	Slight	Moderate	Severe	
Huanghuaihai	19	24	26	31	1618
Inner Mongolia	40	23	22	15	291
Loess region	60	10	23	7	143
Lower Yangtze	22	23	21	34	9480
Northeast China	31	24	21	24	4261
Southern China	16	23	19	42	2257
Southwest China	32	16	18	34	4821

#### Rice leaf roller

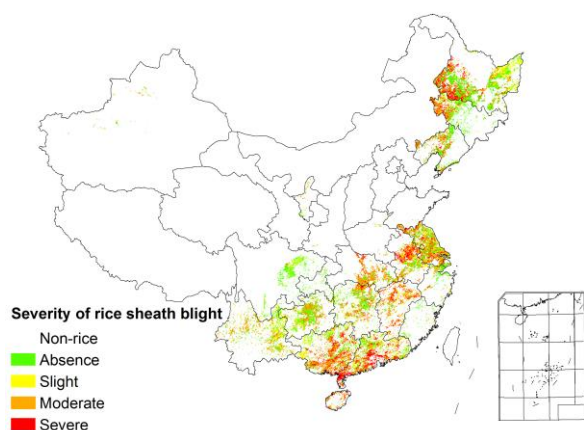
Nationwide, the rice leaf roller (figure 4.9 and table 4.6) damaged around 10 million hectares, most severely in northern Jiangsu, central Anhui, most of Hubei, southern Guangxi, and southern Guangdong. Attacks were moderate in most of Hunan and Yunnan, as well as in central Guizhou and central Heilongjiang.

**Figure 4.9. Distribution of rice leaf roller in China (mid to late September 2016)****Table 4.6. Occurrence and affected area for the rice leaf roller in China (mid to late September 2016)**

Region	Occurrence ratio in % of the cultivated area				Total area/ thousand hectares
	Absence	Slight	Moderate	Severe	
Huanghuaihai	37	16	23	24	1618
Inner Mongolia	65	12	15	8	291
Loess region	68	7	19	6	143
Lower Yangtze	38	16	22	24	9480
Northeast China	61	13	15	11	4261
Southern China	29	18	21	32	2257
Southwest China	40	13	17	30	4821

### Rice sheath blight

For the country as a whole, rice sheath blight (figure 4.10 and table 4.7) damaged around 13.3 million hectares. The pest occurred in most of Jiangsu, central Anhui, central Jiangxi, southern Guangxi, and southern Guangdong where it caused severe damage. Its impact was more limited in southern Heilongjiang, western Jilin, central Hunan, central Hubei, and central Guizhou.

**Figure 4.10. Distribution of rice sheath blight in China (mid to late September 2016)**

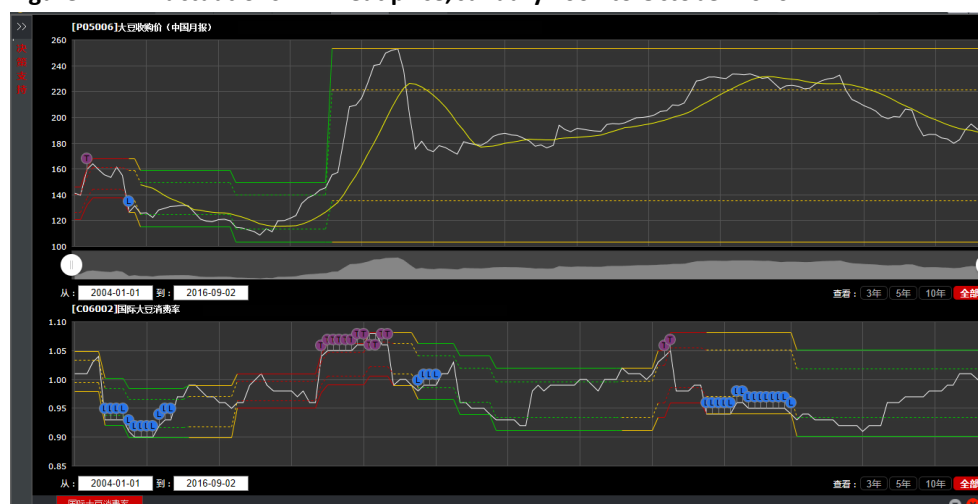
**Table 4.7. Occurrence and affected area for rice sheath blight in China (mid to late September 2016)**

Region	Occurrence ratio in % of the cultivated area				Total area/ thousand hectares
	Absence	Slight	Moderate	Severe	
Huanghuaihai	31	19	22	28	1618
Inner Mongolia	45	10	20	25	291
Loess region	63	10	20	7	143
Lower Yangtze	33	17	21	29	9480
Northeast China	45	15	17	23	4261
Southern China	28	18	20	34	2257
Southwest China	49	18	24	9	4821

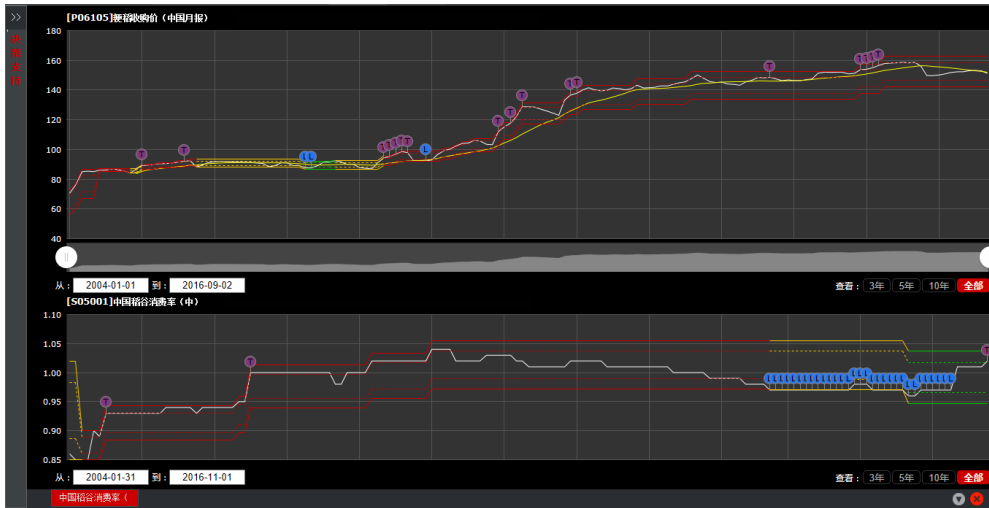
#### 4.4 Outlook for the domestic price of four major crops

The following analysis of domestic prices for soybean, maize, japonica rice, and wheat in China is based on (i) nationwide monthly grain price data between January 2004 and September 2016 provided by the price information center of China's National Development and Reform Commission (NDRC) and (ii) price trend forecasts and early warning obtained by Fang Jingxin's price-spiral model, in addition to other national and international ancillary data sources. The outlook is as follows:

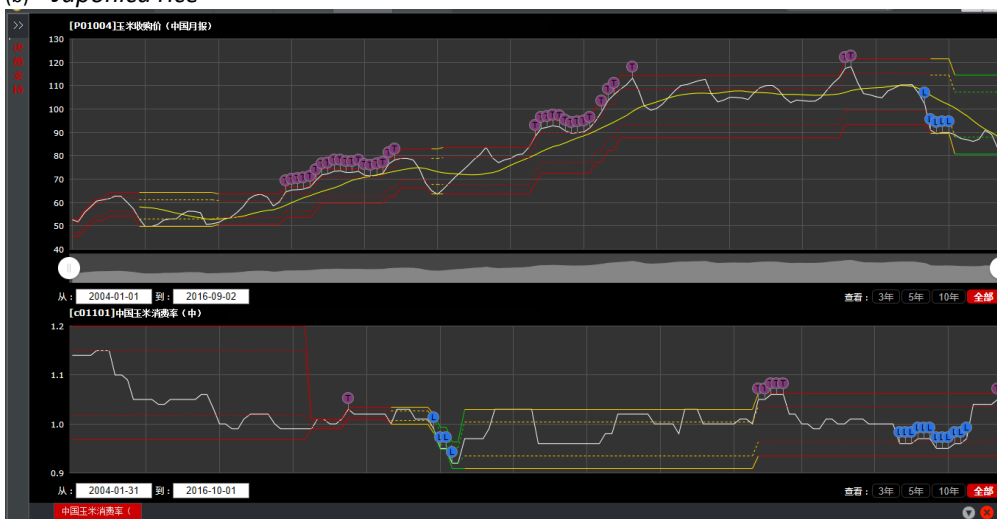
- *Soybean*. At present, both the international soybean consumption rate and the domestic soybean price are in the equilibrium range. As the price of soybean has already been running above the trend line, its fluctuations will be reinforced.
- *Maize*. In terms of consumption, the current maize consumption rate has been entering the top of the consumption tension state. Although its price trend was still falling, it has entered the non-equilibrium range. As some signs suggest maize prices are bottoming out, they are expected to rebound in the near future.
- *Japonica rice*. The current rate for Japonica rice consumption is similar to the one for maize. Its recent downward trend will slow down along with changes in supply and demand.
- *Wheat*. The current wheat consumption rate is in the equilibrium range, while its price is in the non-equilibrium range. The wheat price trend is downward, but is expected to gradually slow down.

**Figure 4.11. Fluctuations in wheat price, January 2004 to October 2016**

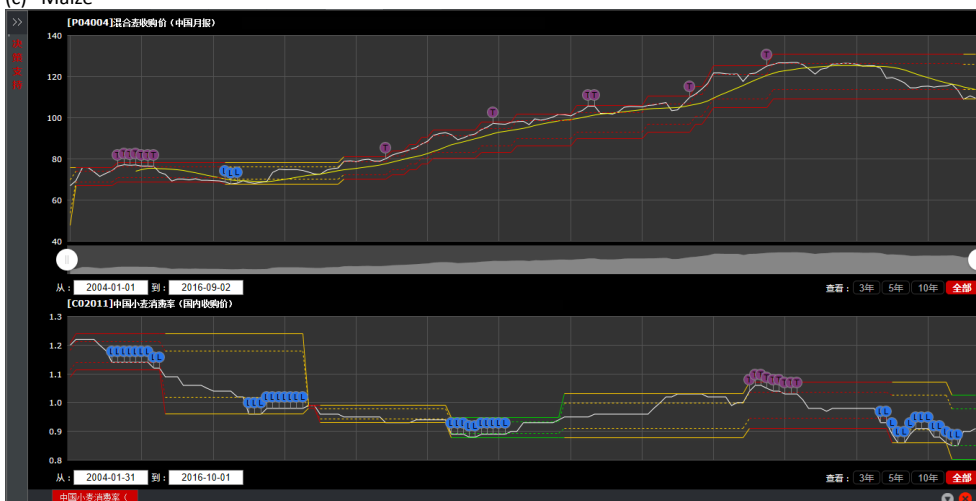
(a) soybean



(b) Japonica rice



(c) Maize



(d) wheat

Note: The graph illustrates the price of wheat for the last 12.5 years since January 1 2004.

## 4.5 Grain and soybean imports and exports of China

### Chinese grain and soybean imports and exports from January to September 2016

#### *Maize*

From January to September 2016, China imported 2.97 million tons of maize, which represented a decrease of 34.3% over the same period in 2015. Ukraine (89.3%), the United States (6.9%), and Russia (2.1%) were the main sources for the imports, the value of which reached US\$ 579million—44.6% below the value for the same period in 2015. Maize exports over this year's first three quarters (1,725.75 tons) decreased by 79.8% and went primarily to the Democratic People's Republic of Korea (82.6%), Russia (17.4%), and the Republic of Korea (1.5%). The exports earned US\$ 617.8 million, down 75.3% from 2015.

#### *Rice*

Over the same January to September period, China imported 2.5643 million tons of rice, an increase of 9.9% compared to the previous year. The imports stemmed from Vietnam, Thailand, and Pakistan, respectively accounting for 49.1%, 24.9%, and 20.3% of the total volume. The expenditure for rice import was US\$1169 million, reflecting a year-on-year growth of 11.3%. Over the period total exports reached 238.600 tons, up 15.5%, mainly to the Republic of Korea, Japan, and Hong Kong (41.7%, 12.6%, and 10.4%, respectively). The value of the exports was US\$211 million, an increase of 15.5% over 2015.

#### *Wheat*

Wheat imports reached 2.87 million tons, an increase of 27.2% over 2015. The main sources include Australia (41.5%), Canada (25.4%), the United States (23.6%), and neighboring Kazakhstan (9.0%). Notwithstanding the increase in volume, the total expenditure of US\$697 million was an increase of just 0.1% compared with 2015. Wheat exports over the same period dropped 10.5% to reach 82,000 tons. Hong Kong (75.4%), Ethiopia (12.9%), and Macao (5.4%) were the main destinations for the exported wheat.

#### *Soybean*

The total import of soybean went up by 2.5% to 61,185,000 tons between January and September of 2016. Brazil, the United States, and Argentina respectively contributed 52.3%, 41.8%, and 6.0%, for a total value of US\$24.46 billion, down 6.6% compared to the period of 2015. Soybean exports of 92,600 tons (-17.5%) earned US\$79.38 million (-24.8%).

### Import prospects for major grains and soybeans

Based on the latest monitoring results, China grain and soybean imports are projected to increase. The projections below (see also figure 4.12) are based on remote sensing data and the Major Agricultural Shocks and Policy Simulation Model, which derives from the standard GTAP (Global Trade Analysis Project).

#### *Maize*

According to the projections, national imports will go down 18.2% and exports will decrease by 30.4% in 2016. The gap between domestic and international prices tends to tighten. Also because of sufficient domestic supply, maize imports continue to decrease and will hardly exceed the 7.2 million tons of prevailing quotas.

### Rice

China's 2016 imports are expected to increase by 21.3% compared to 2015, while exports will go up 8.2% according to the model prediction. With the gradual increase of the difference between international and domestic prices and sufficient domestic supply, imports will increase throughout the year but will be within the limits imposed by prevailing quotas.

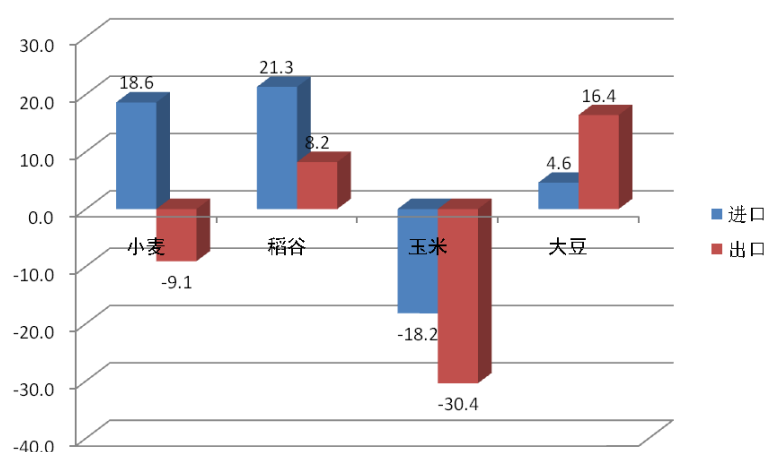
### Wheat

China's wheat imports are expected to increase by 18.6%, but exports are projected to drop 9.1% compared to 2015. As the rate of decline for the international wheat price was larger than for domestic prices from the second half of this year and the price gap of quality wheat between domestic and abroad also narrowed, the rate of increase for wheat imports is expected to slow down and wheat imports will increase slightly.

### Soybeans

Soybean imports will increase by 4.6% while exports will be reduced by 16.4% in 2016, according to the projections. Because the gap between domestic and international prices narrowed and because the share of soybean among crops changed recently in China, the imported volume will be only slightly greater than that for the previous year.

**Figure 4.12. Rate of change of imports and exports for rice, wheat, maize, and soybean in China in 2016 compared to 2015 values (%)**



Source: Authors based on CropWatch remote sensing data and results from the Major Agricultural Shocks and Policy Simulation Model.

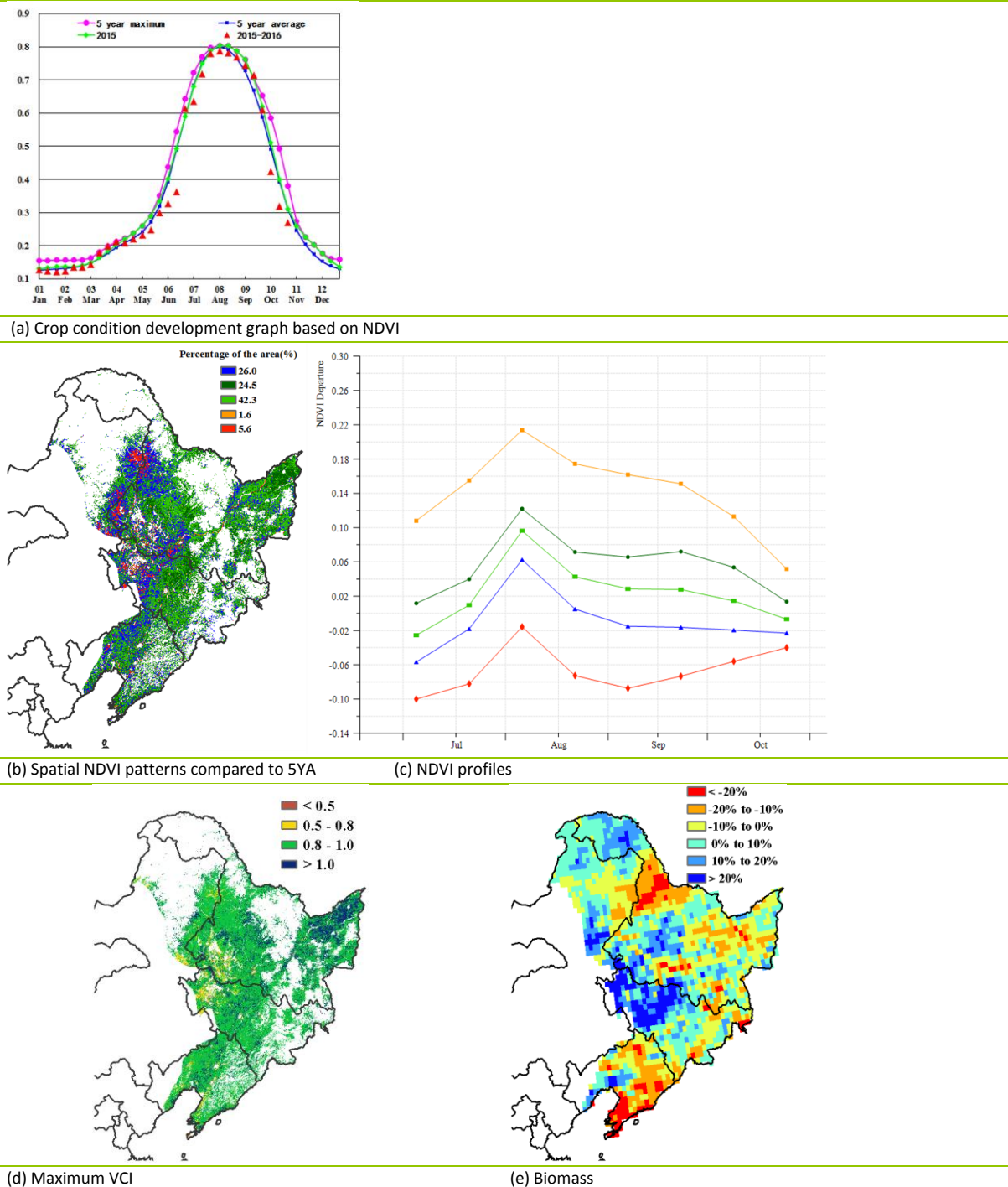
## 4.6 Regional analysis

Figures 4.13 through 4.19 present crop condition information for each of China's seven agricultural regions. The provided information is as follows: (a) Crop condition development graph based on NDVI, comparing the current season up to October 2016 to the previous season, to the five-year average (5YA), and to the five-year maximum; (b) Spatial NDVI patterns from July to October 2016 (compared to the (5YA); (c) NDVI profiles associated with the spatial patterns under (b); (d) maximum VCI (over arable land mask); and (e) biomass for July-October 2016. Additional information about agroclimatic indicators and BIOMSS for China is provided in Annex A, table A.11.

# Northeast region

CropWatch agroclimatic and agronomic indicators describe around average conditions over most of the region during the reporting period. The spring crops (including wheat, maize, rice, and soybean) reached the grain filling to maturity stages from late July to late September and the harvest was concluded in October. As shown in the spatial NDVI patterns, compared to their recent five-year average and the corresponding cluster profiles, most crops (over 50% of the area) were at a slightly above average condition except for a small area in the west near the Greater Hinggan mountains (about 30% of the total area) where condition was below average after August. In Heilongjiang province, VCIx >0.8 confirms the favorable condition of crops. The output expected from the region is better than average.

**Figure 4.13. Crop condition China Northeast region, July-October 2016**

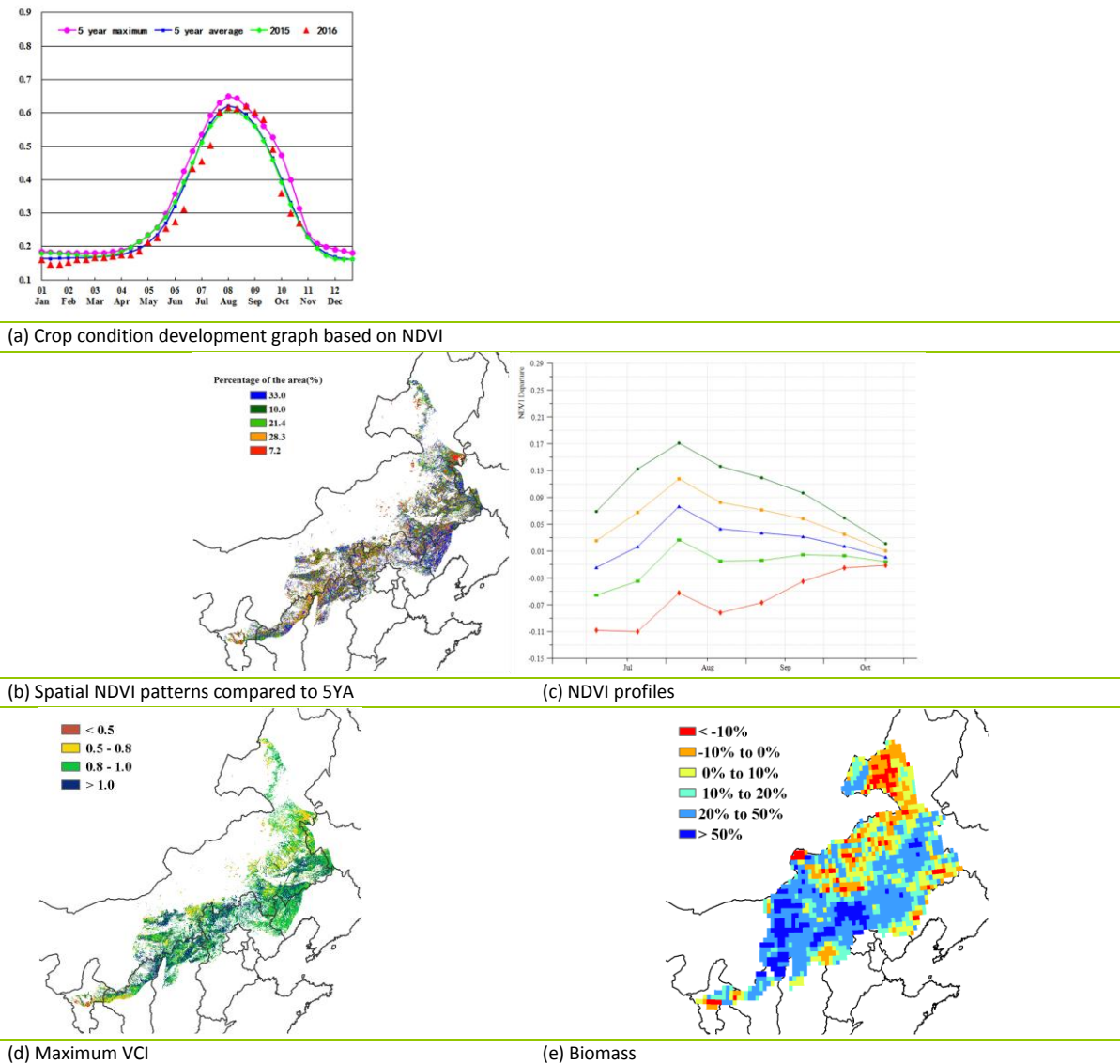


# Inner Mongolia

The condition of maize and soybean, the main summer crops in Inner Mongolia, was generally unfavorable during the reporting period. Rainfall was well above average (RAIN, +57%), but its temporal and spatial distribution was not homogeneous; both the east and the west of the region suffered dry weather from June. Temperature (TEMP) and radiation (RADPAR) were low but close to average (+0.4°C and +3% respectively). Altogether, the region experienced a large potential biomass (BIOMSS) increase of 33% compared to the recent five years.

The crop development graph indicates poor crop condition from June but average NDVI at the peak growing season. East and northeast Inner Mongolia, central Ningxia, and north Shaanxi suffered from drought, which affected crop growth; below average NDVI profiles started in July in about 29% of the region. The potential biomass was poor as well in the area mentioned above. Until mid-August, decreased rainfall affecting crop growth is clearly shown by below-average NDVI, which is confirmed by the spatial NDVI patterns and profiles in about 7% of the region. Thereafter, crop condition improved and reached—and sometimes exceeded—the maximum of the last five years from late August to mid-September. The relief, however, came late and the drought at critical growing periods may eventually influence the crops' condition and yield on a local scale. From late September, below average conditions had little effect as the crops had reached maturity and were ready to harvest, even if excess rainfall locally hampered harvesting. According to the CropWatch indicators, maize production decreased by 7% in Inner Mongolia mainly due to the reduced planted area, and by 6% in Shaanxi compared with the previous season mainly because of both decreased yield and planted area.

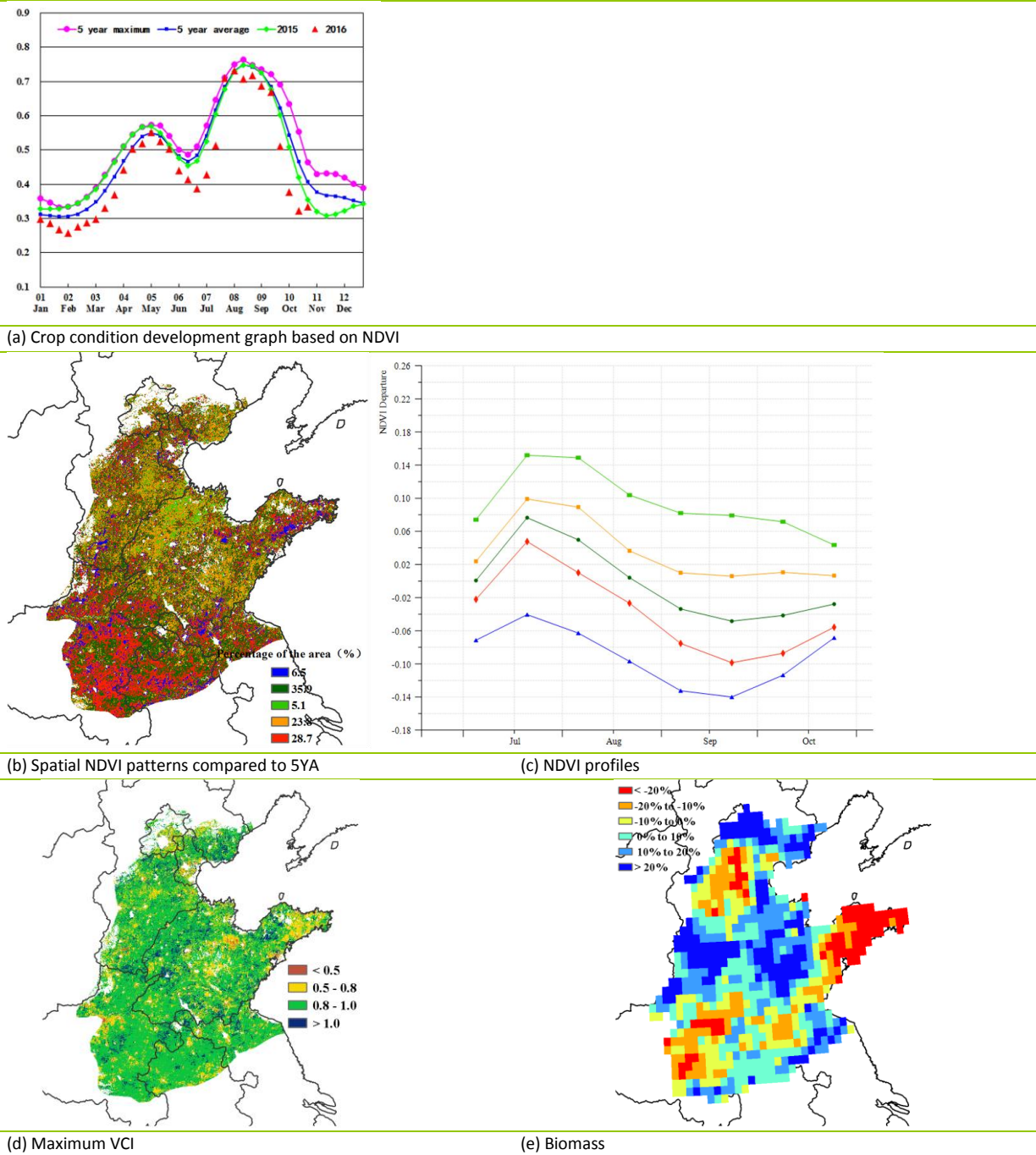
**Figure 4.14. Crop condition China Inner Mongolia, July-October 2016**



# Huanghuaihai

The main crop in Huanghuaihai during the current monitoring period is maize, of which the condition was below the recent five-year average and even worse than the previous year. Unfavorable weather has impacted the sowing and development periods. Poor precipitation (5% below average) somewhat hindered the germination of maize, which is shown by the well below average values in July and August in the NDVI development graph. In addition, RADPAR was 4% lower than average. According to the spatial NDVI patterns, crop condition was below average from the middle of July in almost the whole region. In northern Hebei, Henan, southern Anhui and eastern Shandong, crop condition was consistently below average, being worst during mid-August. Biomass showed a slight increase (1%) but these changes were not homogeneous. The maximum VCI presents low values in some patches, which is consistent with the spatial distribution of NDVI and the biomass production potential.

**Figure 4.15. Crop condition China Huanghuaihai, July-October 2016**

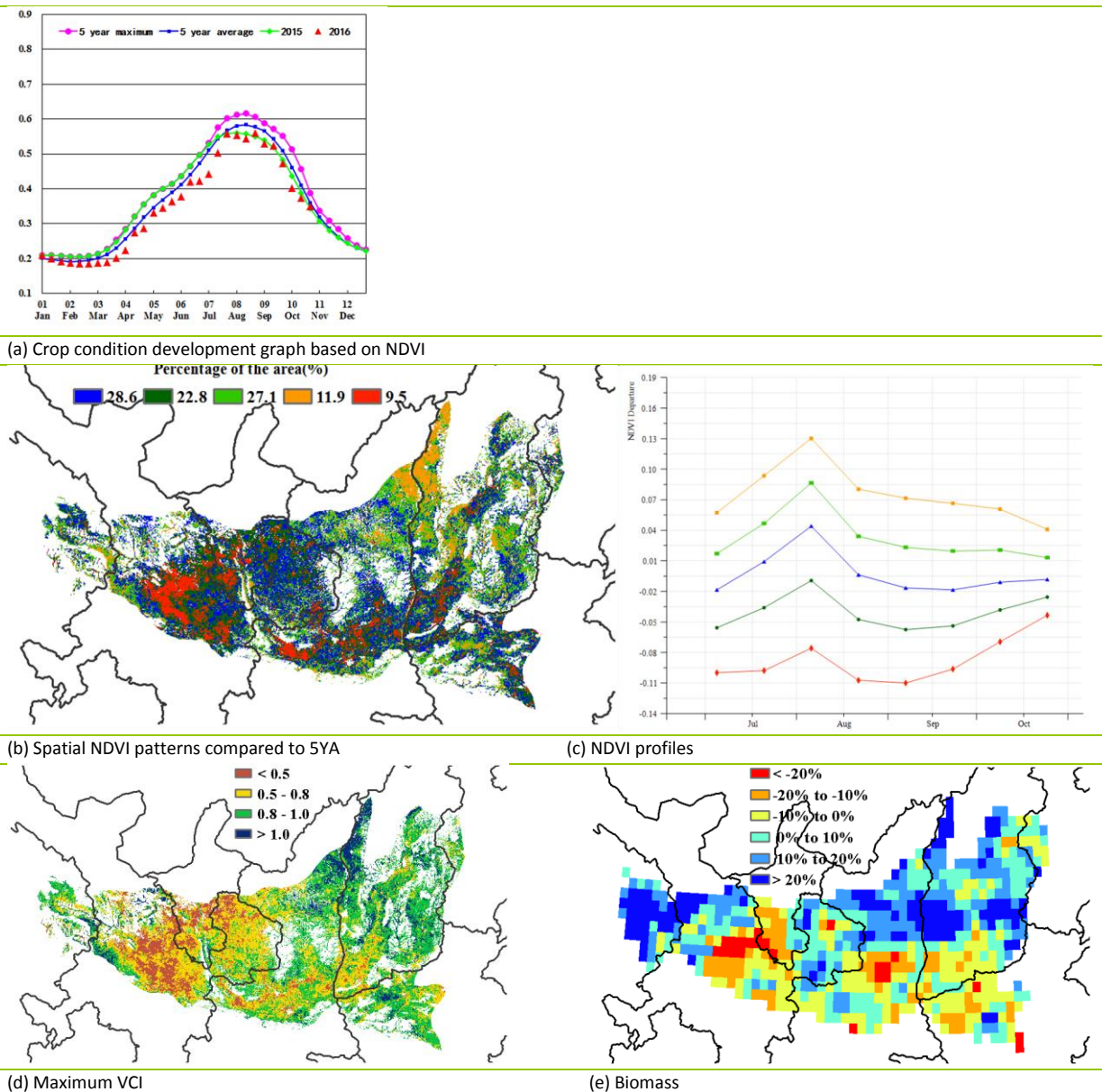


# Loess region

Maize in this area was harvested in late September and early October, and winter wheat has been planted during the monitoring period. From the beginning of July, crop condition was inferior to last year's and below the five-year average. Radiation was below average, while precipitation and temperature were above average (RAIN, +14%), resulting in potential biomass (BIOMSS) to be slightly above average (+7%).

In most of the area, the analyses based on spatial NDVI clusters and profiles are consistent with VCIx. The most favorable conditions occurred mainly in the north of Shanxi and Shaanxi provinces from July to October, due to the abundant rainfall and suitable sunlight. On the contrary—and mostly because of drought during the monitoring period (as confirmed by the maps of potential biomass)—crops were in poor condition (compared to the five-year average) in the provinces of Gansu and Ningxia. Although crop condition in some areas seemed below average in late September, this may be as a result of early harvest rather than a poor crop. The area of cultivated land (CALF) decreased by 5 percentage points compared with recent years.

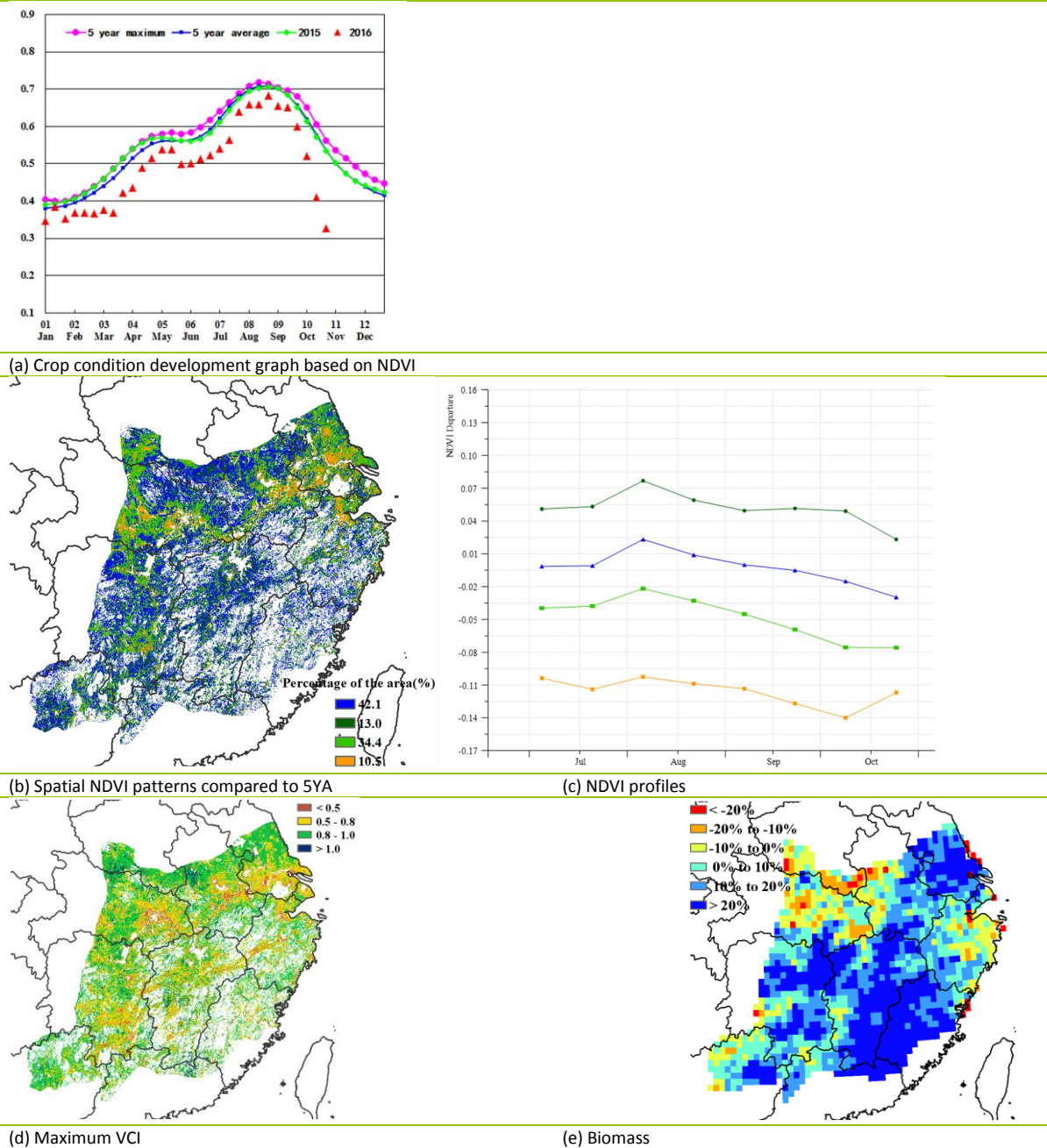
**Figure 4.16. Crop condition China Loess region, July-October 2016**



# Lower Yangtze region

In the Lower Yangtze region, the monitoring period from July to October mainly covers the harvest of semi-late rice and the maturity of late rice. In general, crop condition was below the recent five-year average according to the crop condition development graph. The CropWatch agroclimatic and agronomic indicators show that rainfall (RAIN) was significantly above average (33%), while temperature (TEMP) was close to average (-0.1°C). The region also suffered a very significant drop in PAR (RADPAR -8%) but the BIOMSS production potential was above the recent five-year average (+16%). Profiles of NDVI departure clusters show that crop condition was well below average in 11.1% of the agricultural areas, including the south of Jiangsu, middle of Anhui and Hubei, and the north of Zhejiang province. The BIOMSS map further indicates that the biomass was lower or close to average in the northeast of Zhejiang, west of Anhui, south of Henan, and east of Hubei provinces. CropWatch estimates that production in the Lower Yangtze region is to be below but close to average.

**Figure 4.17. Crop condition Lower Yangtze region, July-October 2016**

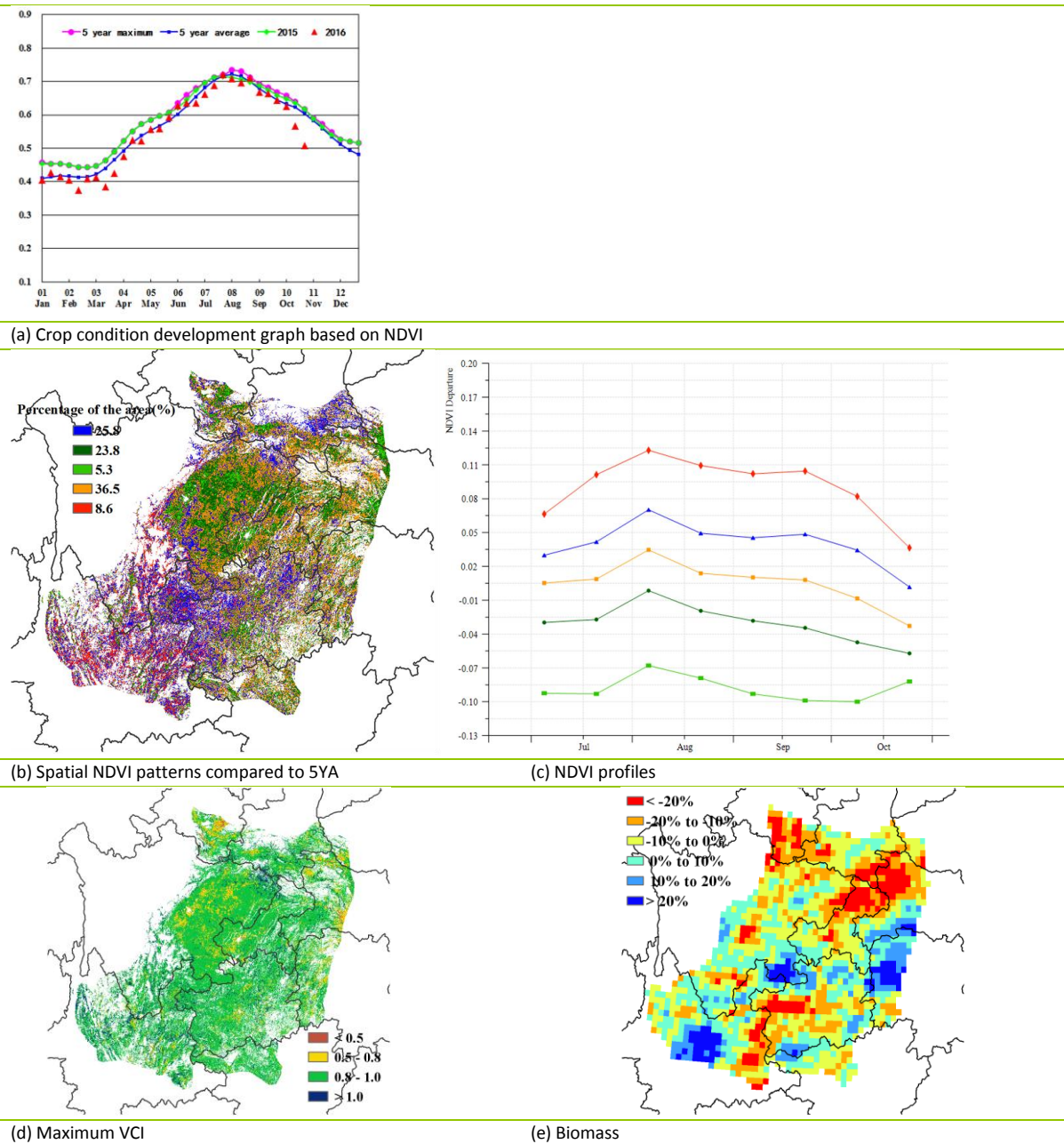


# Southwest China

The condition of crops was partly below average in Southwest China between July and October. The period coincides with the region's harvest season for maize and single cropped rice and the planting of winter wheat. NDVI profiles kept close to their average five-year level from July to the end of September, but then fell rapidly below average in October. The NDVI in eastern Sichuan, most of Chongqing and southern Gansu was a little below the five-year average level. The maximum VCI in southern Gansu was in the range of 0.5-0.8 or below. The following areas should be paid attention to: eastern Sichuan, northern Chongqing, southern Gansu, western Hubei, and western Guizhou. CropWatch found below average precipitation in Chongqing (RAIN, -12%) and Guizhou (-9%), which will have a negative impact on crop condition.

Although the fraction of cropped arable land (CALF) remained average during the monitoring period, the cropping intensity in Southwestern China decreased by 9%, which is expected to negatively influence production.

**Figure 4.18. Crop condition Southwest China region, July-October 2016**

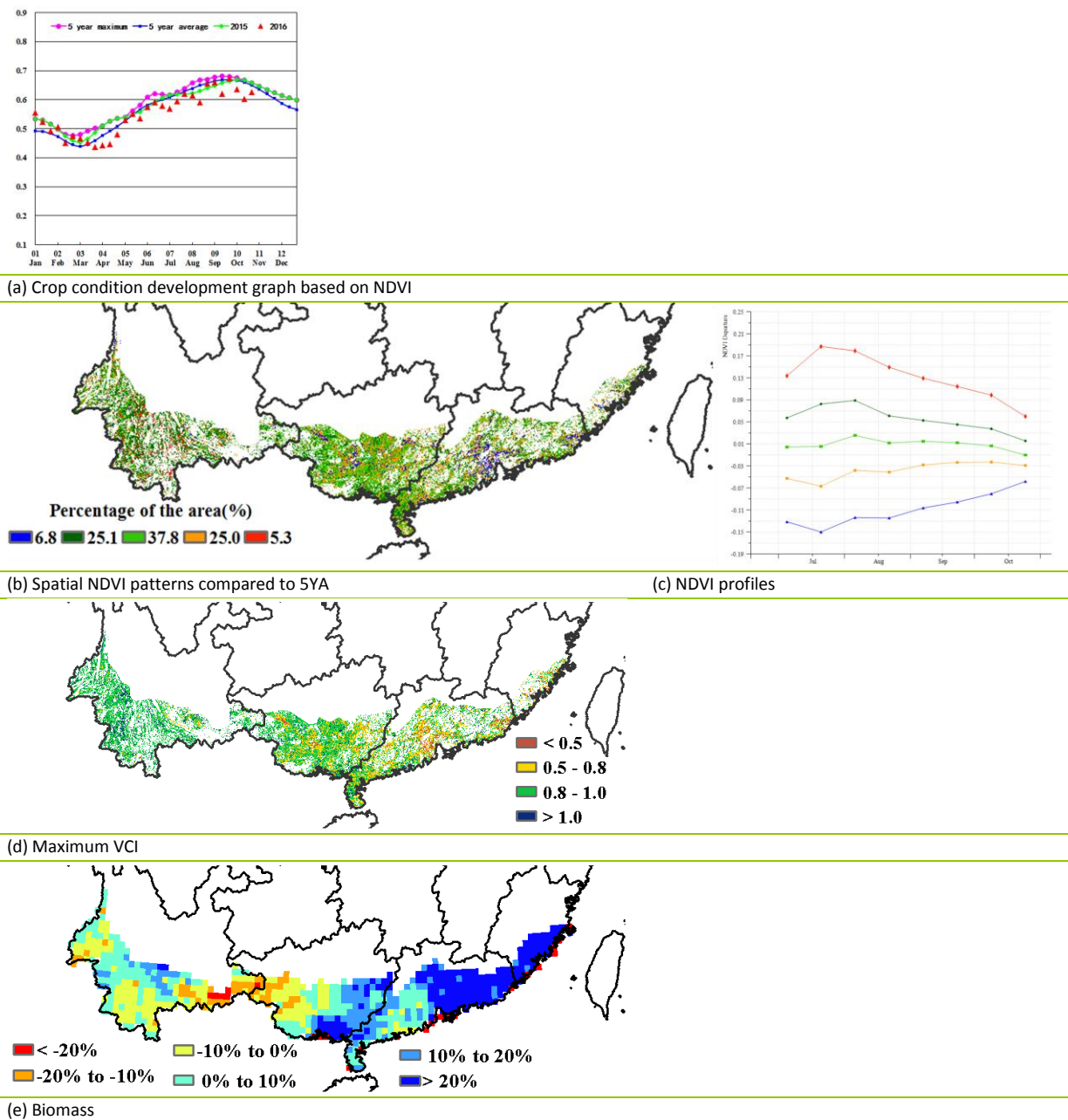


# Southern China

Below average crop condition prevailed in parts of southern China during the reporting period, which covers the end of the early rice harvest and the planting and harvest of late rice. Crop condition was below average from July to the beginning of August, recovered to average in August, but dropped to below average again in September and October. In the center and south of Guangdong and in central Guangxi, NDVI was below the average five-year level with a maximum VCI in the range of 0.5-0.8 or less, while in most of southern Yunnan, NDVI kept close to average and VCIx varied from 0.8 to 1.0. Both CALF and the cropping intensity were almost unchanged compared with the reference value (CALF, -1%; cropping intensity, -1%).

The double-cropped and late rice in central and southern Guangdong and in central Guangxi should be paid attention to because of the unfavorable NDVI profile, possibly due to the excessive rainfall (Guangdong RAIN, +18%; Guangxi, +18%) brought by a series of cyclones and storms during the monitoring period.

**Figure 4.19. Crop condition Southern China region, July-October 2016**



## Chapter 5. Focus and perspectives

*Building on the CropWatch analyses presented in chapters 1 through 4, this chapter includes an updated production outlook for 2016 (section 5.1). Subsequent sections include a focus on agriculture in the Middle East (5.2) and an update on El Niño (5.3).*

### 5.1 CropWatch food production estimates

#### Methodological introduction

Table 5.1 presents the latest revision of the periodic estimate by the CropWatch team of global maize, rice, wheat, and soybean production. For the current reporting period, virtually all 2016 crops have been harvested in the temperate northern hemisphere, while in many tropical areas in both hemispheres rice and maize crops are growing (to be harvested in early 2017) or are close to harvest. In the southern hemisphere the summer season/monsoon season is ongoing.

Importantly, the presented estimates are based on a combination of remote-sensing models (for the major commodities at the national level) and statistical trend-based projections (for minor producers<sup>3</sup> with an output between 100 thousand and one million tons at the national scale). Between 87% (wheat) and 92% (soybean) of the production is modelled, with modelled outputs indicated in red in the table. In addition, for the 31 countries (the “major producers,” which are also the focus of chapters 3 and 4), the quantitative estimates in this chapter are calibrated against national agricultural statistics (as opposed to FAOSTAT). This means that (i) for the largest countries sub-national statistics are used and that (ii) 2015 information is included in the calibration. Calibration is also crop-specific; it is based on different crop masks, and for each crop, both yield variation and cultivated area variation are taken into account when deriving the production estimates. CropWatch production estimates differ from other global estimates by the use of geophysical data in addition to statistical and other reference information, such as detailed crop distribution maps.

#### Production estimates by countries

As shown in table 5.1, CropWatch puts the total output of crops produced in 2016 at 2,460.531 million ton of major grains and 315.663 million tons of soybeans. The major grains are made up almost exactly by 40% maize (994,940 thousand ton, 1.2% above last year's output), 30% rice (as paddy, 736,025 thousand tons, down -0.8% from the previous year) and 30% wheat (729,566 thousand ton, up 1.2 % over 2015).

*Minor producers.* As often happens, the bulk of minor producers—where food is grown more for local consumption by people and animals than for industrial uses and export—generally perform better than the major producers, among others because most of them have not reached the environmental and economic constraints that prevent the expansion of land and the increase of yields. For instance, maize production for these producers is up 2.8%, rice increases 1.4%, wheat by 1.6%, and soybeans by 7.0%, illustrating the overall popularity of soybean that is second only to the appeal for maize.

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<sup>3</sup> The major producers represent at least 80% of production and 80% of exports. Minor producers include the 151 countries from Afghanistan and Angola to Zambia and Zimbabwe.

*Major cereal producers.* Among the three major cereal producers, the output of China reached 519,484 thousand tons, the United States 435,267 thousand tons, and India, significantly less, 261,531 million tons. Although India remains a relatively minor producer of maize (18,649 thousand tons), it still out-produces the 4<sup>th</sup> and 5<sup>th</sup> cereal producers in terms of total cereal output (Brazil: 89,033 thousand tons; and Indonesia: 87,620 thousand tons).

Neither China nor India performed well in 2016 due to the poor environmental conditions, especially in India. While maize stagnates in China, both rice and wheat production drop 1% compared to last year, and for the first time in more than a decade the production of soybean in China is up, resulting from agricultural policy changes. In India, only rice is up by 1%, soybean is on par with 2015, maize is down 1%, and wheat as much as 6%, one of the largest decreases of all the countries monitored by CropWatch. In the United States, on the other hand, while wheat remains stable, the output of all other major commodities increases significantly, with soybean up 3% and both maize and rice growing at least 5%.

*Maize.* Four countries have to be singled out for their poor performance of maize production compared with 2015, namely South Africa (down 32% due to the devastating El Niño triggered drought), Brazil (-12%), Pakistan (-7%), and Egypt (-4%). With the exception of South-Africa (+1%), the same countries also suffered a setback of their rice production (-7%, -3% and -4%, respectively). Among the countries for which specific CropWatch estimates are available<sup>4</sup>, the best performance of maize occurred in Kazakhstan (+5%), Romania (+7%), Uzbekistan (+7%), Iran (+8%), Ukraine (+9%), and Ethiopia (+10%), with those increases usually directly ascribable to more favorable than average weather or—in the case of Ethiopia—more favorable than the very bad 2015 season.

*Rice.* The early 2016 rice crops did poorly in a number of Asian countries because of the prevailing El Niño drought in Southeast Asia that was reported on in detail in the February and May 2016 CropWatch bulletins. The list includes Cambodia (rice production down 10%), Myanmar (-8%), Bangladesh and Vietnam (both -6%), Pakistan (-3%), and the already mentioned China (-1%) where the size of the country and the diversity of agro-ecological conditions provides some protection against extreme weather. Albeit for different reasons, European rice producers (Ukraine, Romania) also underperformed (both at -4%). For the same reasons as those mentioned for maize, Ethiopian rice grew 5%, and so did rice production of the United States (+6%), Iran (+9%), and Uzbekistan (+10%), which is part of a group of countries in Central Asia that benefited from unusually favorable rain for the second consecutive year.

*Wheat.* To some extent the global situation for wheat is always different from that affecting other crops because it is usually grown as a winter crop and because of the very large number of countries where the crop is produced. The most spectacular decrease in wheat production occurred in Turkey (-17%), followed by some major producers and exporters such as India (-6%), Argentina (-4%), and France and the United Kingdom (both at -3%). Large increases are those of Australia (+25%), Kazakhstan (+14%), and Iran (+15%), a country that did well for most crops after a long run of mediocre cropping seasons.

*Soybean.* In a sharp contrast with the large number of producers and major exporters of wheat, the situation for soybean is pretty much the opposite in that it is a summer crop and the bulk of production occurs in just a handful of countries. Egypt, Iran, Canada, and one of the largest producers (Argentina) all underwent a drop of 1%, while Brazil increased production by 2% and both Russia and the United States by 3%.

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<sup>4</sup> As opposed to FAOSTAT based projections.

**Table 5.1. Summary of 2016 production estimates by major country and variation (% , compared with 2015) of maize, rice, wheat, and soybean**

	Maize		Rice		Wheat		Soybean	
	2016	Δ%	2016	Δ%	2016	Δ%	2016	Δ%
Argentina	<b>25710</b>	<b>1</b>	<b>1695</b>	<b>0</b>	<b>11630</b>	<b>-4</b>	<b>51080</b>	<b>-1</b>
Australia	470	3	1507	14	<b>31600</b>	<b>25</b>	99	7
Bangladesh	<b>2375</b>	<b>6</b>	<b>47722</b>	<b>-6</b>	<b>1317</b>	<b>0</b>		
Brazil	<b>70433</b>	<b>-12</b>	<b>11055</b>	<b>-7</b>	<b>7545</b>	<b>8</b>	<b>91774</b>	<b>2</b>
Cambodia	779	-0	<b>8588</b>	<b>-10</b>			166	4
Canada	<b>11701</b>	<b>-1</b>			<b>33290</b>	<b>9</b>	<b>5386</b>	<b>-1</b>
China	<b>200361</b>	<b>0</b>	<b>200532</b>	<b>-1</b>	<b>118591</b>	<b>-1</b>	<b>13287</b>	<b>2</b>
Egypt	<b>5701</b>	<b>-4</b>	<b>6293</b>	<b>-4</b>	<b>10207</b>	<b>3</b>	28	-1
Ethiopia	<b>7157</b>	<b>10</b>	134	5	<b>4743</b>	<b>12</b>	100	14
France	<b>14703</b>	<b>-1</b>	78	-8	<b>37984</b>	<b>-3</b>	208	9
Germany	<b>4602</b>	<b>0</b>			<b>28106</b>	<b>3</b>		
India	<b>18649</b>	<b>-1</b>	<b>156783</b>	<b>1</b>	<b>86099</b>	<b>-6</b>	<b>12176</b>	<b>0</b>
Indonesia	<b>18316</b>	<b>2</b>	<b>69304</b>	<b>3</b>			884	0
Iran	<b>2692</b>	<b>8</b>	<b>2763</b>	<b>9</b>	<b>16073</b>	<b>15</b>	174	-1
Kazakhstan	689	5	411	4	<b>18199</b>	<b>14</b>	271	10
Mexico	<b>23780</b>	<b>0</b>	177	-4	<b>3550</b>	<b>-2</b>	399	10
Myanmar	<b>1746</b>	<b>2</b>	<b>25541</b>	<b>-8</b>	187	1	127	-11
Nigeria	<b>10770</b>	<b>4</b>	<b>4588</b>	<b>1</b>	115	3	662	4
Pakistan	<b>4528</b>	<b>-7</b>	<b>9142</b>	<b>-3</b>	<b>24638</b>	<b>-1</b>		
Philippines	<b>7565</b>	<b>0</b>	<b>20106</b>	<b>3</b>				
Poland	<b>3681</b>	<b>0</b>			<b>10704</b>	<b>3</b>		
Romania	<b>11491</b>	<b>7</b>	47	-4	<b>7675</b>	<b>7</b>	208	8
Russia	<b>12337</b>	<b>3</b>	<b>1017</b>	<b>0</b>	<b>57506</b>	<b>6</b>	<b>2099</b>	<b>3</b>
South Africa	<b>9018</b>	<b>-32</b>	3	1	<b>1704</b>	<b>0</b>	1105	9
Thailand	<b>5080</b>	<b>1</b>	<b>39661</b>	<b>1</b>	1	4	231	3
Turkey	<b>5920</b>	<b>0</b>	937	2	<b>18981</b>	<b>-17</b>	218	12
Ukraine	<b>30774</b>	<b>9</b>	107	-4	<b>24059</b>	<b>3</b>	<b>3799</b>	<b>2</b>
United Kingdom					<b>14337</b>	<b>-3</b>		
United States	<b>367862</b>	<b>5</b>	<b>10528</b>	<b>6</b>	<b>56877</b>	<b>0</b>	<b>110024</b>	<b>3</b>
Uzbekistan	425	7	437	10	<b>6391</b>	<b>-5</b>		
Vietnam	<b>5234</b>	<b>1</b>	<b>42550</b>	<b>-6</b>				
Major producers	884549	1.0	661706	-1.0	632109	1.1	294505	1.8
Minor producers	110391	2.8	74319	1.4	97457	1.6	21158	7.0
All countries	994940	1.2	736025	-0.8	729566	1.2	315663	2.1

Notes: "All countries" combines major and minor producers. Major producers are all the countries listed in the table; minor producers are the remaining countries. Boldfaced numbers in red are model-based estimates by CropWatch calibrated against data up to 2015; normal faced numbers are simple statistical projections based on FAOSTAT data up to 2014.

### Production by importers and exporters

The variation in the global demand for maize, rice, wheat, and soybean can be assessed through variations in the domestic production of major importers<sup>5</sup> (table 5.2). The major importers have generally increased their domestic output, with the notable exceptions of rice (for the top three rice importers resulting from a 1% production drop in China) and wheat (for the top 10 importers with Turkey estimated to have lost 17% of production compared with 2015). Exporters did generally well with a marked increase in wheat availability among the major exporters (+8.0%), resulting from the excellent performance of Canada and Australia. The reduced rice availability for the top 10 exporters (-0.6%) results from the poor

<sup>5</sup> This discussion does not include countries where the 2016 production was estimated based on trend, which are the "minor producers."

performance of several countries, including Pakistan (-3%), Vietnam (-6%), Brazil (-7%), Cambodia (-10%), and Italy (-1%). On the contrary, the production of rice has increased in Australia (+14%) and the United States (+6%).

**Table 5.2. Change ( $\Delta\%$ ) in 2016 production compared with 2015 among the major exporting and importing countries**

			Maize	Rice	Wheat	Soybeans
<b>Exporters</b>	Top 3	Share %	59	61	42	90
		$\Delta\%$	1.8	1.2	8.0	1.8
	Top 10	Share %	89	87	82	100
		$\Delta\%$	2.2	-0.7	5	2
<b>Importers</b>	Top 3	Share %	49	50	43	85
		$\Delta\%$	0	-0.6	3.7	2.8
	Top10	Share %	100	100	100	100
		$\Delta\%$	2	0.1	-1.3	2.7

Notes: Share % is the fraction of exports and imports that is contributed by the top 3 and the top 10 countries. The identification of major exporters and importers was obtained from the following sources: Wheat, maize and rice export data source (2015 data), <http://www.worldstopexports.com/wheat-exports-country/>; Soybean exports combine meal and seeds, <http://legroupindustries.com/top-10-exporters-of-soybeans-and-soybean-meals-by-country/> (2013 data); maize imports (2016 estimates), <http://www.indexmundi.com/agriculture/?commodity=corn&graph=imports>; rice importer (2015), <http://www.worldatlas.com/articles/the-largest-rice-importers-in-the-world.html>; wheat imports, <http://www.indexmundi.com/agriculture/?commodity=wheat&graph=imports>; and soybean imports, (2011) [www.earth-policy.org/datacenter/xls/book\\_fpep\\_ch9\\_3.xlsx](http://www.earth-policy.org/datacenter/xls/book_fpep_ch9_3.xlsx).

The most noteworthy variations among maize exporters include mainly the large drop of production in Brazil (-12%, see table 5.1). On the positive side, the United States (+5%), Ukraine (+9%), and Russia (+3%) deserve mention, as well as the fact that Ukraine exports about three times more maize than Russia. Among wheat exporters, China's neighbor and wheat supplier Kazakhstan (+14%) did as well as the already mentioned Canada (+9%) and Australia (+25%), while France (-3%) and Argentina (-4%), respectively 4<sup>th</sup> and 9<sup>th</sup> exporters, did poorly. Among soybean exporters, only Argentina (3<sup>rd</sup> exporter) needs to be mentioned with a 1% production drop due to water logging resulting from excess precipitation.

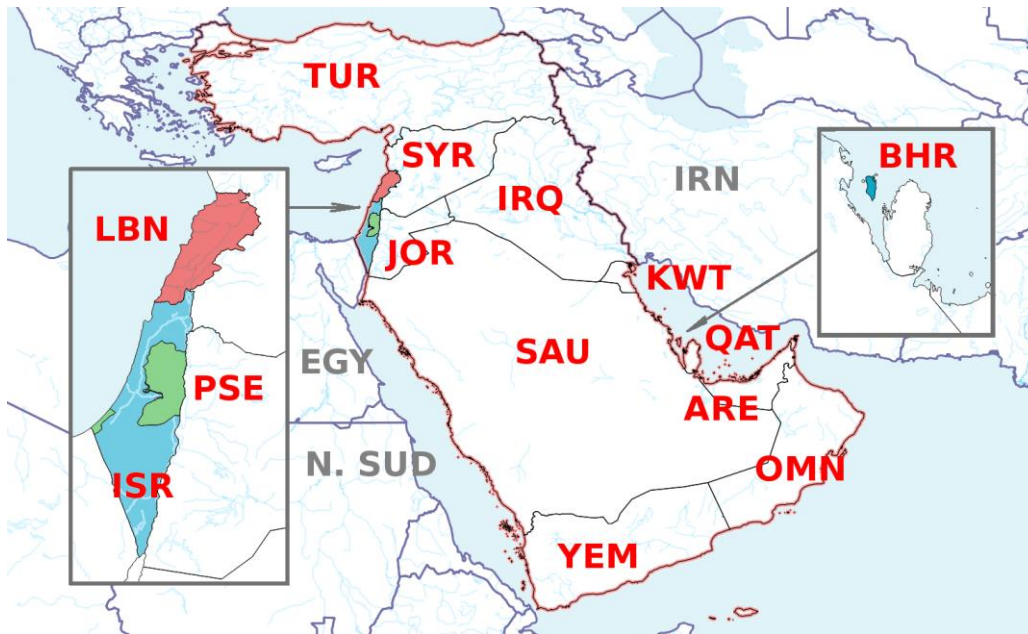
Importer countries that are likely to buy more include Egypt (with a 4% production drop in maize) as well as Japan where the long-term drop in soybean production continued in 2015 (-2%). Reduced imports due to favorable domestic production include Iran for maize (+8%) and rice (+9%), rice in the Philippines (+3%) and in Iraq (+9%), and wheat in Brazil (+8%) and especially Egypt—globally the major wheat importer in the world (+3%).

## 5.2 Focus: Middle East

### Overview

The countries covered in this focus section on the "Middle East" are part of the Arabian Peninsula and western Asia (figure 5.1). They include Turkey (TUR), Israel (ISR), and twelve Arabic countries from Bahrain (BHR) to Iraq (IRQ), Jordan (JOR), Kuwait (KWT), Lebanon (LBN), Oman (OMN), the State of Palestine (PSE,<sup>6</sup> also referred to as *West Bank and Gaza* by the World Bank and *Occupied Palestinian Territory* by FAO), Qatar (QAT), Saudi Arabia (SAU), Syria (SYR), the United Arab Emirates (ARE), and Yemen (YEM). As shown in table 5.3, their areas cover about four orders of magnitude from 770 km<sup>2</sup> in Bahrain to 2.1 million km<sup>2</sup> for Saudi Arabia.

<sup>6</sup> The State of Palestine has Permanent Observer status at the UN; it was recognized by about 70% of countries worldwide, including China but excluding essentially Western Europe and North America.

**Figure 5.1. Middle Eastern countries**

Note: ARE: United Arab Emirates; BHR: Bahrain; EGY: Egypt; IRQ: Iraq; ISR: Israel; JOR: Jordan; KWT: Kuwait; LBN: Lebanon; N. SUD: North Sudan; OMN: Oman; PSE: the State of Palestine; QAT: Qatar; SAU: Saudi Arabia; SYR: Syria; TUR: Turkey; YEM: Yemen.  
Source: Authors.

Half the countries in the region are oil producers, including major ones such as Saudi Arabia, Iraq, the United Arab Emirates, and Kuwait. The share of oil as a percentage of GDP reaches values between 15% and 20% for Bahrain, the Emirates, and Qatar; between 30% and 40% for Oman, Saudi Arabia, and Iraq; and as high as 53% for Kuwait (World Bank 2011). All countries are actively diversifying out of oil but face severe constraints in terms of environment and food security, not to mention crippling political unrest and wars that have been affecting much of the region for decades.

The total population in the region reaches 229 million, with people mostly distributed in Turkey (76 million), Iraq (34 million), Saudi Arabia (30 million), Yemen (26 million), and Syria (19 million). The least populated country is Bahrain with just 1.4 million inhabitants. Interestingly, the most populated countries are also the ones with the smallest urban populations in relative terms. Many countries have population growth rates that are well above the world average (currently close to 1% annually according to Census 2016), for instance in Jordan (3.06%), Qatar (4.72%), Kuwait (4.81%), Lebanon (5.99%), and Oman (8.45%). The lowest values for population growth rate in the region occur in Israel (1.66%), Turkey (1.69%), and Bahrain (1.76%), as well as in Syria (-2.27%) due to the war that has been ongoing for six years and the ensuing massive emigration. According to UNHCR (2016), the region has many internally displaced persons, mostly in Iraq and Syria, as well as close to 5 million refugees distributed between Egypt, Jordan, Turkey, and Lebanon. In addition, as a result of favorable economic conditions, many countries in the region have also been the target of emigration, with immigrants mainly from Asian countries such as Bangladesh and Indonesia. As a result of refugee and economic migrant movements, some Middle Eastern countries have large populations of non-nationals, with population shares as high as 31% (Saudi Arabia), 40% (Jordan), or even 70% (Kuwait), 74% (Qatar), and 84% (United Arab Emirates) (table 5.3).

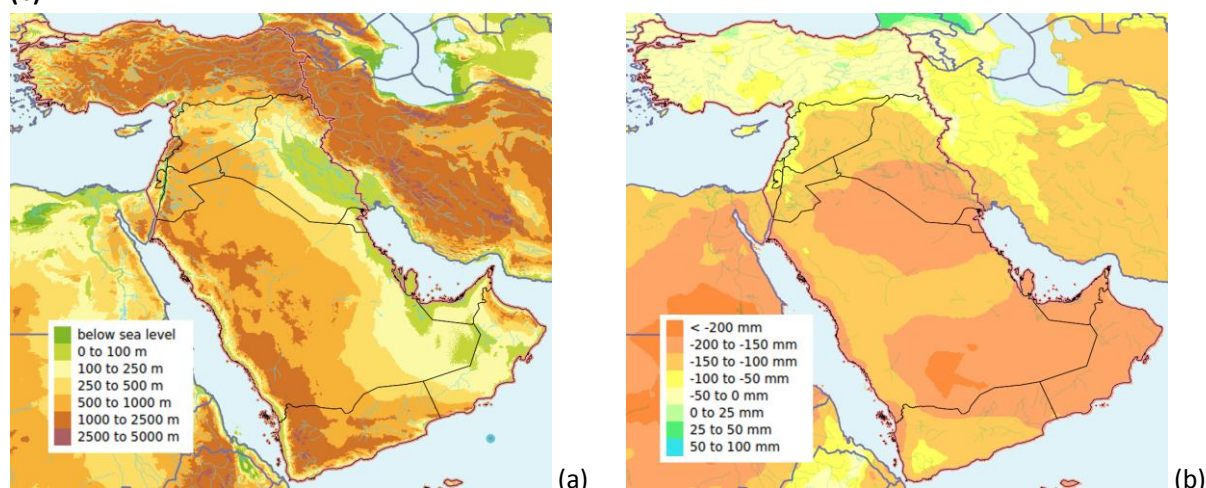
Even without considering difficult environmental conditions, the declining food production in the region, and persistently low crude oil prices, indices of poverty, political stability, and food security are particularly unfavorable in some countries in the region. For instance, Global Food Security Indices (GFSI) remain below 60 in Yemen (GFSI is 34), Syria (GFSI is 36), and Jordan (GFSI is 57) (table 5.3). Yemen in fact is the 11<sup>th</sup> most insecure food country in the world. Human Development Indices do not exceed 0.70 in

Yemen (0.50), Syria (0.59), and Iraq (0.65), countries where the Political Stability Indices of the World Bank are also very negative (Syria, -2.76; Yemen, -2.53; Iraq, -2.47; and Lebanon, -1.72).

### Environmental conditions and agriculture

In spite of generally high elevations (figure 5.2a), the Middle East is one of the driest places on earth (figure 5.2b), with large deficits of rainfall when compared with the evaporative power of the atmosphere (as expressed by Potential Evapotranspiration, PET). Only very limited areas of Turkey and Lebanon have an annual excess of rainfall over PET. As a result, permanent rivers are rare and include mostly the Tigris and Euphrates rivers and the Jordan. The first two originate in eastern Turkey and flow mostly through central and eastern Iraq. The discharge is directly related to winter precipitation in the Mediterranean area, resulting in winter flow usually being 10 times larger than summer flow (UNU, 1995). The basin of the Jordan River touches Syria, Israel, and Palestine, as well as Lebanon and Jordan which derive about 70% of their freshwater resources from perennial rivers (ECOMENA, 2016). The flow peaks in winter and often dries completely in summer as a result of the natural variability combined with extensive use for irrigation (up to 90% of the flow). One of the consequences of this is the drying of the Dead Sea, which has been likened to the Aral Sea disaster. Oman, Saudi Arabia, Syria, the United Arab Emirates, and Yemen are dependent on surface water and seasonal rivers. Finally, the region is also rich in oases mostly fed by fossil and slowly renewable water in desert areas.

**Figure 5.2. Elevation (a) and difference between average monthly rainfall and potential evapotranspiration (b)**

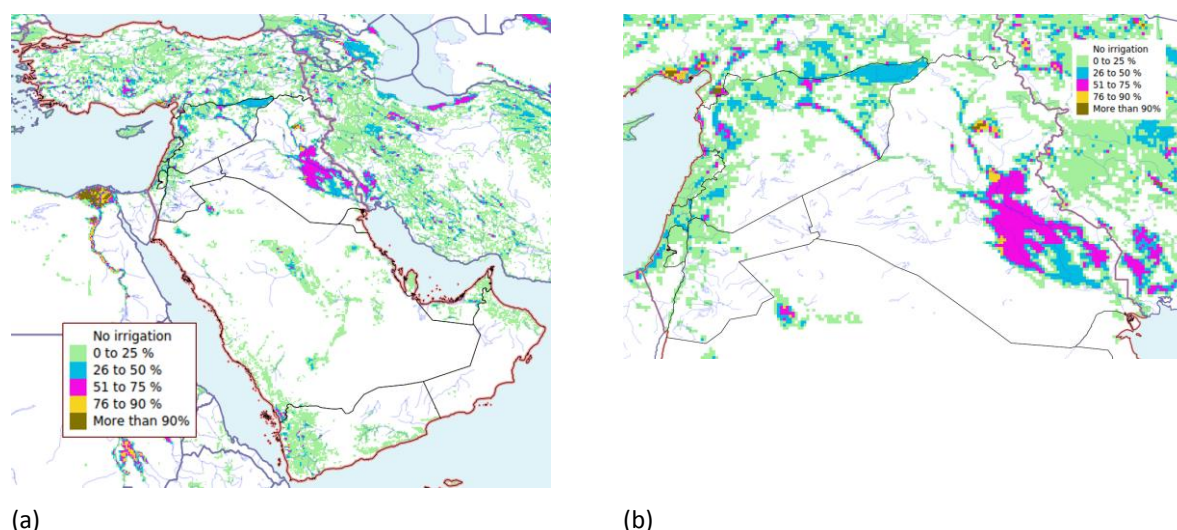


Source: Based on rainfall and on PET computed from New\_locClim (Grieser et al, 2006).

Figures 5.3a and b show the extent of irrigation in the region. All surface waters as well as ground water are put to use, and desalination has become a major source of freshwater, albeit too expensive for irrigation use (ECOMENA, 2016).

As shown in table 5.3, agriculture makes up a large share of water use, as expressed by the percentage of total renewable water resources (TRWR). If some countries are still in a favorable situation (for example Lebanon, which uses 17% of its renewable water for agriculture and 24% for agriculture, domestic and industrial uses combined, or Turkey with uses of 16% and 20% respectively for those uses), many other countries are approaching the point when they need to tap in to non-renewable water resources (Jordan, 65% and 92%; Israel, 57% and 80%; Iraq 58% and 73%). Some of the main countries in terms of area have already started using their non-renewable resources, such as in particular Yemen (154% and 169%) and Saudi Arabia (867% and 942%; see Wergosum 2011 for a detailed analysis of the situation in Saudi Arabia). This situation is highly unsustainable and may potentially lead to more unrest in the region.

Figure 5.3. Percentage of land irrigated per pixel



Note: Figure b presents a detail of figure 1.  
Source: Based on GMIA data (FAO, 2016).

Table 5.3. Selected descriptors and reference data about the Middle Eastern countries

Variable (and source)	ARE	BHR	IRQ	ISR	JOR	KWT	LBN	OMN	PSE	QAT	SAU	SYR	TUR	YEM
Land area (LAT, 1000 km <sup>2</sup> ) (9)	84	0.77	430	22	89	18	10	310	6	12	2100	180	770	528
Agric. Land (LAA, % of LAT) (8)	5	11	21	24	12	9	64	5	44	6	81	76	50	45
Arable land (LAR, % of LAT) (8)	0	2	12	13	3	1	13	0	8	1	1	25	27	2
Population (POPT, million) (8)	9	1	34	8	7	4	5	4	4	2	30	19	76	26
Growth rate/year of POPT,% (7)	1.89	1.76	3.31	1.66	3.06	4.81	5.99	8.45	2.75	4.72	2.32	-2.27	1.69	2.57
Urban pop. (% of POPT) (6)	79	88	69	90	74	98	83	69	68	93	77	49	60	23
Immigrants in % of POPT (4)	84	55	0.3	27	40	70	n.a.	31	6	74	31	6	6	1
Global Food Security Index (1)	72	70	n.a.	79	57	74	n.a.	74	n.a.	78	71	36	64	34
Human Development Index (2)	0.85	0.82	0.65	0.89	0.75	0.82	0.77	0.79	0.68	0.85	0.84	0.59	0.76	0.50
Political Stability Index (3)	0.81	-0.94	-2.47	-0.99	-0.56	0.14	-1.72	0.66	n.a.	1.00	-0.24	-2.76	-1.06	-2.53
GDP/capita, 1000 \$/year (11)	64	43	15	43	11	75	15	40	5	139	51	n.a.	19	4
Agric. contribution, % GDP (10)	n.a.	0	n.a.	n.a.	4	0	6	1	5	0	2	n.a.	9	n.a.
% change LAR/20 years (12)	11	-22	-19	-15	-9	124	-31	15	-54	10	-14	-3	-15	-21
Wheat+rice import (kg/cap.) (6)	52	288	114	145	229	138	157	114	151	78	151	108	72	138
Cereal imports % available (13)	13	98	100	50	92	96	97	87	95	95	99	91	45	82
Wheat, % of cereal imports (6)	77	46	49	75	50	40	37	52	55	56	40	16	37	78
Rice, % of cereal imports (6)	5	32	40	24	4	7	22	5	24	12	34	10	9	10
All water uses in % of TRWR (5)	1867	206	73	80	92	2075	24	85	49	374	943	84	20	169
Agric. water use in % TRWR (5)	2208	137	58	57	65	2460	17	83	23	452	867	87	16	154

Notes: LAT: Land area; LAA: Agricultural land; LAR: Arable land; POPT: Population; TRWR: Total Renewable Water Resources; for country abbreviations, see note figure 5.1.

Sources: (1) Global food security index, varies from 0 (bad) to 100 (good), 2016 data, Economist 2016; (2) Human development index, 2014 values (0.35 to 0.95), <http://hdr.undp.org/en/composite/HDI>; (3) Political stability index, 2014 values, varies from -2.76 (Low) to 1.54 (high), [http://www.theglobaleconomy.com/rankings/wb\\_political\\_stability/](http://www.theglobaleconomy.com/rankings/wb_political_stability/); (4) World Bank data for 2015 <http://www.un.org/en/development/desa/population/migration/data/estimates2/estimates15.shtml>; (5) TRWR, Total renewable water resources, <http://www.fao.org/nr/water/aquastat/main/index.stm>, most recent data available. In some countries, the percentage of agricultural water withdrawal exceeds total water withdrawal. This is because the first one refers to freshwater (withdrawal by source) and the second includes both freshwater and non-conventional water (withdrawal by sector). Non-conventional water includes desalinated sea or brackish water, direct use of (treated) waste-water and direct use of agricultural drainage water; (6) Based on 2009-13 FAOSTAT data; (7) Wikipedia, 2010-15 UN estimates, [https://en.wikipedia.org/wiki/List\\_of\\_countries\\_by\\_population\\_growth\\_rate](https://en.wikipedia.org/wiki/List_of_countries_by_population_growth_rate); (8) 2013 data from world bank; (9) Same as (8), two significant digits for 2015 data; same as 8, average of whichever years are available between 2011 and 2015; (10) World Bank, based on FAO data; (11) current international \$, World Bank data. Average of whichever years are available between 2011 and 2015; (12) percent change of arable land between 1991-95 and 2009-13. Based on FAOSTAT data; (13) same source as (6). The variable is the percentage of cereal imports in the total available cereals, i.e. the sum of imports and local production.

## Agricultural production and trends

The total agricultural production of recent years is shown in table 5.4 below. It amounts to 212.9 million ton per year for the main crop categories, including 44.2 million ton per year of cereals. This is approximately equivalent to 200 kg per person per year.

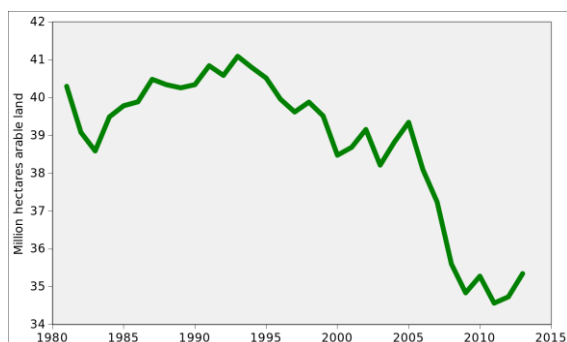
**Table 5.4. Production and imports of crops in the Middle East (2012-2014 average)**

Crop category (source)	Production		Imports	
	MT/Y	%	MT/Y	%
Cereals (1)	44.2	36.3	42.1	72.1
Vegetables (2)	41.9	34.4	9.1	15.6
Fruits	23.9	19.6		
Roots (3)	7.6	6.2	0.6	1.0
Oil-crops	1.7	1.4	4.7	8.0
Pulses	1.6	1.3	1.1	1.9
Fiber crops	1.0	0.8	0.8	1.4
<b>Total</b>	<b>212.9</b>	<b>100</b>	<b>58.4</b>	<b>100</b>

Notes: MT/Y= million tons/year. (1) Cereals include rice as milled equivalent; (2) for imports, vegetables and fruits are combined; (3) production includes "roots and tubers" but imports include only potatoes.

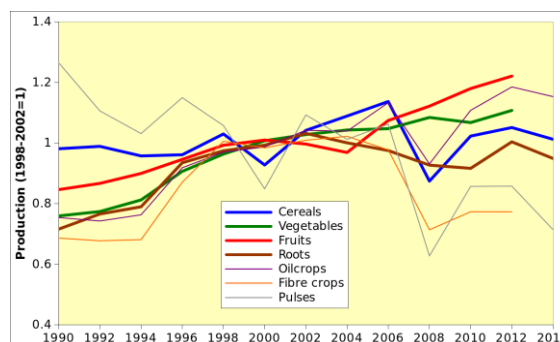
Arable land has been decreasing in most of the region over the last 20 years (figure 5.4), and so has the contribution of agriculture to the GDP (values are low and variable, from 0% to 9% in Turkey; table 5.3). Table 5.3 provides additional detail about arable land shrinkage, with drops particularly large in Palestine (-54%), Yemen (-21%), Iraq (-19%), Israel and Turkey (-15%), and Saudi Arabia (-14%). Increases have taken place in some of the smaller countries where non-renewable water is liberally used in agriculture.

**Figure 5.4. Total arable land variation from 1981 in the Middle East**



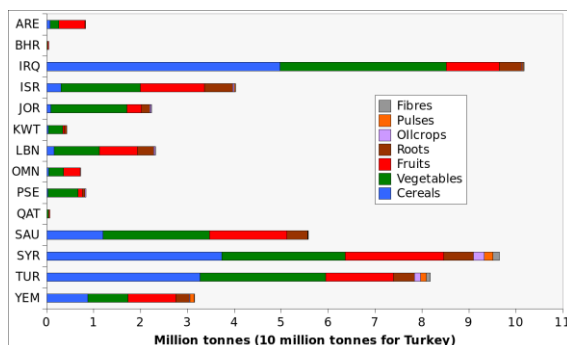
Source: Based on FAOSTAT data

**Figure 5.5. Production trend for main crop categories in the Middle East**



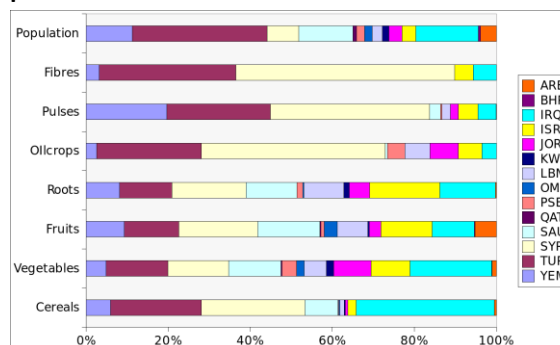
Source: Based on FAOSTAT data

**Figure 5.6. Total production by crop-type and country**



Source: Based on FAOSTAT data

**Figure 5.7. Relative share of population and crop production between countries**



Source: Based on FAOSTAT data



Wheat is the major staple in the region and constitutes also the bulk of imports, about one fifth (19.6%). This is followed by “other cereals,” (mostly maize as cattle feed (17.1%)), which compares with feeds and fodder, making up 8.7%. The region also imports sizeable volumes of meat (2.8% of imports) and milk products (7%). Edible oil (4.7%) and sugar (7.2%) also deserve mentioning.

Turkey and Iraq are the largest wheat and edible oil importers, while Turkey and the Emirates are the largest feed importers. Saudi Arabia is the major importer of “other cereals,” fruits and vegetables, as well as meat and milk products.

In most countries of the region, about 90% or more of the cereal consumption is obtained through imports. Exceptions are the United Arab Emirates (only 13% of cereal imported), Israel (50%), and Turkey (45%) (see table 5.3). All countries import more wheat than rice, and wheat accounts for 16% (Syria) to 78% (Yemen) of cereal imports. Most countries import between 100 and 200 kg of “wheat+rice” per capita.

## Discussion

Several countries in the Middle East region (including Iraq and Syria) that used to be considered “bread baskets” have become very vulnerable to food insecurity due to their heavy dependence on imported food. The region is currently among the largest food—and especially wheat—importers in the world and derives about 50% of its calories from imports (35% of calories are derived from wheat only). According to a publication by the World Bank, FAO and IFAD (2009) this percentage of calories from imports is to increase to 64% by 2030.<sup>7</sup> This happens against the backdrop of sustained population increases and declining agricultural production due to land degradation and policies, including policies to protect ground water resources. Many people in the region are poor and spend between one third and more than half of their income on food (World Bank/FAO/IFAD, 2009).

The causes of national food production declines are complex. They also include under-investment in agriculture, war, and endemic unrest in many areas, as well as the perception of agriculture as a minor sector compared with the “oil rent” of many countries.

In reality, it is difficult to clearly separate causes from effects, but water and land availability are among the main issues. Countries now resort to several forms of “non-conventional water” obtained by desalination of sea and brackish water or recycling of waste-water and agricultural drainage water. The over-use of river water combined with the climate-conditioned reduction in flow of the Jordan, Euphrates, and Tigris Rivers have led to a drop in national production compared with their peak in the early 21<sup>st</sup> century, most evidently in Syria, Iraq, and Jordan.

Due to the well-established links between water and energy consumption (Siddiqi and Anadon 2011 and ECOMENA 2016), badly needed economic development is bound to further increase water needs in a region that already suffers from the highest per capita rates of freshwater extraction in the world (804 m<sup>3</sup>/year) and already over-exploits its renewable water resources. The water cycle uses up to 12% of national electricity consumption and this number is continuously on the rise. In the United Arab Emirates, about 20% of electricity is used for desalination, while in most other countries the percentage is still relatively low (around 10%).

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<sup>7</sup> The issues have been known for years and many insightful analyses and recommendations exist (Jury and Vaux 2007; Earthscan/FAO 2011; LPI 2011; Sowers et al 2011; GEO5 2012; GWP/INBO 2012; Islar 2012; Hendrix and Brinkman 2013; and Mekkonen and Hoekstra 2016). Proposed solutions, on the “technical side”, include land reclamation, salt-tolerant agriculture, improved water and energy use efficiency in agriculture and society at large, improved food processing, investments in agriculture and agronomic research, strengthening of safety nets, improved access to family planning services, education, outsourcing production to other countries, and even the “more effective use of financial instruments to hedge risk” (World Bank/FAO/IFAD 2009).

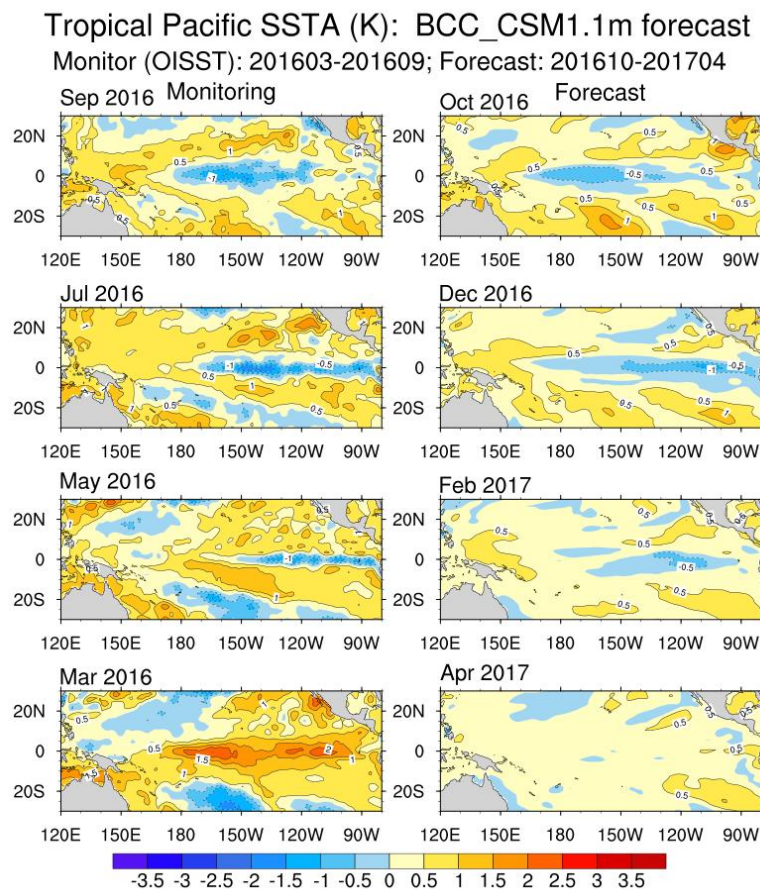
Due to the interconnectedness of climate, food production, demographics, the oil rent, overconsumption of water, energy use, environmental conservation, economic development, and the inherently international dimension of surface and ground water resources, no evident way-out exists for the many kinds of insecurity (RBAS, 2009) that affect the Middle East region.

### 5.3 Update on El Niño

El Niño has continued to be neutral and La Niña did not cross critical thresholds during the third quarter of 2016. The eastern tropical Pacific Sea Surface Temperatures (SST) have cooled rapidly between March and October 2016, based on the OISST (Optimum Interpolation SST). SSTs are predicted to remain cool but average until the first quarter of 2017, according to forecasts from the 15 models at Beijing Climate Center (figure 5.8).

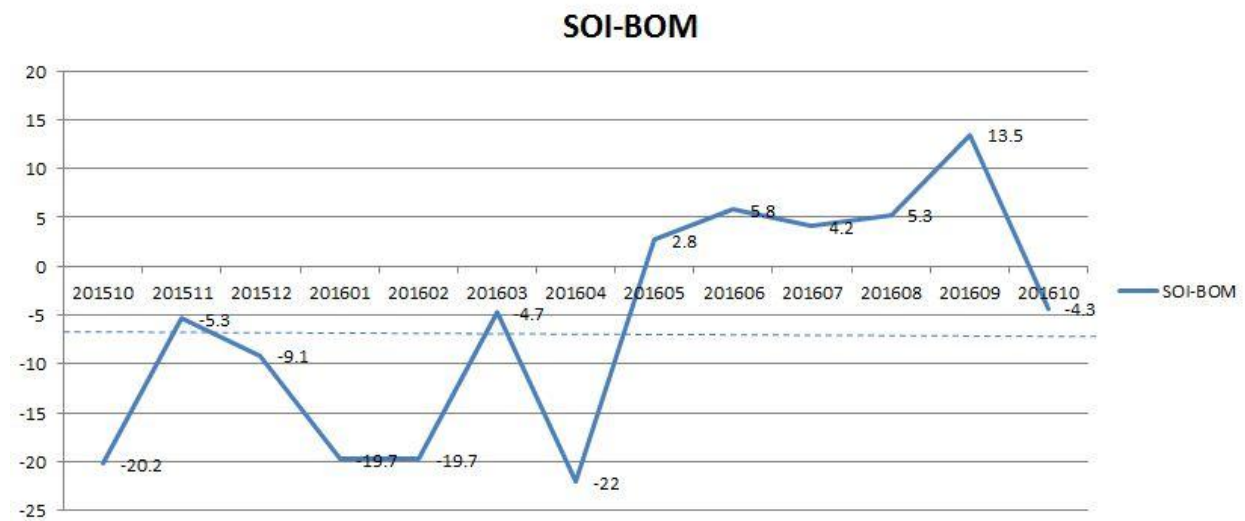
Figure 5.9 illustrates the behavior of the standard Southern Oscillation Index (SOI) of the Australian Bureau of Meteorology (BOM) from October 2015 to October 2016. During the current season, SOI has increased gradually from +4.2 in July to +5.3 in August and increased rapidly to 13.5 in September, before dropping sharply to -4.3 in October, indicating neutral conditions of El Niño and the possibility of a weak La Niña at the end of 2016. NOAA confirms the cooler-than-average SST in the central-eastern tropical Pacific Ocean and also that La Niña has only about a one in two chance to persist through the winter of 2016-17 (figure 5.10).

**Figure 5.8. Tropical Pacific SSTA (Forecasted and monitored datasets)**



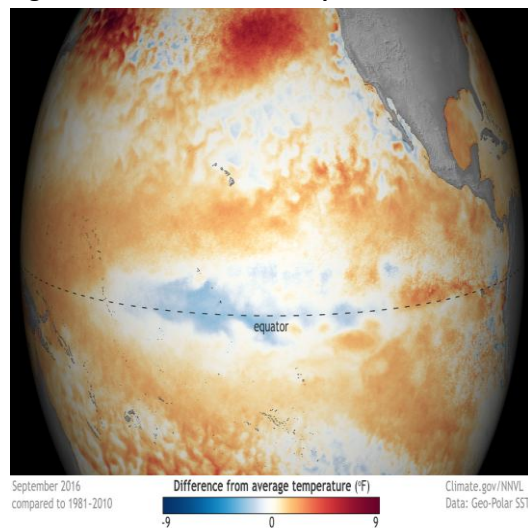
Source: [http://cmdp.ncc-cma.net/download/ENSO/Variables\\_evolution/ENSO\\_SSTA\\_Patterns\\_O7P7\\_20161001.png](http://cmdp.ncc-cma.net/download/ENSO/Variables_evolution/ENSO_SSTA_Patterns_O7P7_20161001.png)

**Figure 5.9. Monthly SOI-BOM time series for October 2015 to October 2016**



Source: <http://www.bom.gov.au/climate/current/soi2.shtml>.

**Figure 5.10. Sea surface temperature difference from average temperature, September, 2016**



Source: Climate.gov, <https://www.climate.gov/sites/default/files/geopolar-ssta-monthly-nnvl--1000X555--2016-09-00.png>

Both BOM and NOAA nevertheless issued a La Niña watch, stating conditions are weak for La Niña to emerge in late 2016 and early 2017. In the next few months, CropWatch will keep a close eye on the development of La Niña and the regions that show sensitivity to this event.

## Annex A. Agroclimatic indicators and BIOMSS

**Table A.1. July-October 2016 agroclimatic indicators and biomass by global Monitoring and Reporting Unit**

65 Global MRUs	RAIN		TEMP		RADPAR		BIOMSS		
	Current (mm)	15YA dep. (%)	Current (°C)	15YA dep. (°C)	Current (MJ/m <sup>2</sup> )	15YA dep. (%)	Current (gDM/m <sup>2</sup> )	5YA dep. (%)	
1	Equatorial central Africa	446	-2	25.2	0.6	1177	7	1206	-1
2	East African highlands	451	-24	19.5	-0.3	1154	2	1297	-16
3	Gulf of Guinea	951	11	26.1	-0.4	977	0	2045	3
4	Horn of Africa	67	-41	23.5	-0.7	1303	4	230	-41
5	Madagascar (main)	119	-2	21.0	-0.7	1141	3	374	-12
6	Southwest Madagascar	37	-40	21.0	-1.0	1219	2	164	-32
7	North Africa-Mediterranean	83	-15	24.0	-0.2	1302	0	353	-6
8	Sahel	638	16	28.8	-0.4	1246	1	1629	9
9	Southern Africa	56	-11	21.6	0.2	1205	3	211	-15
10	Western Cape (South Africa)	67	-58	12.8	1.1	959	2	292	-51
11	British Columbia to Colorado	267	41	11.5	-0.5	1085	-5	936	32
12	Northern Great Plains	555	97	18.1	0.0	1053	-5	1493	58
13	Corn Belt	475	16	18.7	1.0	987	-2	1464	8
14	Cotton Belt to Mexican Nordeste	399	-10	24.9	0.5	1143	1	1185	-9
15	Sub-boreal America	367	34	11.6	-0.4	794	-8	1379	25
16	West Coast (North America)	135	45	16.7	-0.4	1237	-3	375	25
17	Sierra Madre	592	-6	20.1	-0.4	1226	1	1543	-4
18	SW U.S. and N. Mexican highlands	177	-4	21.4	-0.2	1293	0	662	1
19	Northern South and Central America	900	-4	26.9	-0.2	1101	4	2005	-2
20	Caribbean	829	7	27.1	0.1	1209	-1	1945	-1
21	Central-northern Andes	311	-11	15.8	0.4	1152	5	769	-5
22	Nordeste (Brazil)	72	26	27.1	0.5	1252	2	220	5
23	Central eastern Brazil	205	-1	25.0	-0.4	1142	2	707	3
24	Amazon	393	3	28.4	-0.1	1160	3	1187	3
25	Central-north Argentina	98	5	18.3	-1.2	989	1	356	3
26	Pampas	428	-3	15.9	-0.6	897	0	1015	-11
27	Western Patagonia	247	-36	7.5	0.7	729	-2	769	-11
28	Semi-arid Southern Cone	45	-35	10.6	-0.1	952	0	205	-27
29	Caucasus	124	-27	18.5	-0.7	1133	0	491	-21
30	Pamir area	217	35	17.8	-0.1	1233	-1	656	35
31	Western Asia	74	28	23.4	-0.4	1238	0	260	15
32	Gansu-Xinjiang (China)	374	175	16.8	-0.2	1092	-3	1064	132
33	Hainan (China)	1407	26	27.2	0.1	1017	-3	2189	9
34	Huanghuaihai (China)	438	-5	23.1	0.1	973	-4	1273	1
35	Inner Mongolia (China)	428	57	15.8	-0.3	1025	-3	1315	33
36	Loess region (China)	419	14	18.3	0.4	987	-3	1321	7
37	Lower Yangtze (China)	673	33	24.9	-0.1	952	-8	1613	16
38	Northeast China	371	-1	15.9	-0.4	931	-2	1257	4
39	Qinghai-Tibet (China)	751	8	12.4	0.2	1011	0	1338	7
40	Southern China	811	9	24.7	0.0	976	-3	1866	7
41	Southwest China	539	-3	21.3	0.1	896	-1	1490	-5
42	Taiwan (China)	1211	23	25.2	-0.2	1012	-5	1974	16
43	East Asia	440	-28	17.4	0.1	885	-2	1381	-8
44	Southern Himalayas	1190	17	25.4	-0.3	899	-4	1906	4
45	Southern Asia	959	0	27.0	-0.3	892	-4	1678	-6
46	Southern Japan and Korea	678	-14	23.0	1.9	922	-3	1589	-11
47	Southern Mongolia	506	201	15.1	-0.3	1093	-3	1125	97

65 Global MRUs		RAIN		TEMP		RADPAR		BIOMSS	
		Current (mm)	15YA dep. (%)	Current (°C)	15YA dep. (°C)	Current (MJ/m <sup>2</sup> )	15YA dep. (%)	Current (gDM/m <sup>2</sup> )	5YA dep. (%)
48	Punjab to Gujarat	689	33	29.1	-0.7	1008	-5	1224	20
49	Maritime Southeast Asia	1025	26	25.7	0.3	1001	-4	2109	15
50	Mainland Southeast Asia	1297	9	27.2	-0.1	929	-1	2357	6
51	Eastern Siberia	256	-12	10.3	-1.0	793	-2	979	-16
52	Eastern Central Asia	288	19	9.4	-0.7	883	-4	1071	10
53	Northern Australia	214	128	24.8	1.5	1141	-5	650	89
54	Queensland to Victoria	176	8	12.3	-0.5	881	-7	762	19
55	Nullarbor to Darling	99	-53	11.3	-1.5	881	-4	422	-43
56	New Zealand	131	-55	8.8	0.4	685	-7	544	-42
57	Boreal Eurasia	325	-1	10.3	0.1	665	-5	1099	-6
58	Ukraine to Ural mountains	246	4	14.6	-0.5	787	-3	994	-1
59	Mediterranean Europe and Turkey	121	-26	20.3	1.4	1195	1	454	-23
60	W. Europe (non Mediterranean)	256	-14	16.0	-0.2	877	-1	998	-9
61	Boreal America	464	23	8.8	1.6	614	-3	1225	9
62	Ural to Altai mountains	237	16	13.0	-0.3	854	0	927	9
63	Australian desert	93	3	13.0	-0.8	945	-5	441	9
64	Sahara to Afghan deserts	43	42	29.9	-0.4	1384	1	152	16
65	Sub-arctic America	183	62	-0.1	4.1	302	0	756	205

Table A.2. July-October 2016 agroclimatic indicators and biomass by country

31 Countries		RAIN		TEMP		RADPAR		BIOMSS	
		Current (mm)	15YA Departure (%)	Current (°C)	15YA Departure (°C)	Current (MJ/m <sup>2</sup> )	15YA Departure (%)	Current (gDM/m <sup>2</sup> )	5YA Departure (%)
[ARG]	Argentina	218	-6	14.6	-0.8	906	-1	604	-14
[AUS]	Australia	158	-1	13.2	-0.5	907	-7	678	7
[BGD]	Bangladesh	1729	19	28.5	-0.5	836	-6	2374	6
[BRA]	Brazil	268	1	25.4	-0.2	1144	2	781	0
[CAN]	Canada	359	24	12.4	0.1	853	-6	1284	25
[CHN]	China	583	14	21.3	0.0	954	-4	1413	11
[DEU]	Germany	226	-23	15.8	0.2	800	-2	978	-16
[EGY]	Egypt	3	-31	26.4	-0.4	1371	0	16	-6
[ETH]	Ethiopia	545	-21	20.3	-0.3	1134	2	1512	-13
[FRA]	France	171	-41	16.7	-0.2	979	3	709	-35
[GBR]	UK	290	-12	13.7	0.4	694	-4	1128	-9
[IDN]	Indonesia	1001	36	25.7	0.2	999	-5	2027	21
[IND]	India	1039	12	27.1	-0.4	895	-6	1696	3
[IRN]	Iran	25	-39	23.1	-0.5	1311	1	76	-42
[KAZ]	Kazakhstan	229	56	14.6	-0.8	921	-2	840	34
[KHM]	Cambodia	1495	29	28.0	-0.6	976	-2	2536	8
[MEX]	Mexico	644	-9	24.1	-0.2	1215	2	1435	-6
[MMR]	Myanmar	1237	-1	25.9	-0.1	824	-2	2268	0
[NGA]	Nigeria	888	8	26.5	-0.6	1051	0	1981	4
[PAK]	Pakistan	292	6	27.0	-0.3	1217	2	666	3
[PHL]	Philippines	1282	11	26.3	0.8	1022	-1	2261	2
[POL]	Poland	318	28	14.9	-0.6	755	-6	1235	21
[ROU]	Romania	207	-27	16.5	-0.8	952	-1	864	-17
[RUS]	Russia	240	-1	13.6	-0.4	807	-2	982	-3
[THA]	Thailand	1048	9	27.1	-0.2	967	0	2271	7
[TUR]	Turkey	75	-43	19.7	0.1	1214	0	317	-37
[UKR]	Ukraine	190	-13	16.4	-0.6	894	0	789	-12
[USA]	USA	437	23	20.6	0.5	1099	-1	1217	18

31 Countries	RAIN		TEMP		RADPAR		BIOMSS	
	Current (mm)	15YA Departure (%)	Current (°C)	15YA Departure (°C)	Current (MJ/m <sup>2</sup> )	15YA Departure (%)	Current (gDM/m <sup>2</sup> )	5YA Departure (%)
[UZB] Uzbekistan	95	169	21.1	-0.5	1219	-2	327	133
[VNM] Vietnam	1255	12	26.6	0.3	981	0	2158	1
[ZAF] South Africa	107	-12	15.5	0.3	1091	2	389	-13

See note table A.1.

**Table A.3. Argentina, July-October 2016 agroclimatic indicators and biomass (by province)**

	RAIN		TEMP		RADPAR		BIOMSS	
	Current (mm)	15YA Departure (%)	Current (°C)	15YA Departure (°C)	Current (MJ/m <sup>2</sup> )	15YA Departure (%)	Current (gDM/m <sup>2</sup> )	5YA Departure (%)
Buenos Aires	203	-29	11.5	-0.5	810	-5	700	-23
Chaco	250	26	18.3	-1.4	950	0	730	8
Cordoba	109	-27	13.8	-0.9	953	0	399	-26
Corrientes	570	34	17.3	-1.0	919	1	1066	-11
Entre Rios	242	-29	14.6	-0.9	880	-2	753	-26
La Pampa	250	23	11.8	-0.5	845	-5	791	14
Misiones	672	0	18.6	-0.4	941	3	1635	-1
Santiago Del Estero	108	7	17.3	-1.3	979	-1	425	14
San Luis	145	9	12.6	-0.5	967	1	459	-11
Salta	91	72	18.2	-1.0	1030	0	301	50
Santa Fe	208	-9	15.5	-1.0	929	-1	631	-18

See note table A.1.

**Table A.4. Australia, July-October 2016 agroclimatic indicators and biomass (by state)**

	RAIN		TEMP		RADPAR		BIOMSS	
	Current (mm)	15YA Departure (%)	Current (°C)	15YA Departure (°C)	Current (MJ/m <sup>2</sup> )	15YA Departure (%)	Current (gDM/m <sup>2</sup> )	5YA Departure (%)
New South Wales	193	29	11.8	-0.8	900	-8	797	36
South Australia	197	21	11.7	-0.4	817	-6	801	21
Victoria	165	-24	10.3	-0.1	734	-9	781	-4
W. Australia	94	-52	12.4	-1.0	911	-3	407	-42

See note table A.1.

**Table A.5. Brazil, July-October 2016 agroclimatic indicators and biomass (by state)**

	RAIN		TEMP		RADPAR		BIOMSS	
	Current (mm)	15YA Departure (%)	Current (°C)	15YA Departure (°C)	Current (MJ/m <sup>2</sup> )	15YA Departure (%)	Current (gDM/m <sup>2</sup> )	5YA Departure (%)
Ceará	8	-75	28.2	0.3	1383	2	44	-69
Goiás	162	-7	25.5	-0.5	1213	3	622	1
Mato Grosso do Sul	291	0	24.0	-1.4	1112	3	974	3
Mato Grosso	255	6	28.4	0.1	1193	2	900	13
Minas Gerais	140	-10	23.4	0.3	1131	0	521	-4
Parana	652	12	19.3	-0.6	1005	3	1502	3
Rio Grande do Sul	634	-8	16.5	-0.2	871	1	1404	-14
Santa Catarina	703	2	16.1	0.0	886	2	1441	-11
Sao Paulo	262	-13	21.6	-0.7	1093	3	878	-9

See note table A.1.

**Table A.6. Canada, July-October 2016 agroclimatic indicators and biomass (by province)**

	RAIN		TEMP		RADPAR		BIOMSS	
	Current (mm)	15YA Departure (%)	Current (°C)	15YA Departure (°C)	Current (MJ/m <sup>2</sup> )	15YA Departure (%)	Current (gDM/m <sup>2</sup> )	5YA Departure (%)
Alberta	297	50	10.8	-0.8	857	-8	1161	37
Manitoba	433	73	13.7	-0.3	846	-9	1555	47
Saskatchewan	335	66	12.0	-0.8	855	-10	1281	48

See note table A.1.

**Table A.7. India, July-October 2016 agroclimatic indicators and biomass (by state)**

	RAIN		TEMP		RADPAR		BIOMSS	
	Current (mm)	15YA Departure (%)	Current (°C)	15YA Departure (°C)	Current (MJ/m <sup>2</sup> )	15YA Departure (%)	Current (gDM/m <sup>2</sup> )	5YA Departure (%)
Arunachal Pradesh	1692	10	22.5	-0.5	774	-6	2214	4
Andhra Pradesh	807	9	28.0	-0.4	934	-3	1565	-9
Assam	1664	18	29.4	0.1	813	-5	2400	4
Bihar	1325	38	29.2	-1.1	848	-10	2162	17
Chandigarh	1323	18	26.5	-0.5	820	-9	2199	9
Chhattisgarh	766	-24	27.4	-1.3	882	-7	1369	-1
Daman and Diu	615	22	29.8	-0.5	1033	-3	1507	15
Delhi	733	-3	28.5	-0.5	877	-10	1330	9
Dadra and Nagar Haveli	539	-67	24.5	-0.6	867	7	1384	-35
Gujarat	674	-19	15.2	-0.3	1087	-1	1310	-7
Goa	599	27	29.1	-0.5	1061	-3	1313	10
Himachal Pradesh	1129	14	27.5	-0.4	873	-7	2139	6
Haryana	469	-62	25.3	-0.1	924	6	1233	-43
Jharkhand	469	-44	24.5	-0.7	912	-1	1176	-27
Kerala	1858	-12	25.5	0.3	792	-7	2424	4
Karnataka	1111	12	25.9	-0.7	818	-8	1787	5
Meghalaya	1157	14	23.5	0.5	832	-1	2209	0
Maharashtra	1413	62	26.9	-0.6	831	-11	1903	15
Manipur	1587	15	23.8	-0.3	865	-2	2407	2
Madhya Pradesh	1510	19	23.4	0.8	827	-4	2260	0
Mizoram	1023	-12	27.5	-0.1	824	-7	2071	-2
Nagaland	326	0	30.0	-	1143	3	1085	0
Orissa	471	-5	28.6	-0.4	1103	1	1068	-12
Puducherry	809	79	29.1	-0.9	1015	-6	1337	32
Punjab	1078	-17	13.1	-1.5	849	-20	1341	-6
Rajasthan	411	-31	28.6	0.6	1125	5	1155	-26
Sikkim	2139	43	28.0	-0.2	851	-4	2586	9
Tamil Nadu	1061	3	19.2	0.4	994	-2	1562	-1
Tripura	1013	29	29.1	-0.5	920	-7	1817	11
Uttarakhand	1433	11	29.1	0.1	850	-6	2211	4
Uttar Pradesh	1692	10	22.5	-0.5	774	-6	2214	4
West Bengal	807	9	28.0	-0.4	934	-3	1565	-9

See note table A.1.

**Table A.8. Kazakhstan, July-October 2016 agroclimatic indicators and biomass (by oblast)**

	RAIN		TEMP		RADPAR		BIOMSS	
	Current (mm)	15YA Departure (%)	Current (°C)	15YA Departure (°C)	Current (MJ/m <sup>2</sup> )	15YA Departure (%)	Current (gDM/m <sup>2</sup> )	5YA Departure (%)
Akmolinskaya	180	20	13.1	-0.9	846	-2	791	18
Karagandinskaya	188	32	12.3	-1.5	896	-2	796	25

	RAIN		TEMP		RADPAR		BIOMSS	
	Current (mm)	15YA Departure (%)	Current (°C)	15YA Departure (°C)	Current (MJ/m <sup>2</sup> )	15YA Departure (%)	Current (gDM/m <sup>2</sup> )	5YA Departure (%)
Kustanayskaya	157	7	14.5	-0.6	863	0	695	6
Pavlodarskaya	226	39	13.6	-0.8	829	-2	866	20
Severo	214	10	13.4	-0.2	799	0	928	11
Vostochno	333	79	12.2	-0.9	963	-2	1090	49
Zapadno	149	51	17.5	-0.4	887	-5	677	41

See note table A.1.

**Table A.9. Russia, July-October 2016 agroclimatic indicators and biomass (by oblast, kray and republic)**

	RAIN		TEMP		RADPAR		BIOMSS	
	Current (mm)	15YA Departure (%)	Current (°C)	15YA Departure (°C)	Current (MJ/m <sup>2</sup> )	15YA Departure (%)	Current (gDM/m <sup>2</sup> )	5YA Departure (%)
Bashkortostan	174	-22	14.1	0.6	830	2	784	-19
Chelyabinskaya	173	-21	13.5	0.2	818	3	811	-13
Gorodovikovsk	235	1	19.4	-1.4	954	-3	968	-1
Krasnodarskiy	179	-32	14.3	-1.0	907	2	826	-25
Kurganskaya	207	-5	13.4	0.2	787	2	906	-3
Kirovskaya	259	-7	13.2	0.5	717	-1	1063	-10
Kurskaya	270	28	14.8	-1.0	824	-1	1020	8
Lipetskaya	235	11	14.6	-0.9	794	-3	970	1
Mordoviya	204	-15	14.3	-0.3	775	-3	919	-13
Novosibirskaya	205	-11	11.8	-0.3	823	5	865	-13
Nizhegorodskaya	216	-17	13.8	-0.1	735	-3	981	-12
Orenburgskaya	149	3	15.4	-0.1	859	-3	688	3
Omskaya	197	-11	12.6	0.3	782	3	879	-7
Permskaya	188	-35	13.3	1.2	778	8	845	-29
Penzenskaya	201	-6	14.5	-0.5	797	-3	908	-4
Rostovskaya	145	-14	18.2	-0.9	942	-2	684	-10
Ryazanskaya	246	2	14.2	-0.6	757	-4	1032	-3
Stavropolskiy	154	-23	19.4	-1.2	946	-4	722	-15
Sverdlovskaya	219	-16	13.2	1.1	755	5	938	-14
Samarskaya	193	7	15.4	0.2	827	-2	839	3
Saratovskaya	194	29	16.4	-0.4	838	-5	826	19
Tambovskaya	193	-5	14.8	-0.6	799	-4	886	-4
Tyumenskaya	221	-4	12.9	0.6	771	4	955	-3
Tatarstan	202	-11	14.8	0.4	800	1	898	-10
Ulyanovskaya	247	18	15.0	0.0	800	-3	1039	12
Udmurtiya	209	-21	13.8	0.8	766	3	924	-18
Volgogradskaya	176	33	17.5	-1.0	881	-5	798	28
Voronezhskaya	165	-3	15.9	-0.4	847	-3	776	-2

See note table A.1.

**Table A.10. United States, July-October 2016 agroclimatic indicators and biomass (by state)**

	RAIN		TEMP		RADPAR		BIOMSS	
	Current (mm)	15YA Departure (%)	Current (°C)	15YA Departure (°C)	Current (MJ/m <sup>2</sup> )	15YA Departure (%)	Current (gDM/m <sup>2</sup> )	5YA Departure (%)
Arkansas	376	-13	24.6	0.6	1100	-3	1223	-6
California	71	48	18.1	-0.5	1366	-1	231	25
Idaho	190	77	13.4	-1.0	1191	-4	768	67
Indiana	523	27	21.1	1.0	1016	-6	1567	17
Illinois	615	56	21.3	0.9	1020	-7	1759	38
Iowa	857	109	19.5	0.5	1039	-5	2004	57
Kansas	740	107	22.3	0.2	1143	-3	1701	48
Michigan	407	19	18.0	1.5	973	-4	1391	17
Minnesota	762	121	16.6	0.2	961	-6	1873	54
Missouri	703	59	22.3	0.7	1070	-5	1754	32
Montana	317	127	14.3	-0.9	1074	-6	1238	95
Nebraska	558	85	19.4	0.1	1119	-4	1589	51
North Dakota	550	150	15.8	-0.2	985	-6	1646	82
Ohio	436	12	20.8	1.4	1032	-1	1480	8
Oklahoma	562	55	24.5	0.1	1189	0	1608	40
Oregon	152	41	15.1	-0.7	1152	-4	477	19
South Dakota	575	126	18.5	0.2	1101	-1	1660	72
Texas	310	-6	26.1	0.2	1200	0	985	-2
Washington	200	56	14.8	-1.0	1039	-8	705	61
Wisconsin	741	90	17.5	0.8	959	-5	1806	40

See note table A.1.

**Table A.11. China, July 2016 - October 2016 agroclimatic indicators and biomass (by province)**

	RAIN		TEMP		RADPAR		BIOMSS	
	Current (mm)	15YA Departure (%)	Current (°C)	15YA Departure (°C)	Current (MJ/m <sup>2</sup> )	15YA Departure (%)	Current (gDM/m <sup>2</sup> )	5YA Departure (%)
Anhui	673	23	24.4	-0.3	932	-7	1568	9
Chongqing	485	-12	22.5	0.1	881	-4	1410	-9
Fujian	704	29	24.6	0.4	948	-10	1862	29
Gansu	324	1	16.4	0.7	991	-1	1158	13
Guangdong	818	18	26.3	-0.3	992	-6	1919	20
Guangxi	762	18	25.9	0.0	1017	-1	1731	10
Guizhou	437	-9	21.8	0.0	910	-1	1315	-7
Hebei	503	46	19.5	-0.2	991	-5	1379	19
Henan	350	2	15.0	-0.6	914	-2	1246	5
Heilongjiang	407	-15	23.3	0.2	963	-3	1246	-8
Hubei	594	18	23.4	0.0	931	-6	1401	-3
Hunan	650	42	24.2	-0.6	934	-8	1498	15
Jilin	665	22	24.5	0.2	921	-7	1645	16
Jiangsu	676	46	25.6	-0.3	971	-9	1659	25
Jiangxi	421	10	16.5	-0.4	943	-3	1345	11
Liaoning	389	-11	18.7	-0.2	975	-3	1228	-5
Inner Mongolia	358	37	15.0	-0.4	1008	-2	1219	29
Ningxia	247	11	17.6	0.8	1084	-1	991	22
Sichuan	463	0	19.6	0.5	948	-3	1451	3
Shandong	416	-11	23.0	0.5	983	-2	1225	-3
Shaanxi	512	44	17.4	0.1	992	-5	1395	15
Shanxi	596	-2	19.9	0.2	866	0	1540	-2
Yunnan	673	0	19.6	0.0	929	1	1717	-2
Zhejiang	620	8	25.1	0.7	930	-9	1571	4

See note table A.1.

## Annex B. 2016 production estimates

Tables B.1-B.5 present 2016 CropWatch production estimates for Argentina, Australia, Brazil, Canada, and the United States.

**Table B.1. Argentina, 2016 maize and soybean production, by province (thousand tons)**

	Maize		Soybean	
	2016	Δ%	2016	Δ%
Buenos Aires	7104	-1	14067	-1
Córdoba	7044	0	12107	1
Entre Rios	1143	3	3597	6
San Luis	1116	0		
Santa Fe	4299	2	10541	1
Santiago Del Estero	1215	0		
<b>Sub total</b>	<b>21921</b>	<b>0</b>	<b>40312</b>	<b>1</b>
Others	3790	9	10769	-8
<b>Argentina</b>	<b>25711</b>	<b>1</b>	<b>51080</b>	<b>-1</b>

Δ% indicates percentage difference with 2015.

**Table B.2. Australia, 2016 wheat production, by state (thousand tons)**

	Wheat	
	2016	Δ%
New South Wales	9277	31.8
South Australia	5116	22.7
Victoria	4341	28.7
Western Australia	12895	20.6
<b>Sub total</b>	<b>31629</b>	<b>25.1</b>
Others	632	18.4
<b>Australia</b>	<b>32261</b>	<b>25.0</b>

Δ% indicates percentage difference with 2015.

**Table B.3. Brazil, 2016 maize, rice, wheat, and soybean production, by state (thousand tons)**

	Maize		Rice		Wheat		Soybean	
	2016	Δ%	2016	Δ%	2016	Δ%	2016	Δ%
Goiás	6366	-25					9802	-2
Mato Grosso	17973	-9					26810	3
Mato Grosso Do Sul	6587	-14					6388	1
Minas Gerais	6027	-18					3512	-3
Parana	14452	-4			2315	4	17227	0
Rio Grande Do Sul	4613	-5	8493	-2	4528	12	13529	-1
Santa Catarina	2810	-8	1021	-3	357	23	1708	0
Sao Paulo	3589	-6					2172	0
<b>Sub total</b>	<b>62417</b>	<b>-11</b>	<b>9514</b>	<b>-2</b>	<b>7200</b>	<b>10</b>	<b>81148</b>	<b>1</b>
Others	8015	-16	1541	-28	346	-22	10678	12
<b>Brazil</b>	<b>70432</b>	<b>-12</b>	<b>11055</b>	<b>-7</b>	<b>7546</b>	<b>8</b>	<b>91826</b>	<b>2</b>

Δ% indicates percentage difference with 2015.

**Table B.4. Canada, 2016 wheat production, by province (thousand tons)**

	Wheat	
	2016	Δ%
Alberta	9380	13.2
Manitoba	3777	3.4
Ontario	1725	0.0
Saskatchewan	14330	9.8
<b>Sub total</b>	<b>29212</b>	<b>9.3</b>
others	4077	3.2
<b>Canada</b>	<b>33289</b>	<b>8.5</b>

Δ% indicates percentage difference with 2015.

**Table B.5. United States, 2016 maize, rice, wheat, and soybean production, by state (thousand tons)**

States	Maize		Rice		Wheat		Soybean	
	2016	Δ%	2016	Δ%	2016	Δ%	2016	Δ%
Alabama	1176	0					504	-2
Arkansas	2559	6	5338	6	644	-6	4544	5
California			1754	6	664	13		
Colorado	3340	-11			2433	-1		
Georgia	1423	-1			311	0		
Idaho					2692	0		
Illinois	61729	11			1226	0	15551	5
Indiana	27262	8			747	8	8656	5
Iowa	60238	7					13955	2
Kansas	14815	11			8453	8	4050	5
Kentucky	5936	-2			994	-1	2248	-1
Louisiana	1729	5	1516	7			2237	6
Maryland					474	-1	620	-2
Michigan	9909	7			1055	7	2493	0
Minnesota	28824	2			1770	-3	8419	1
Mississippi	2370	7	664	7	343	0	3191	5
Missouri	16623	7	676	2	1192	1	7043	7
Montana					5445	-2		
Nebraska	42689	2			2106	2	7823	0
New York	2567	-7			164	-1		
North Carolina	2699	1			1209	-1	1914	2
North Dakota	7906	5			9505	2	5502	2
Ohio	14208	6			1202	8	7093	4
Oklahoma	1104	-11			1373	-5		
Oregon					981	-15		
Pennsylvania	3877	-5			265	-1	762	-6
South Carolina					281	-11		
South Dakota	17981	1			3724	15	6028	-3
Tennessee	3825	3			762	-12	2064	3
Texas	6533	-11	504	3	2137	3		
Virginia	1413	-2			489	1	694	-1
Washington					2918	1		
Wisconsin	13145	3			450	0	2257	2
<b>Sub total</b>	<b>355880</b>	<b>5</b>	<b>10452</b>	<b>6</b>	<b>56009</b>	<b>2</b>	<b>107648</b>	<b>3</b>
<b>United States</b>	<b>367862</b>	<b>5</b>	<b>10528</b>	<b>6</b>	<b>57877</b>	<b>0</b>	<b>110024</b>	<b>3</b>

Δ% indicates percentage difference with 2015.

## Annex C. Quick reference to CropWatch indicators, spatial units, and production estimation methodology

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](http://www.cropwatch.com.cn).

### 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			
<b>BIOMSS</b>			
<b>Biomass accumulation potential</b>			
Crop/ Ground and satellite	Grams dry matter/m <sup>2</sup> , 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 (2011-15), with departures expressed in percentage.
<b>CALF</b>			
<b>Cropped arable land and cropped arable land fraction</b>			
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 (2011-15), with departures expressed in percentage.
<b>CROPPING INTENSITY</b>			
<b>Cropping intensity Index</b>			
Crop/ Satellite	Number of crops growing over a year for each pixel	Cropping intensity index describes the number of times the same hectare 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. It can be expressed as a dimensionless number (e.g., 1.85) or percentage (185%).	Cropping intensity is presented as maps by pixels or spatial average pixels values for MPZs, 31 countries, and 7 regions for China. Values are compared to the average of the previous five years, with departures expressed in percentage.

INDICATOR			
<b>NDVI</b>			
<b>Normalized Difference Vegetation Index</b>			
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 (2011- 15), and as spatial patterns compared to the average showing the time profiles, where they occur, and the percentage of pixels concerned by each profile.
<b>RADPAR</b>			
<b>CropWatch indicator for Photosynthetically Active Radiation (PAR), based on pixel based PAR</b>			
Weather /Satellite	W/m <sup>2</sup> , 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 (2001-15), 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.
<b>RAIN</b>			
<b>CropWatch indicator for rainfall, based on pixel-based rainfall</b>			
Weather /Ground and satellite	Liters/m <sup>2</sup> , CWSU	The spatial average (for a CWSU) of rainfall accumulation over agricultural pixels, weighted by the production potential.	RAIN is shown as the percent departure of the RAIN value for the reporting period, compared to the recent fifteen-year average (2001-15), 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.
<b>TEMP</b>			
<b>CropWatch indicator for air temperature, based on pixel-based temperature</b>			
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 (2001-15), 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.
<b>VCIx</b>			
<b>Maximum vegetation condition index</b>			
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.
<b>VHI</b>			
<b>Vegetation health index</b>			
Crop/ Satellite	Number, pixel to CWSU	The average of VCI and the temperature condition index (TCI), with TCI defined like VCI but for	Low VHI values indicate unusually poor crop condition, but high values, when due to low temperature, may be difficult to interpret. VHI is

INDICATOR			
		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).	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.

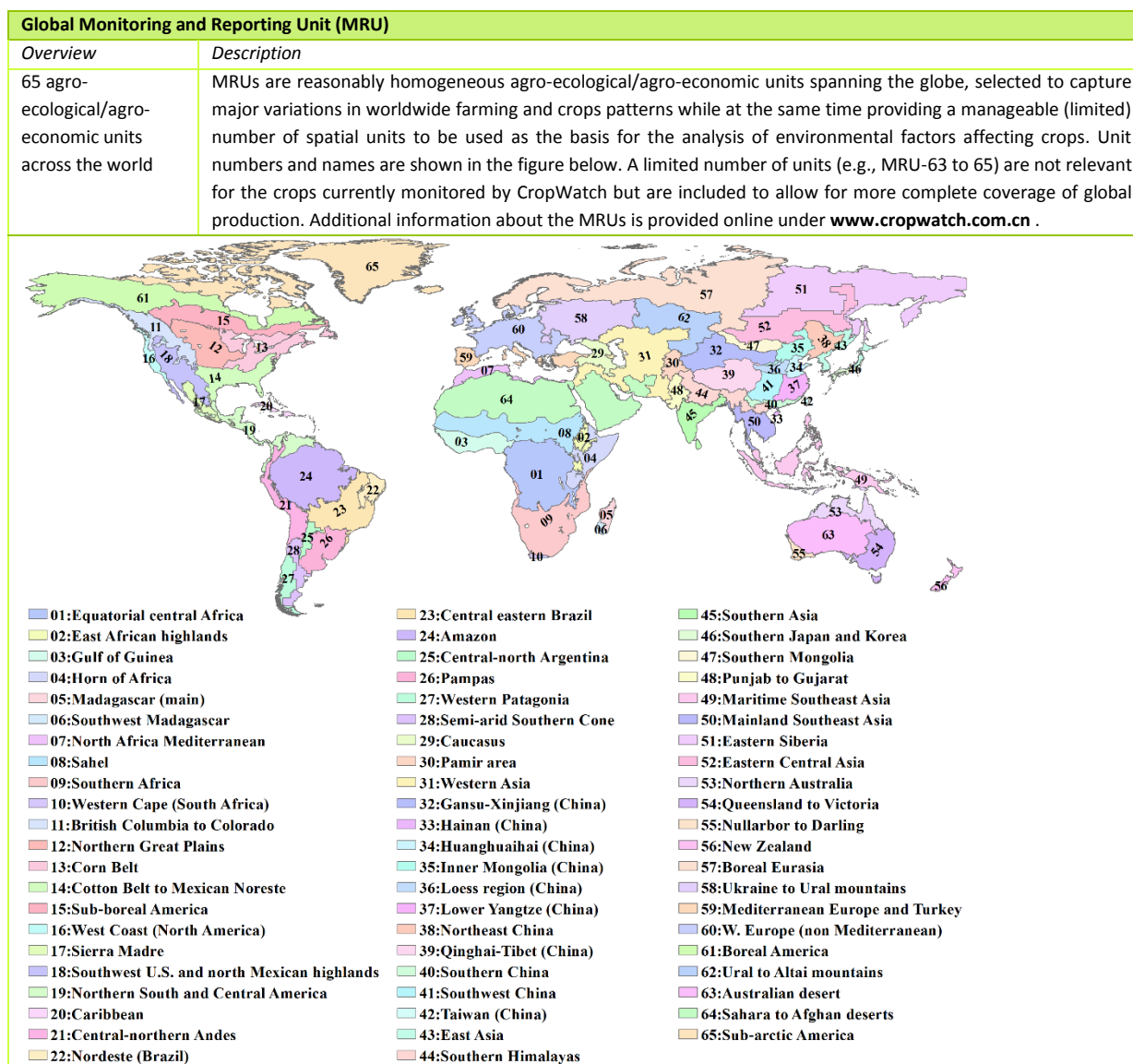
Note: Type is either "Weather" or "Crop"; source specifies if the indicator is obtained from ground data, satellite readings, or a combination; units: in the case of ratios, no unit is used; scale is either pixels or large scale CropWatch spatial units (CWSU). Many indicators are computed for pixels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

SPATIAL LUNITS	
CHINA	
Overview	Description
Seven monitoring regions	The seven regions in China are agro-economic/agro-ecological regions that together cover the bulk of national maize, rice, wheat, and soybean production. Provinces that are entirely or partially included in one of the monitoring regions are indicated in color on the map below.
	





### 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 31 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 2014 of aggregated FAOSTAT data (using aggregated world production minus the sum of production by the 31 CropWatch monitored countries).

## Data notes and bibliography

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## Online resources

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This bulletin is only part of the CropWatch resources available. Visit [www.cropwatch.com.cn](http://www.cropwatch.com.cn) for access to additional resources, including the methods behind CropWatch, country profiles, and other CropWatch publications. For additional information or to access specific data or high-resolution graphs, simply contact the CropWatch team at [cropwatch@radi.ac.cn](mailto:cropwatch@radi.ac.cn).

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### Online Resources posted on [www.cropwatch.com.cn](http://www.cropwatch.com.cn):

- ✓ **Definition of spatial units**  
A description of the four spatial levels of analysis: Monitoring and Reporting Units (MRU), Major Production Zones (MPZ), selected countries, and the use of sub-national administrative areas.
- ✓ **Methodology**  
Overview of CropWatch data sources and methods.
- ✓ **Time series of indicators**  
Background data on agroclimatic indicators presented in a series of tables.
- ✓ **Country profiles**  
Short profiles for each of the 30 countries and China highlighting key facts of interest to agriculture.
- ✓ **Country long term trends**  
Quick overview of average crop area, yield, and production values for maize, rice, soybean, and wheat for recent years, along with long-term (2001-12) trends (based on FAOSTAT data).

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CropWatch bulletins introduce the use of several new and experimental indicators. We would be very interested in receiving feedback about their performance in other countries. With feedback on the contents of this report and the applicability of the new indicators to global areas, please contact:

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