



**Aerospace Information Research Institute (AIR)
Chinese Academy of Sciences (CAS)**



Introduction of CropWatch Cloud Platform

Miao Zhang, on behalf of the CropWatch team

PhD, Associate Professor

2nd July 2024

**Workshop on advancing satellite-based crop monitoring to increase resilience in the face of
global food insecurity, 2-5 July 2024, Nigeria**



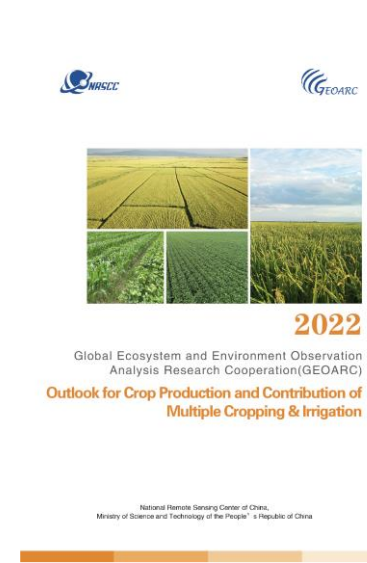
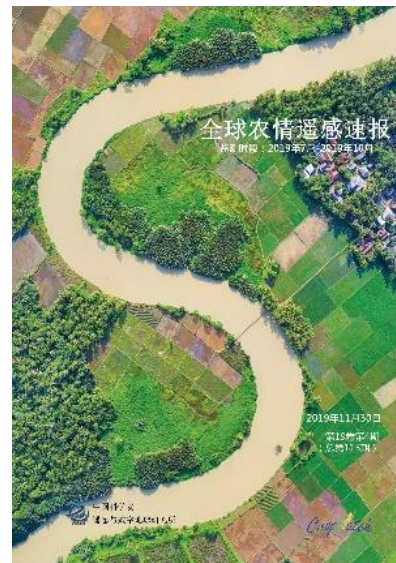
Outlines

- CropWatch Cloud and the methodologies
- Updates
 - Service modes
 - New tools for field data collection
 - Baseline dataset
 - User defined crop monitoring
- Conclusion remarks



CropWatch Cloud

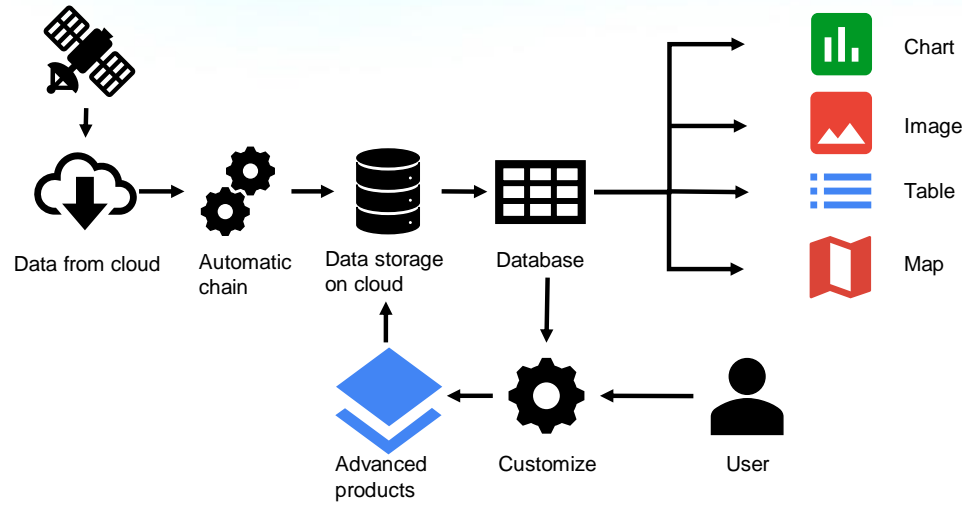
- CropWatch is a satellite-based hierarchical method of crop monitoring, with indicators of agro-climatic, agronomics, area, yield and production, earlier warning
- Release Quarterly and annually bulletins on global crop monitoring, covering 173 countries and regions down to provincial scales, with special focus on 47 key agricultural countries



-  **CropWatch-Pro**
• An online tool for people to produce crop monitoring products at any time and anywhere.
[Enter](#)
-  **CropWatch-Explore**
• An online interface for people to explore and analysis all the crop information data easily.
[Enter](#)
-  **CropWatch-Project**
• An online platform for people to create and write the crop bulletin.
[Enter](#)
-  **CropWatch-Bulletin**
• An webpage for people to read CropWatch bulletin.
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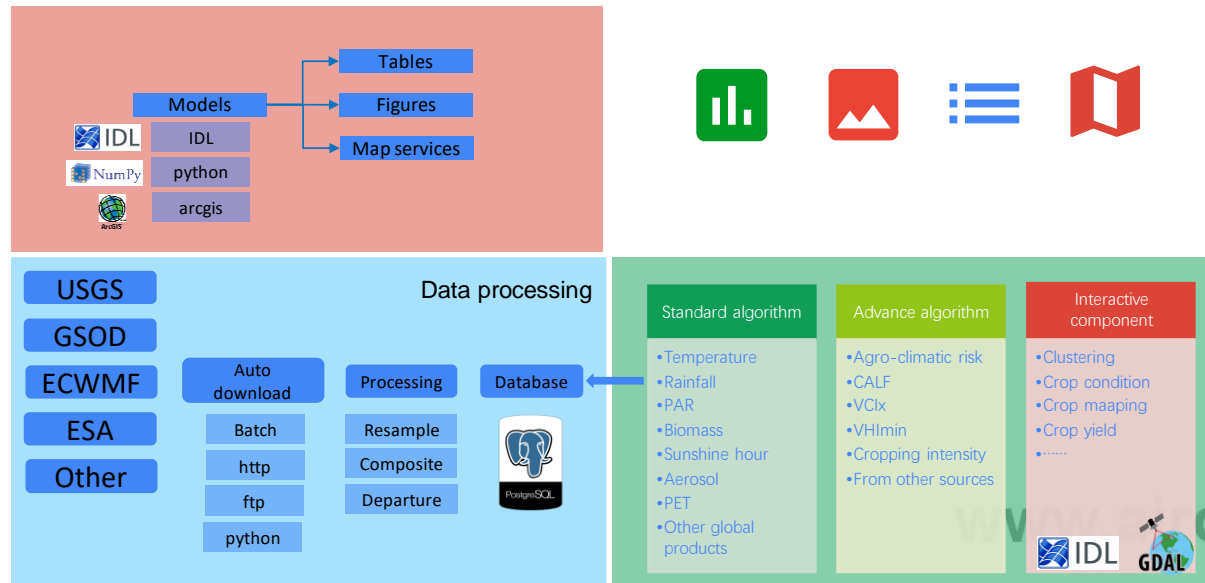
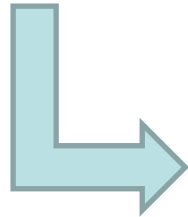


Auto data fetching and preprocessing



Automatic fetching

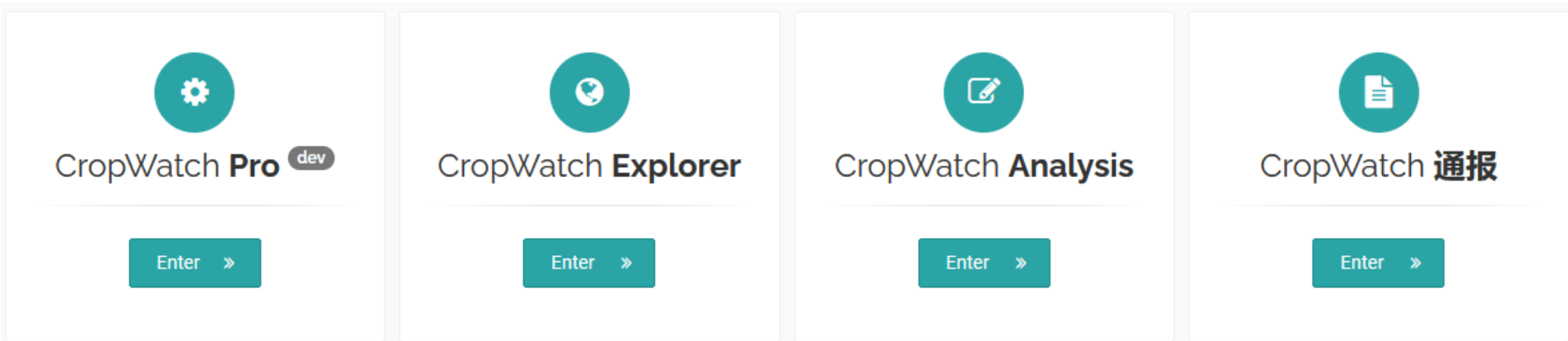
Auto preprocessing





CropWatch Components

- ***CropWatch-Pro***: to produce crop indicators at any time and anywhere
- ***CropWatch-Explorer***: to explore and download crop information
- ***CropWatch-Analysis***: to analyze crop information jointly or individually
- ***CropWatch-Bulletins***: an web page for release bulletins, and methods



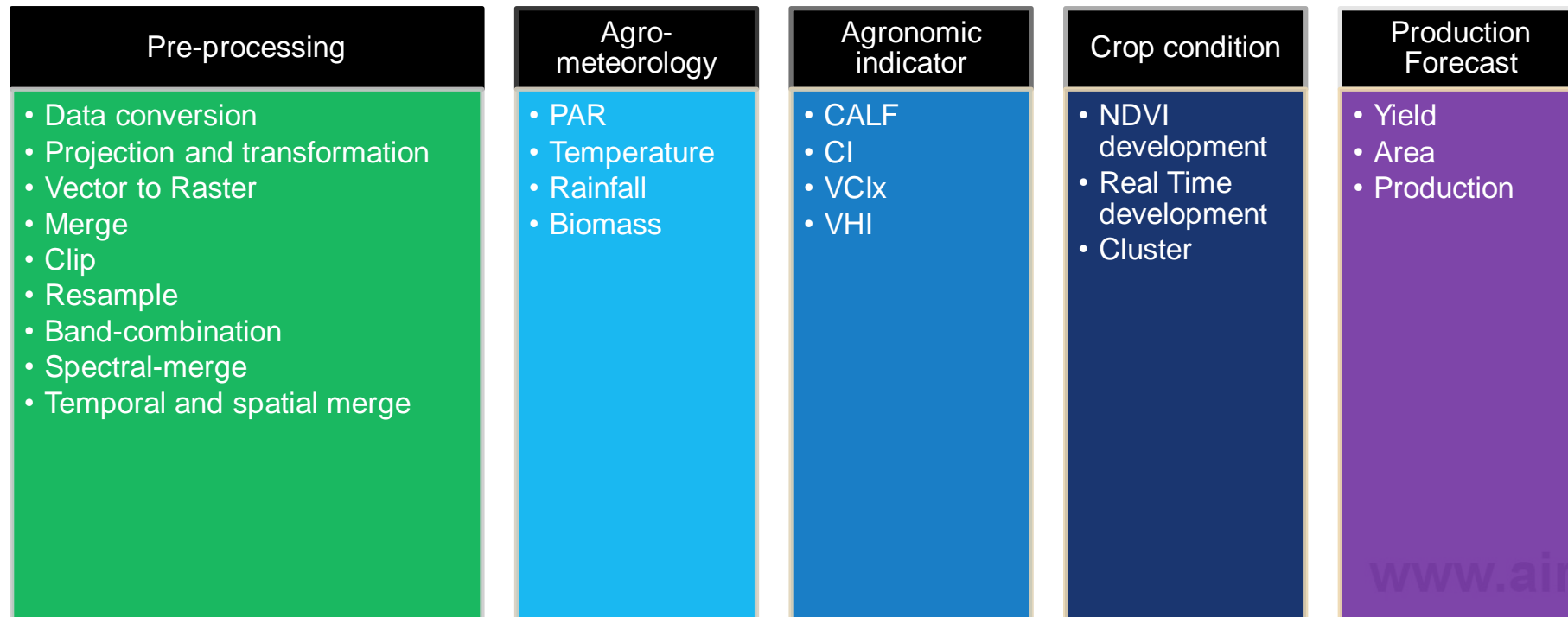
cloud.cropwatch.com.cn

www.aircas.ac.cn



Component 1: CropWatch Processing

- CropWatch Processing offers an auto-processing chain from pre-processing of raw data to production outlook
- CropWatch generates 32 agro-climatic, agronomic, early warning indicators, and crop production (area, yield) and early warning,
 - Drought indices are included, spi, spei, vci, tci and vhi, cdwi,

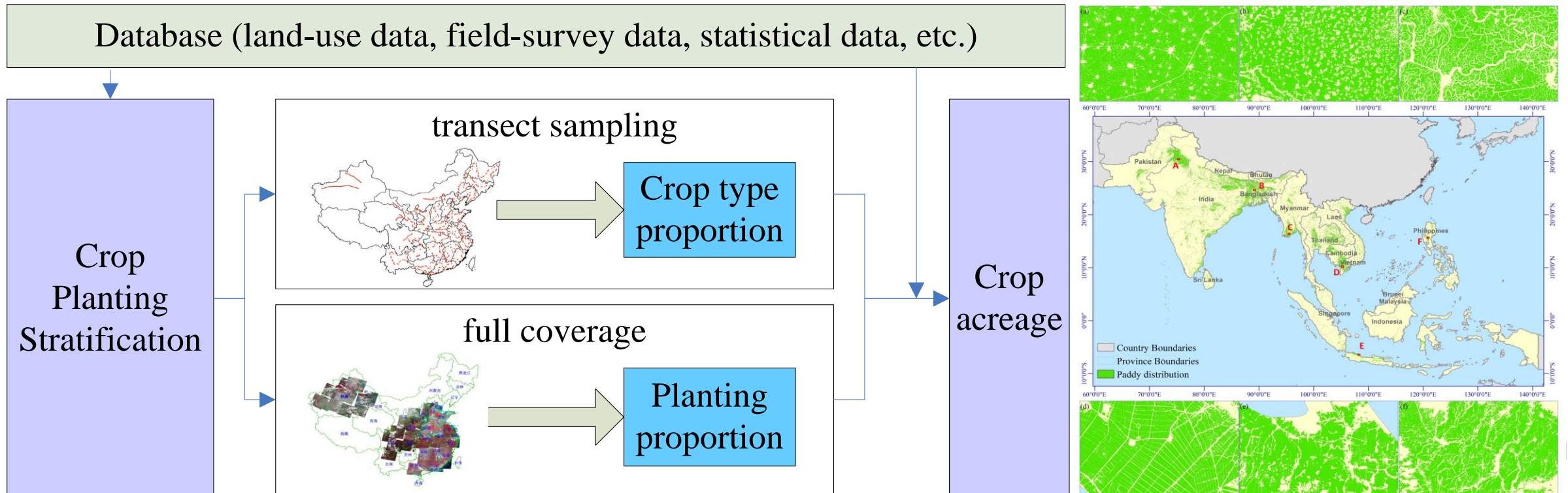




Crop Areas

- Crop area information needs field data
- CropWatch integrates crop area estimation with geo-statistics & crop mapping
 - The CPTP method in complex agricultural landscapes (66%)
 - Transfer learning methods are integrated to reduce the reliance on in situ data (34%)

$$\text{Crop type area} = \text{Cropland area} * \text{UEC} * \text{cropping proportion} * \text{crop type proportion}$$



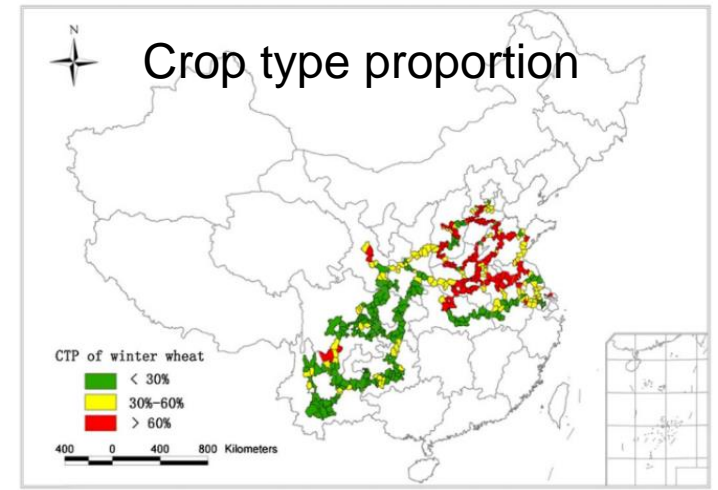
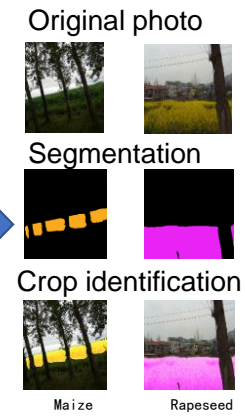
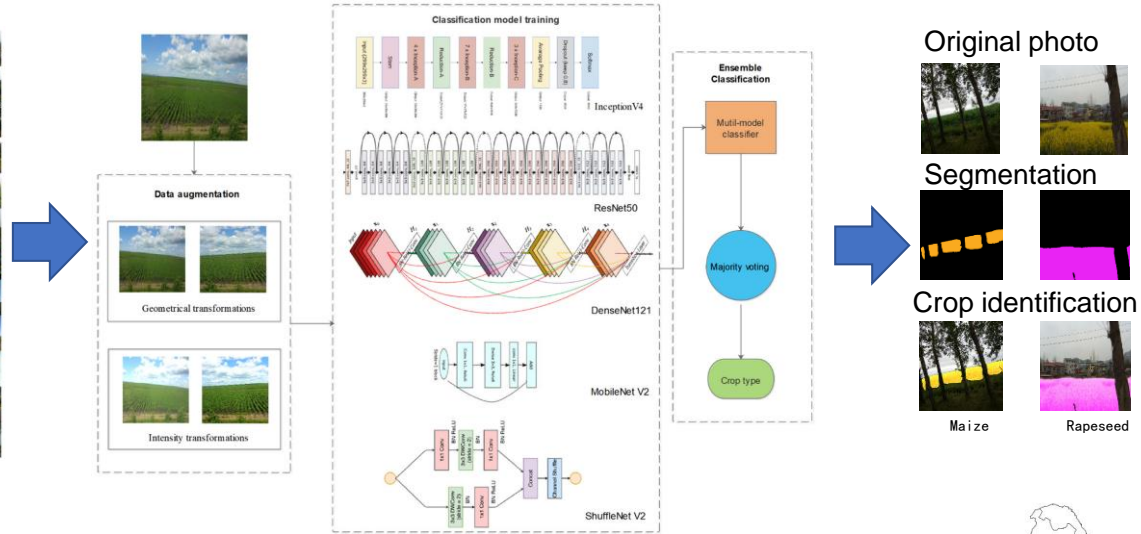


Area estimates at fragmented areas

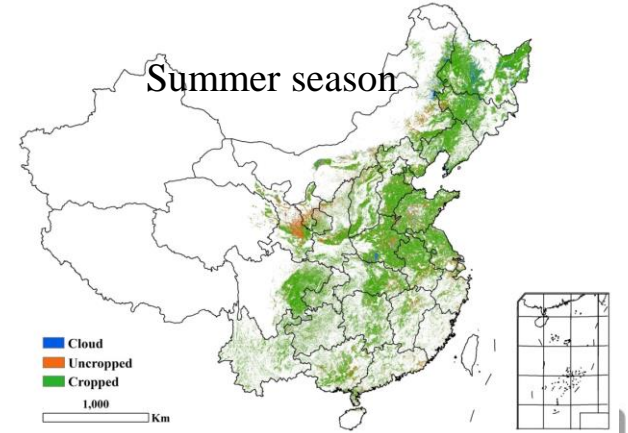
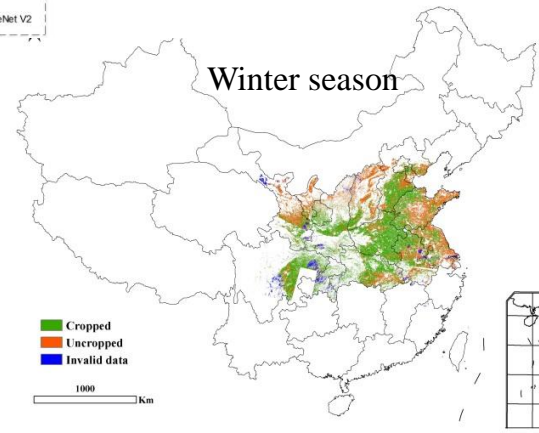
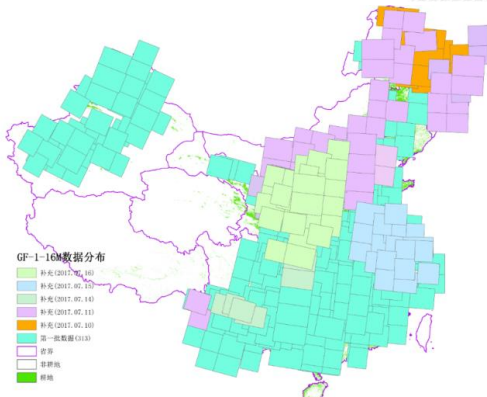
- Fully automated objects identification from massive photos by integration of multiple deep learning networks
- Currently major crops such as wheat, soybean, rice, maize, rapeseed could be precisely identified



Wu et al., 2021



Remote sensing-based identification of cropped and fallow fields



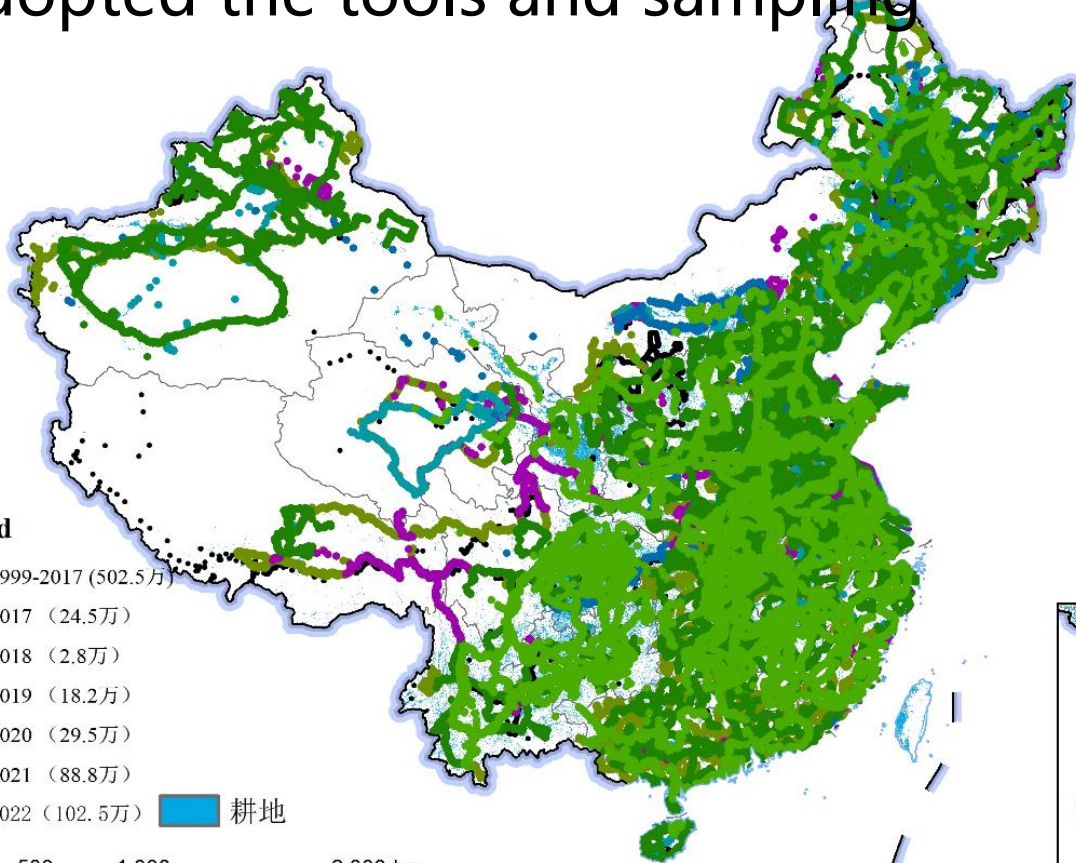
$$\text{Crop type area} = \text{cropland area} * \text{cropping proportion} * \text{crop type proportion}$$



Crop type proportion sampling

China: Millions of samples collected every year

Global application: More than 20 countries already adopted the tools and sampling



UNCTAD Innovation @UNCTAD · 20h ·
 #Kenya completed the first field study on crop growth monitoring and yield prediction, under the #UNCTAD-#China Academy of Science #CropWatch Innovative Cooperation Programme. unctad.org/project/cropwa...

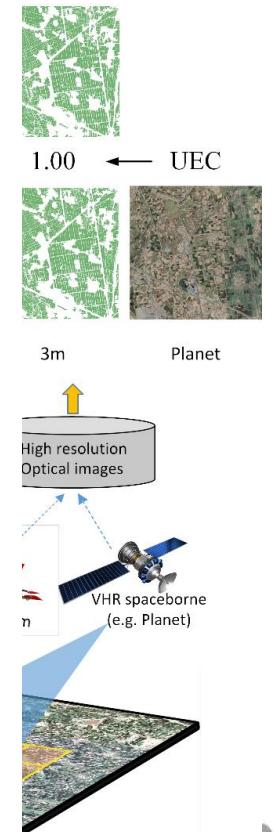
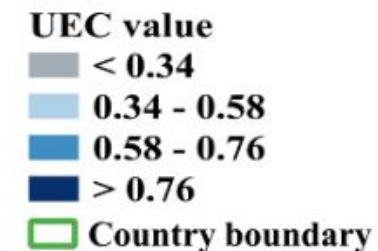
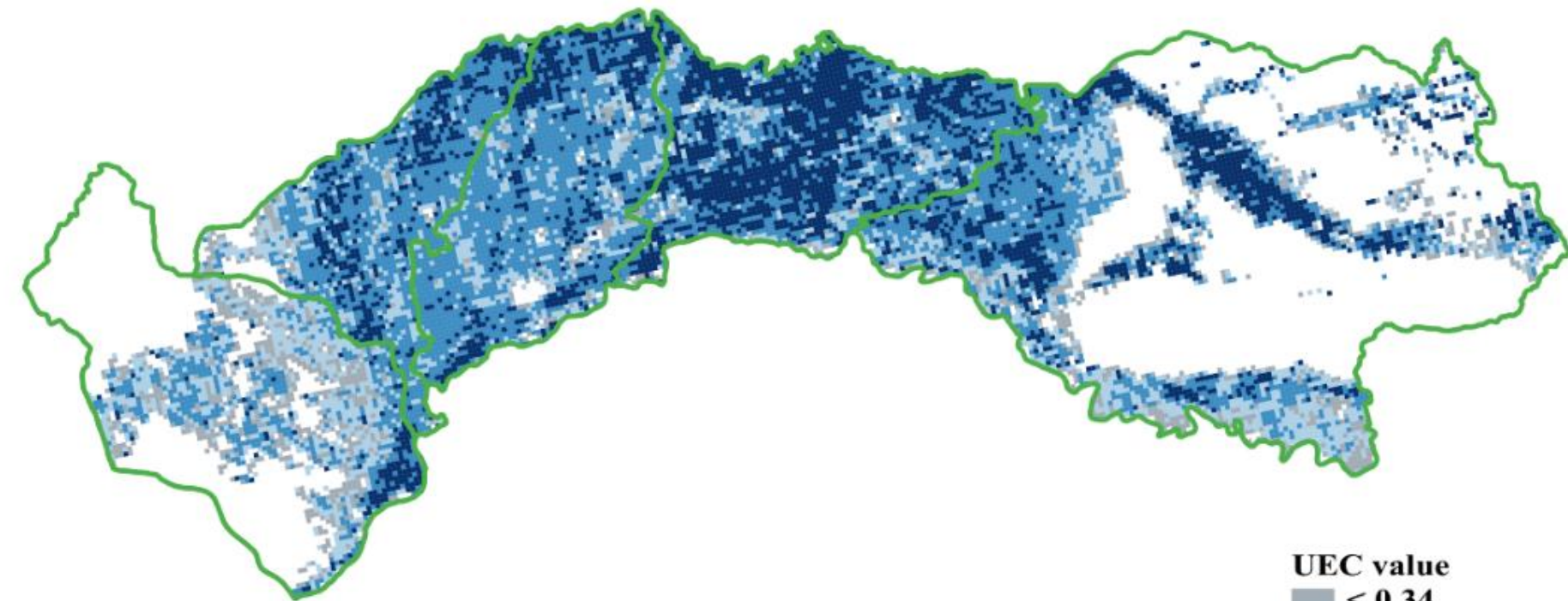
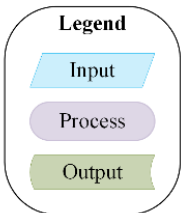
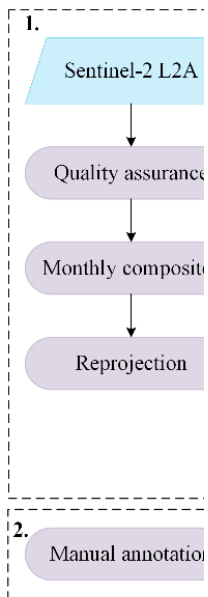


全球推广应用



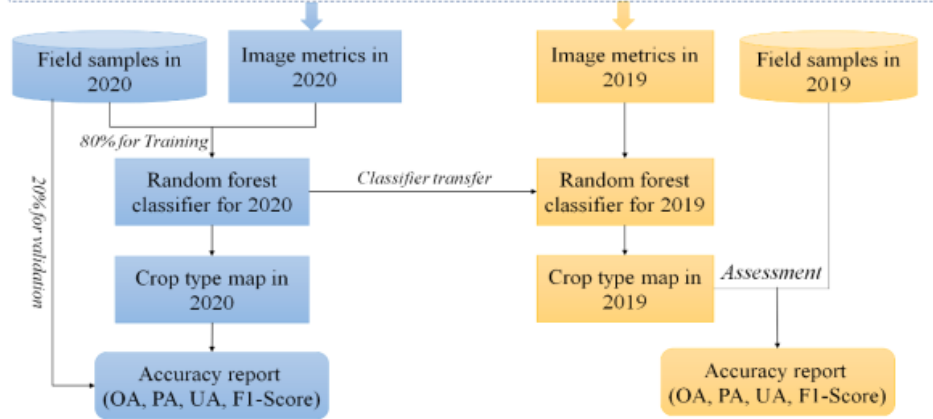
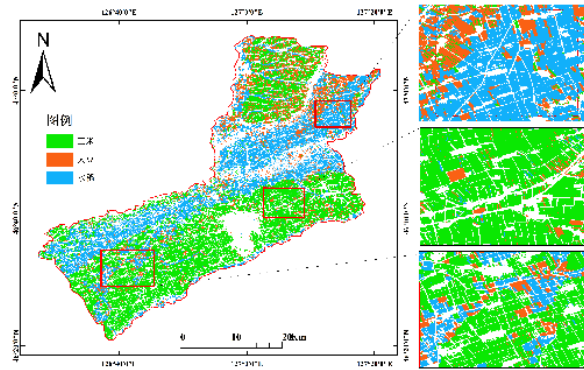
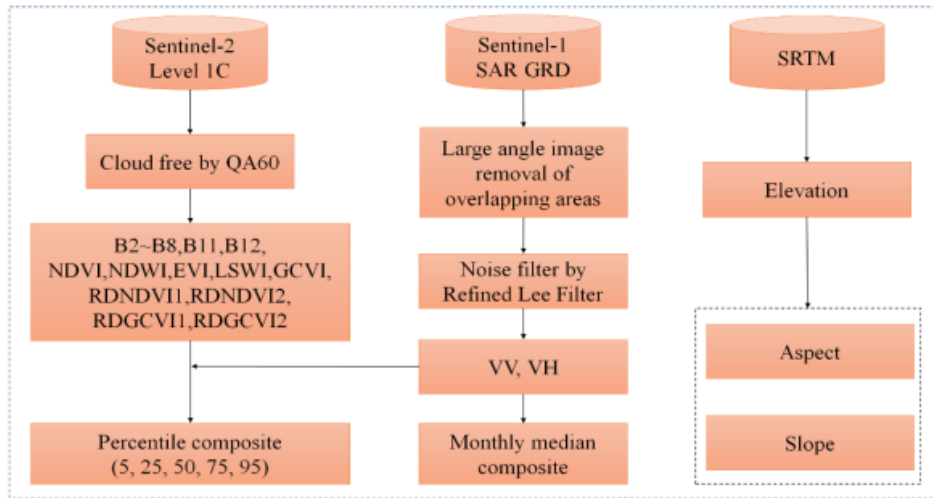
Unbiased estimating coefficient for existing cropland datasets

Due to both scaling effect and classification errors, we propose a method for accurately estimating cropland area using the unbiased estimating coefficient (UEC) from existing cropland datasets

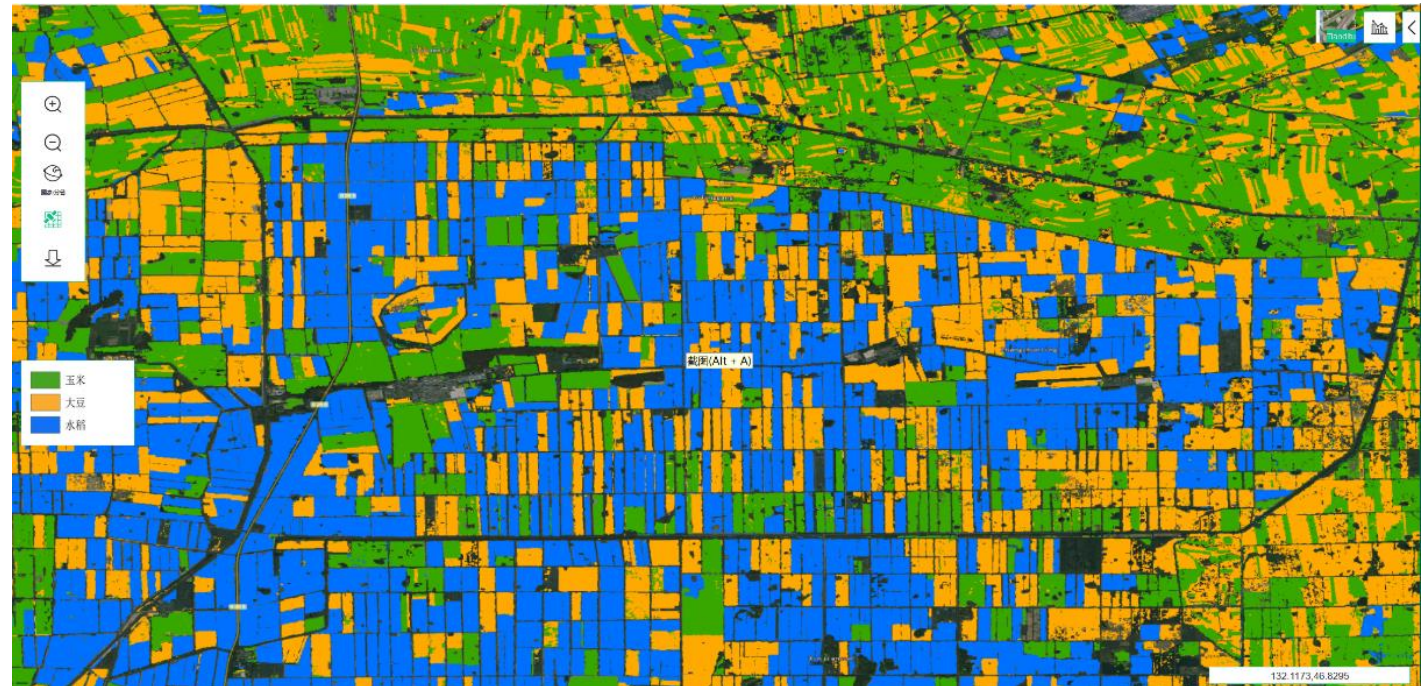




High resolution crop type monitoring services

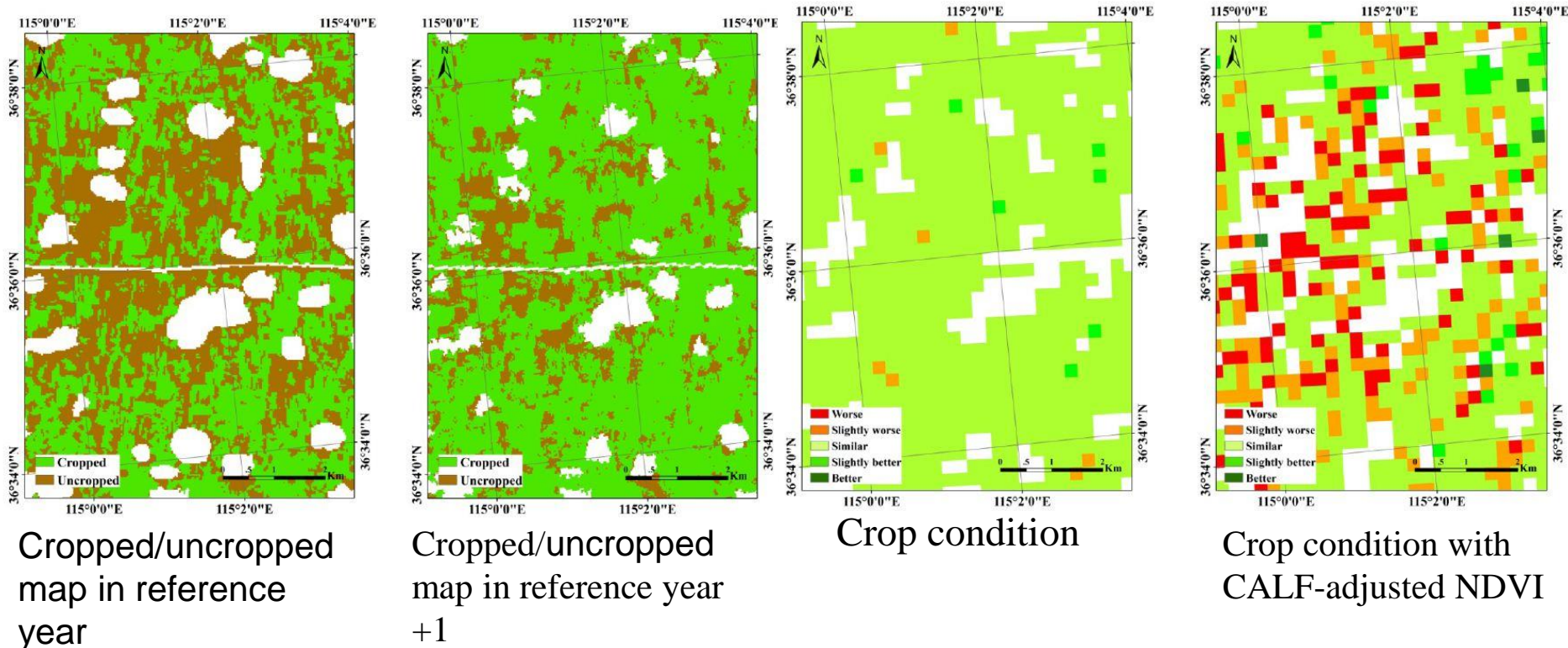


- Legend**
- Generation of metrics
 - Classifier training and crop classification in 2020
 - Classifier transfer and crop classification in 2019



Crop Condition

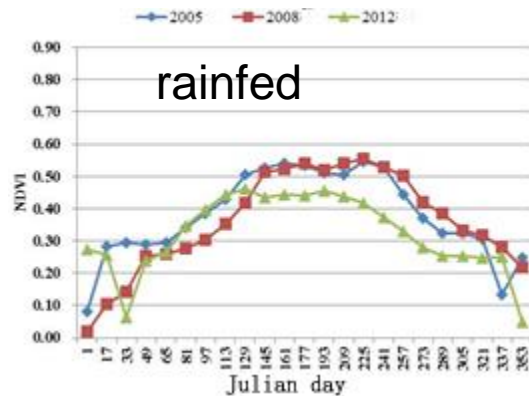
- adopting NDVI adjustments characterizing crop rotations or interannual phenological shifts, and this omission results in misleading information.



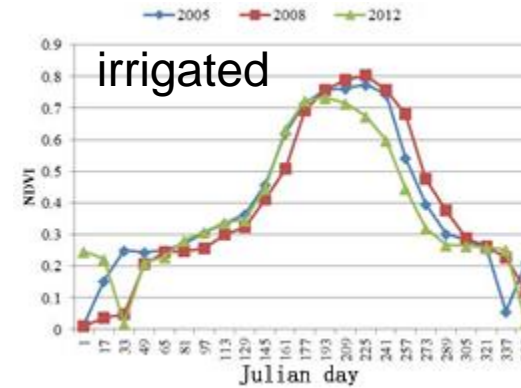


Crop Condition by separating irrigation and rainfed fields

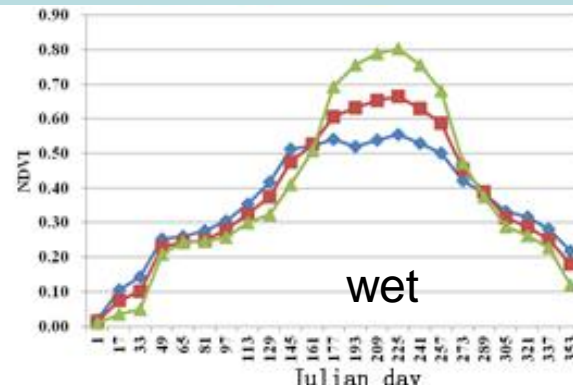
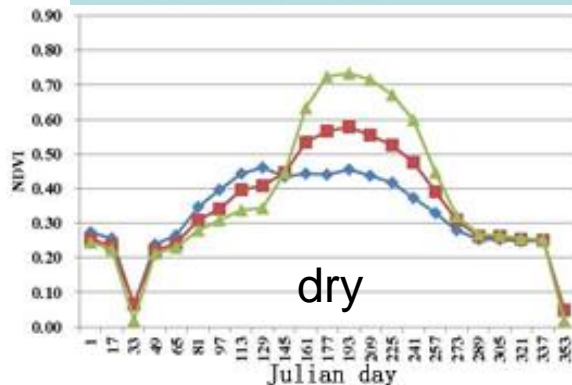
- Improve condition monitoring by separating irrigated and rain-fed arable land



Wet year: 2005
Normal year: 2008
Dry year: 2012.



The difference of crop condition between rainfed and irrigated fields: Because of sufficient water, crop condition and production remain stable in irrigated areas, while they fluctuate between wet and dry years in rainfed areas.

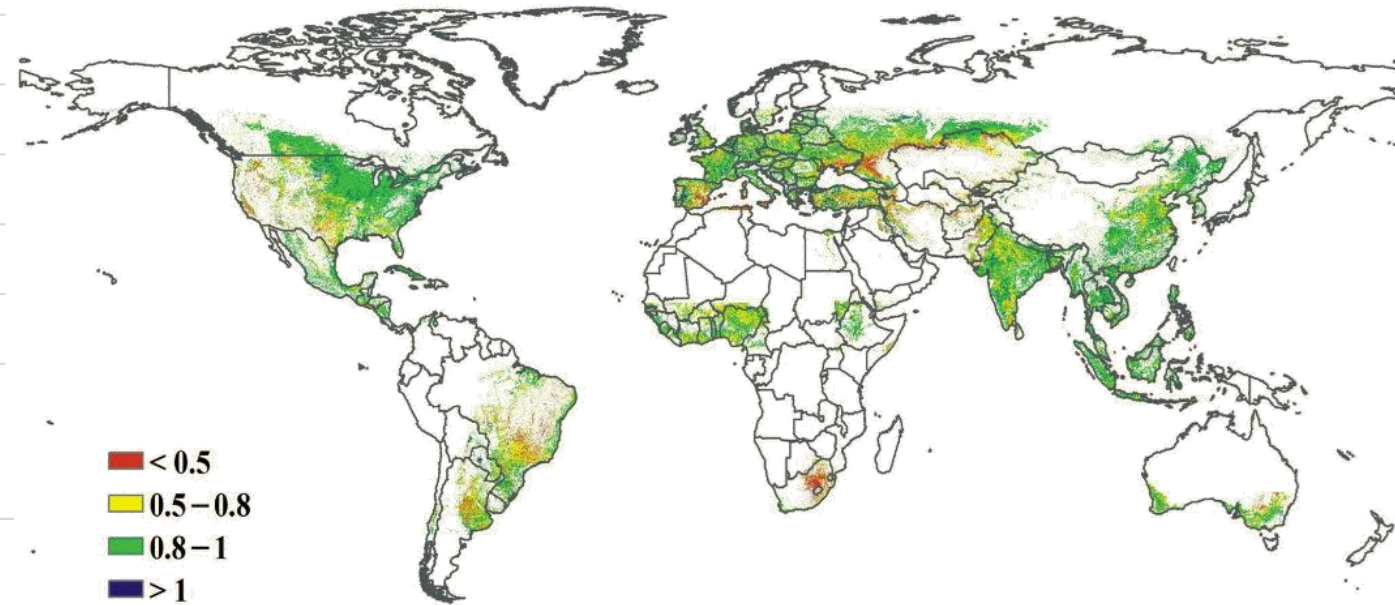
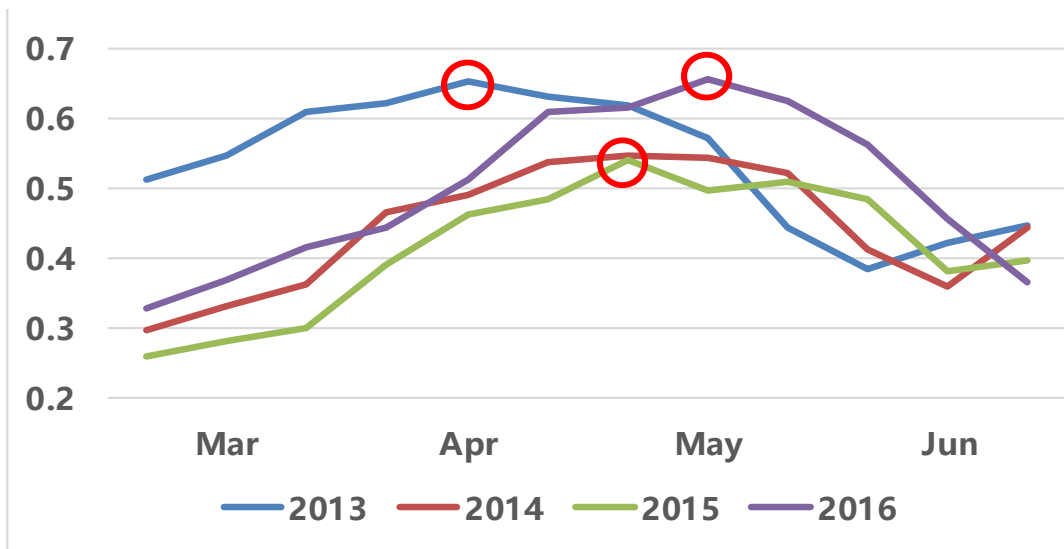


Rainfed: Blue
Irrigated: Green
Mixed: Red



Seasonal maximum vegetation condition index

- VCIx is designed to eliminate the impacts of the crop phenology shifts between years and at different latitude
 - VCIx compares peak of vegetation index profile with the historic peak over the same growing season
 - VCIx is at range of [0, 1], where the high values are better crop condition and low values indicate worse crop condition

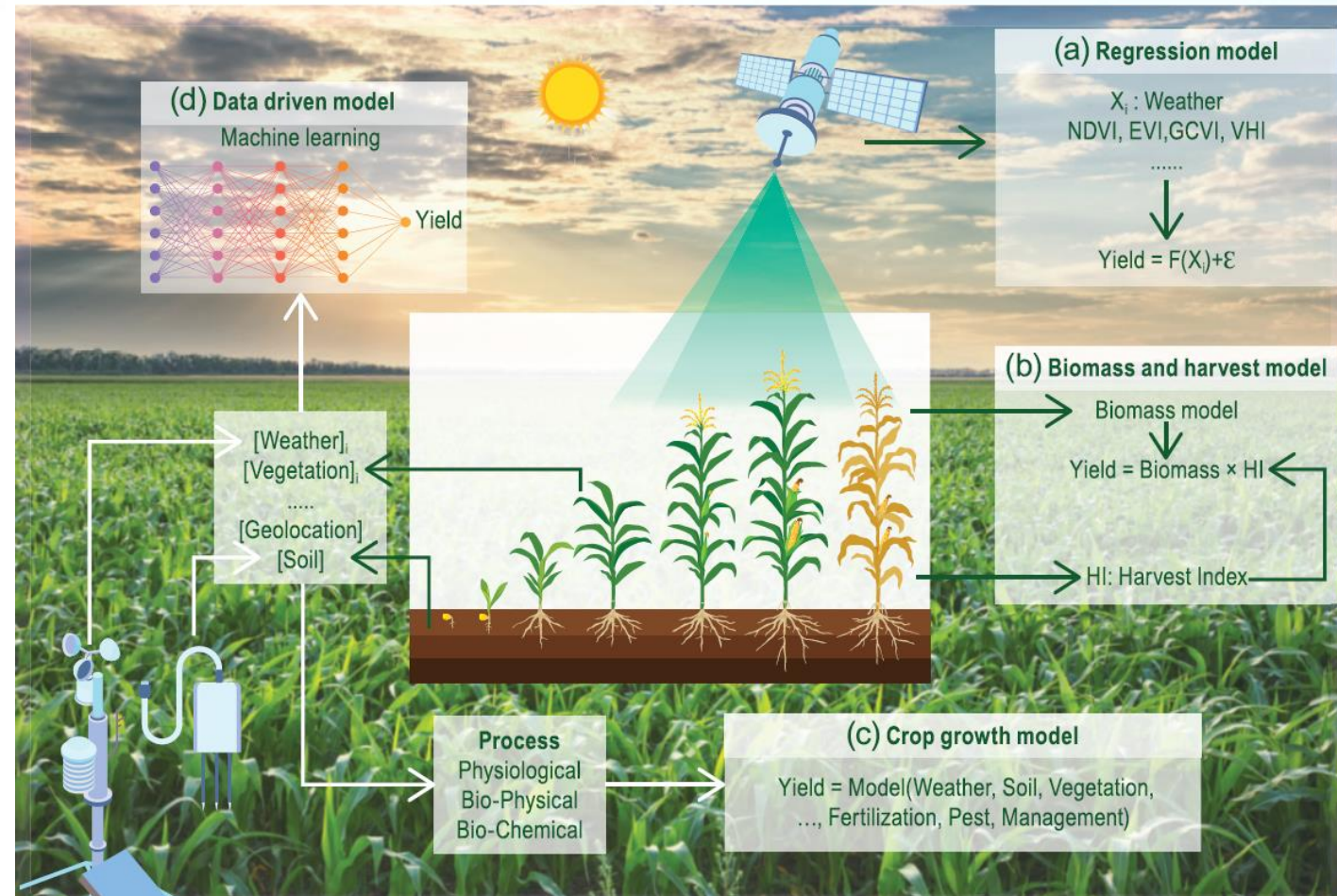


$$VCIx = \frac{NDVI_{max_c} - NDVI_{min_h}}{NDVI_{max_h} - NDVI_{min_h}}$$



Yield models

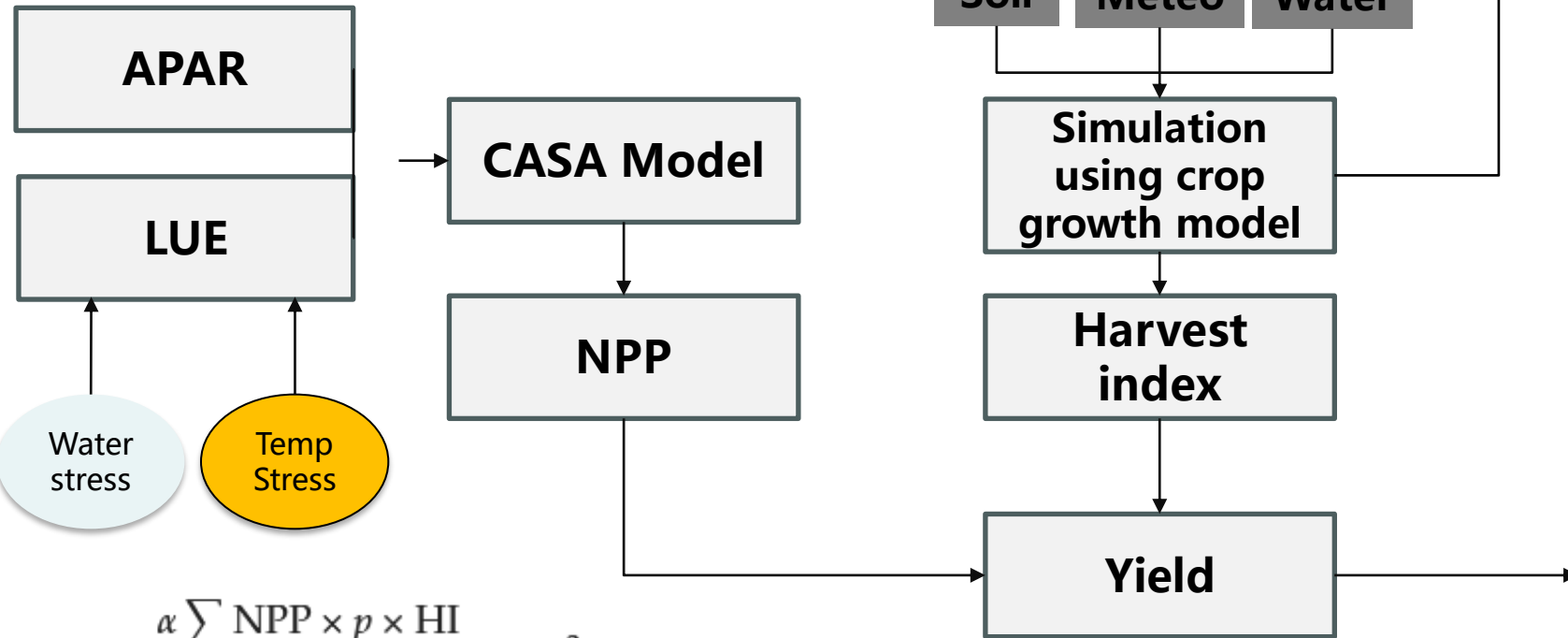
- Yield prediction component is the weakest component in crop monitoring
 - VI saturation leads to poor performance when predicting yields, especially in dense or irrigated crop regions.
 - VIs have not precisely captured crop yield determinants, especially under extreme climatic conditions.
 - The uncertainty of current crop growth models makes it difficult to scale up to facilitate operational yield predictions.
- 4 types yield models are developed and integrated into CropWatch to reduce the uncertainty of yield prediction
 - Agro climate
 - VIs
 - Biomass-harvest
 - Machine learning





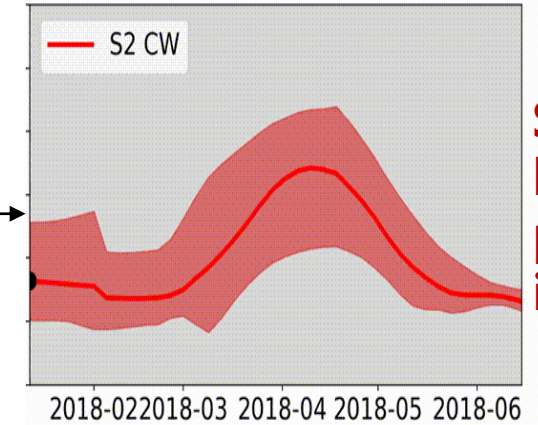
Biomass - harvest index model for yield

- A light use efficiency model was used to integrate environmental factors and the characteristics of vegetation to calculate crop biomass
- Harvest index is simulated by crop growth model under stress

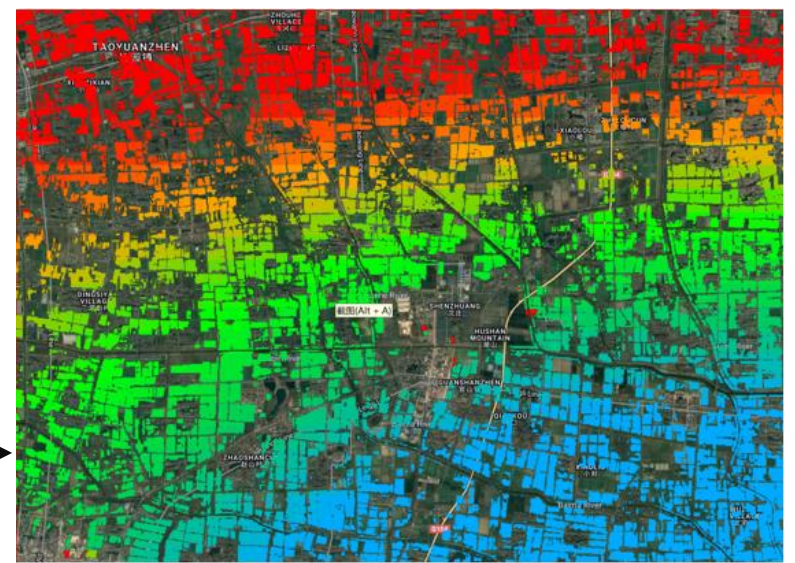


$$\text{Yield} = \frac{\alpha \sum \text{NPP} \times p \times \text{HI}}{1 - \omega} \times 10^{-2}$$

$$\text{NPP}(x, t) = \text{APAR}(x, t) \times \epsilon(x, t)$$



Simulate biomass partitioning



小麦单产(kg/ha) 4290 - 4339

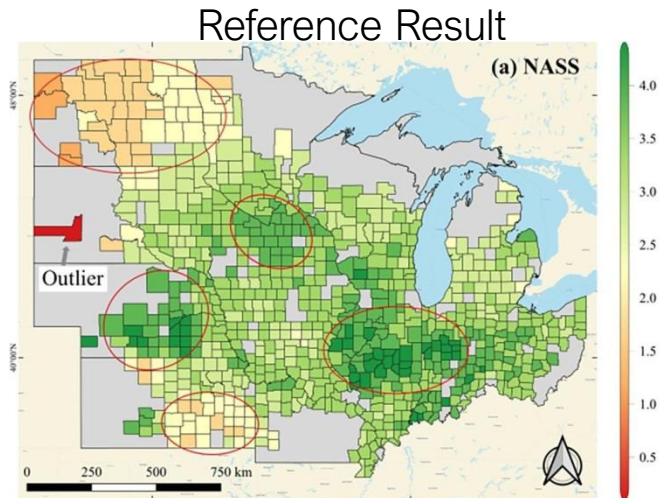
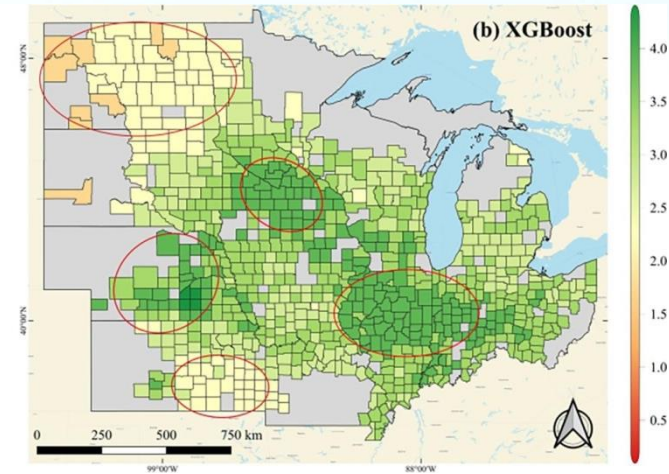
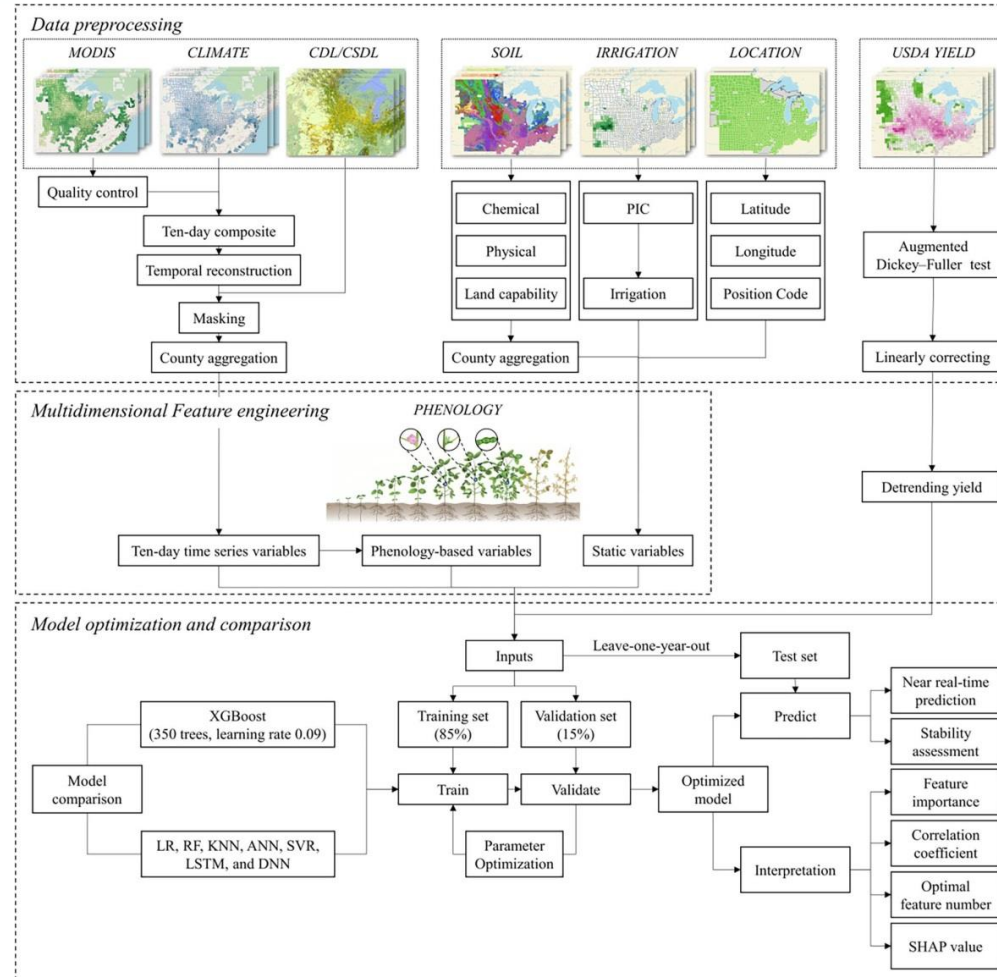
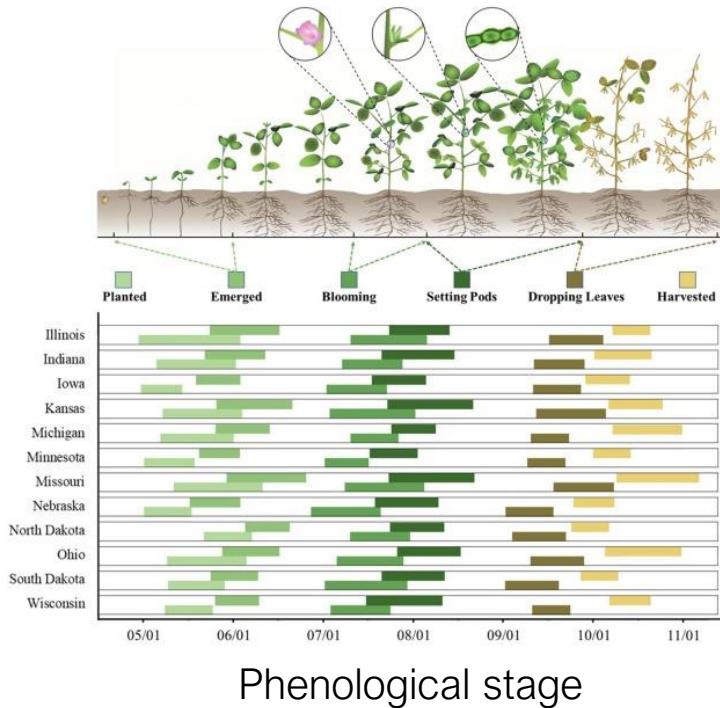


Data Driven Model for yield prediction

Yield = Function(climate, soil, vegetation, management)

Function: ML or DL

X: climate, soil, veg, management variables at different phenological stage.



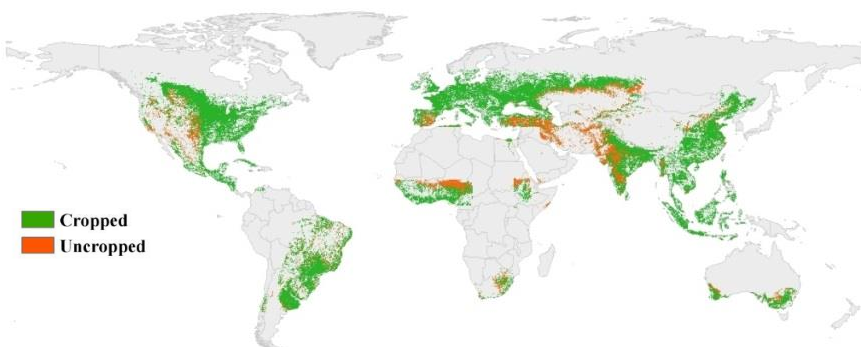
Predicted result
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Flowchart of Data Driven

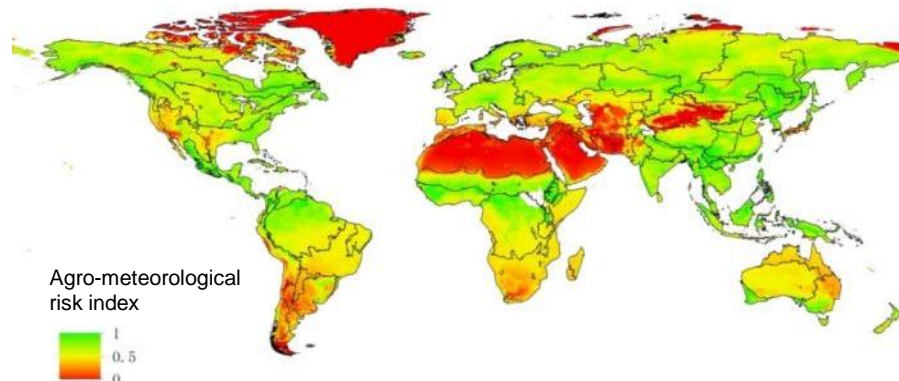


Early warning indicators

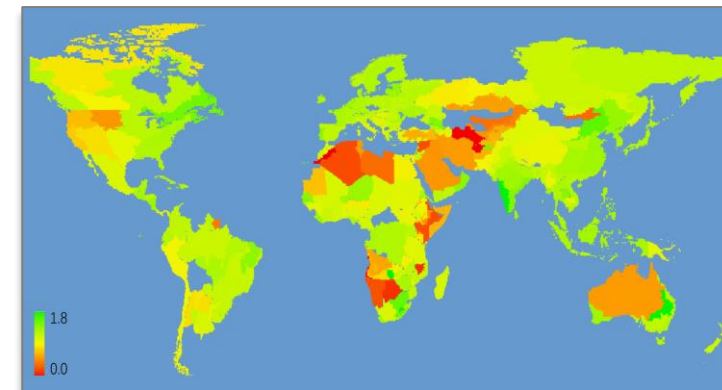
- Cropped arable land fraction (CALF) represents the total cropping proportion at early growing stage
- Agro-meteorological risk index (AMRI) considering meteorological suitability for crops at different growing stage is used for yield alarming
- Crop production index (CPI), integrating cropping area, condition, irrigation, intensity, productivity



CALF



AMR

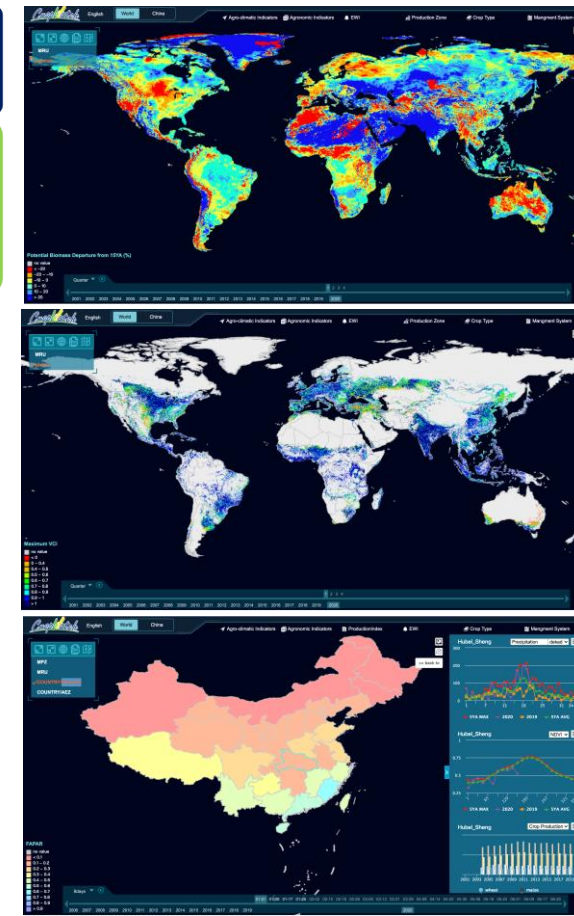
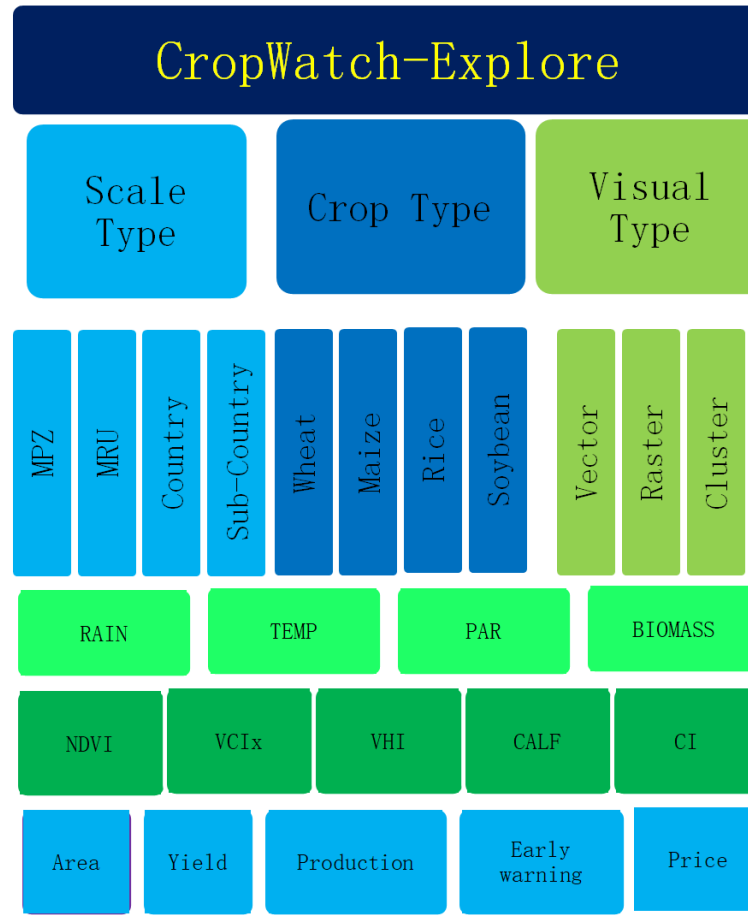
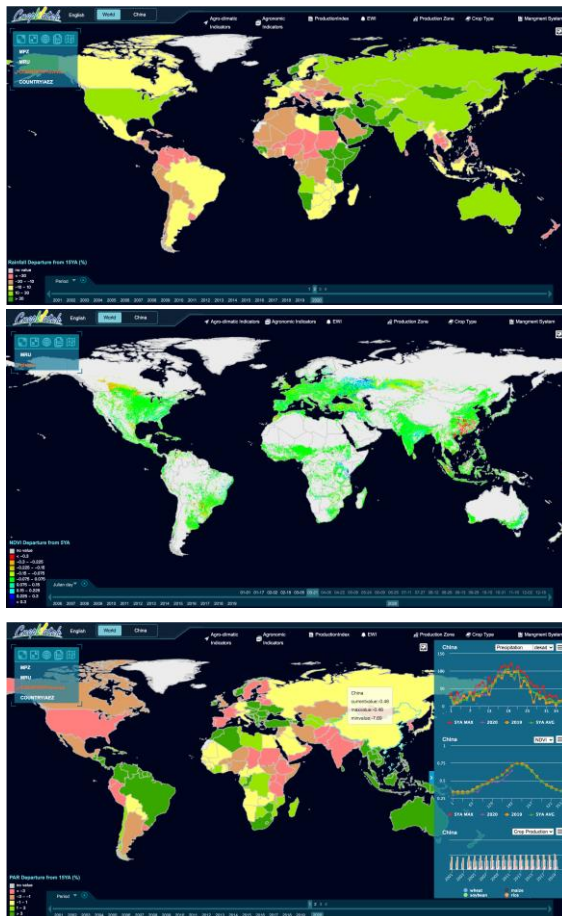


CPI



Component 2: CropWatch Explore

CropWatch-Explore explore and visualize data products in vector, raster, global, country, districts, crops, indicators....





Component 3: CropWatch Analysis

- CropWatch Analysis is cloud based participatory platform for individuals or team from over the world analyzing CropWatch indicators for the global, a country or IOA to better use local knowledge.
- It provides create document, allocate and manage tasks, monitor schedule and publish the document online functions which let people over the world finish their documents together on the cloud platform.



CropWatch Team



Experts across the world



Author assignment and analysis

Home > Reports > August 2018 CropWatch bulletin

August 2018 CropWatch bulletin

Changsheng created at 2018-08-06 15:48:43 · current status is Created

Executive summary

#	Section	Author	Status	Options
1	Executive summary	zenghongwei rene	Published	

Global agroclimatic patterns

#	Section	Author	Status	Options
1	Global agroclimatic patterns	rene mshirbeny	Published	

Crop and environmental conditions in major production zones

#	Section	Author	Status	Options
1	Overview	yann	Published	
2	West Africa	ephin	Published	
3	North America	zenghongwei	Published	
4	South America	deabelle	Published	
5	South and Southeast Asia	mshirbeny	Published	
6	Western Europe	zhuweiwei	Published	
7	Central Europe to Western Russia	xingqiang	Published	

Main producing and exporting countries

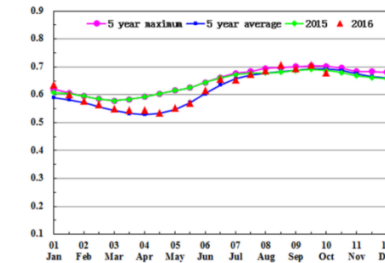
#	Section	Author	Status	Options
1	Overview	rene	Published	
2	Country analysis	Changsheng	Published	
3	Argentina	deabelle	Published	
4	Australia	xingqiang	Published	
5	Bangladesh	mshirbeny	Published	
6	Brazil	Miao	Published	
7	Canada	zhaodan	Published	
8	Germany	zhuweiwei	Published	
9	Egypt	Mohsen	Published	

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.

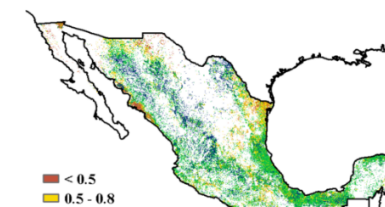
The CropWatch agroclimatic indicators show that rainfall and temperature separately dropped below average by 9% and 0.2°C while RADPAR increased by 2%. Consequently, BIOMSS was below average by 6%. In contrast, CALF and cropping intensity increased respectively by 5% and 3%. The map of spatial patterns 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 3.20. Mexico crop condition, July-October 2016



(a) Crop condition development graph based on NDVI





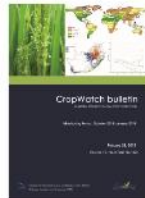
Component 4: CropWatch Bulletin

Provide global crop report as pdf or html format



Home >> Bulletin >> February 2019 CropWatch Bulletin (Vol. 19, No. 1)

February 2019 CropWatch Bulletin (Vol. 19, No. 1)



This bulletin features the latest production outlook for the major producers in the southern hemisphere and some isolated northern hemisphere countries where crop development is sufficiently advanced. Focusing on the months of October 2018 to January 2019, chapters cover global, national, and regional-level agroclimatic conditions and the condition of crops that were growing or harvested during this time. For China, the bulletin presents crop conditions for each of seven key agro-ecological zones. The focus section reports on recent disaster events with an impact on agriculture, the possibility of an El Niño event.

Full report

报告全文

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Key messages from the report:

- Agro-climatic patterns over agricultural areas: global rainfall was above average (4%), temperature was below average (-0.1°C), and sunshine was 1% above average. Most below average rainfall areas with deficits more severe than 20% are consistent with El Niño patterns.
- Agronomic indicators: Unfavorable conditions were observed in Romania (significantly below average Cropped Arable Land Fraction, CALF), Turkey, Ukraine, Kazakhstan, Pakistan, Mongolia, Morocco, Zambia and Mozambique show large increases in CALF. High Maximum Vegetation Condition Index (VCI) values, indicating favorable crops, occur mostly in Asia. The situation is mixed in Afghanistan (with lowest VCI at 0.45 among 42 key countries, but 25% above average CALF).
- China: agro-climatic conditions were generally below average with deficits of rainfall (7%) and sunshine (6%). Temperature was average but the nationwide CALF fell 2% below the average value of the previous five years.
- Production outlook: the reporting period saw the harvest of wheat in the Southern Hemisphere. Production of maize in Argentina and Mexico is above last year's output (8% and 21%, respectively) while South Africa suffered a marked drop (-14%); production of wheat in Australia suffered a marked drop as well (-13%), and so did Argentina (-3%).

Introduction

This CropWatch bulletin summarizes global crop condition developments and agroclimatic factors from October 1, 2018 to January 31, 2019 through 4 zoom in from a global overview of agroclimatic indicators (Chapter 1) to detailed descriptions of crop and environmental conditions in large production zones (Chapter 2), to individual country analyses covering 42 major producers and exporters including agro-ecological zones (Chapter 3) and China (Chapter 4). A special focus section is included in Chapter 5, covering crop production for 2018-2019 for countries in Southern Hemisphere, disaster events, and an update on El Niño. This first part of the report includes the cover, table of contents, abbreviations, a short overview of the different sections of the bulletin and executive summary.

Download

Introduction



Menu

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FEBRUARY 2019 CROPWATCH BULLETIN

All Summary cropwatch

South and Southeast Asia Crop and environmental conditions in major production zones

Author: zhaost, mshwDenny, editor: neme

Satisfactory crop condition prevailed over the South and Southeast Asian MPZ during the monitoring period with the maximum Vegetation Condition Index (VCI) reaching 0.66, even if the biomass production potential (BIOMSS) was 8% lower than the 5-year average. The fraction of cropped arable land (CALF) was average. Most uncropped arable land occurs in India. RAIN was well below average (-20%) but both temperature and photosynthetically active radiation were slightly above average (TEMP +0.1°C, RADPAR +2%).

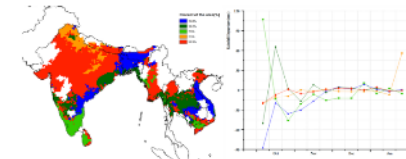
Some national RADPAR values had significant positive anomalies as for instance in the Philippines (+7%) and Cambodia (+6%). Myanmar recorded a slight negative anomaly (RADPAR -1%). Other countries recorded positive values but close to average. TEMP stayed close to average; Sri Lanka and Indonesia recorded negative departures (0.6°C and 0.4°C respectively), while Vietnam and Thailand were both slightly warmer (0.5°C) than the average. The largest anomalies occurred at the beginning of the reporting in central India (close to +3°C anomaly in and around Madhya Pradesh, about +2.5°C anomaly in and East of Thailand). Close to average temperature prevailed throughout the monitoring period from western Myanmar across Bangladesh to most of northern India.

For RAIN, the largest anomalies were those of Nepal (-48%), Bangladesh (-38%), India (-35%) and the Philippines (-25%) as well as Myanmar where excess precipitation was recorded (+22%). Most anomalies occurred at the beginning of the reporting period in October, with the largest excesses in southern India, Sri Lanka and the Mekong Delta area, and deficits in coastal Andhra Pradesh, Bangladesh and central Vietnam.

As a reflection of the agro-climatic conditions during the reporting period, the biomass accumulation potential fell below the reference of the 5YA. The largest BIOMSS departures are those in India (-24%), Philippines (-18%), Bangladesh (-18%), Myanmar (+24%), Vietnam (+23%) and Thailand (+20%).

Low values of VHI minimum were recorded mainly in India, Cambodia, Thailand, and Myanmar. Maximum VCI appeared mainly in India and Thailand.

Figure 2.4. South and Southeast Asia MPZ: Agroclimatic and agronomic indicators, October 2018 – January 2019.





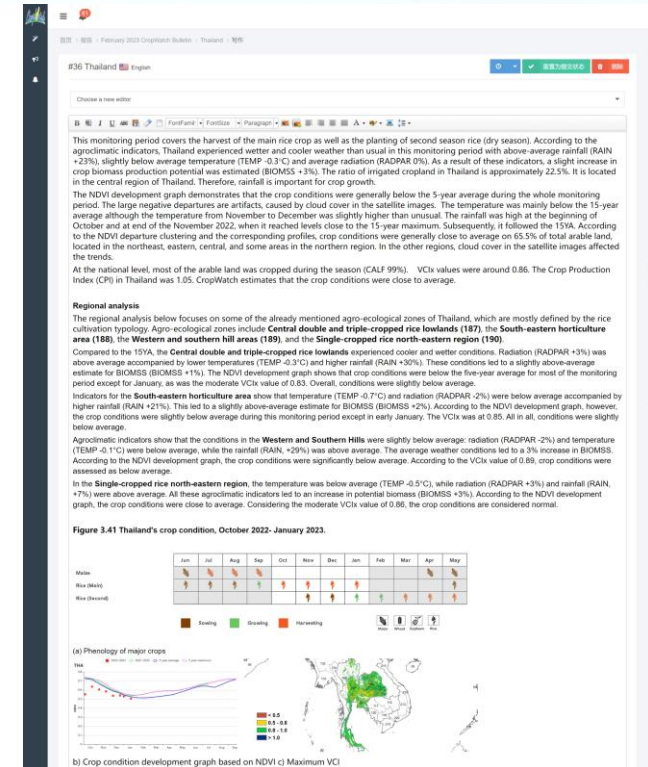
Outlines

- CropWatch Cloud and the methodologies
- Updates
 - Service modes
 - New tools for field data collection
 - Baseline dataset
 - User defined crop monitoring
- Conclusion remarks



Service modes

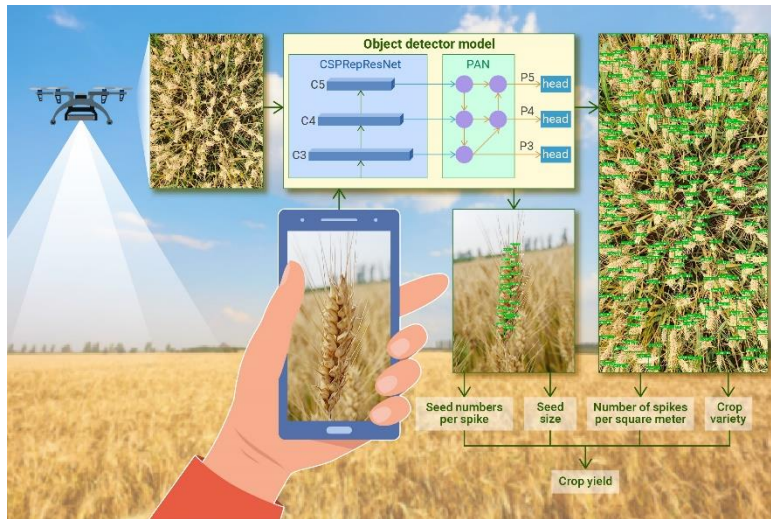
- Customization of CropWatch and/or development of CMS for specific needs (Mozambique),
- data processing engine and download for local services (Thailand),
- independent analysis for a country or IOA (Argentina, Cambodia, Mongolia)
- Reducing the cost and technical barrier of establishing CMS



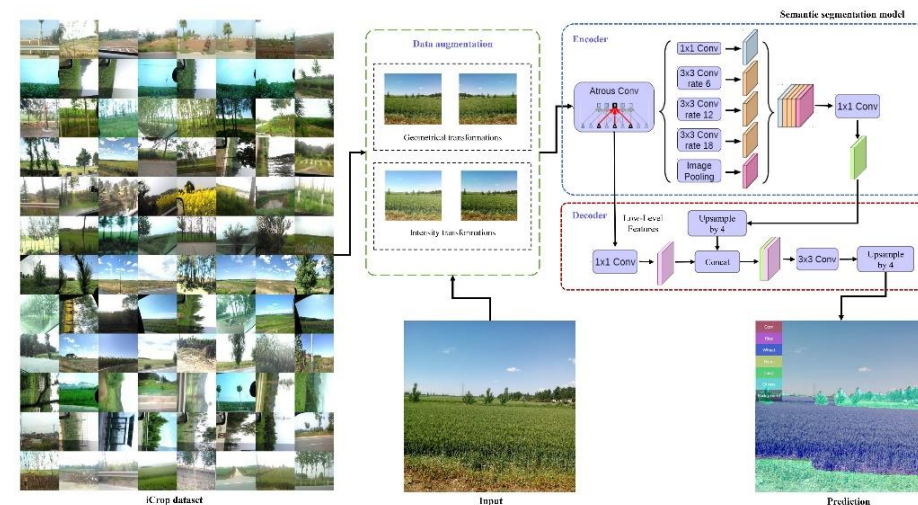


Tools for ground truth data collection

- The field data collection prevents most systems have crop area and yield components
 - Cost, labor and time consuming
- Two tools developed for free use
 - GVG app for crop identification and FieldWatch for yield measurement with image recognition



FieldWatch for yield data measurements

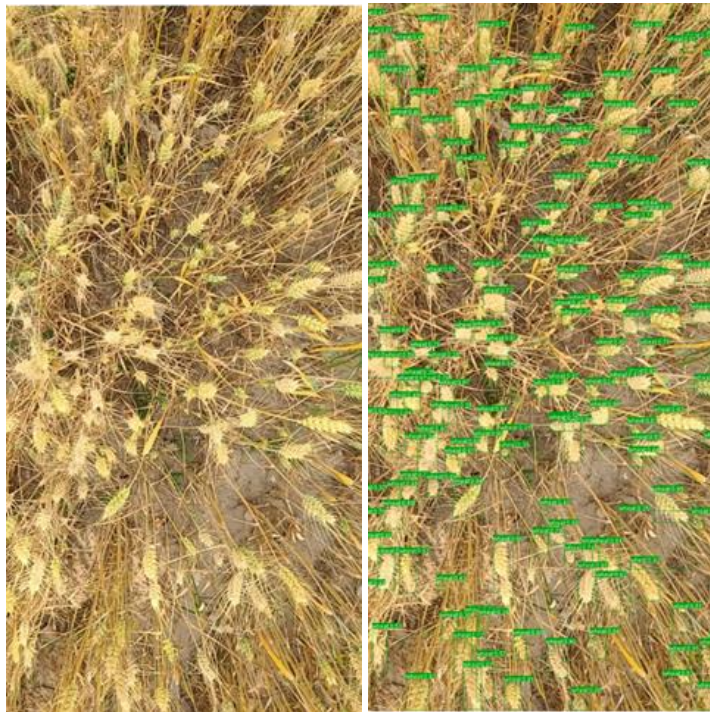


GVG Crop type identification from geo-tagged photos



FieldWatch for yield data collection

- With the support of the DL model, the number of ears/m², and seed number per ear, size of seed are determined for crop yield estimation with accuracy of 92%
- FieldWatch supports disease identification, parcel crop condition and production



< 产量预测-分析结果

分析结果

作物类型:小麦

作物品种:大兴

产量:45517.25(公斤)

单产:580.78(公斤/亩)

俯拍谷穗图片 [点击图片放大预览](#)

原始图片 [点击图片放大预览](#)



识别图片 [点击图片放大预览](#)



WW

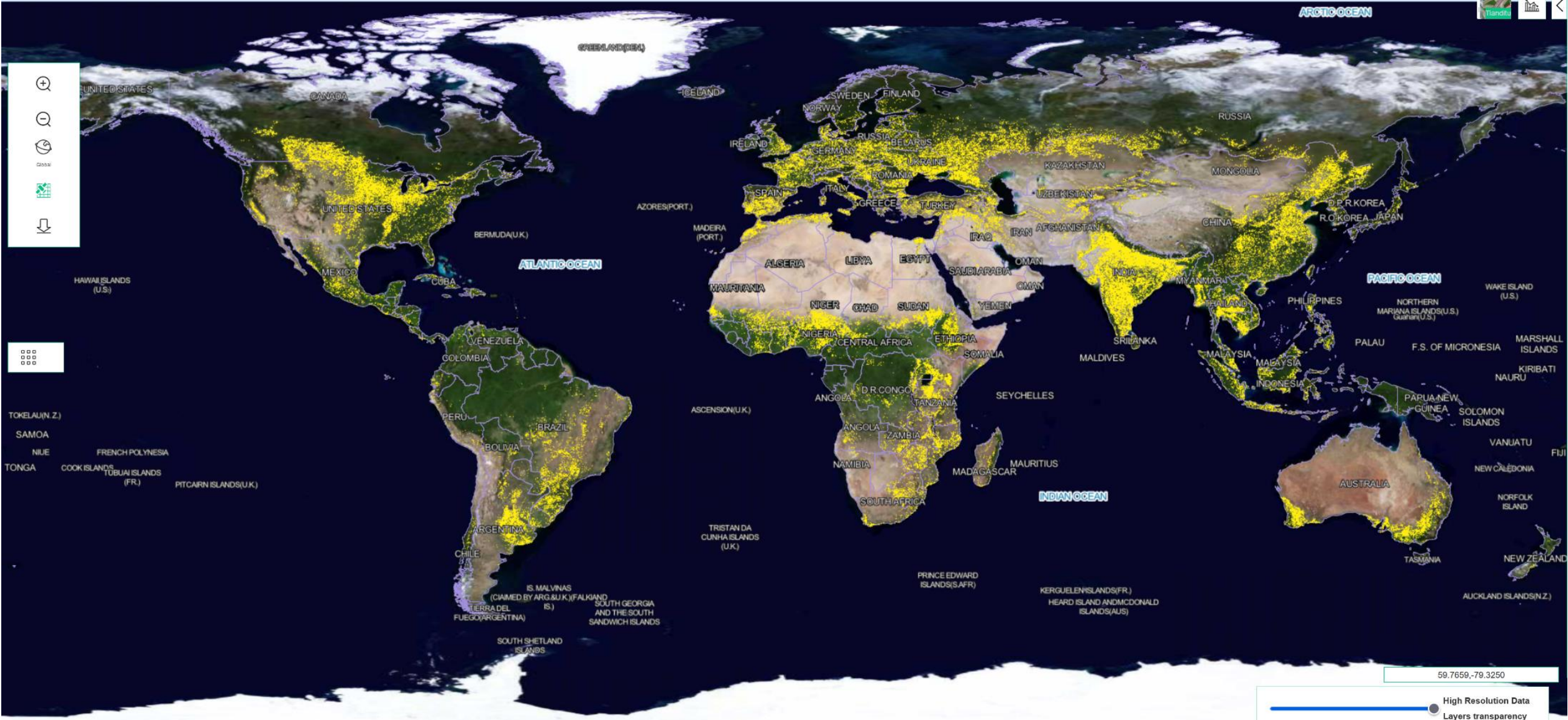
Global Cropland Data at 30m



CropWatch

- Agro-climatic Indicators
- Agonomic Indicators
- Production Index
- Early Warning Indicators
- High-resolution monitoring
- High-Resolution Products
- Crop Type
- Production Zone
- Management System

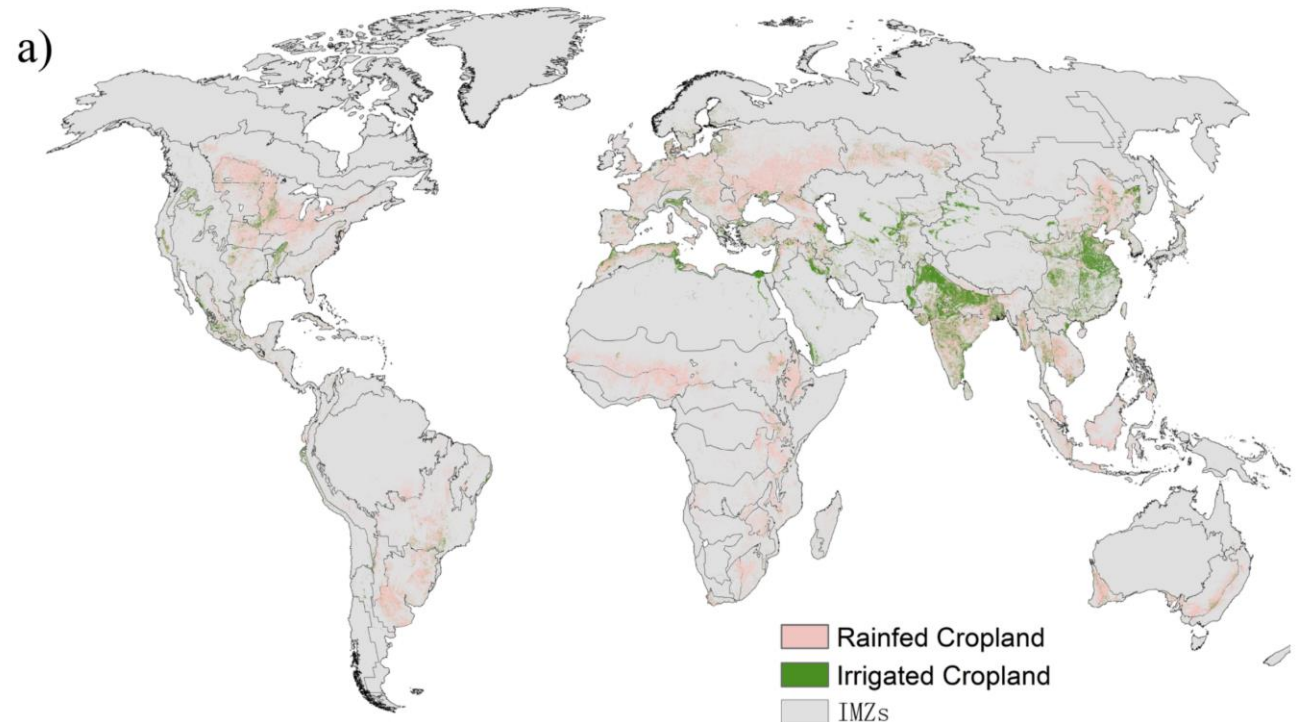
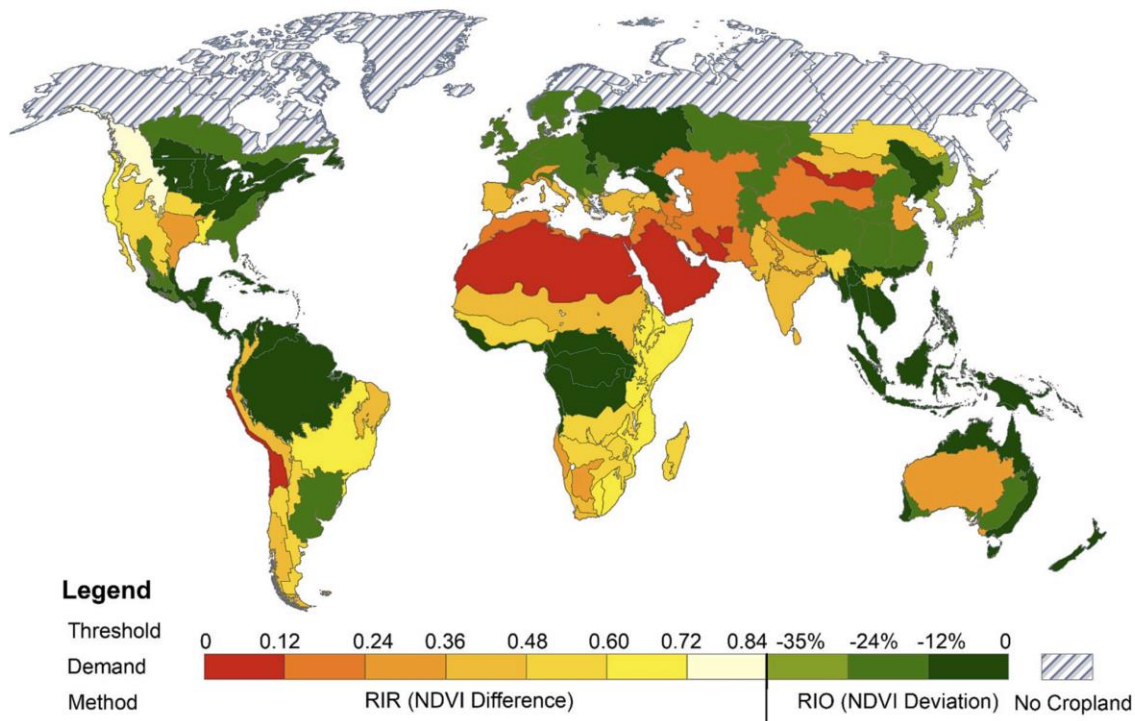
English zengh...





Irrigated Cropland Mapping

- Mapping the extent of irrigation with the NDVI differences between irrigated and non-irrigated croplands under water stress;
- The irrigation area at a 30-m resolution is 23.4 % of global cropland in the period 2010–2019, with an overall accuracy of 83.6 % globally
- Separating regular and intermittent irrigation





Global Cropping Intensity at 30m

CropWatch

Agro-climatic Indicators

Agronomic Indicators

Production Index

Early Warning Indicators

High-resolution monitoring

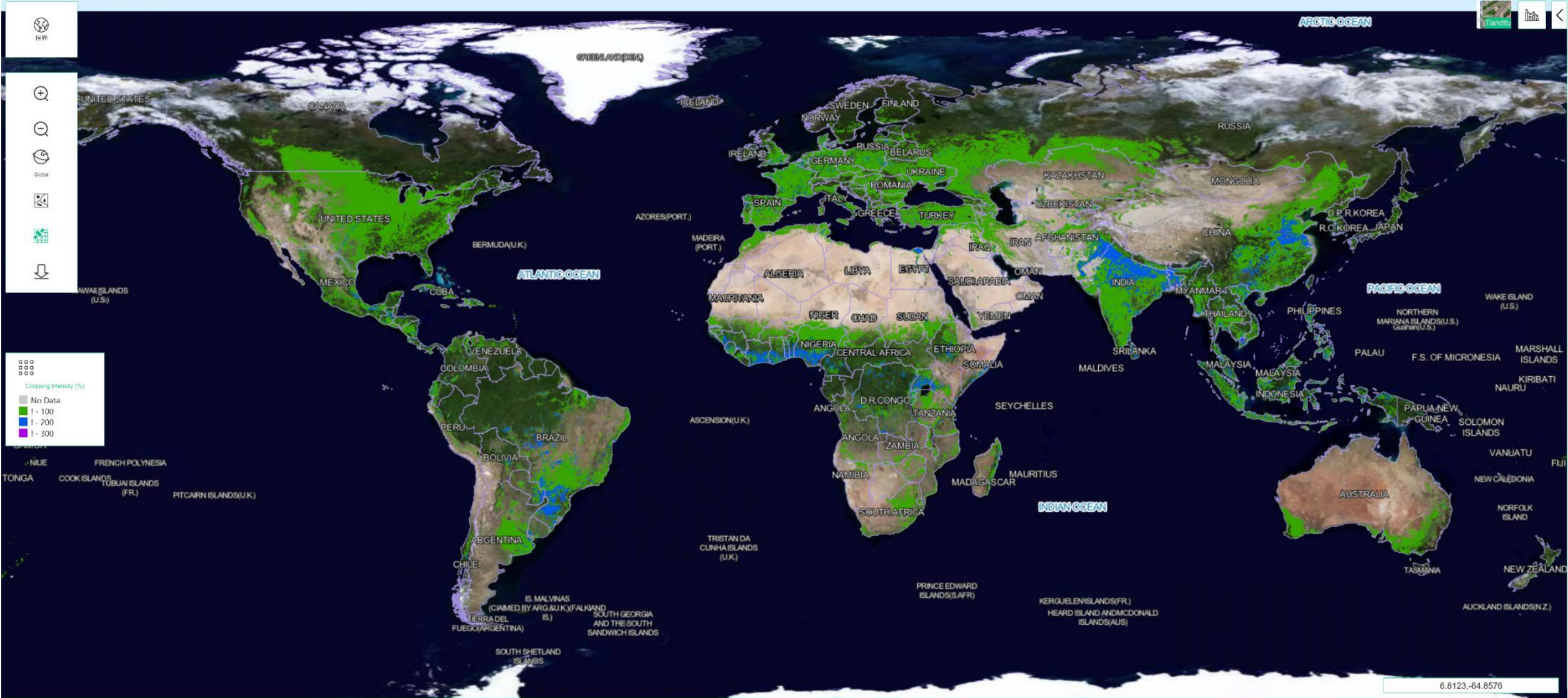
High-Resolution Products

Crop Type

Production Zone

Management System

English zengh...





Users to conduct crop monitoring on your own

- CropWatch provide solutions for users to carry out self-serviced crop monitoring by selecting their preferred indicators, models for the user's area of interest, allowing users actively involved from remote sensing data preparation to the final synthesized analysis

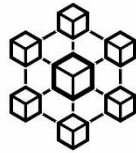
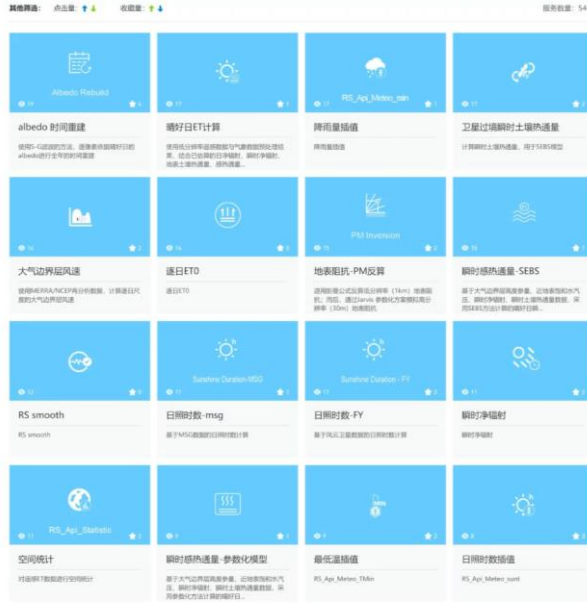


地面调查APP



单产观测APP

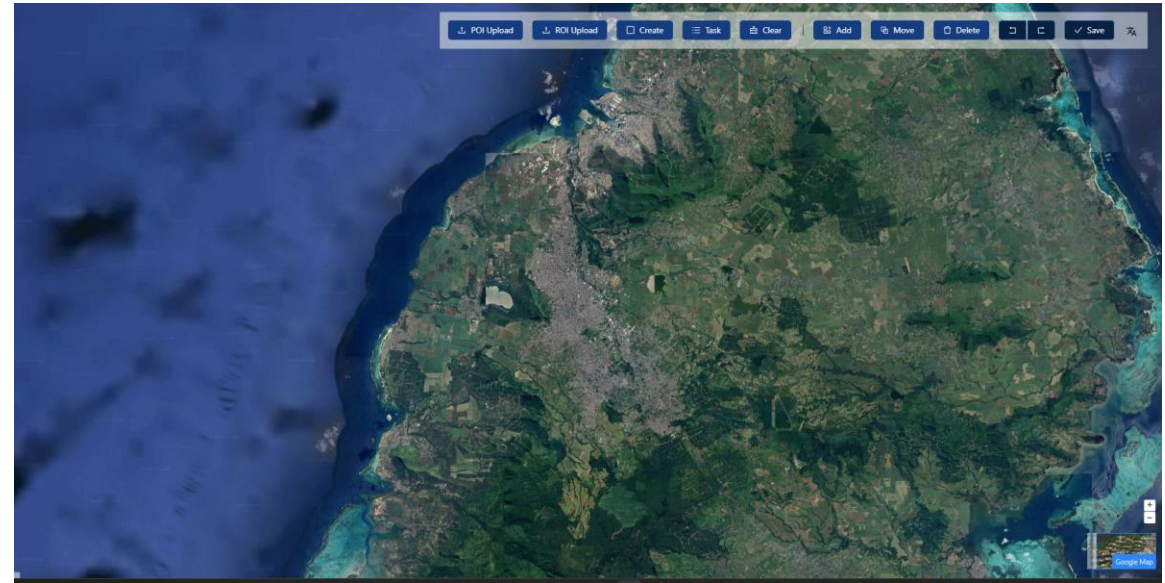
Smart APPs providing ground truth data support



Microservice



Process engine



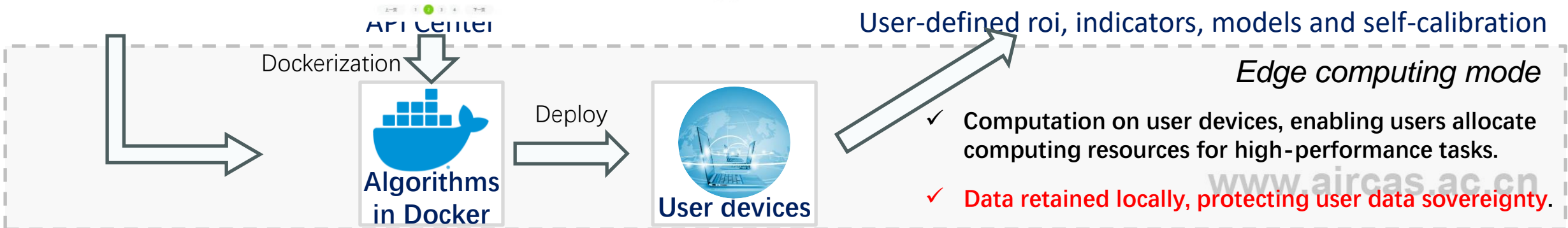
User-defined roi, indicators, models and self-calibration

Edge computing mode

- ✓ Computation on user devices, enabling users allocate computing resources for high-performance tasks.

- ✓ Data retained locally, protecting user data sovereignty.

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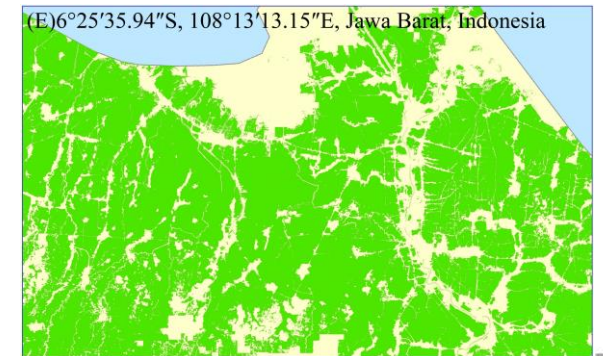
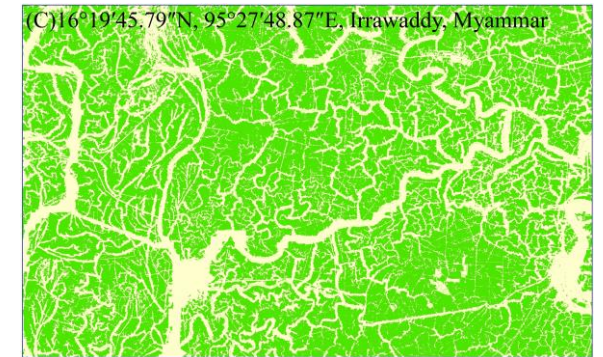
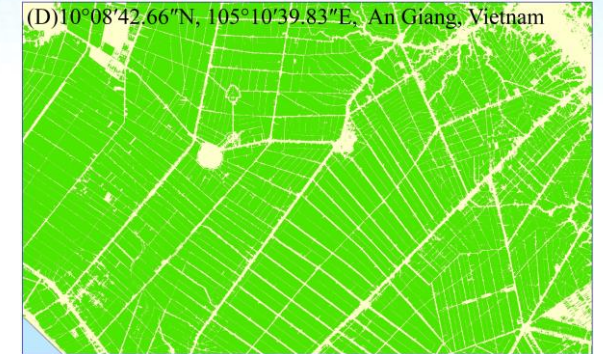
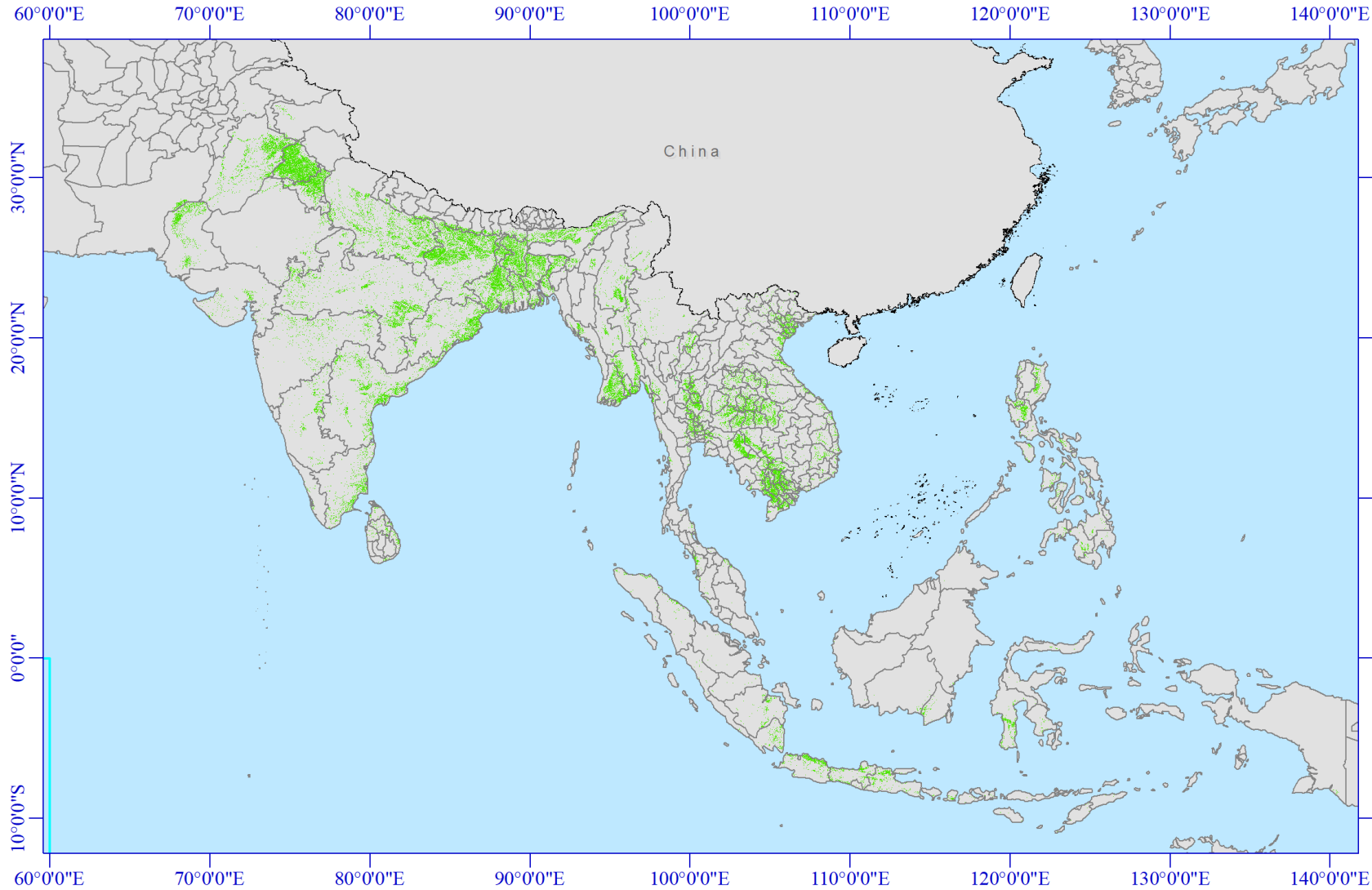
Field-based high resolution crop type mapping

Field level crop map





Paddy rice mapping





Outlines

- Overview of CropWatch
- Updates
 - Service modes
 - New tools for field data collection
 - Baseline dataset
 - User defined crop monitoring
- Conclusion remarks



CropWatch Vision

- Promoting ownership
 - Customized according to the specific demand for each country and work as a national/regional system
- Respecting privacy and data sovereignty
 - Providing crop monitoring APIs to address the data sovereignty
 - Countries will strengthen the agricultural monitoring capacity on their own
- Reducing constraints
 - Cloud based system assessable from internet everywhere without investment on computing infrastructure, storage, etc



Take home message

- Website <http://cloud.cropwatch.com.cn/>
- GVG APP: <https://gvgserver.cropwatch.com.cn/download> (Android)
<https://apps.apple.com/py/app/gvg%E5%86%9C%E6%83%85%E9%87%87%E9%9B%86/id1244686128> (iOS)
- FieldWatch APP:
<https://play.google.com/store/apps/details?id=com.wisewoods.xtt&pli=1>
- CropWatch Knowledge Package on GEO Knowledge Hub: <https://gkhub.earthobservations.org/packages/pp5h-ea276>
- Archive bulletins: <http://cloud.cropwatch.com.cn/site/bulletin>
- Research publications: <http://cloud.cropwatch.com.cn/publications/index>
- Email address: cropwatch@aircas.ac.cn



Openly shared datasets

- Global cropland mask @30m: https://data.casearth.cn/thematic/cbas_2022/158
- Global cropping intensity @30m: <https://doi.org/10.7910/DVN/86M4PO>
https://data.casearth.cn/thematic/cbas_2022/160
- Global irrigation proportion @100m: <https://doi.org/10.7910/DVN/HKBAQQ>
- Global crop area, yield and production: <https://doi.org/10.7910/DVN/G1HBNK>
- Synthesis of Global ET: <https://doi.org/10.7910/DVN/ZGOUED>
- Africa Cropland Layer: <https://doi.org/10.6084/m9.figshare.13520141.v1>

Workshop on advancing satellite-based crop monitoring to increase resilience
in the face of global food insecurity, 2-5 July 2024, Nigeria



Thank you!

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