Institute of Remote Sensing and Digital Earth
Chinese Academy of Sciences

Regional Workshop on understanding the operational aspect of the drought observation system in Mongolia

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DroughtWatch Method and Development

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Institute of Remote Sensing and Digital Earth (RADI)
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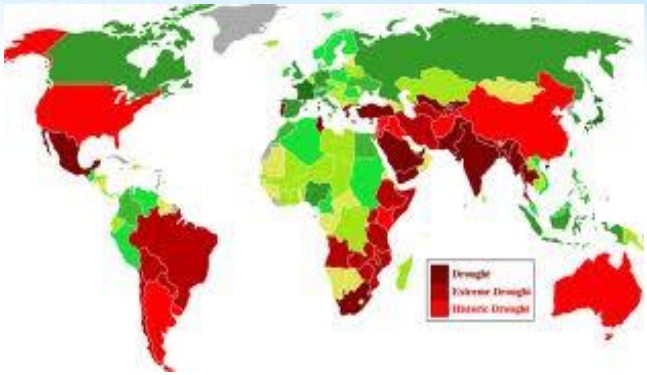
Contents

- Background
- Introduction to DroughtWatch
- Methods of Drought Monitoring
- Products validation
- Applications and Prospects

Background

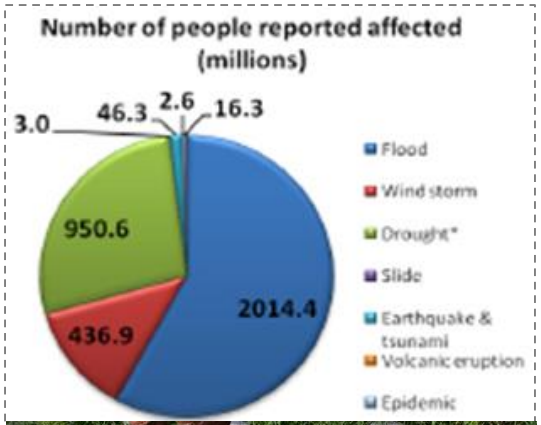
Drought – Serious natural hazard

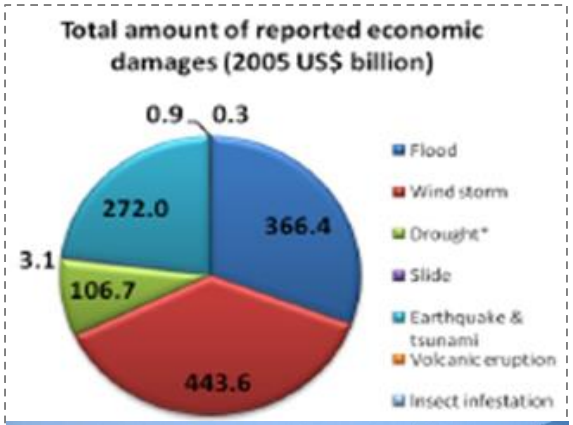
- happened in most areas of globe.
- rank first among all natural hazards when measured in terms of the number of people affected, total economic loss, social effect and long-term impact.

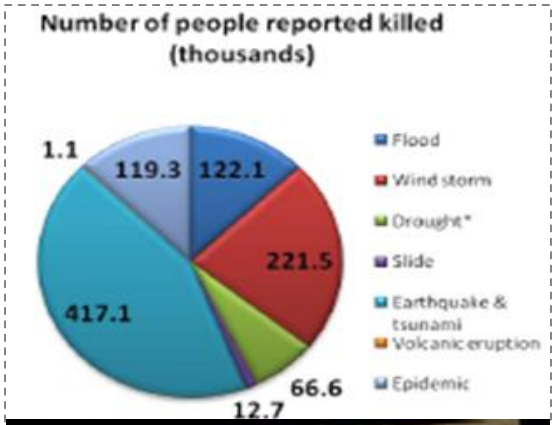


(source:unitedcats.wordpress.com)

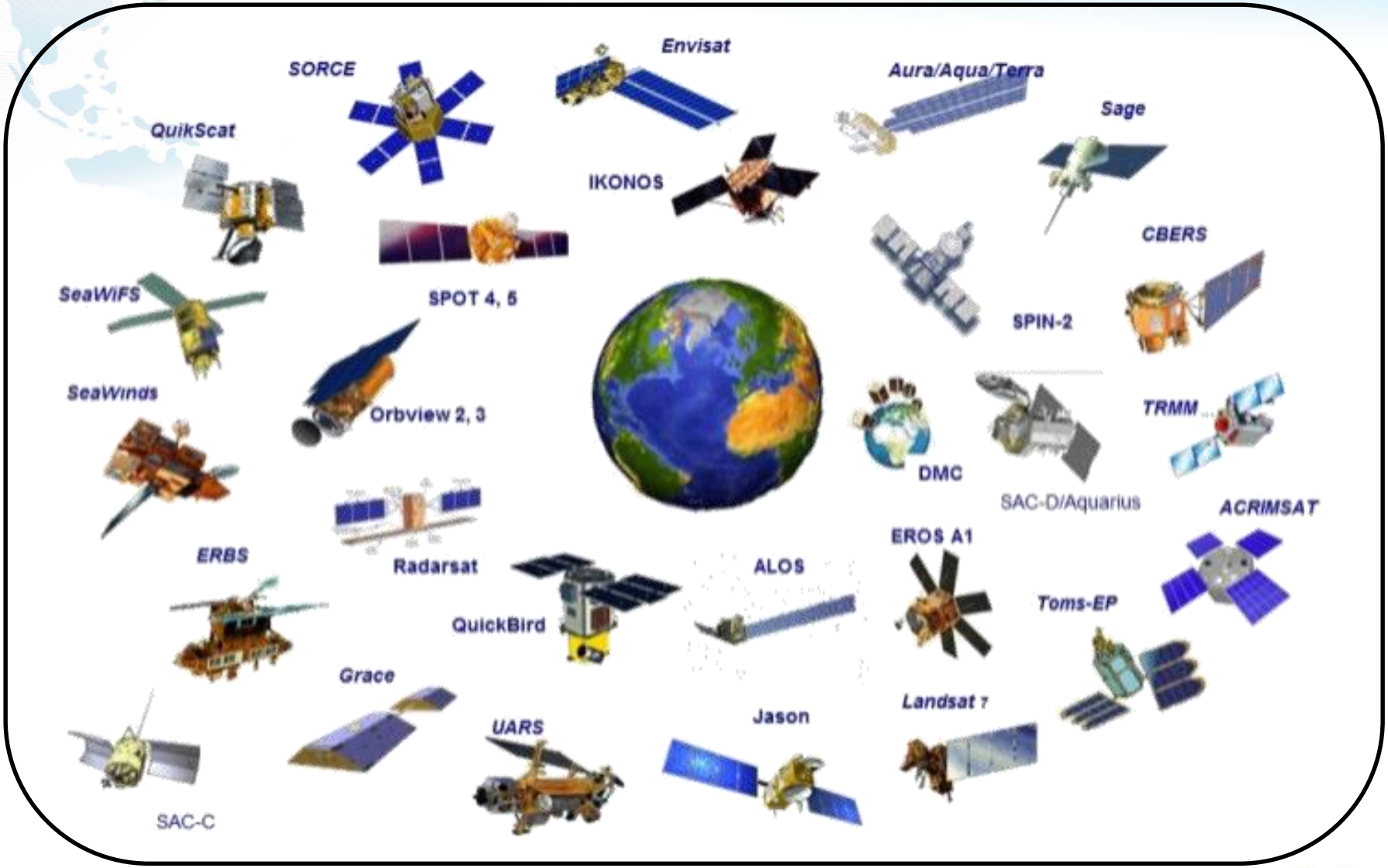
Source: UN-ISDR (International Strategy for Disaster Reduction) – Period 1991-2005







Reliable multi source remote sensing data for Agricultural drought monitoring



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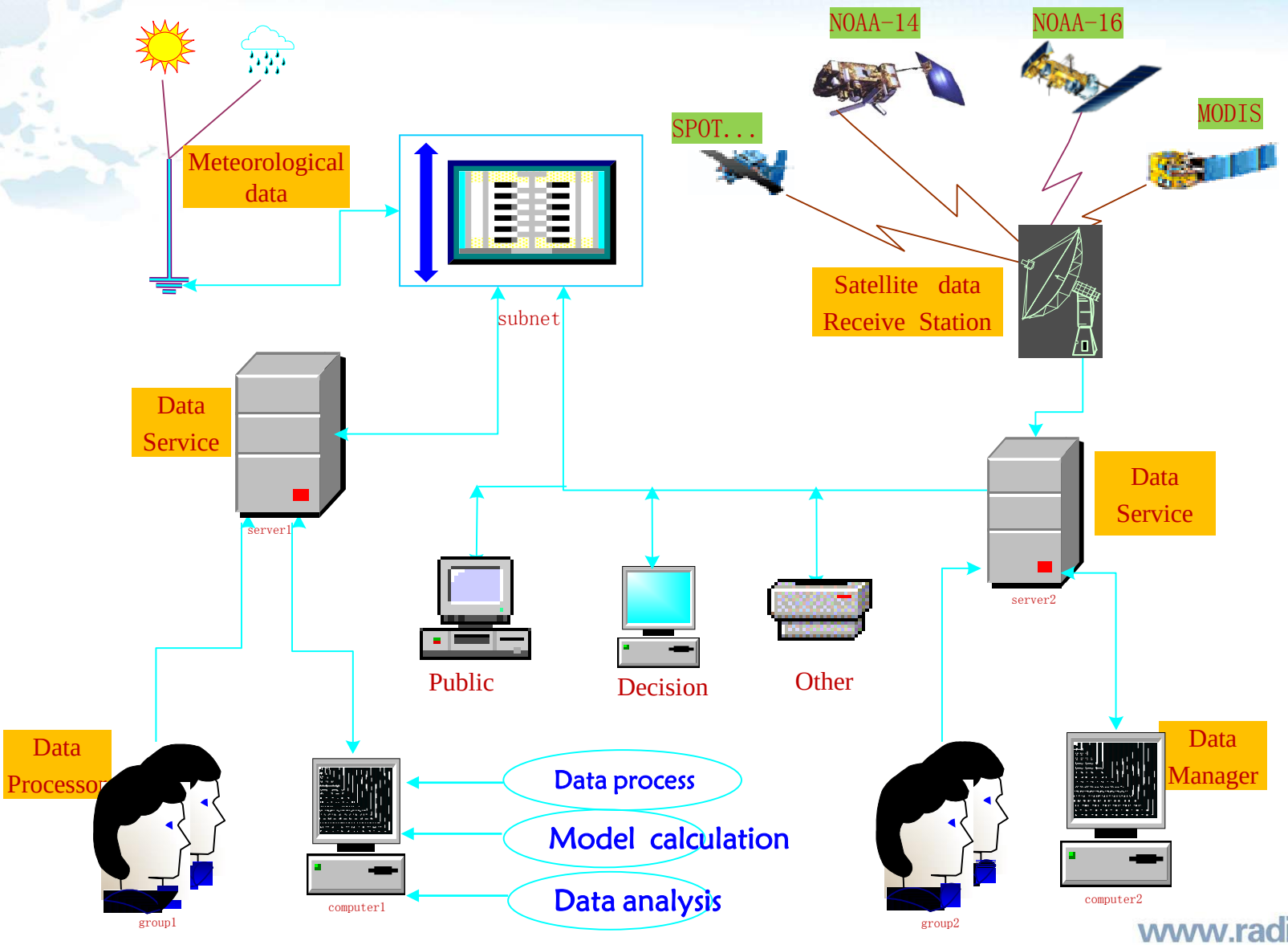
DroughtWatch Architecture

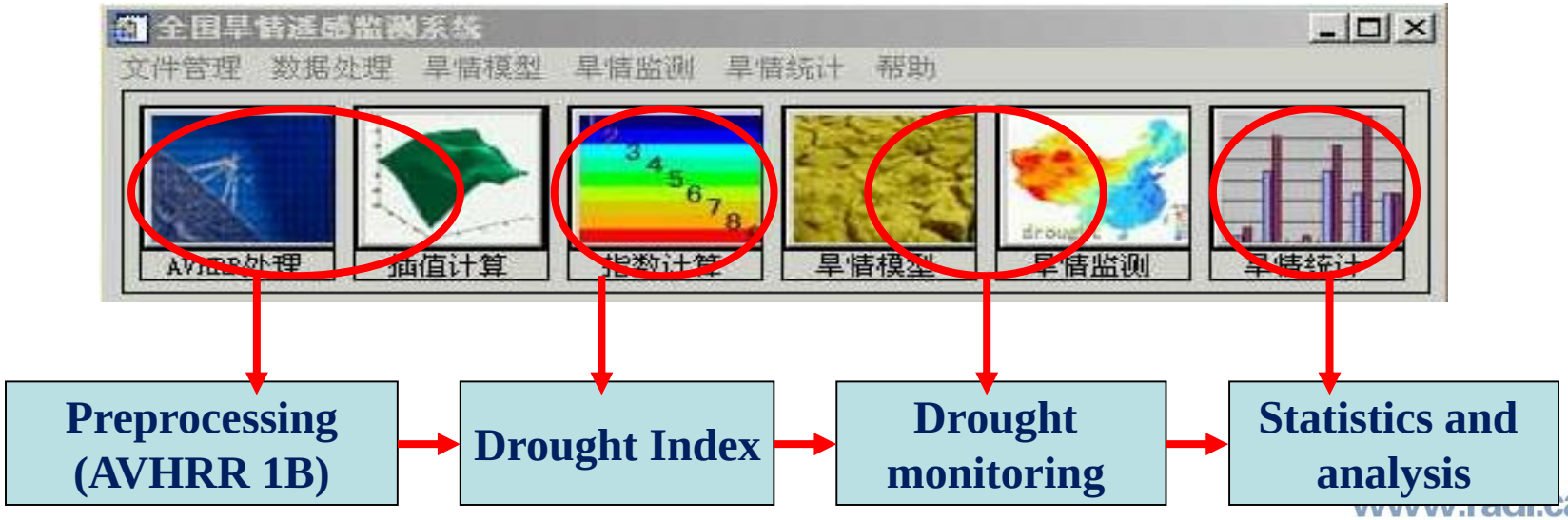


Evolution of DroughtWatch (1998-2018)

Version	Major Revision	Improvement	Time
V1.1	Several calculation modules built by program	Try to finish the part of drought monitoring by the computer	1998
V1.2	The drought monitoring system based on AVHRR, named as DroughtWatch for China	Drought monitoring can be calculated automatically	2006
V1.3	Replacement of AVHRR with MODIS	MODIS is beyond AVHRR specially in image quality and geometry location accuracy	2008
V2.1	automatic operation system was emerged	The system can be automatically run	2009-2010
V2.2	Update the basedata(cropland, maxmin data)	Improving the accuracy and stability	2012
V3.1	Extend to the other countries	Developing the system applicability	2013-2014
V4.1	Interactive drought monitoring system for globe	Interaction functions and information demonstration were involved	2015-2017
V4.2	Drought forecasting in short terms	Improving drought forecasting functions	2018-2019

DroughtWatch 1.2(Chinese)

- **Input:** AVHRR/NOAA(4km*4km), soil moisture data
- **Range:** China
- **Indices:** VCI,TCI,VHI,NDWI
- **Output(Drought products):**
  - Temporal resolution: dekad/month
  - forms: raster data, drought distribution map, statistics data by different administrators.



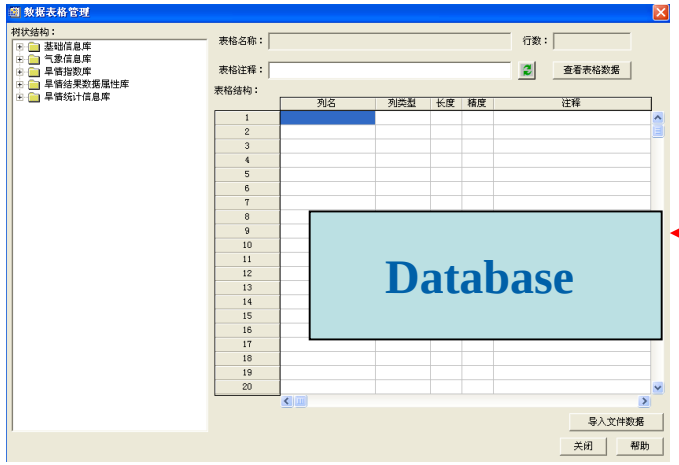
DroughtWatch 2.1(Chinese)

Preprocessing (MODIS 1B)

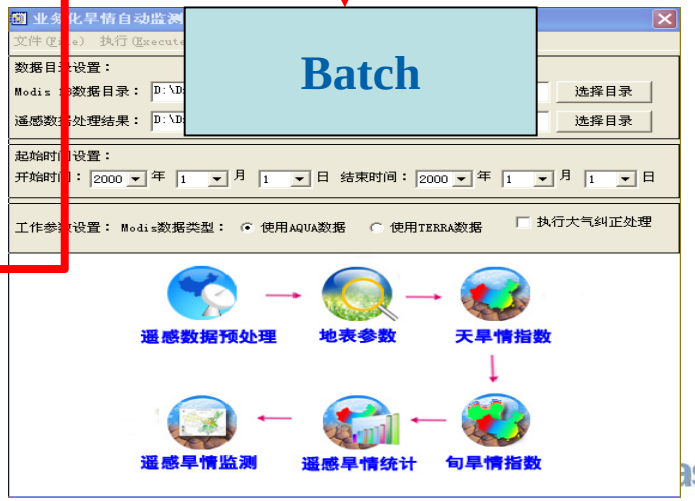
Drought Index

Drought monitoring

Drought statistics



Database



Batch

DroughtWatch 3.1(English+Chinese)

- **Input:** MODIS(1km*1km), soil moisture, rainfall, meteorological and statistics data
- **Range:** global(country scale)
- **Indices:** VCI,TCI,VHI, NDDI, VSWI, AI,SPI
- **Output(Drought products):**
  - Temporal resolution: pentad/dekad/month
  - forms: raster data, drought distribution map, statistics data by different administrators.
- **Updating:**
  - database modules: manage many kinds of data
  - Batch function: Drought monitoring can be calculated automatically .

DroughtWatch 3.1(English+Chinese)

- **Data management**

  (in-situ, statistics, Geotiff etc.)

- **Data preprocessing**

  (RS data processing, composition)

- **Indices calculation**

- **Drought monitoring**

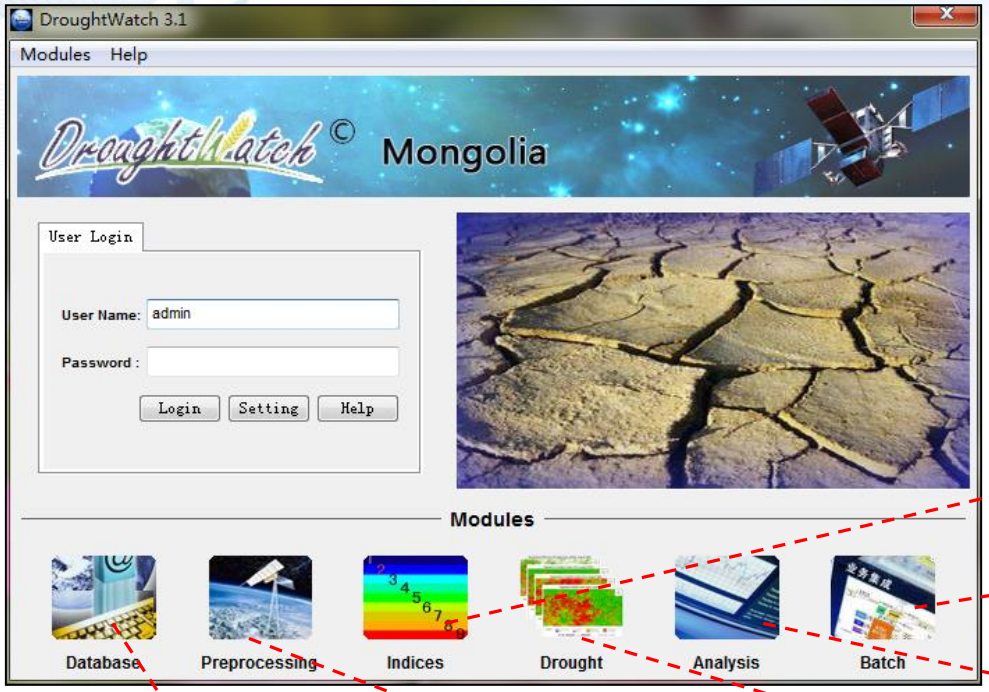
  (by single index and combination indices, dashboard)

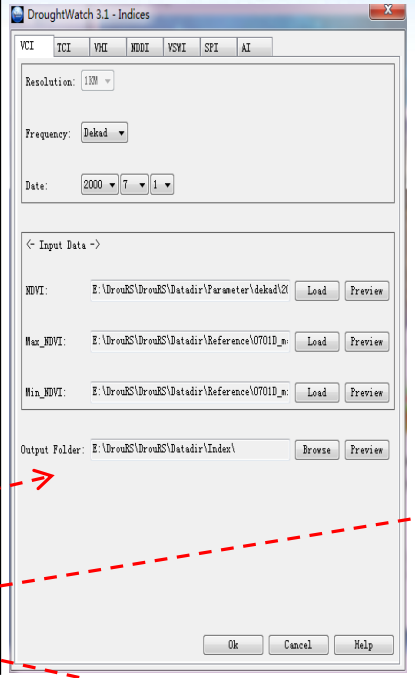
- **Statistics and analysis**

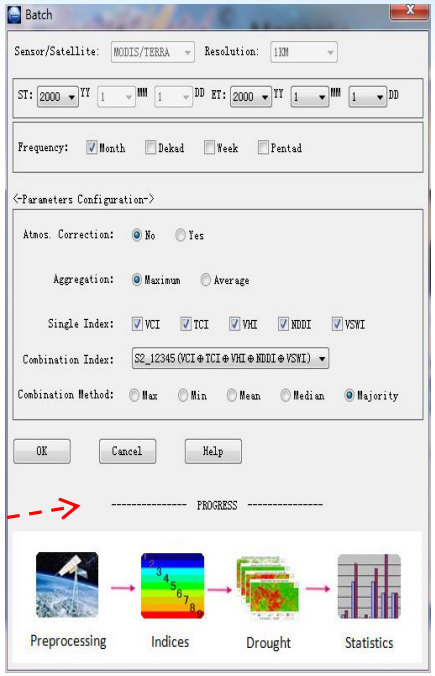
  (over the spatial, over time interval)

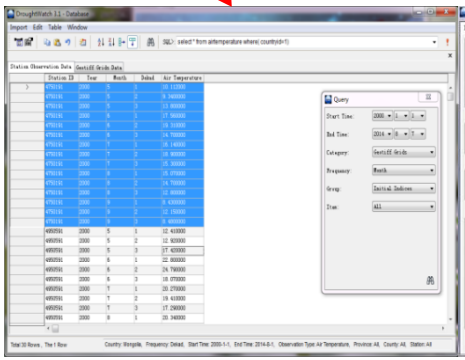
- **Batch for the whole procedure**

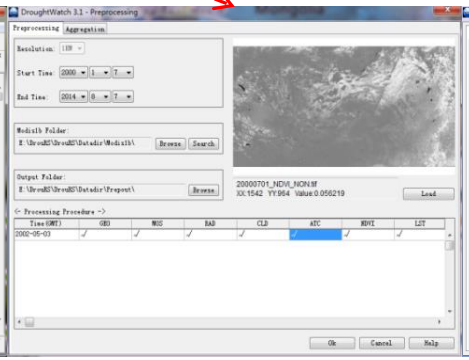
The Interface of DroughtWatch3.1 (Mongolia)

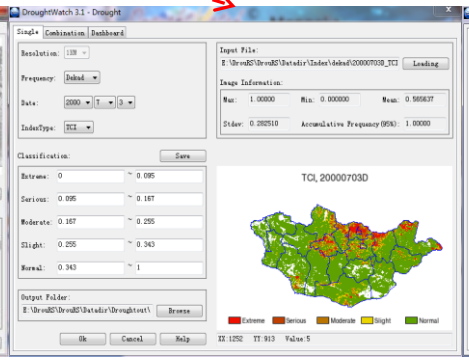


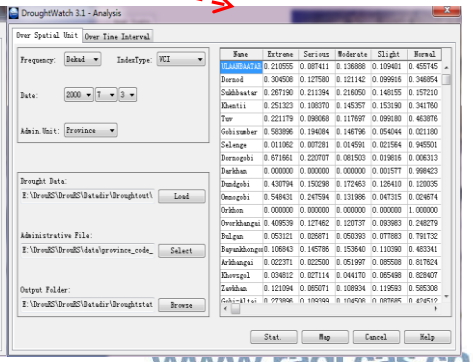




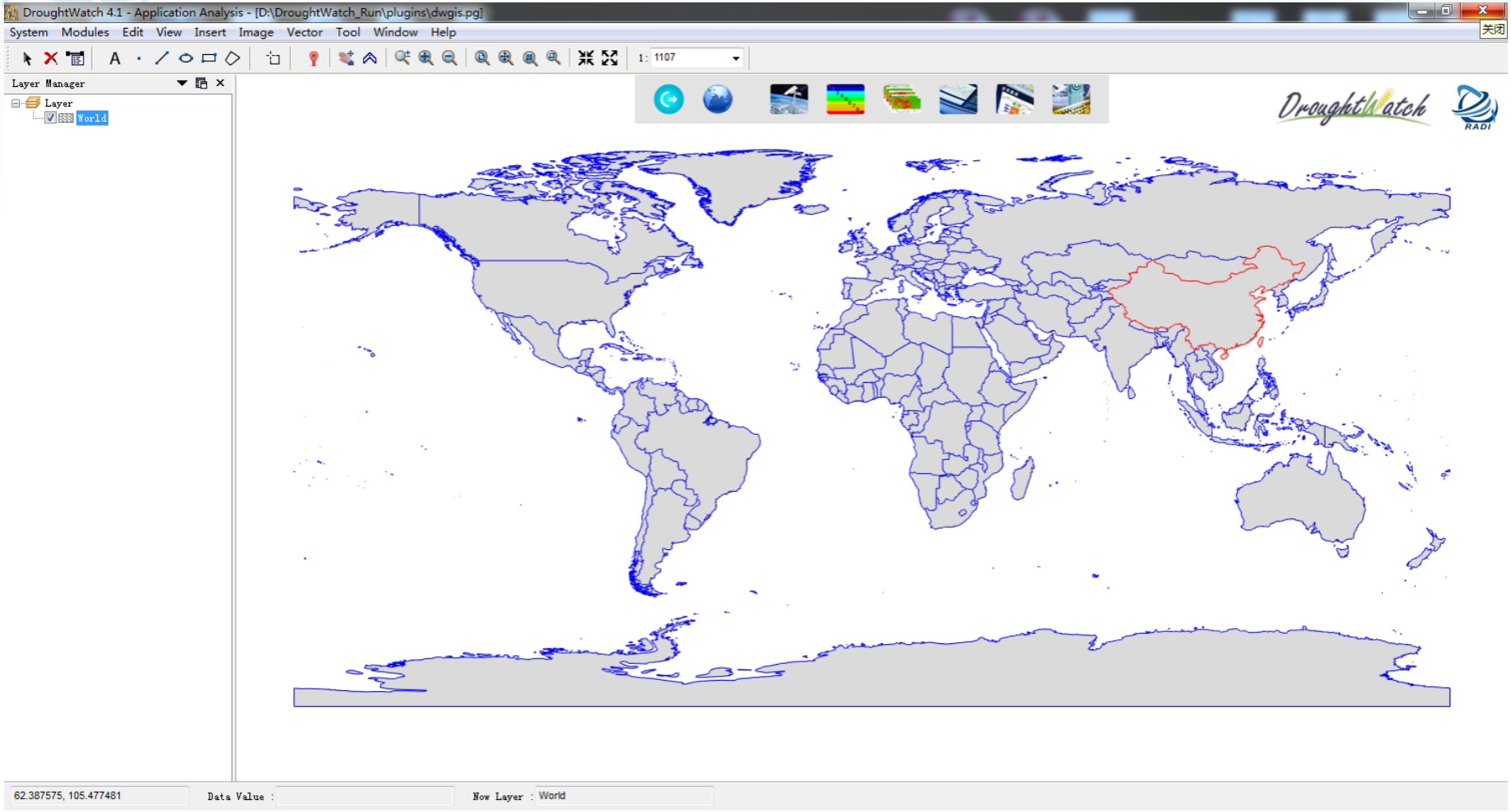








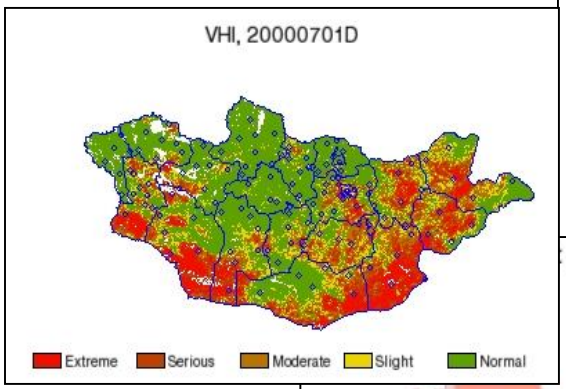
The Interface of DroughtWatch4.1

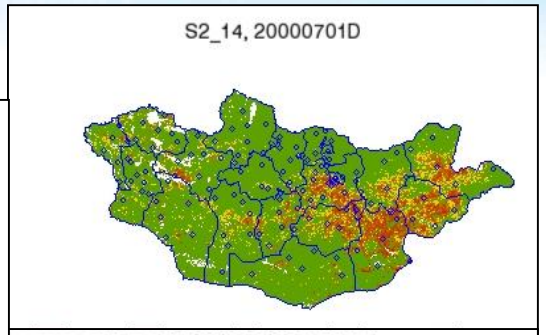


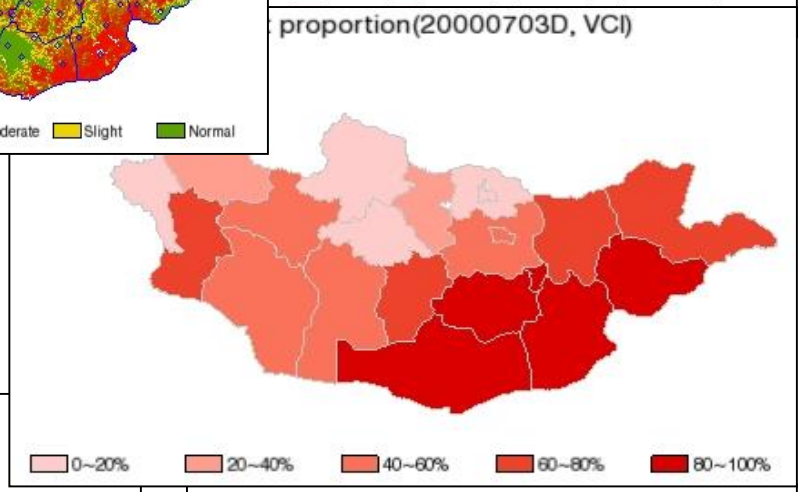
DroughtWatch products

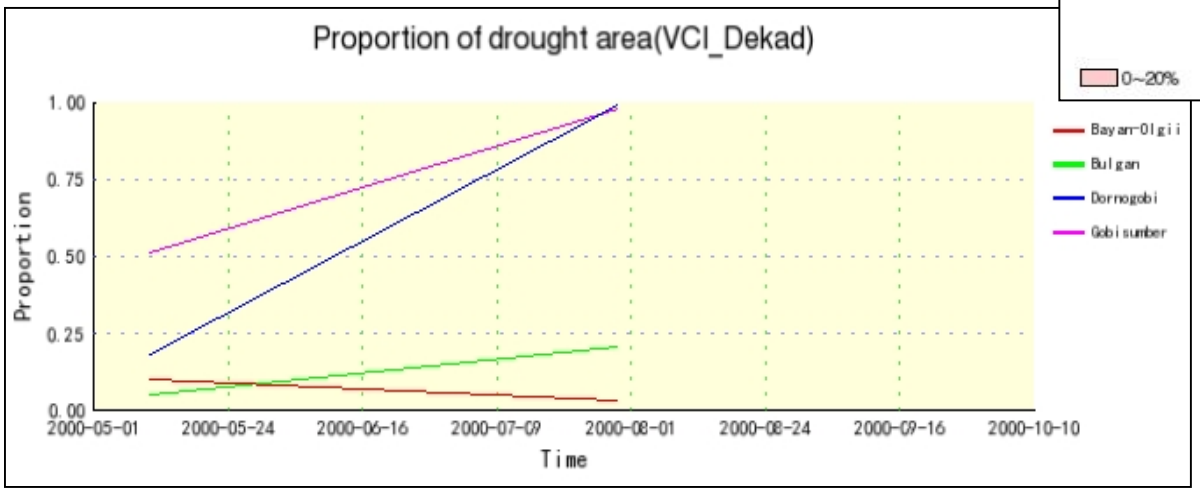
Forms(database, tables, files, maps, charts, graphs)

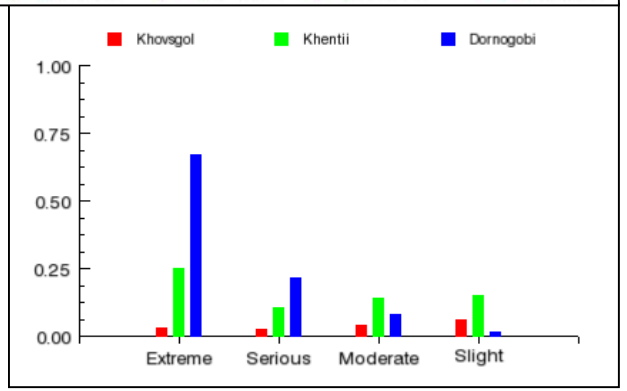
- Drought map and comparison results
- Spatial distribution maps
- Time change charts
- Drought classification graphs











DroughtWatch ® Features

- Continuous operation from 1998
- Remote sensing data are main data sources
- Independent without using statistic data
- Automatic processing
- Validation and uncertainty analysis continuously
- Crucial information services to different government departments

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Drought indices selection

- Collected and surveying all drought indices existed(several dozens).
- Compared the advantage and disadvantage for every drought index, and determining which index is suitable for the certain country or region.

- CWSI-Crop Water Stress Index
- RDRI –Remote Sensing Drought Risk Index
- NDVI –Normalized Difference Vegetation Index
- NDVIA –Anomaly of NDVI
- NDWI –Normalized Difference Water Index
- NDII –Normalized Difference Infrared Index
- SVI –Standardized Vegetation Index
- LWCI –Leaf Water Content Index
- SRWI –Simple Ratio Water Index
- VCI –Vegetation Condition Index
- TCI –Temperature Condition Index
- VHI –Vegetation Health Index
- GVWI –Global Vegetation Water moisture Index
- VTCI-Vegetation Temperature Condition Index
- VCADI –Vegetation Condition AlbedoDrought Index
- PDI –Perpendicular Drought Index
- MPDI –Modified Perpendicular Drought Index
- NMDI – Normalized Multi-Band Drought Index
- VegDRI–Vegetation Drought Response Index

...

Normalized Difference Water Index (**NDWI**)
Normalized Difference Drought Index (**NDDI**)
Vegetation Condition Index (**VCI**)
Temperature Condition Index (**TCI**)
Vegetation Health Index (**VHI**)
Vegetation temperature condition index (**VTCI**)
Normalized Multi Drought Index (**NMDI**)
Vegetation Supply Water Index (**VSWI**)
Visible and Shortwave infrared Drought Index (**VSDI**)

Drought indices method

Satellite-Based Drought Index	Formula(e)
VCI	$VCIj = \frac{NDVI_j - NDVI_{min}}{NDVI_{max} - NDVI_{min}} \times 100\%$ NDVImax and NDVImin are the maximum and minimum NDVI in multi-year dataset
TCI	$TCIj = \frac{LST_{max} - LST_j}{LST_{max} - LST_{min}} \times 100\%$ LSTmax and LSTmin are the maximum and minimum LST in multi-year dataset
VHI	$VHI = a \times VCI + (1 - a) \times TCI$
VTCI	$VTCI_i = \frac{LST_{NDVI_{i,MAX}} - LST_{NDVIi}}{LST_{NDVI_{i,MAX}} - LST_{NDVI_{i,MIN}}}$ $LST_{NDVI_{i,MAX}} = a1 + b1 \times NDVI_i \quad LST_{NDVI_{i,MIN}} = a2 + b2 \times NDVI_i$
NMDI	$NMDI = \frac{R_{860nm} - (R_{1640nm} - R_{2150nm})}{R_{860nm} - (R_{1640nm} + R_{2150nm})}$
VSDI	$VSDI = 1 - [(\rho_{SWIR} - \rho_{Blue}) + (\rho_{Red} - \rho_{Blue})]$
VSWI	$VSWI = \frac{T_S}{NDVI}$
NDWI	$NDWI = \frac{\rho_{SWIR} - \rho_{NIR}}{\rho_{SWIR} + \rho_{NIR}}$
NDDI	$NDDI = \frac{NDVI - NDWI}{NDVI + NDWI}$

How to select suitable Indices?

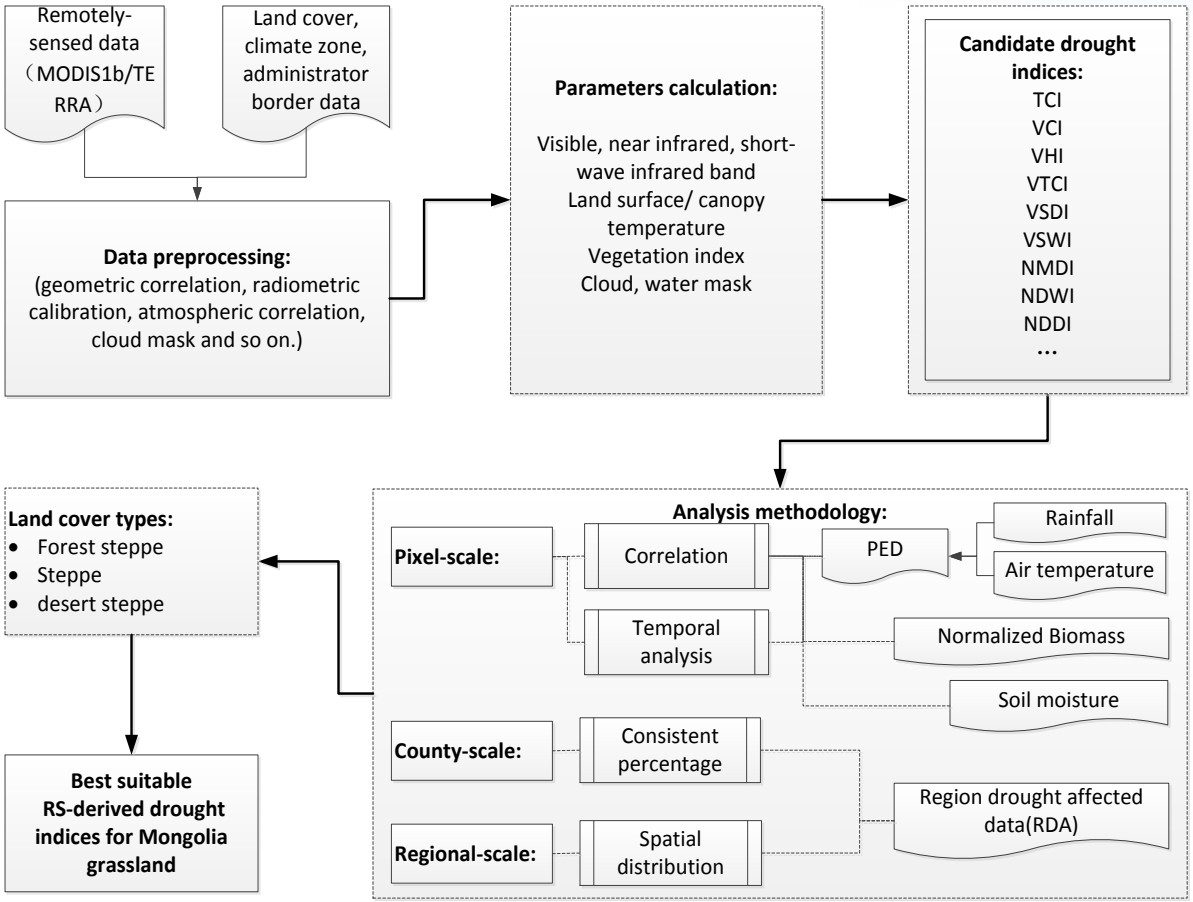
Drought indices selection

Adaptability analysis

- Correlation coefficient
- Consistence Percentage
- Spatial Analysis

Reference Indicators

- Meteorological indices
- Soil moisture
- Normalized biomass
- Regional drought-affected data
- Yield departure



Adaptability analysis framework of the RS-derived drought indices

Pixel scale

In different land covers and vegetation growth periods, compare the relations with drought indices and relevant parameters.

Correlation analysis between drought indices and PED

RS-derived indices	Forest steppe	Steppe	Desert steppe
TCI	**–0.69/–0.43/–0.57/0.07**	**–0.71/–0.35/–0.56/0.08**	**–0.62/–0.28/–0.46/0.09**
VCI	–0.57/–0.20/–0.34/0.14	–0.68/–0.27/–0.47/0.10	–0.58/–0.16/–0.40/0.11
VHI	**–0.75/–0.36/–0.61**/0.09	**–0.76/–0.52/–0.66/0.07**	**–0.75/–0.31/–0.56**/0.11
NDWI	–0.65/–0.20/–0.50/0.10	–0.69/–0.29 /–0.54/0.09	–0.58/–0.20 /–0.43/0.09
NDDI	0.58/0.21/0.44/0.10	0.62/0.02 /0.39/0.15	0.39/–0.04/ 0.15/0.12
VSWI	**0.70/0.35/0.54/0.09**	**0.73/0.35/0.58/0.10**	**0.64/0.33/0.48/0.09**
VTCI	–0.63/–0.29/–0.48/0.08	–0.59/–0.23 /–0.46/0.09	–0.57/–0.22/–0.39/0.10
VSDI	0.48/0.02/ /0.25/0.11	0.35/–0.29 /0.13/0.13	–0.11/0.23 /0.09/0.10
NMDI	–0.59 /0.05 /–0.27/**0.20**	0.48/–0.52/0.10/**0.24**	0.51/0.13/ 0.31/**0.13**

Pixel scale

Correlation analysis between drought indices and soil moisture

RS-derived indices	Forest steppe	Steppe	Desert steppe
TCI	**0.58/0.03/0.36/0.16**	0.63/0.05/0.39/0.15	0.49/0.13/0.32/0.13
VCI	0.17/0.13/0.08/0.10	0.49/0.10/0.24/0.13	**0.58/0.35/0.43/0.08**
VHI	**0.42/0.10/0.32/0.13**	**0.67/0.10/0.40/0.15**	**0.61/0.37/0.48/0.08**
NDWI	0.29/0.06/0.17/0.13	**0.69/0.02/0.26/0.17**	0.43/0.08/0.22/0.34
NDDI	–0.32/0.00/–0.18/0.10	–0.62/–0.10/–0.19/0.17	–0.19/0.00/–0.10/0.07
VSWI	–0.37/0.00/–0.28/0.12	**–0.65/0.00/–0.38/0.14**	**–0.58/–0.40/–0.48/0.07**
VTCI	**0.51/0.00/0.29/0.14**	0.60/0.00/0.33/0.14	0.47/0.03/0.25/0.17
VSDI	0.32/0.01/0.11/0.17	0.43/0.03/0.25/0.16	0.54/0.02/0.19/0.27
NMDI	–0.29/0.00/0.02/0.25	–0.39/0.00/–0.06/0.16	–0.49/0.00/–0.26/0.25

Pixel scale

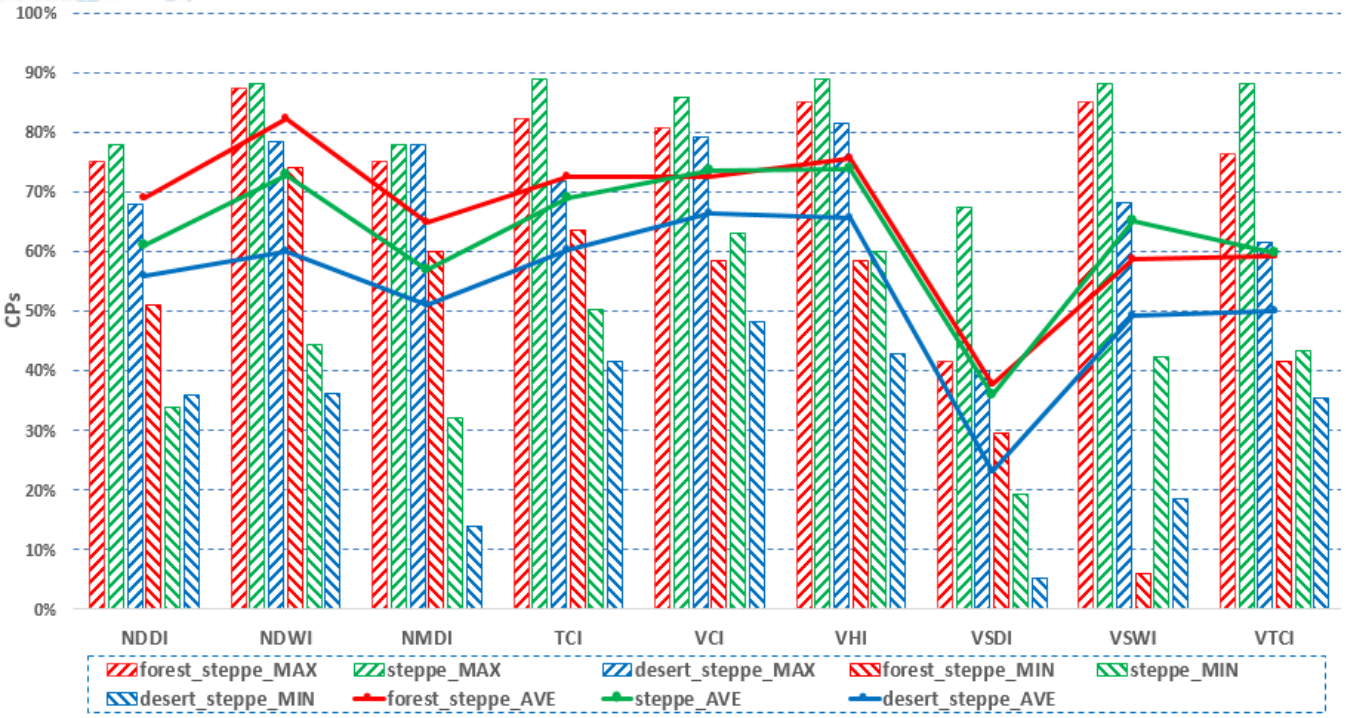
Correlation analysis between drought indices and normalized biomass

RS-derived indices	Forest steppe	Steppe	Desert steppe
TCI	0.70/0.04/0.43/0.19	0.80/0.09/0.45/0.21	–0.46/0.73/0.23/0.30
VCI	***0.83/0.35/0.64/0.16***	**0.94/0.12/0.57/0.16**	**0.92/0.28/0.67/0.15**
VHI	***0.87/0.30/0.62/0.17***	**0.94/0.38/0.60/0.14**	0.82/0.32/0.59/0.16
NDWI	***0.92/0.48/0.70/0.14***	**0.95/0.15/0.61/0.17**	**0.86/0.08/0.48/0.20**
NDDI	–0.81/0.14/–0.57/0.17	–0.80/–0.08/–0.50/0.19	–0.57/0.11/–0.33/0.17
VSWI	–0.78/0.38/–0.59/0.14	–0.88/–0.33/–0.59/0.14	**–0.83/–0.26/–0.60/0.12**
VTCI	0.61/–0.21/0.32/0.22	0.72/–0.32/0.31/0.25	0.68/–0.76/0.05/0.34
VSDI	0.49/–0.48/–0.08/0.25	0.73/–0.56/0.02/0.33	0.82/–0.70/–0.05/0.38
NMDI	0.69/0.00/0.39/0.22	–0.70/0.67/–0.16/0.38	–0.79/0.05/–0.36/0.23

$$Biomass_{normalized}(\mathrm{i,n}) = \frac{Biomass(i,\ n) - Biomass_{\min}(i,\ n)}{Biomass_{max}(i,n) - Biomass_{min}(i,n)}$$

County scale

Comparisons with the region drought-affected area in County



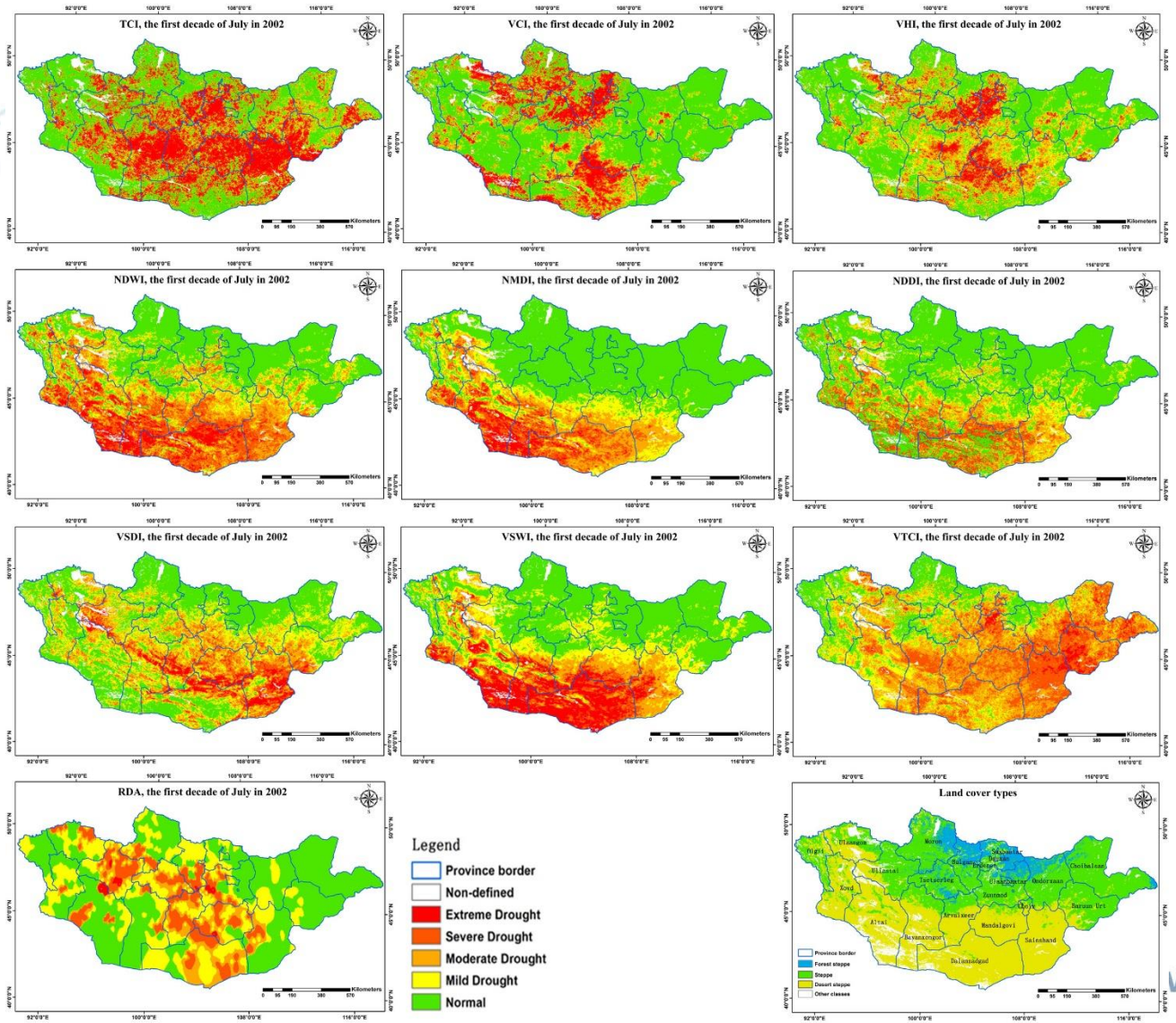
CP was used to describe the relationship between field-derived vegetation conditions and RS-derived drought indicators in three land cover types.

$$CP_{county} = \frac{\mathrm{CN}}{\mathrm{TN}} * 100\%$$

- The VCI, TCI, VHI, and NDWI are more sensitive to grassland drought and had stronger relationships with the RDA.

Regional scale

Spatial consistence comparisons(2002)



Comprehensive results

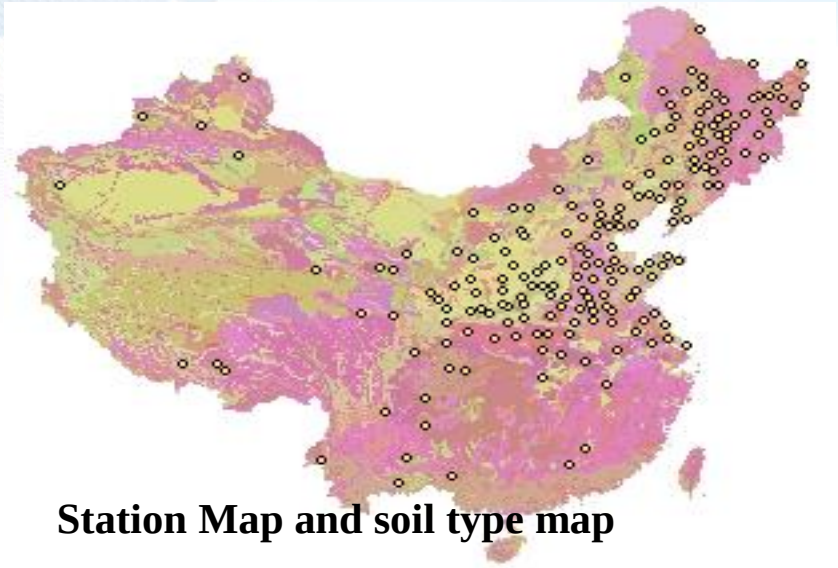
Sensitivity of RS-derived drought indices to the reference indicators

Reference indicators	Forest steppe	Steppe	Desert steppe
PED	VHI*/TCI**	VHI*/TCI **	VHI*/VSWI**
Soil moisture	TCI*/VTCI**	NDWI*/VHI**	VHI*/VSWI**
NorBio	NDWI*/VHI**	VHI */NDWI**	VCI*/VSWI**
RDA	NDWI*/VHI **	VHI*/VCI**	VCI*/VHI**
RDA spatial distribution	NDWI*/VHI**	VHI*/VCI**	VHI*/VCI**

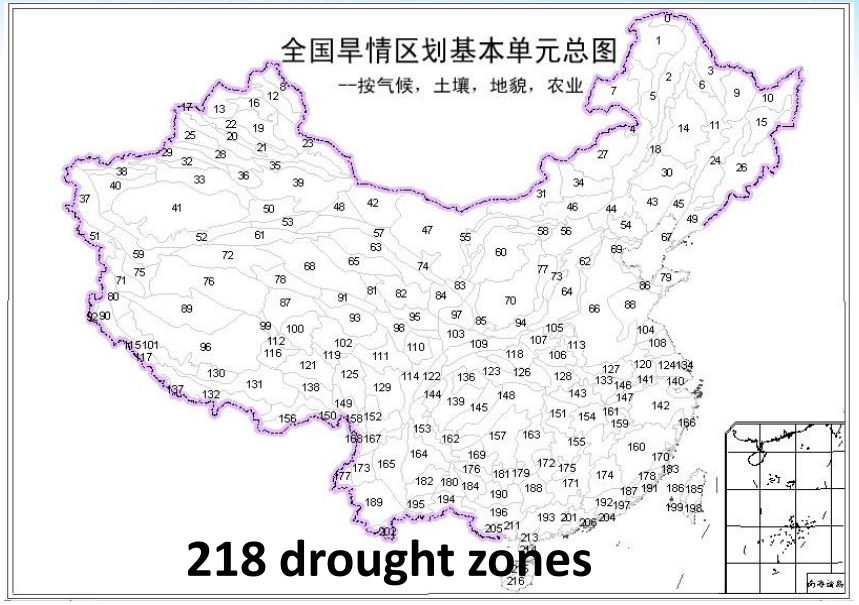
NDWI-VCI-TCI

How to develop the drought combined model?

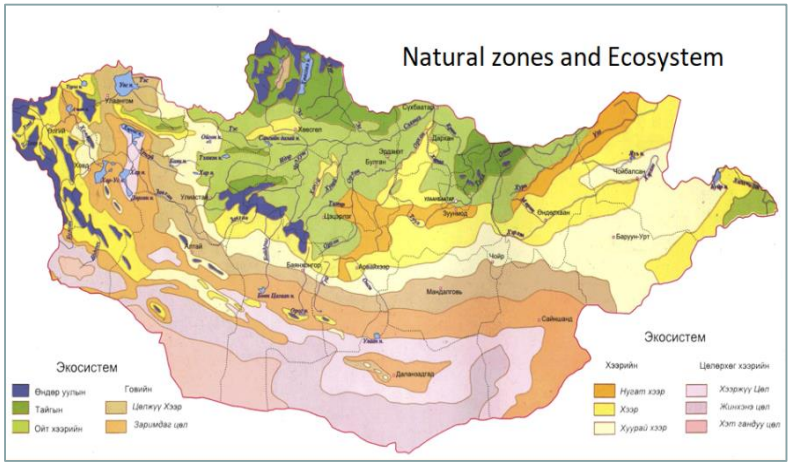
Local ecosystem

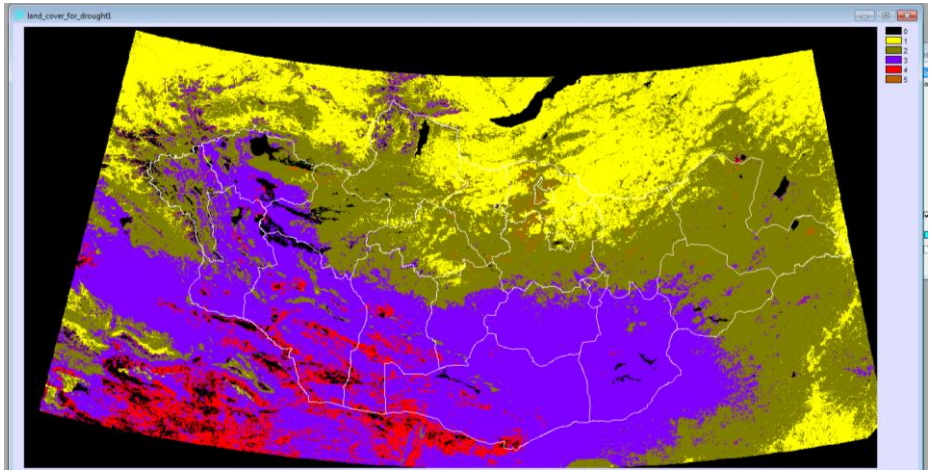


Station Map and soil type map



218 drought zones





Forest steppe & steppe & desert steppe

Seasonal variation

China

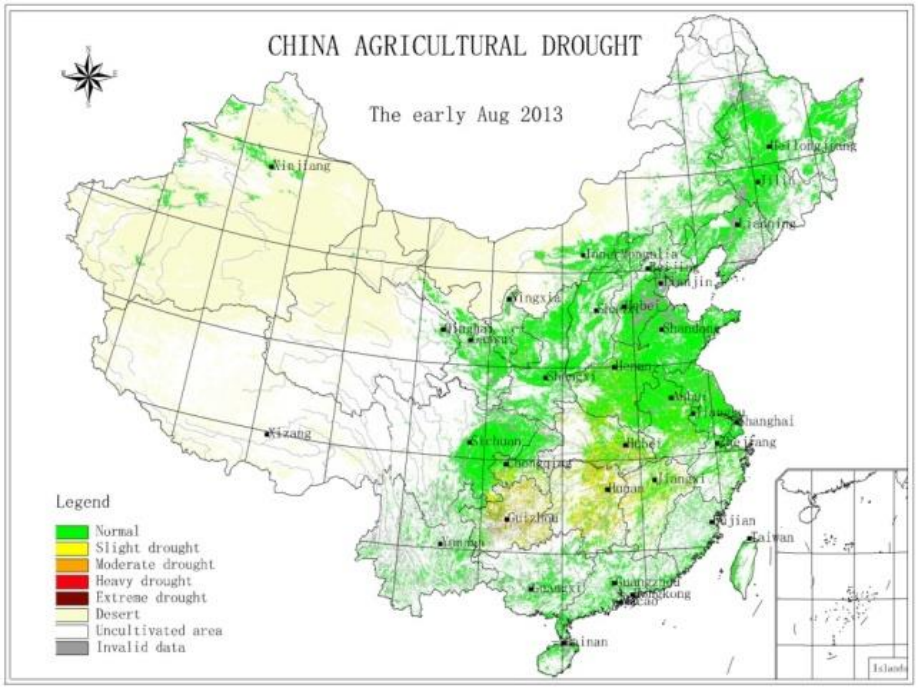
区划号	2月	3月	4月	5月	6月	7月	8月	9月	10月	11月	12月		1月	2月	3月	4月	5月	6月	7月	8月	9月	10月	11月	12月
1	TH	TW	TH	TW	TH	TH	HW	HW	TH	TW	TH	TH	111	TH	TW	TW	TW	TH	HW	TH	VH	TW	TW	TH	TW
2	TH	TW	TH	TW	TH	TH	HW	HW	TH	TW	TH	TH	112	TH	TW	TW	TW	TH	HW	TH	VH	TW	TW	TH	TW
3	TH	TW	TH	TW	TH	TH	HW	HW	TH	TH	TH	TH	113	TH	TH	TH	HT	TH	TH	HT	HT	VH	TH	TH	TW
4	TH	TW	TH	TW	TH	TH	HW	HW	TH	TH	TH	TH	114	TW	TW	HW	HT	HW	VH	HW	VT	TW	HW	TH	TW
5	TH	TW	TH	TW	TH	TH	HW	HW	TH	TW	TH	TH	115	TH	TW	TW	TW	TH	HW	TH	VH	TW	TW	TH	TW
6	TH	TW	TH	TW	TH	TH	HW	HW	TH	TH	TH	TH	116	TH	TW	TW	TW	TH	HW	TH	VH	TW	TW	TH	TW
7	TH	TW	TW	TW	TH	HW	TH	HW	VH	TH	TH	TH	117	TH	TW	TW	TW	TH	HW	TH	VH	TW	TW	TH	TW
8	TH	TW	TH	TW	TH	TH	HT	HW	HT	HT	TH	TH	118	TH	TH	TH	HT	TH	TH	HT	HT	VH	TH	TH	TW
10	TH	TW	TH	TW	TH	TH	HT	HW	HT	HT	TH	TH	119	TH	TW	TW	TW	TH	HW	TH	VH	TW	TW	TH	TH
11	TH	TW	TH	TW	TH	TH	HW	HW	TH	TW	TH	TH	120	TW	TH	TH	HT	HT	TH	HT	HT	HW	HW	TH	TH
12	TH	TW	TW	TW	TH	HW	TH	HW	VH	TH	TH	TH	121	TH	TW	TW	TW	TH	HW	TH	VH	TW	TW	TH	TH
13	TH	TW	TW	TW	TH	HW	TH	HW	VH	TH	TH	TH	122	TW	TW	HW	HT	HW	VH	HW	VT	TW	HW	TH	TH
14	TH	TW	TH	TW	TH	TH	HW	HW	TH	TH	TH	TH	123	TH	TH	TW	HW	TH	VH	HW	TH	HT	TH	TH	TH
15	TH	TW	TH	TW	TH	TH	HT	HW	HT	HT	TH	TH	124	TW	TH	TH	HT	HT	TH	HT	HT	HW	HW	TH	TH
16	TH	TW	TW	TW	TH	HW	TH	HW	VH	TH	TH	TH	125	TH	TW	TW	TW	TH	HW	TH	VH	TW	TW	TH	TH
17	TH	TW	TW	TW	TH	HW	TH	HW	VH	TH	TH	TH	126	TH	TH	TH	HT	TH	TH	HT	HT	VH	TH	TH	TH
18	TH	TW	TH	TW	TH	TH	HW	HW	TH	TH	TH	TH	127	TW	TH	TH	HT	HT	TH	HT	HT	HW	HW	TH	TH
..	TH	TW	TW	TW	TH	HW	TH	HW	VH	TH	TH	TH	.....	TW	TH	TH	HT	HT	TH	HT	HT	HW	HW	TH	TH
109	TH	TW	TW	TW	TH	HW	TH	HW	VH	TH	TH	TH	218	TH	TW	TW	TW	TH	HW	TH	VH	TW	TW	TH	TH

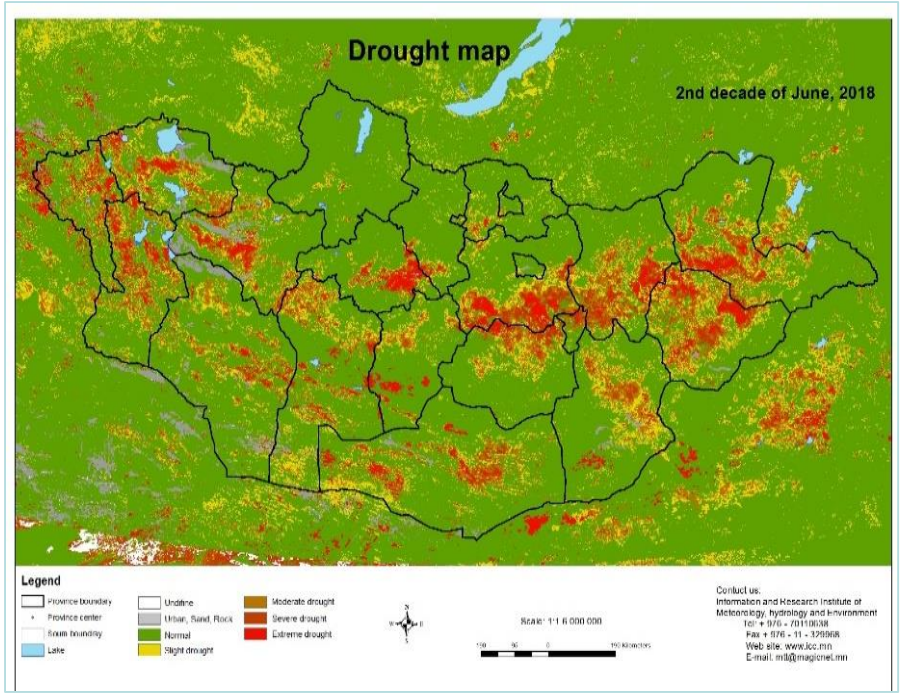
Mongolia

Weights	May	June	July	August	September
Wtci (VHI a)	0.41	0.31	0.27	0.31	0.42
Wvci (VHI b)	0.59	0.69	0.73	0.69	0.58

The suggested index was presented in the table for each district in different months after the analysis of indices & references data (soil moisture, biomass and so on).

Drought Combined Model





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- Background
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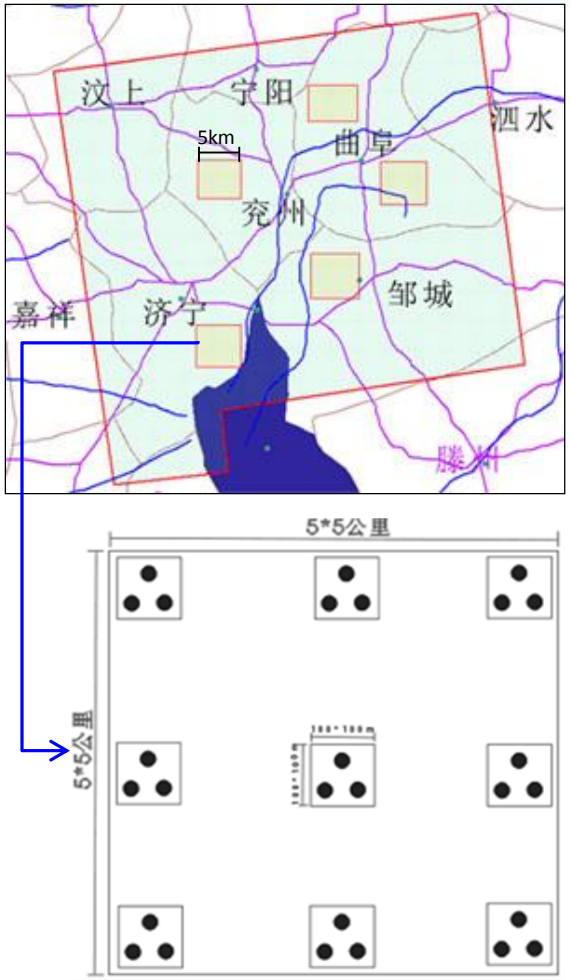
Validation in China

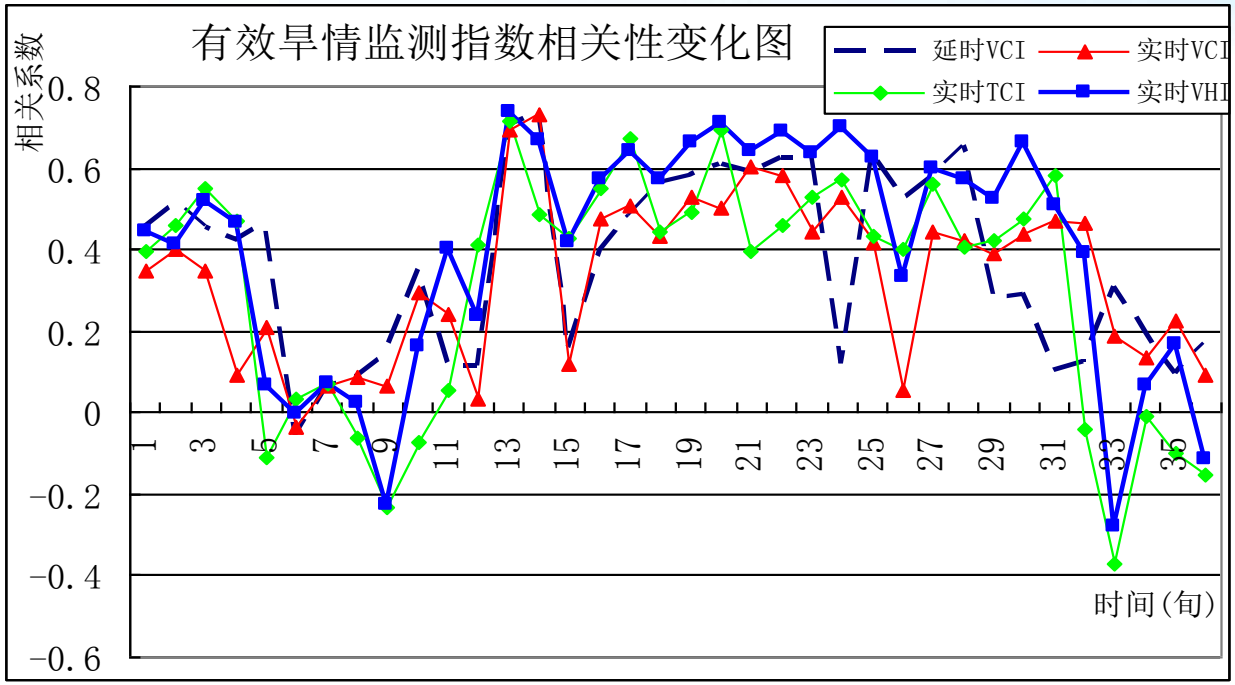
- Study area: Jining, Shandong
- Time: April-May 2005
- Relation analysis: indices and soil moisture
- The relation between indices and soil moisture:

  VHI > TCI >VCI

Depth	TCI_R^2	VCI_R^2	VHI_R^2
10cm Soil moisture	0.93	0.66	0.97
20cm Soil moisture	0.91	0.60	0.92



Validation in China



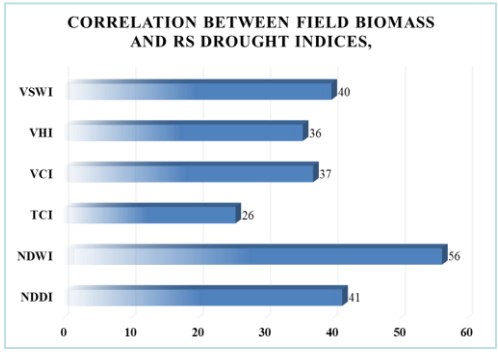
Soil moisture data from 70 stations and drought indices in 2003-2005 were used to analysis:

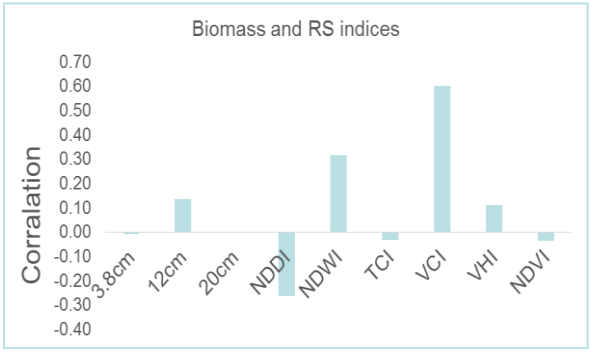
- VHI have high relation with soil moisture in the growth season of crop,
- Especially, during crop growth seasoning of April to October,VHI has good preformance,
- TCI is good for Nov-March, winter season

Validation in Mongolia

Drought products validation with field data from 2014-2017:

- Soil moisture
- Biomass
- Regional drought affected data from field observation

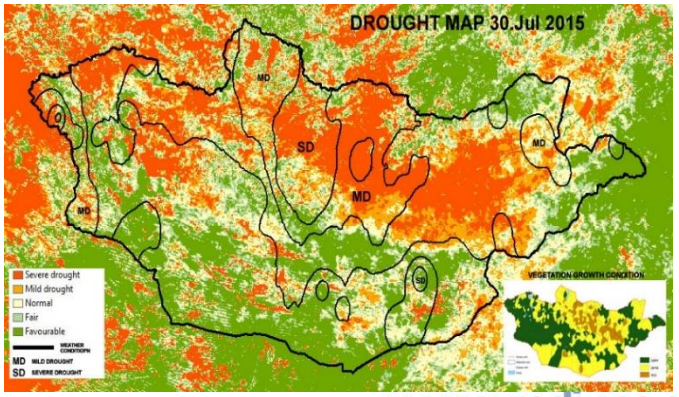




	BIOMASS ce/ha (averaged by two plot)	NORMAL	ANOMAL
VHI	0.42	0.76	0.69
TCI	0.55	0.78	0.67
VCI	0.45	0.29	0.09
NDDI	0.29	0.09	0.12
VSWI	-0.13	-0.05	0.34
NDVI	0.55	0.08	-0.45

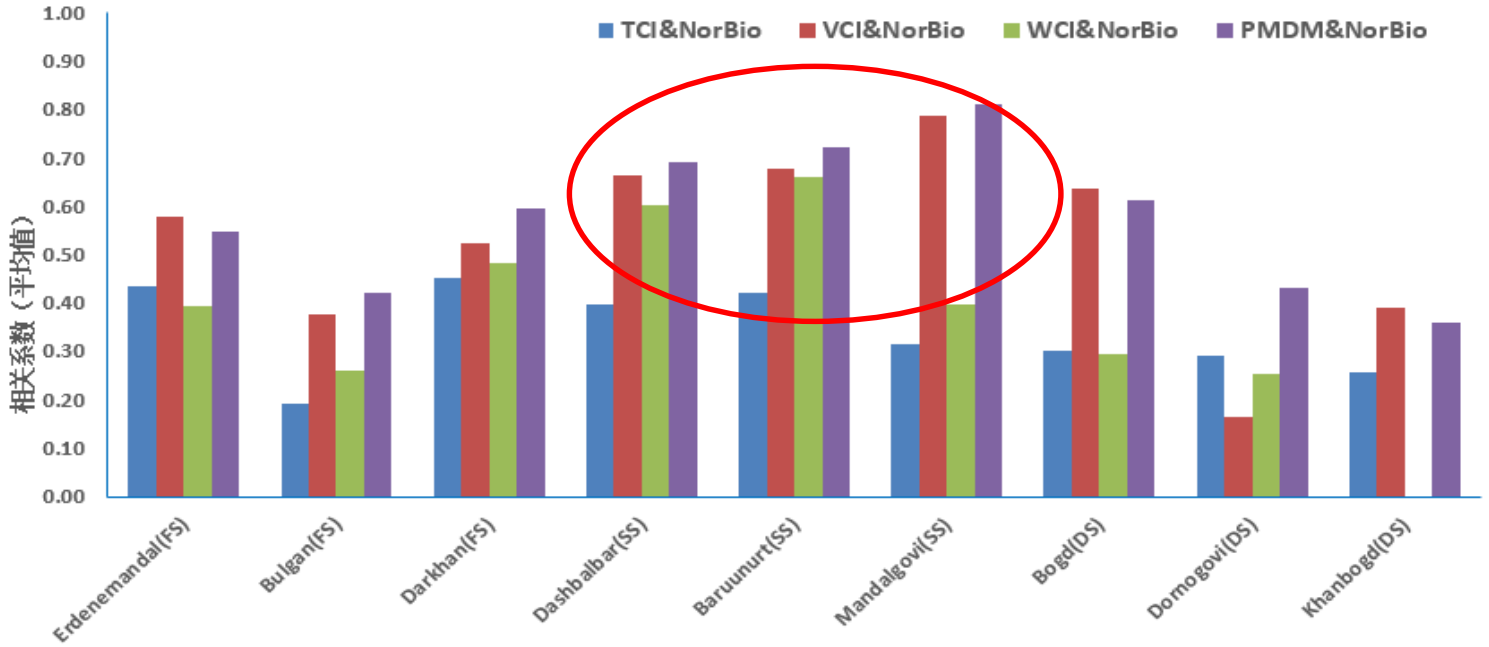
Decade	5_3	6_1	6_2	6_3	7_1	7_2	7_3	8_1	8_2	8_3	9_1	9_2	9_3
May-I-VHI	-0.09	0.16	-0.12	0.05	0.16	0.31	0.13	0.08	0.08	0.11	0.22	0.37	-0.23
May-II-VHI	0.11	0.33	0.19	0.32	0.47	0.47	0.41	0.14	0.22	0.25	0.35	0.45	0.16
May-III-VHI	0.25	0.52	0.48	0.62	0.53	0.11	-0.03	0.01	-0.13	0.06	-0.11	0.12	-0.29
June-I-VHI		0.47	0.54	0.71	0.44	0.00	-0.16	-0.17	-0.30	-0.14	-0.18	-0.10	-0.48
June-II-VHI			0.58	0.74	0.48	0.06	-0.11	-0.11	-0.21	0.00	-0.10	-0.06	-0.25
June-III-VHI				0.52	0.74	0.54	0.49	0.39	0.38	0.50	0.38	0.54	0.36
July-I-VHI					0.71	0.62	0.62	0.52	0.54	0.62	0.49	0.58	0.38
July-II-VHI						0.66	0.64	0.78	0.76	0.81	0.46	0.54	0.67
July-III-VHI							0.60	0.71	0.73	0.78	0.53	0.45	0.62
Aug-I-VHI								0.67	0.60	0.70	0.28	0.40	0.57
Aug-II-VHI									0.58	0.69	0.34	0.36	0.65
Aug-III-VHI										0.71	0.46	0.51	0.53
Sep-I-VHI											0.44	0.49	0.85
Sep-II-VHI												0.40	0.65

R2	NDDI	VSWI	TCI	VCI	VHI
Soil moisture(TDR,12CM)	0.545	0.690	0.774	0.773	0.877
Soil moisture(TDR,20CM)	0.765	0.623	0.823	0.749	0.890
Soil moisture(EBA,10CM)	0.073	0.194	0.171	0.189	0.204



Validation in Mongolia

- Biomass of 131 sites from 2015 to 2017, were used for drought combined model(PMDM) validation.
- The highest correlation between PMDM and Normalized biomass is steppe area; followed by forest and desert steppe.
- PMDM and Normalized biomass are better correlation than single index.



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Applications

DroughtWatch had been deployed to several relative departments of China(agriculture, meteorology, disaster mitigation, water resource and so on).

应 用 证 明

项目名称	国家 863 课题“粮食预警遥感辅助决策系统” 子课题“旱情遥感监测与验证”
应用成果名称	旱情遥感监测系统
应用单位	水利部水利信息中心
通讯地址	北京市宣武区白广路二条
联系电话	010- 63202400
应用成果起止时间	2005 年 6 月--

应用情况及社会效益：

中国科学院遥感应用研究所承担的国家 863 计划“粮食预警遥感辅助决策系统”课题连续 2 年为我单位提供《全国旱情遥感监测报告》（旬报）。并于 2005 年 8 月将“旱情遥感监测系统”移植到水利部水利信息中心运行，通过调试已于 2005 年 9 月投入试运行。系统内容包括遥感数据标定、几何纠正、气象数据处理、大气纠正、BRDF 纠正、地表参数提取、MVC 数据拼接、NDVI 与 TS 最值计算、指数提取以及遥感指数旱情监测等。

系统运行方便、操作简单，实现了 NOAA AVHRR 数据预处理、遥感指数计算以及旱情监测的无缝连接，是一个标准化、规范化的集成系统，在水利系统有很好的应用推广前景。

系统提供的旱情监测结果已为全国抗旱决策提供服务。

用户签名（盖章）：水利部水利信息中心

2005 年 9 月 12 日

应 用 证 明

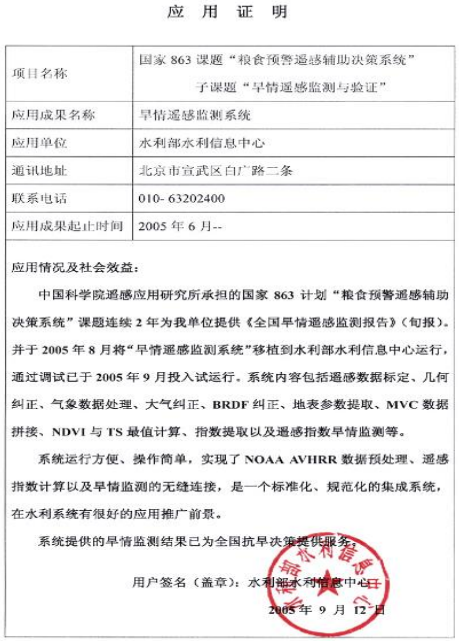
项目名称	基于 MODIS 卫星遥感旱情监测系统改造
应用成果名称	基于 MODIS 的全国旱情遥感监测系统
移植单位	水利部水利信息中心
通讯地址	北京市宣武区白广路二条
联系电话	010-63203517
移植时间	2009 年 12 月
移植内容	系统路径设置，数据获取子系统（遥感数据获取），MODIS 预处理子系统（文件读取模块、辐射纠正模块、几何纠正模块、大气纠正模块、云标识模块、地表参数提取模块，参数设置模块），旱情指数计算子系统，旱情监测子系统。

系统评价：

基于 MODIS 的全国旱情遥感监测系统于 2009 年 12 月移植到中心，试运行时间为 2010 年 1 月-2010 年 12 月。系统设置简单，模块分布合理，且功能齐全。运行方便、操作简单，将各个功能模块都集成在统一的界面下，是一个标准化规范化的集成系统。截止目前运行稳定，可以满足中心业务运行的需求。

移植单位（盖章）：水利部水利信息中心

2010 年 9 月 1 日



应 用 证 明

项目名称	国家 863 课题“粮食预警遥感辅助决策系统” 子课题“旱情遥感监测与验证”
应用成果名称	旱情遥感监测系统
应用单位	水利部水利信息中心
通讯地址	北京市宣武区白广路二条
联系电话	010- 63202400
应用成果起止时间	2005 年 6 月--

应用情况及社会效益：

中国科学院遥感应用研究所承担的国家 863 计划“粮食预警遥感辅助决策系统”课题连续 2 年为我单位提供《全国旱情遥感监测报告》（旬报）。并于 2005 年 8 月将“旱情遥感监测系统”移植到水利部水利信息中心运行，通过调试已于 2005 年 9 月投入试运行。系统内容包括遥感数据标定、几何纠正、气象数据处理、大气纠正、BRDF 纠正、地表参数提取、MVC 数据拼接、NDVI 与 TS 最值计算、指数提取以及遥感指数旱情监测等。

系统运行方便、操作简单，实现了 NOAA AVHRR 数据预处理、遥感指数计算以及旱情监测的无缝连接，是一个标准化、规范化的集成系统，在水利系统有很好的应用推广前景。

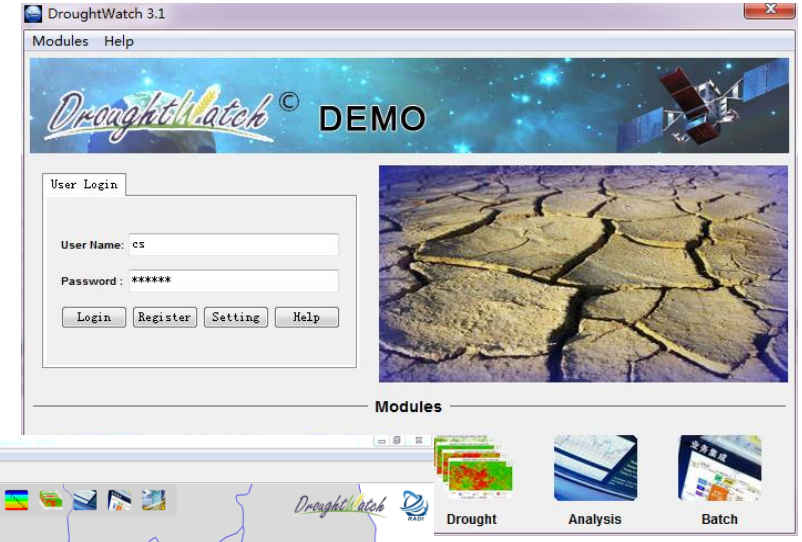
系统提供的旱情监测结果已为全国抗旱决策提供服务。

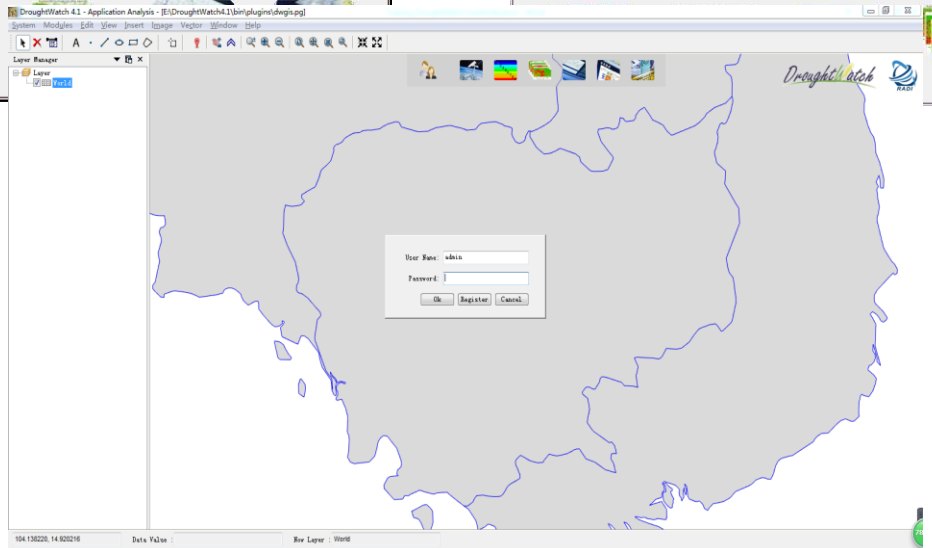
用户签名（盖章）：水利部水利信息中心

2005 年 9 月 12 日

Applications

DroughtWatch has been installed, and deployed into the Mongolia(2014), Sri Lanka(2015), and Cambodia(2018).

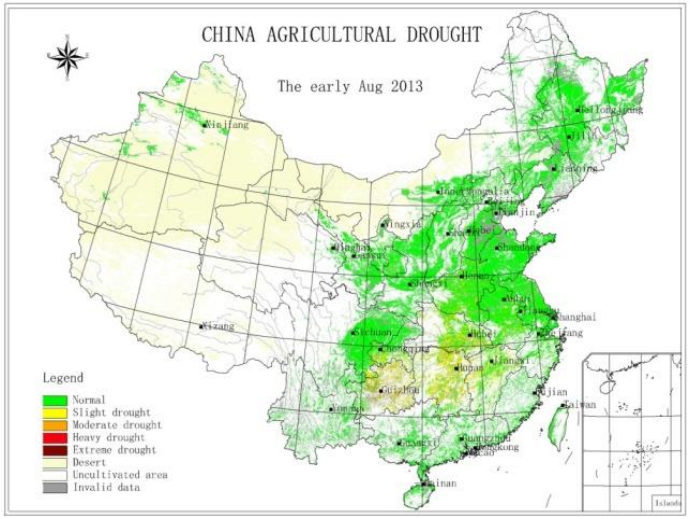


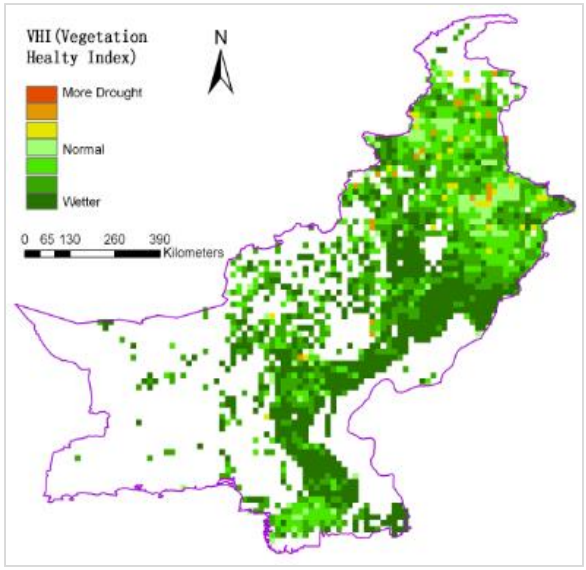


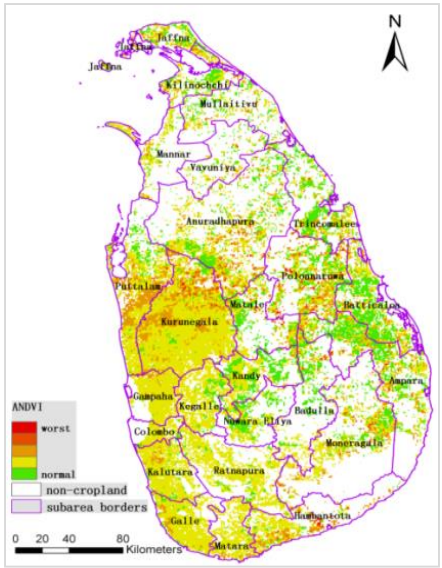
Applications

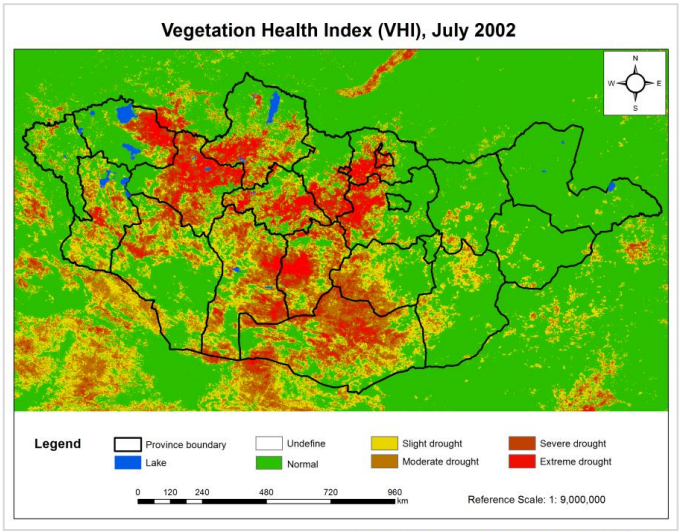
Agricultural drought monitoring was carried out in some countries by the DroughtWatch:

- China(2000-2018),
- Mongolia (2000-2018),
- Pakistan (2014),
- Sri lanka (2017),
- Cambodia(2000-2018)
- and so on



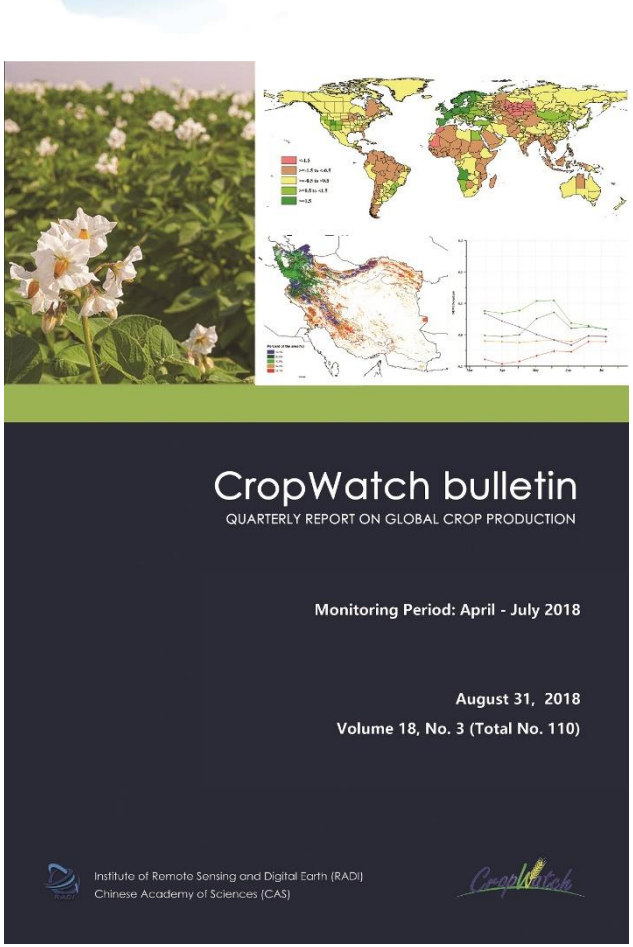


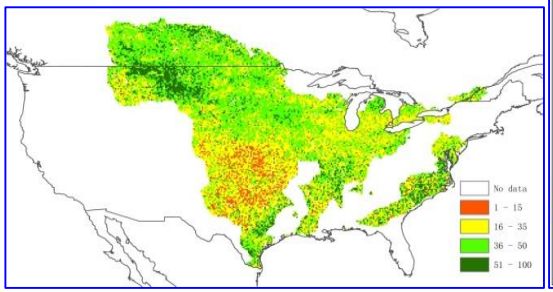


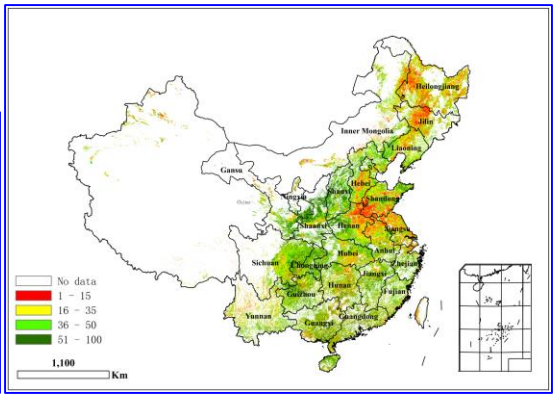


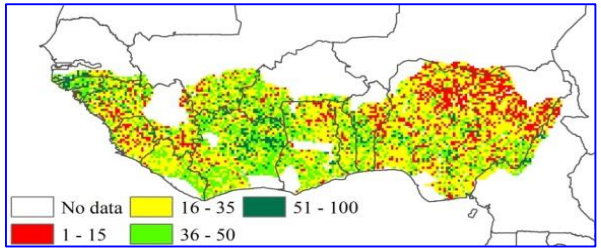
Applications

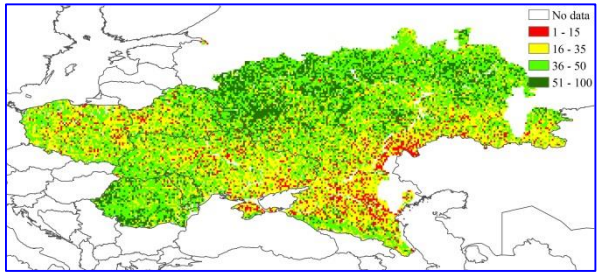
Drought results for were involved into quarterly CropWatch Bulletin, which was open to globe.

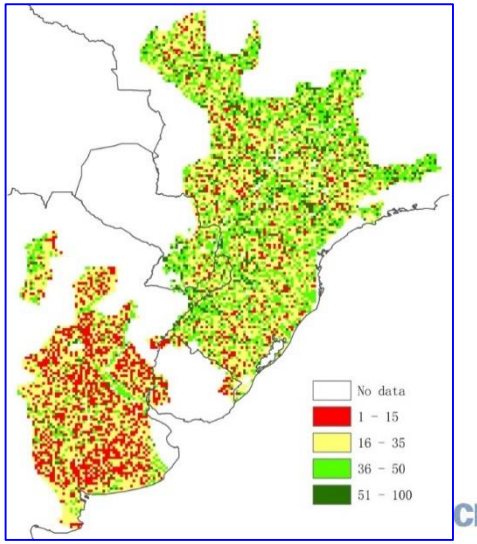












Prospects

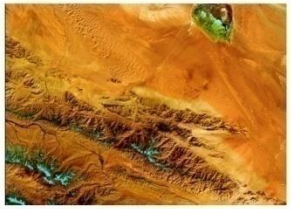
1. System upgrade

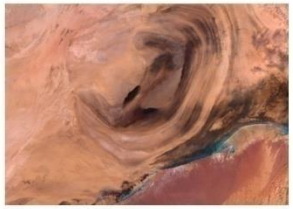
- Modifying the data processing module for Chinese higher satellite data
- Model finalization will be updated in the system
- Model calibration and validation in more countries or regions

2. Method development

- Drought monitoring based on available water in the crop/steppe root zone
- Drought forecasting are carrying out

Thanks!



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