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

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Ulaanbaatar, Mongolia

Drought Watch localization

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Background

Mongolia has a severe climate with high seasonal variations and a low annual average in rainfall.

As a country,

- sensitive ecosystems,
- natural restoration is poor
- agricultural sector is directly dependent on climate

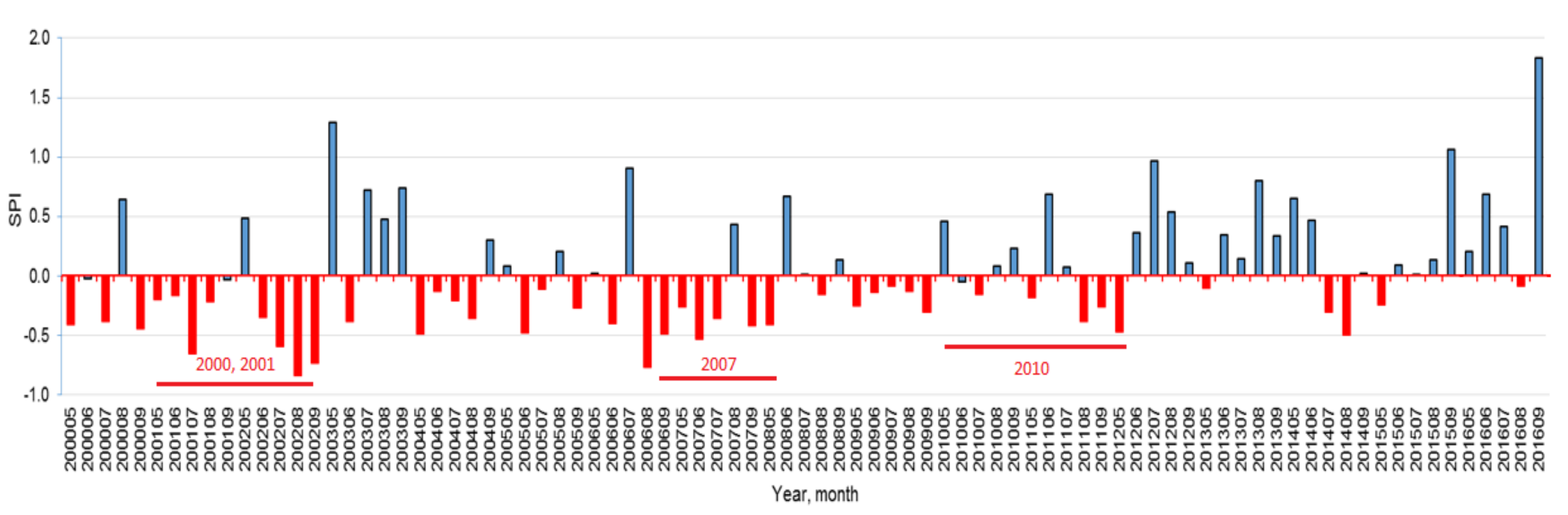
Droughts have a major negative impact on the country's socio-economic, especially herders or animal husbandry.

Environmental and ecosystem degradation, such as drying up of surface water, forest and pasture fires and pests, decreased plant yields, and one indicator in the desertification. It has been coming to a significant negative impact on the environment due to drought frequency. Drought is closely linked to the food supply of the population, and drought issues are important in national security.

Background

Regional climate warming Mongolia has increased by 0.1 to 3.7 degree during last 60 years. There is also evidence that spring precipitation has decreased by 17%, while summer precipitation has increased by 11%. Drought was reported that the frequency of drought in the spring and summer has increased from 1-2 to 3-4 times every 5 years [Luvsan.N].

Drought has a disturbing effect not only on agricultural productivity and hydrological resources but also on the natural vegetation, and hence it may accelerate desertification processes associated with destructive human activities (overgrazing) in semi-arid pastureland areas of Mongolia.

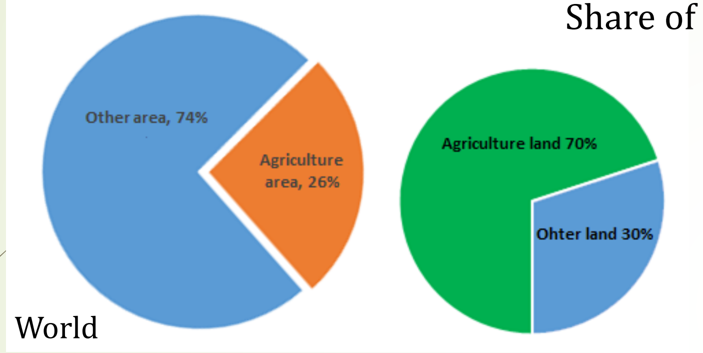


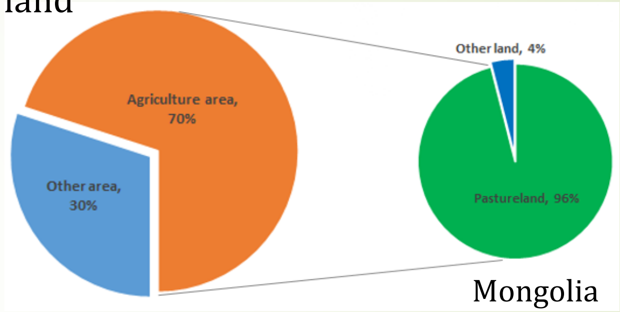
Long term meteorological drought index (PED and SPI)

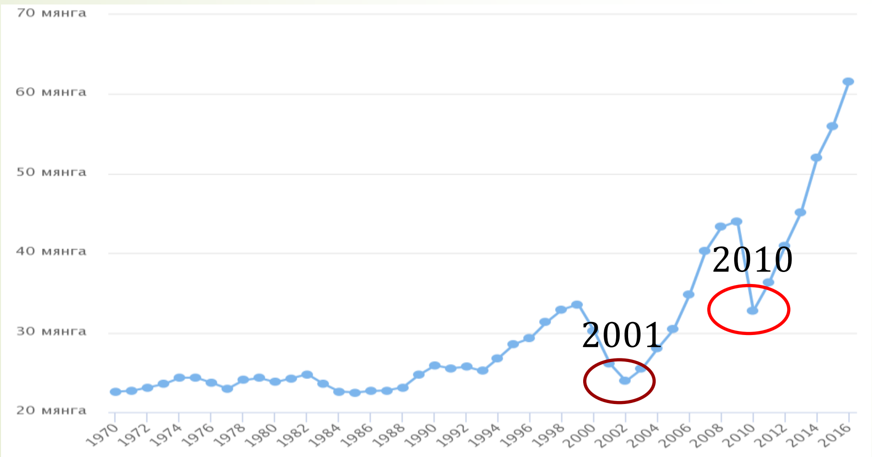
Background

Currently estimate that 73% of the Mongolian land area and 96% of the Mongolian agricultural area are covered by grasslands, which contribute to the livelihoods of over 1 million people or one third of the population.

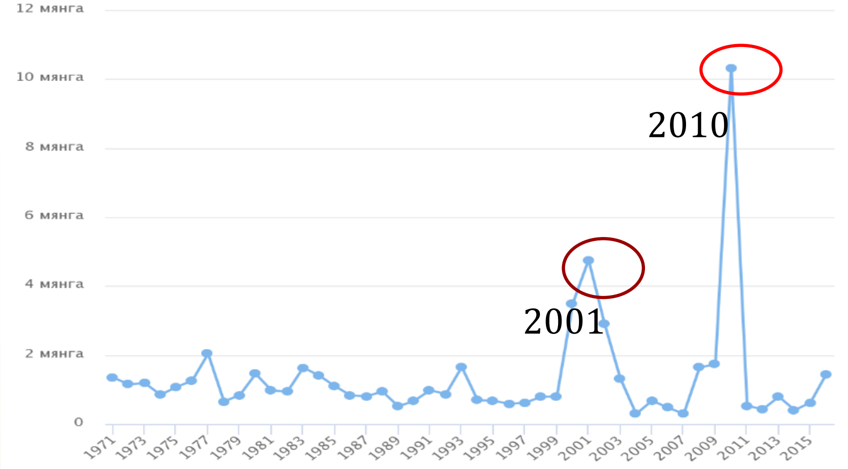
Share of agriculture and pasture land







The number of livestock



Livestock mortality

In 2002 (Mongolia) the drought damage amounted to 31.6 billion Tugriks or 28.1 million US dollar. Dr M. Bayasgalan 2005

Drought monitoring needs or challenges

Climate change, vulnerability of disaster and application

- *Harsh continental climate. (Mongolia is one of the countries where climate change is occurring.)*
- *Most affected country to disasters. (The frequency and magnitude of natural disasters (drought, dzud, fire) have tendency to increase due to climate change and global warming)*
- *Agriculture still plays a major role in the national economy. The agriculture sector employs 35 percent of the total population, produces 17.9 % of GDP and accounts for 30 percent of the country's export.*

To developing the drought monitoring operational system based on space technology

- *Develop space technology, methodology, and management to use drought monitoring in Mongolia.*
- *To improve disaster preparedness capacity and to fully employ satellite data and technology for drought monitoring*
- *Disseminate drought data for users through the environmental database*

Source: http://mofa.gov.mn/

DroughtWatch localization

- To define the suitable drought indices for drought monitoring in Mongolia
- DroughtWatch technology support and system deploying
- Methodology
- Results application and validation
- Customization

Suitable drought indices

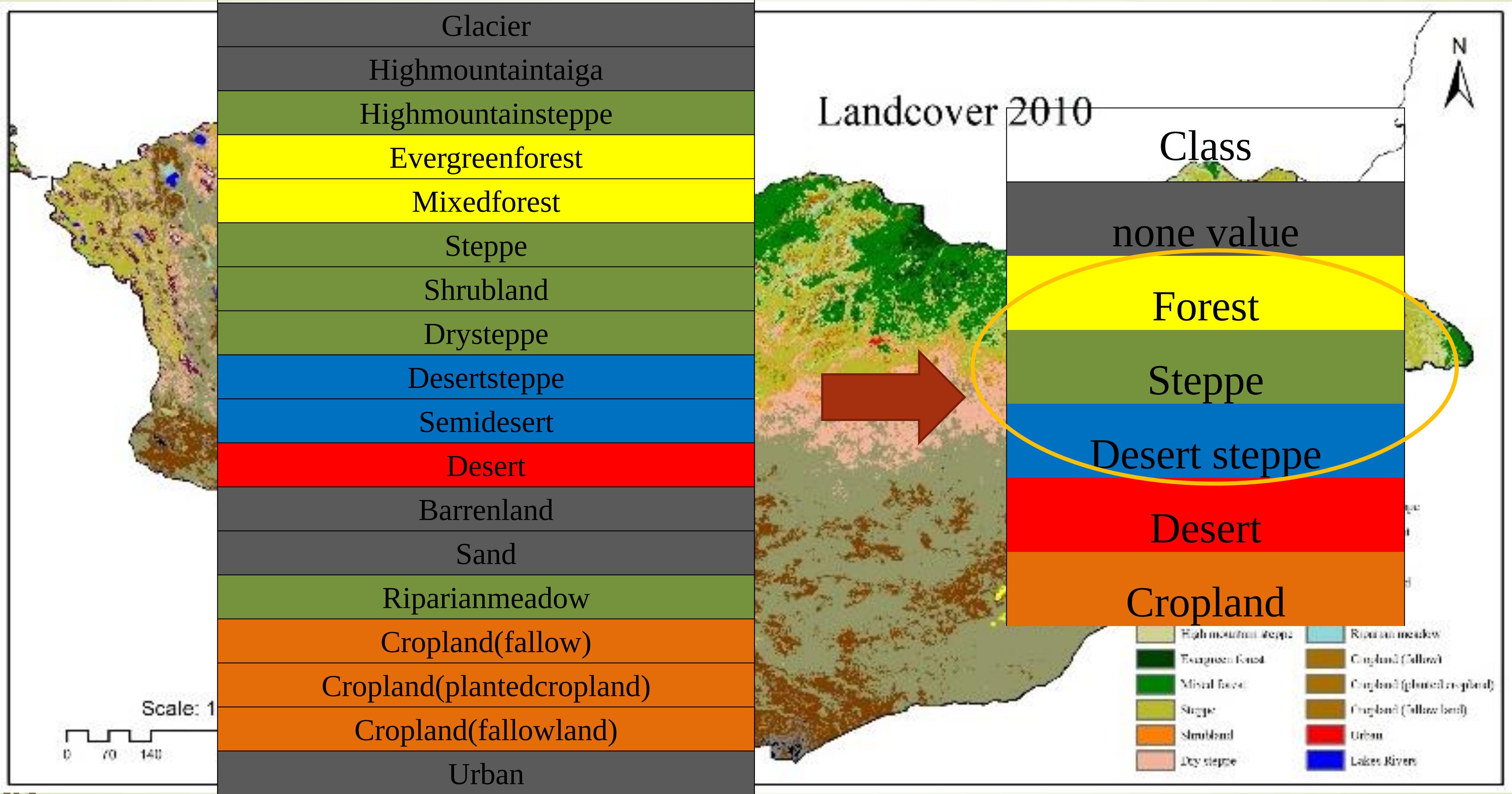
- Aridity Index (AI)
- Standardized precipitation index (SPI)

Meteorological indices

- 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)

Remote Sensing indices

Analyzed the differences between RS and ground drought indices and soil moisture.



Class
Glacier
Highmountaintaiga
Highmountainsteppe
Evergreenforest
Mixedforest
Steppe
Shrubland
Drysteppe
Desertsteppe
Semidesert
Desert
Barrenland
Sand
Riparianmeadow
Cropland(fallow)
Cropland(plantedcropland)
Cropland(fallowland)
Urban
LakesRivers

Class
none value
Forest
Steppe
Desert steppe
Desert
Cropland

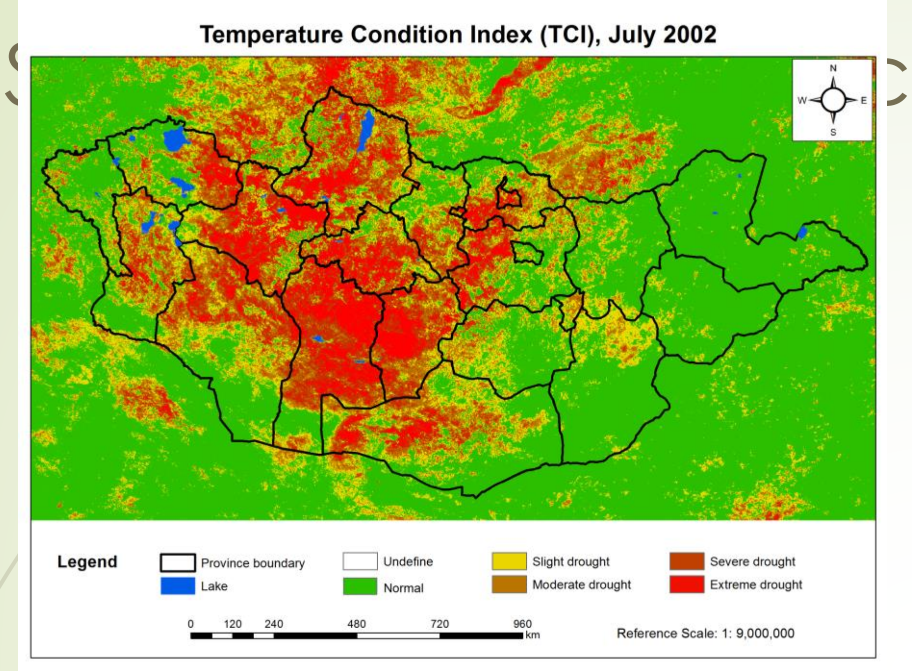
Suitable drought indices

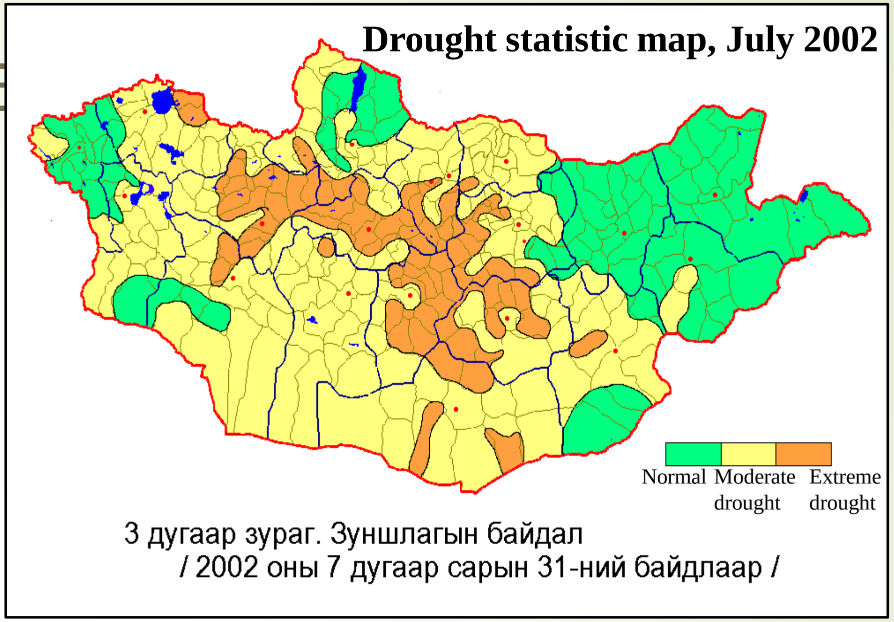
Correlation coefficient r analysis between 10 cm of Soil moisture and RS indices

r Correlation between 10 cm of soil moisture and RS indices										r= 40 >	r= 30 >
Natural zone	**Month**	**NDDI**	**NMDI**	**VHI**	**VCI**	**TCI**	**VTCI**	**VSWI**	**VSDI**		
Forest zone	May	0.02	0.02	0.17	0.28	0.56	0.47	0.21	0.20	NDDI/VHI/TCI/VTCI/VSWI	
	June	0.47	0.23	0.26	0.21	0.22	0.12	0.32	0.10		
	July	0.64	0.47	0.68	0.70	0.62	0.53	0.60	0.04		
	August	0.47	0.23	0.29	0.28	0.23	0.19	0.29	0.49		
	September	0.70	0.26	0.43	0.22	0.63	0.42	0.42	0.24		
Steppe zone	May	0.15	0.33	0.17	0.09	0.16	0.18	0.43	0.12	VSWI	VHI/VCI/VTCI/
	June	0.19	0.27	0.21	0.11	0.26	0.18	0.43	0.06		
	July	0.28	0.28	0.32	0.31	0.28	0.38	0.49	0.10		
	August	0.27	0.24	0.39	0.33	0.35	0.49	0.53	0.16		
	September	0.20	0.24	0.23	0.16	0.23	0.32	0.49	0.25		
Desert steppe zone	May	0.18	0.09	0.24	0.14	0.24	0.11	0.10	0.13	VHI	VCI/TCI
	June	0.12	0.13	0.30	0.30	0.12	0.15	0.09	0.08		
	July	0.14	0.25	0.17	0.15	0.12	0.19	0.23	0.20		
	August	0.06	0.23	0.40	0.32	0.32	0.22	0.27	0.20		
	September	0.20	0.21	0.43	0.42	0.31	0.07	0.25	0.06		

r Correlation between SPI and RS indices										r= 40 >	r= 30 >
Natural zone	**Month**	**VSDI**	**NMDI**	**NDDI**	**VCI**	**TCI**	**VHI**	**VTCI**	**VSWI**		
Forest zone	May	0.02	0.32	0.14	0.10	0.16	0.18	0.06	0.07		TCI
	June	0.05	0.12	0.07	0.03	0.02	0.03	0.19	0.07		
	July	0.17	0.05	0.39	0.18	0.30	0.26	0.40	0.34		
	August	0.32	0.18	0.10	0.07	0.43	0.29	0.20	0.20		
	September	0.29	0.03	0.24	0.02	0.38	0.19	0.26	0.29		
Steppe zone	May	0.17	0.16	0.00	0.04	0.32	0.16	0.16	0.25	TCI/VSWI	TCI/VHI/VTCI
	June	0.07	0.15	0.10	0.10	0.22	0.19	0.23	0.31		
	July	0.05	0.26	0.28	0.26	0.38	0.34	0.34	0.44		
	August	0.02	0.27	0.20	0.31	0.52	0.46	0.45	0.48		
	September	0.22	0.25	0.17	0.13	0.45	0.32	0.31	0.42		
Desert steppe zone	May	0.16	0.11	0.01	0.04	0.48	0.25	0.32	0.15	TCI	VHI/VTCI
	June	0.13	0.28	0.15	0.11	0.27	0.22	0.32	0.34		
	July	0.07	0.30	0.10	0.22	0.44	0.37	0.31	0.31		
	August	0.10	0.17	0.01	0.24	0.50	0.42	0.31	0.24		
	September	0.17	0.24	0.16	0.24	0.31	0.32	0.11	0.23		

Correlation coefficient r analysis between SPI and RS indices





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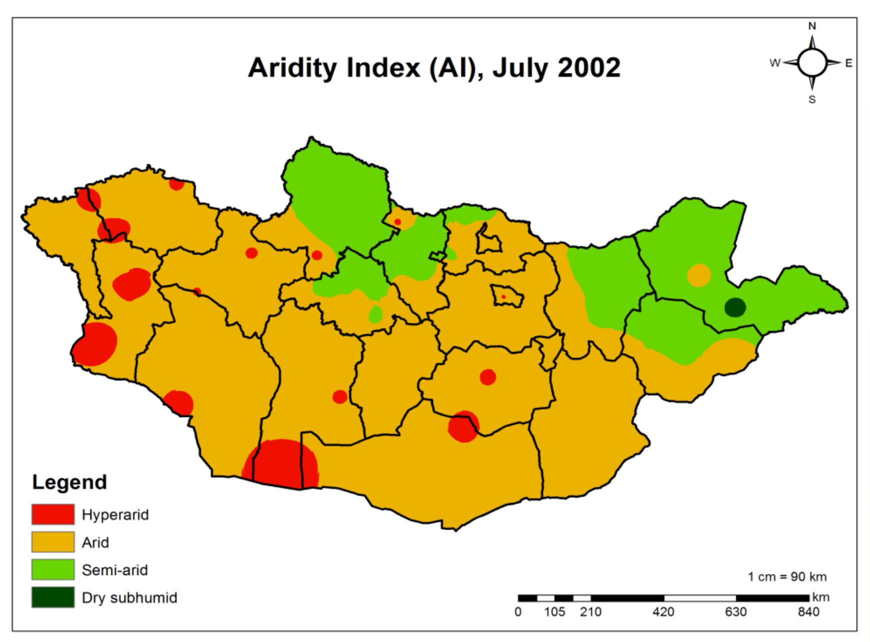
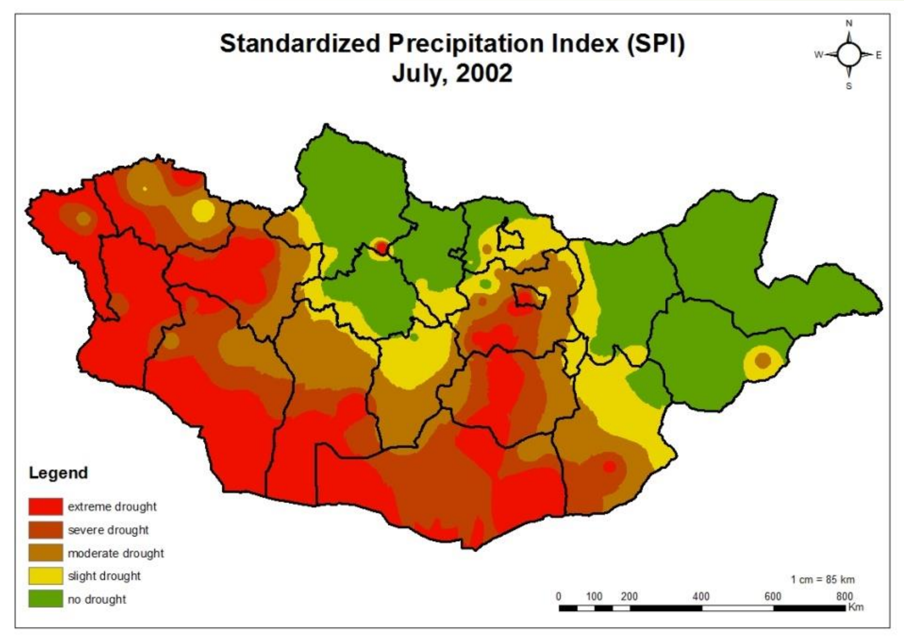




Reference

Reference

Suitable drought indices

- We have estimated to correlation coefficient **r** analysis between RS indices and based on ground of meteorological drought indices and soil moisture (5, 10cm).
- Also we did comparison analysis between RS, ground indices and the summer condition.

From the results below:

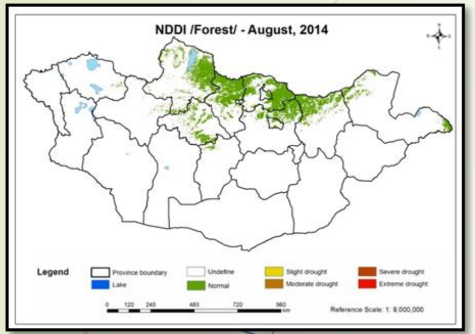
NDDI and VSWI were suitable in the Forest

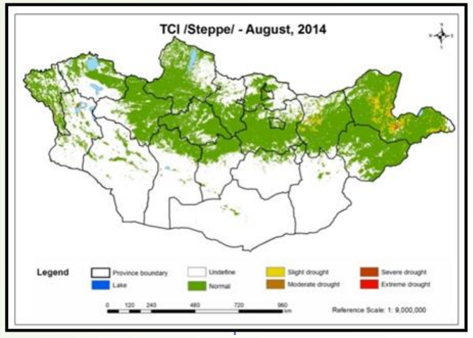
TCI, VCI and VHI were - Steppe

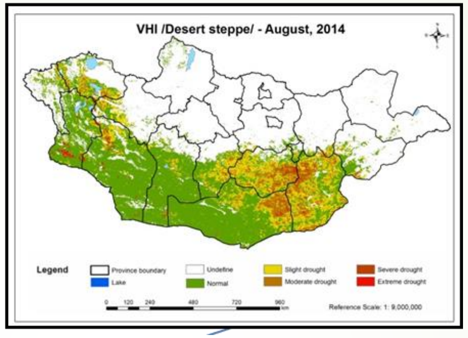
VHI was – Desert steppe

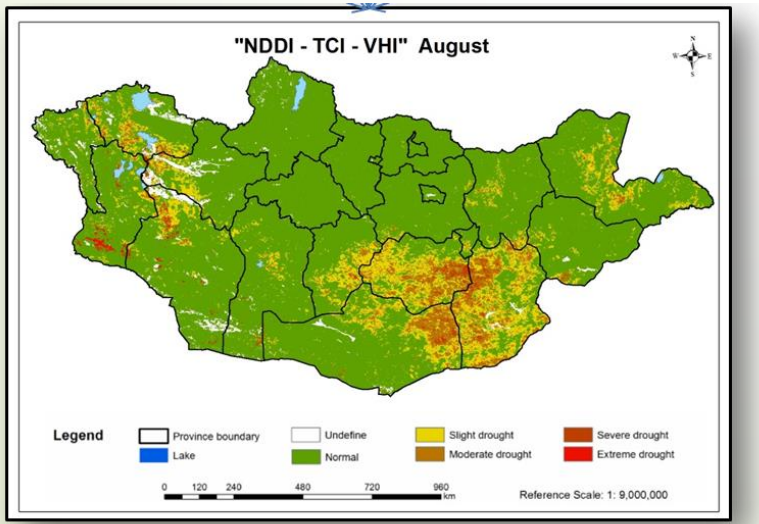
Suitable drought indices for each zones

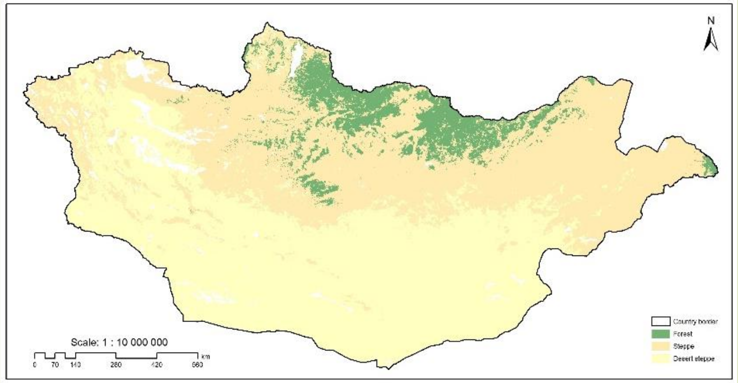
Forest steppe & steppe & desert steppe

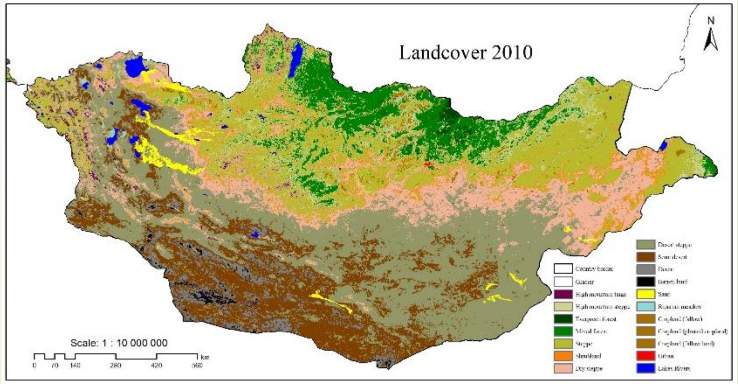






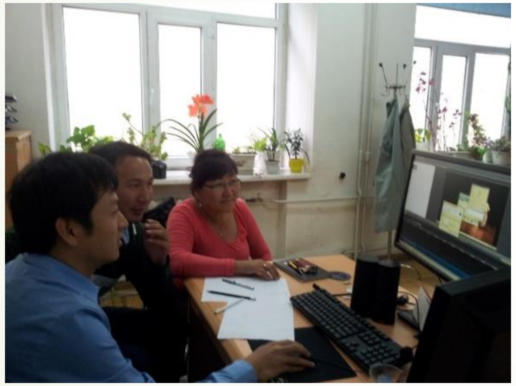




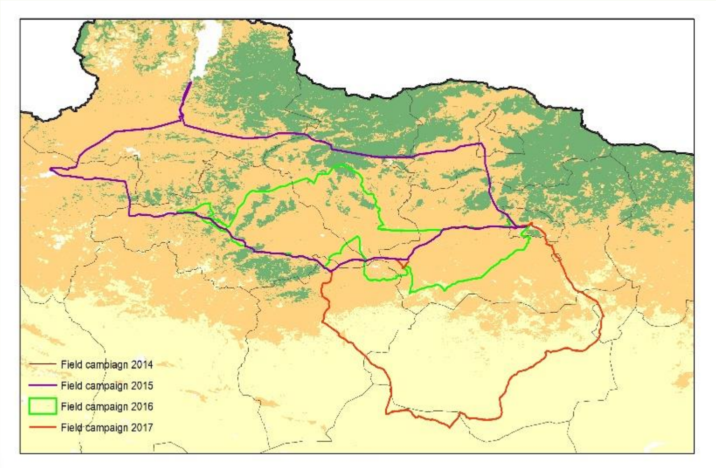


DroughtWatch installation

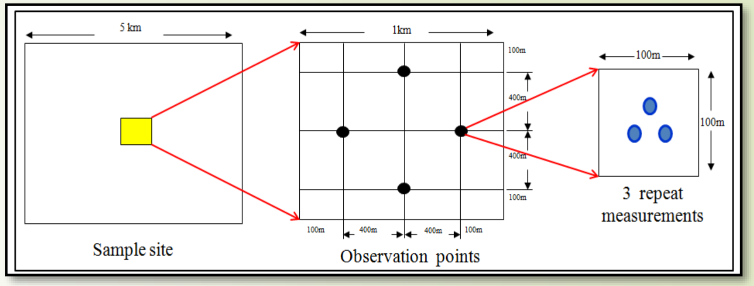
- DroughtWatch system installed in August, 2014 in the Remore sensing division, Information and Research Institute of Meteorology, Hydrology and Environmental
- DroughtWatch havs been using for drought monitoring and operational service since 2015



Joint field campaign



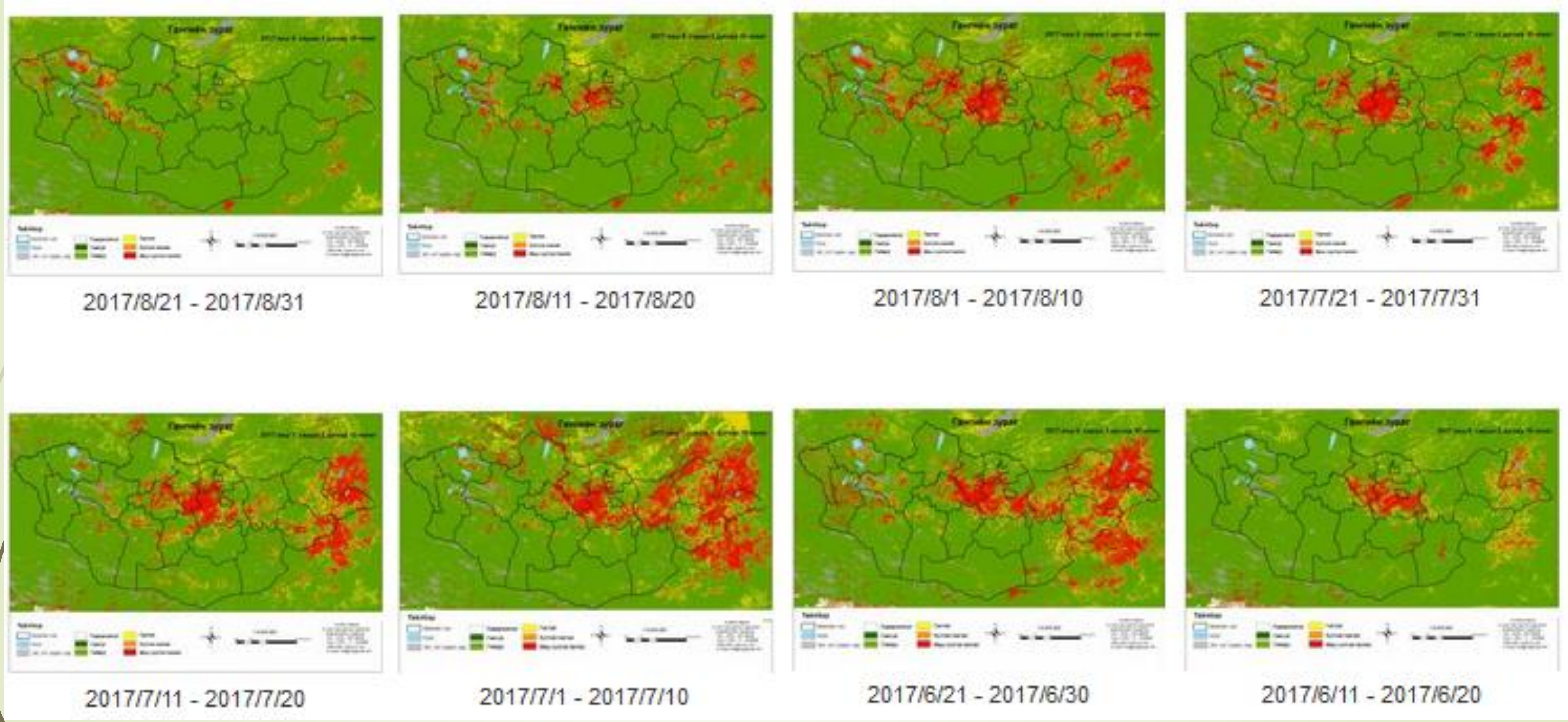
Methodology



Collecting samples

- Field campaign from 2014 to 2017 (July to August) were carried out by China and Mongolia technicians.
- Parameters: **Soil moisture, biomass, vegetation spectrum, height, coverage, and livestock loss** number so on.
- Participants: 6 specialists of IRIMHE and 6 specialists of RADI.

DroughtWatch results



Customization for seasonal variation

- To propose an approach a **variant of the VHI (nVHI) applicable throughout the Mongolia country.**
  - Calculated the regression coefficients using fenced biomass against the two variables (TCI, VCI)

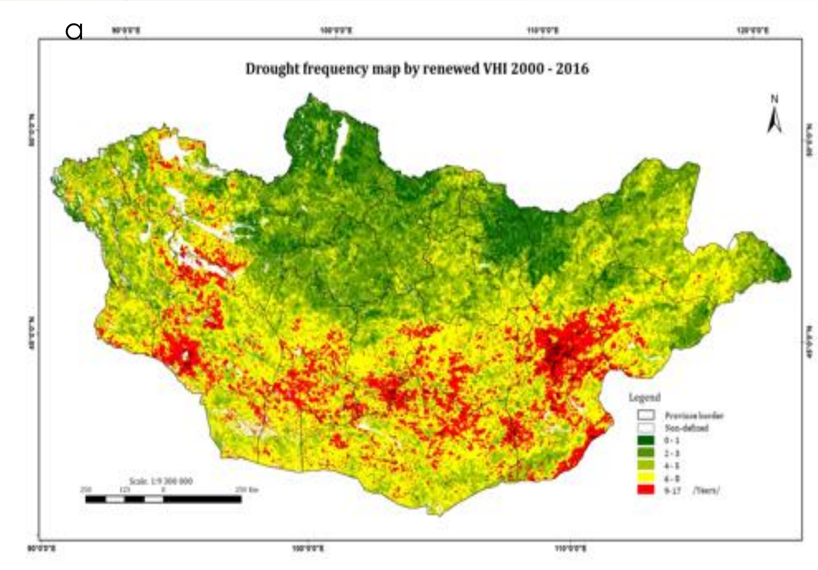
$$nVHI = Wvci * VCI + Wtci * TCI$$

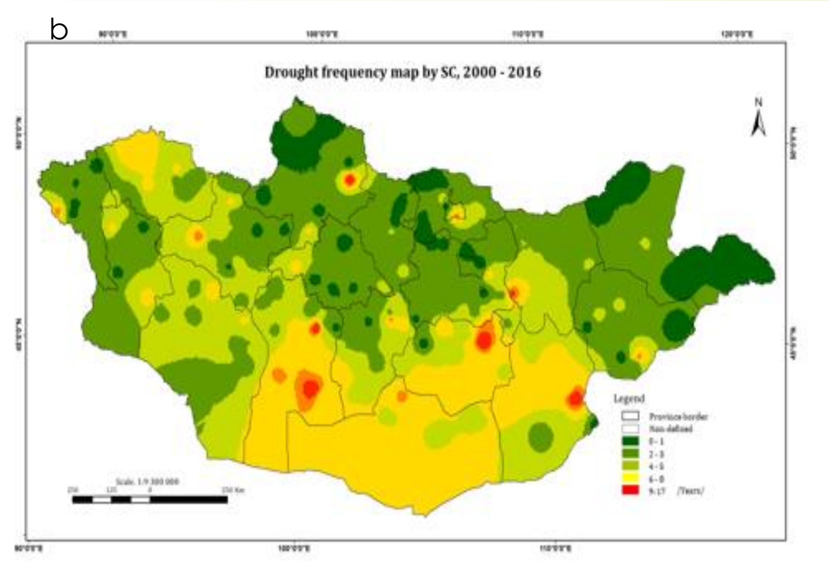
Weights	May	June	July	August	September
Wtci (VHI a)	0.41	0.31	0.27	0.31	0.42
Wvci (VHI b)	0.59	0.69	0.73	0.69	0.58

The determined weight (Wtci, Wvci) of the TCI and VCI in a calculation of VHI. The results indicated, the VCI and TCI were significantly related to FBio with average correlation coefficient (ave_R2) 0.31 - 0.36, and ave_R2 were 0.17 – 0.19, separately. Those correlations are most correlated to a weight of drought indices. Therefore, a ratio of weights was Wvci: 0.7, Wtci: 0.3 in June to August but it decreased a little to Wvci: 0.6, Wtci: 0.4 in May and September. The nVHI is suitable for use in drought research in Mongolia, and it is considered to be available for use in a detailed analysis and validation. Because the verification, by renewed coefficient, correlation coefficients have increased compared with before inclusion of VHI.

Customization - drought frequency

- The drought frequency maps based on **nVHI** and Summer condition 2000 – 2016





The general form of frequency was similar and increasingly from north to south, east to west is in line with the general moisture regime of our country.

It has been shown that during the last 17 years, the nVHI in some part of Dornogovi, Dundgobi and Bayankhongor provinces have been poor for 10-17 years

Drought Watch system - Work capacity, advantages

- Easy to use a system for operational drought service (pre-processing, calculating of drought indices and mapping)
- Drought system included a statistical tool available for detailed information
- Previous year's time data can also be processed
- Drought products are important for the Dzud assessment and prediction.
- A wide range of available database has been created to use for other scientific researches.
- The system has been processing a remote sensing data and mapping by a spatial level in the monthly.

Thank you for your attention