



Historic fire regime modeling elements using GIS and Remote Sensing

Tsolmon R, Oyuntsetseg Ts, Oyudari V

National University of Mongolia, School of Physics and Electronics,
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Specifications of Mongolia

The territory stretches 1,259 kilometers from north to south and 2,392 kilometers from east to west. The total length of the border is 8,161.8 kilometers; 3,485.0 kilometers borders with Russia, and 4,676.8 kilometers with China.

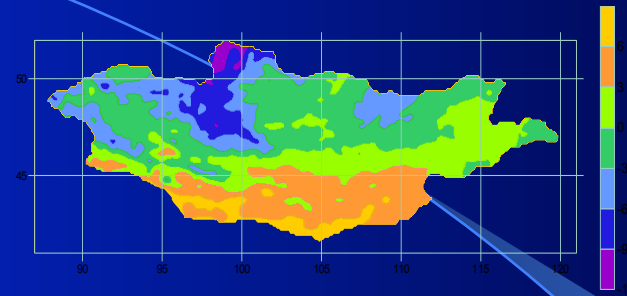
It is located on average altitude is 1580 meters above the sea level.

Mongolia is one of the rich natural countries in the world.





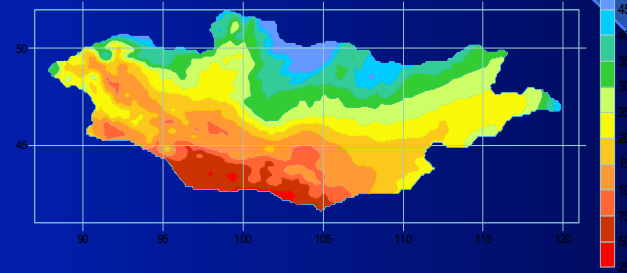
Specifications of Mongolia



Air temperature

January: -15°C -34°C

July: $+15^{\circ}\text{C}$ $+30^{\circ}\text{C}$



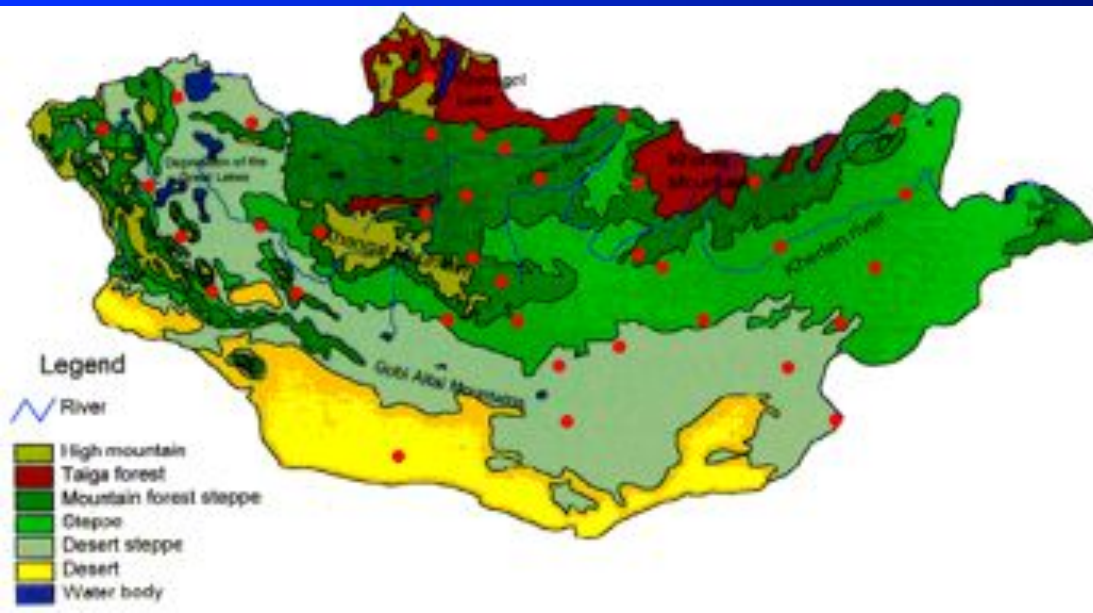
Precipitation:

300-600 mm – mountain

150-300 mm – forest st., steppe

50-150 mm – gobi, desert

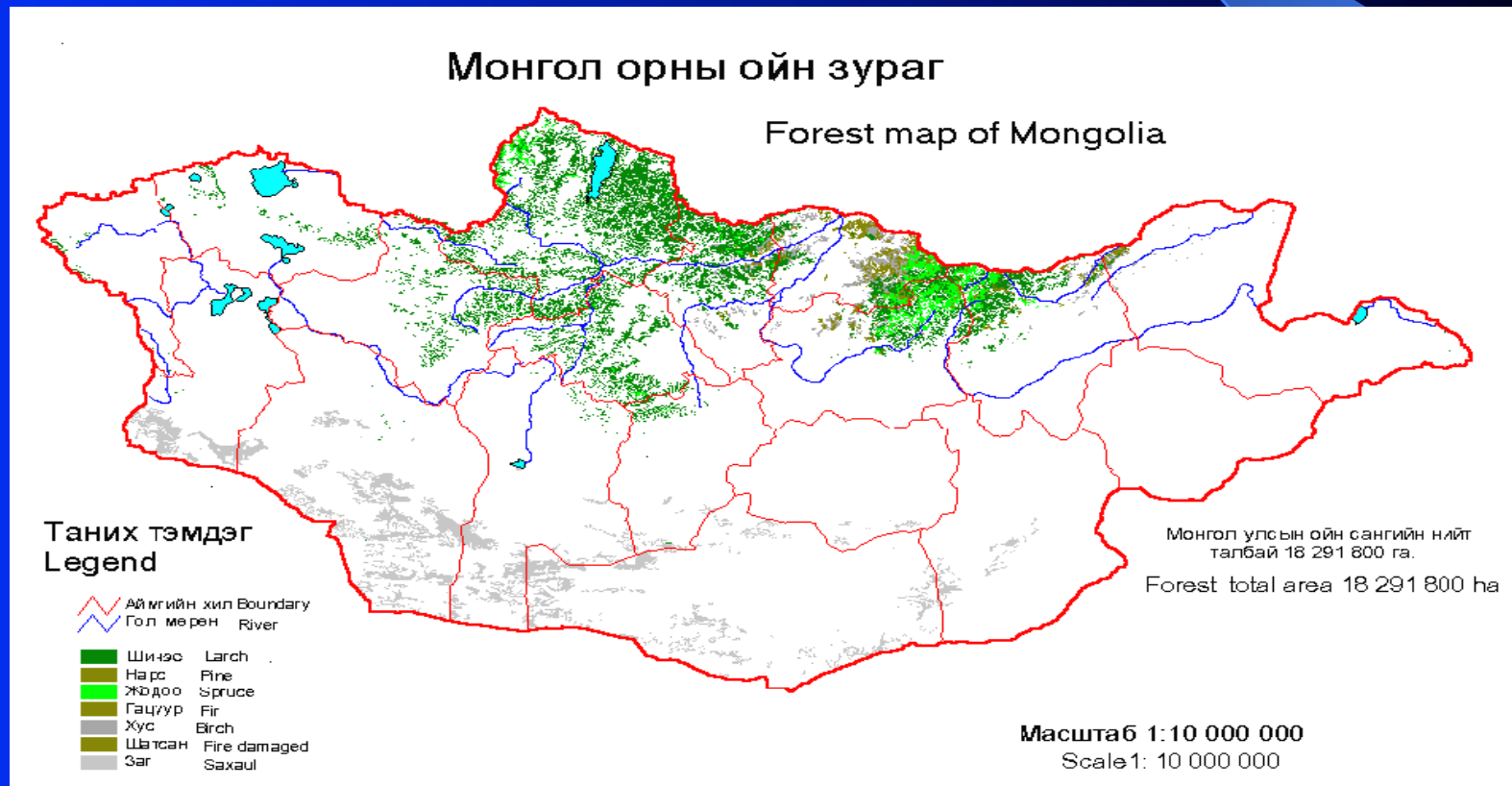
- Different Natural zones
- Severe Continental Climate
(4 seasons, long winter, short summer)



There are 7 natural zones: High Mountain Zone, Taiga Forest Zone, Mountain Forest Steppe Zone, Steppe Zone, Desert-Steppe Zone, Gobi Desert Zone, Wetlands.

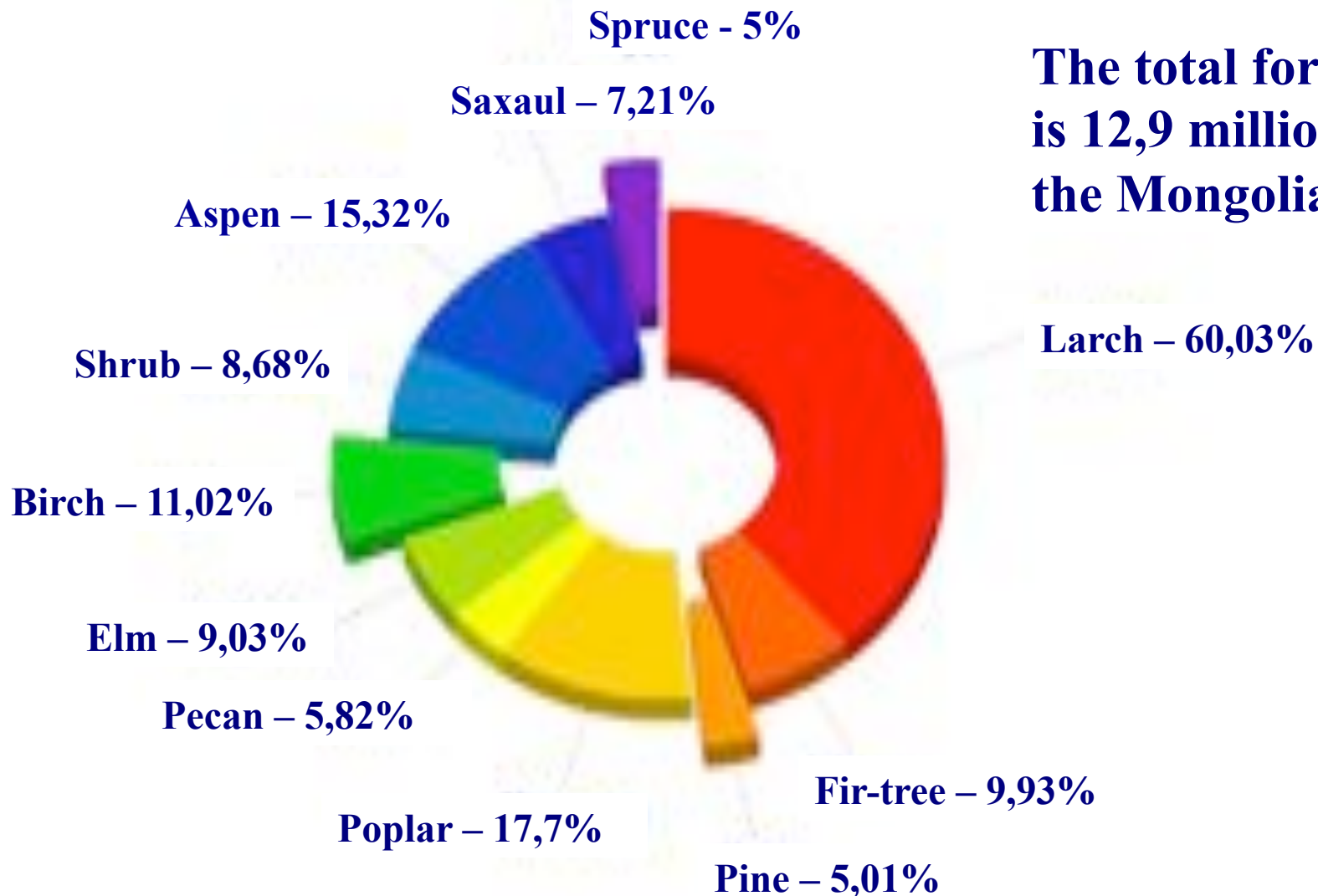
National forest resources

- Mongolia has relatively low forest cover with just over 8 percent of the country covered by closed forests. The forests are mainly located in the north-central parts of the country, forming a transition zone between the Great Siberian boreal forest and the Central Asian steppe desert. In Khentii and Khovsgol, the mountain slopes are clothed with boreal taiga forest.



Percent of forest area /types/

**The total forest area
is 12,9 million ha in
the Mongolia**



Forest fire

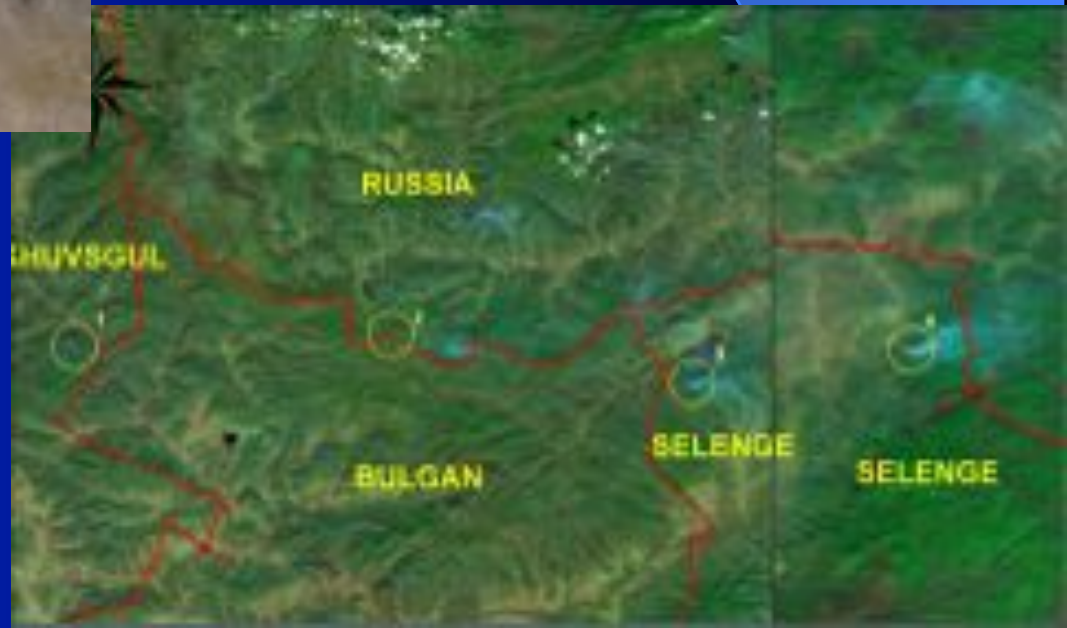
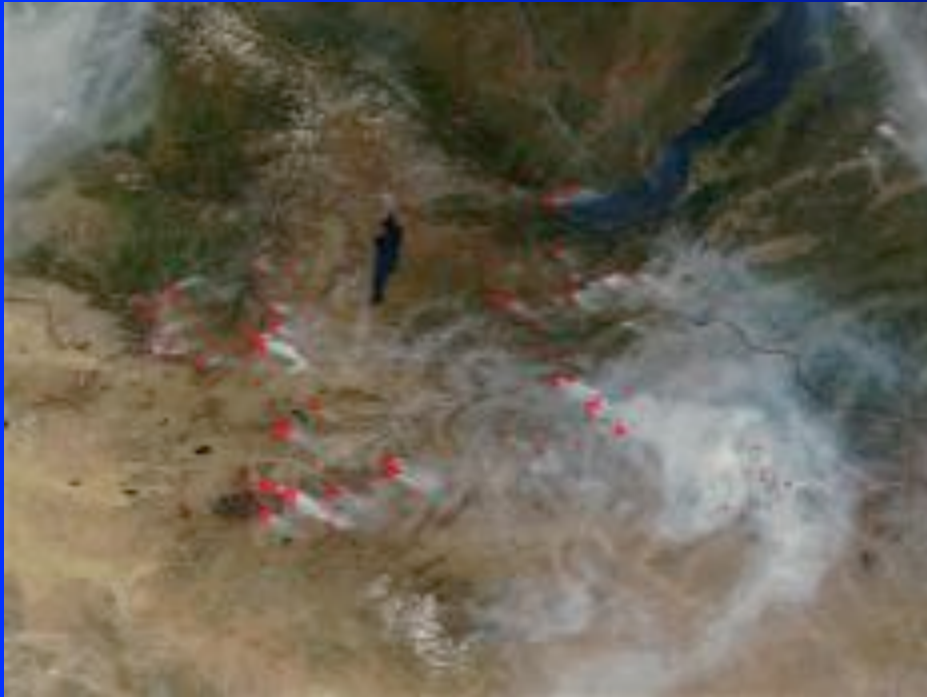
- Forest and steppe fire cases: as of 2009-2010 Mongolia has a 1.5 hundred thousand km² of territory and most of the territory is steppe and Gobi desert. Nomadic life style and agriculture is a traditional and most popular way of living and steppe and forest fires causes huge damages to the pasture field which can significantly affect the livestock and livelihood of the herder families.



Forest fire MODIS-Terra satellite image (25 September, 2011)



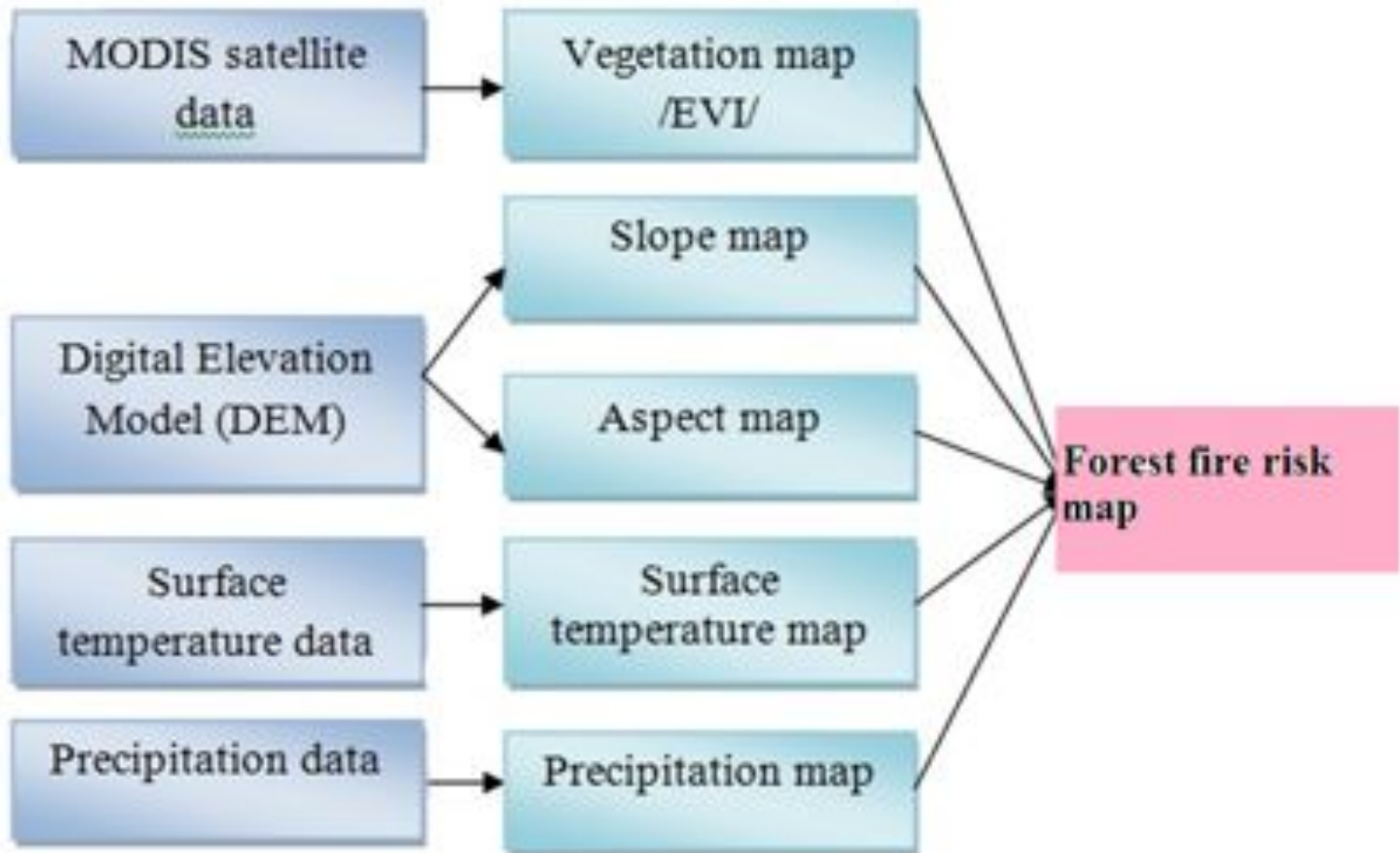
Forest fire MODIS-Terra satellite image (07 October, 2011)



Historic Fire Regime Prediction Model

- Mongolian forests are found along the Khangai, Khentii, Khuvsgul and Mongol Altai ranges, are playing an important role in protecting water and soil resources, maintaining the ecological balance of nature in the region.
- Forest fire is major cause of forest degradation.
- The objective of this research is to map the forest fire risk in the Selenge province using Remotely sensed data and GIS data
- To map forest fire risk using by Digital Elevation Model (DEM), surface temperature, vegetation, precipitation data

Methodology



Methodology

ASPECT AND SLOPE MAPS

Warm Aspect (Southeast) = 125° to 145°

Warm Aspect (South) = 145° to 165°

Warm Aspect (Southwest) = 165° to 185°

Cool Aspect = 185.1° to 124.1°

Steep Slope = $\geq 35\%$

Shallow Slope = $\leq 35\%$

Methodology

Aspect and Slope combination

Aspect/Slope Combinations	Topographical Code
Cool Aspect/Steep Slope	I
Warm Aspect/Steep Slope (Southeast)	II
Warm Aspect/Steep Slope (South)	III
Warm Aspect/Steep Slope (Southwest)	IV
Warm and/or Cool Aspect/Shallow Slope	V

Description of aspect/slope combinations and corresponding topographical codes used in the Historic Fire Regime model.

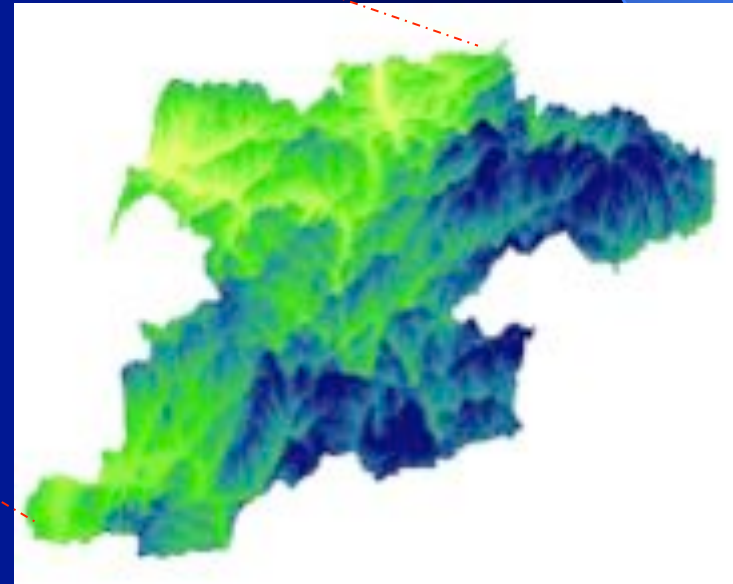
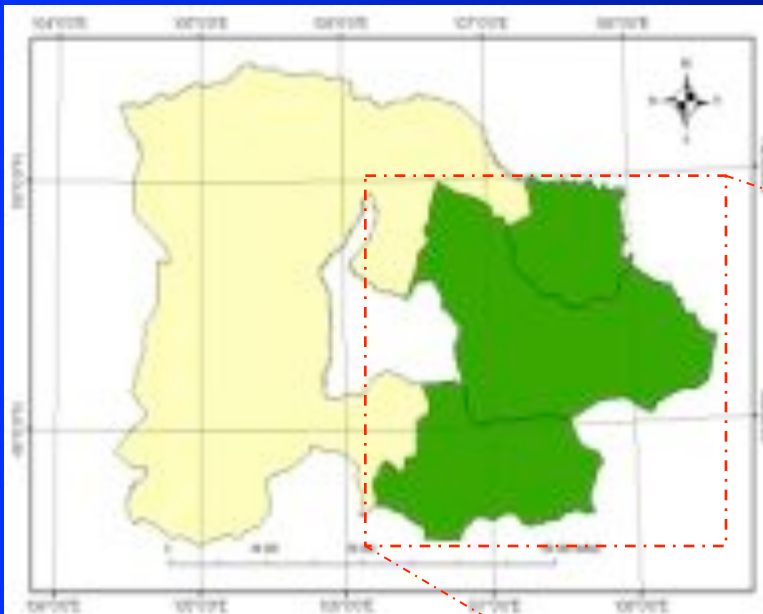
The vegetation classification code and topographical classification code for the historic fire regime (traditional methodology)

Table 4. Historic Fire Regime Prediction Model

Historic Fire Regime	Vegetation Classification Code	Topographical Classification Code	Comments
1 - No fire	Tundra (non-forest/xeric)	All aspects: I, II, III, IV, V	High alpine ecosystems of lichens, moss; horizontally discontinuous fuels.
2 - Frequent (<10 years), stand replacement	Steppe (non-forest/xeric) Sub-Taiga (non-forest/xeric)	All aspects: I, II, III, IV, V	Warm and cool aspects/slopes of grass/forb/shrub
3 - Frequent (<10 years), mixed-severity	Steppe (low-forest: BERO-POTR) Steppe (high-forest: BERO-POTR) Sub-Taiga (low-forest: LASI) Sub-Taiga (high-forest: LASI)	Warm aspects: II, III, IV	Warm aspect forests of LASI, PISY, and BERO-POTR mixed with grass
4 - Frequent (<30 years), mixed-severity	Steppe (non-forest: mesic) Sub-Taiga (low-forest: LASI) Sub-Taiga (high-forest: LASI) Sub-Taiga (non-forest: mesic) Taiga (non-forest/xeric) Taiga (low-forest: LASI) Taiga (high-forest: LASI)	Cool low-elevation riparian + Warm mid-elevation + Warm subalpine	Cool, low elevation riparian zones, plus mid-elevation warm aspect forests of LASI, PISY, and BERO-POTR mixed with grass, and warm aspect subalpine (Taiga) forests of LASI
5 - Frequent (<50 years), mixed-severity	Taiga (non-forest: mesic) Taiga (low-forest: LASI) Taiga (high-forest: LASI)	Cool mid-elevation riparian + Cool subalpine	Cool, mid-elevation riparian zones, plus cool aspect subalpine (Taiga) forests of LASI, PISI, AB3I, PISI and forbs
6 - Infrequent (>100 years), mixed-severity	Tundra (low-forest: LASI-PISI) Tundra (high-forest: LASI) Tundra (non-forest: mesic)	All aspects: I, II, III, IV, V	High-elevation forests and meadows that contain continuous to discontinuous fuels

Study Area

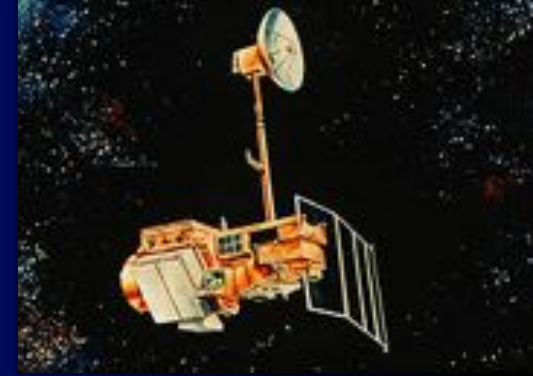
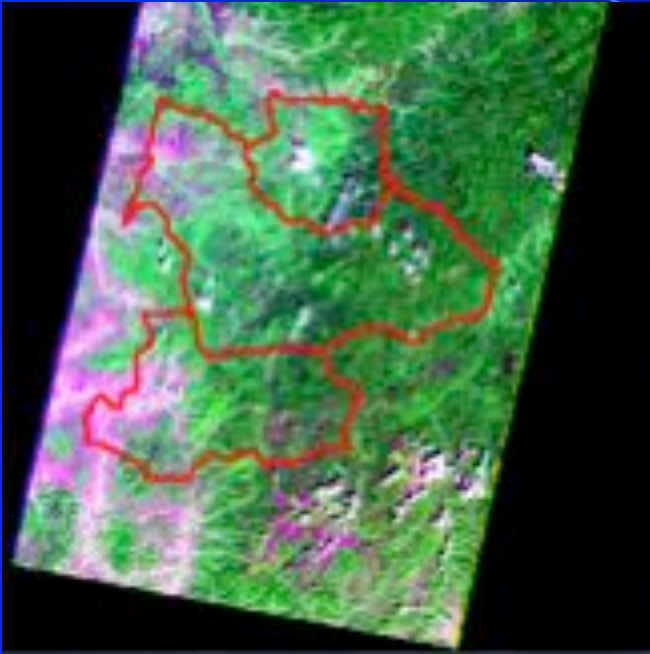
The main study area is Khuder, Eruu, Mandal soum of Selenge province in Mongolia $48^{\circ}55'N$ - $50^{\circ}0'N$, $106^{\circ}18'E$ - $108^{\circ}58'E$
Study area's territory total size 15.877 km².



Data used

- Landsat satellite data – September, 2002
- ASTER (Advanced Spaceborne Thermal Emission and Reflection Radiometer) satellite, DEM (Digital Elevation Modal) data /30m resolution/
- MODIS (Moderate Resolution Imaging Spectroradiometer) satellite data – September, 2002 years

Landsat satellite image

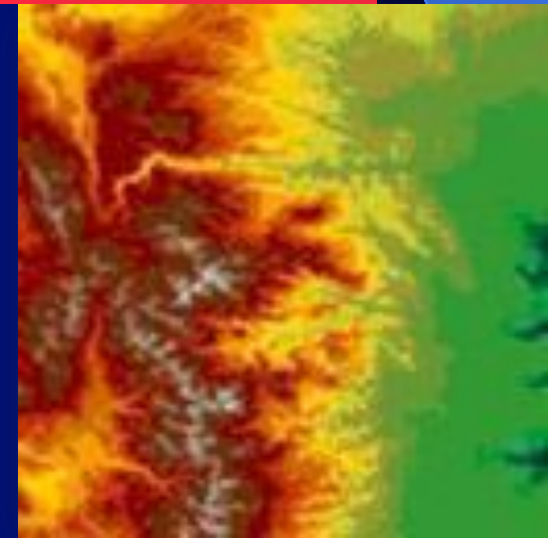


Resolution 30m
-path 131
-row 25, 26

Digital Elevation Model (DEM)

Resolution: 30m-1 km

- Elevation
- Slope
- Aspect
- Hill shade



Precipitation data



Climate data from metrological organisation of Mongolia

Sub province	Precipitation, mm
Eroo	7,5
Mandal	6,8
Khuder	12,3

Analysis

Vegetation map - EVI- Enhanced Vegetation

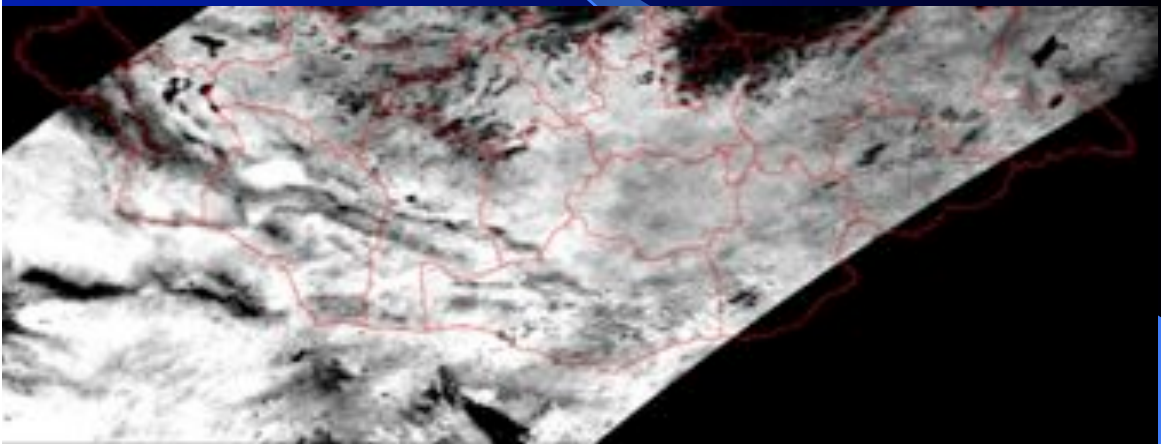
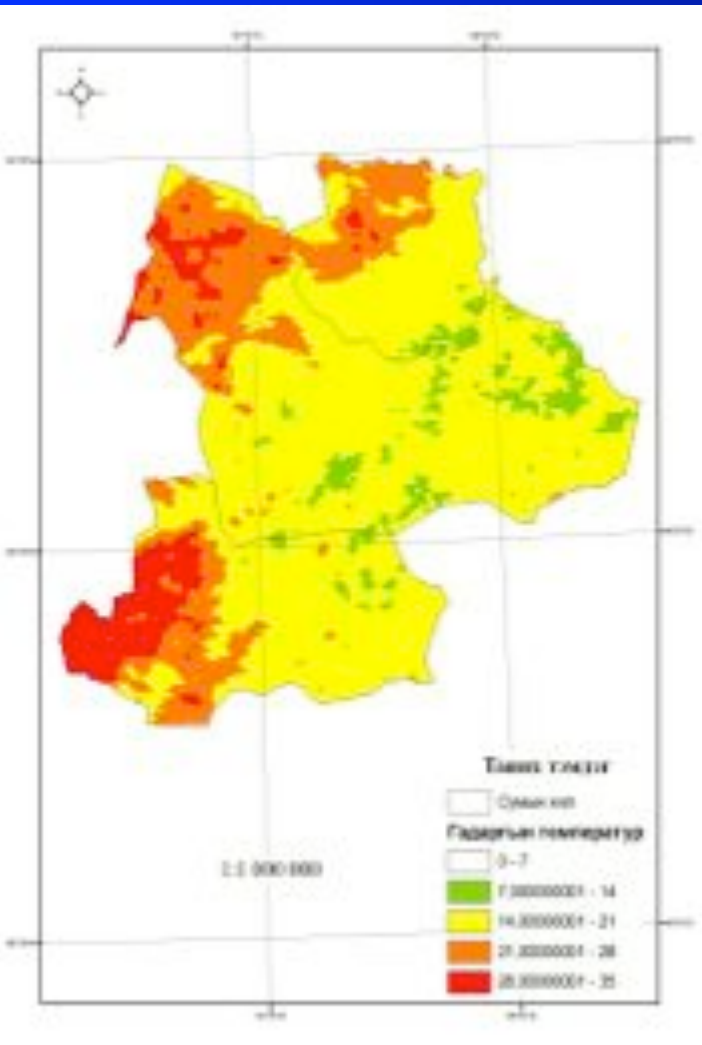


Vegetation classification form

Vegetation classification code	Range
1	Non-vegetation
2	Low
3	Middle
4	High
5	The highest

Analysis

Surface temperature data .
Using MODIS satellite.
-Resolution 1 km

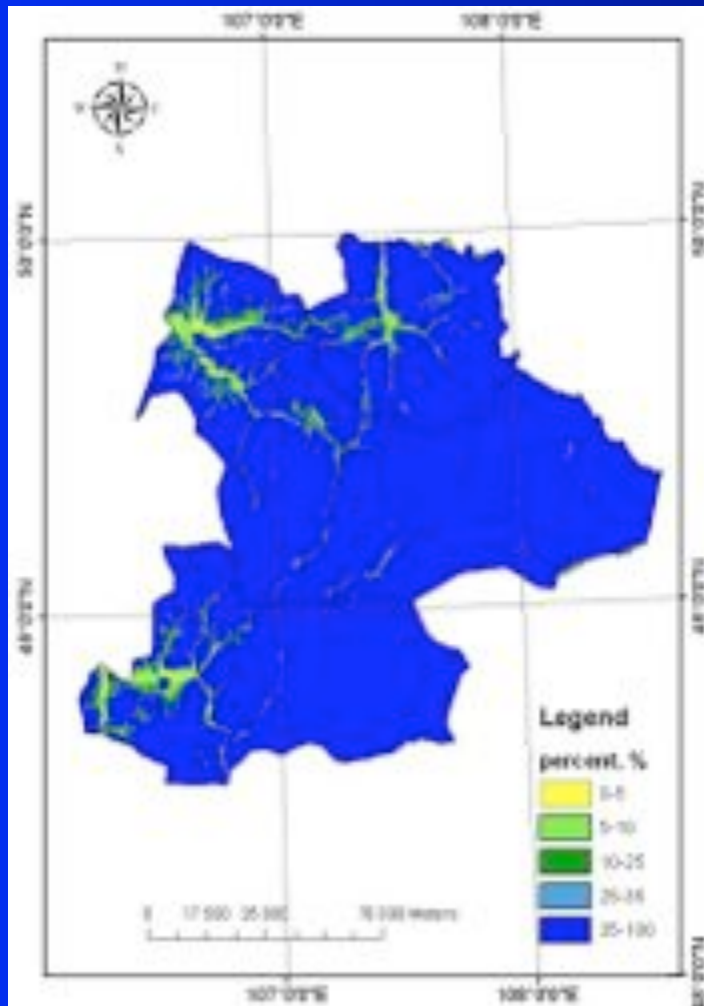


Classification of Surface Temperature data

Surface Temperature(°C)	Class code	Class value
0-7	1	The lowest
7-14	2	Low
14-21	3	Middle
21-28	4	High
28-35	5	The highest

Analysis

Digital Elevation Model (DEM)-30m



Slope map

Slope classification form

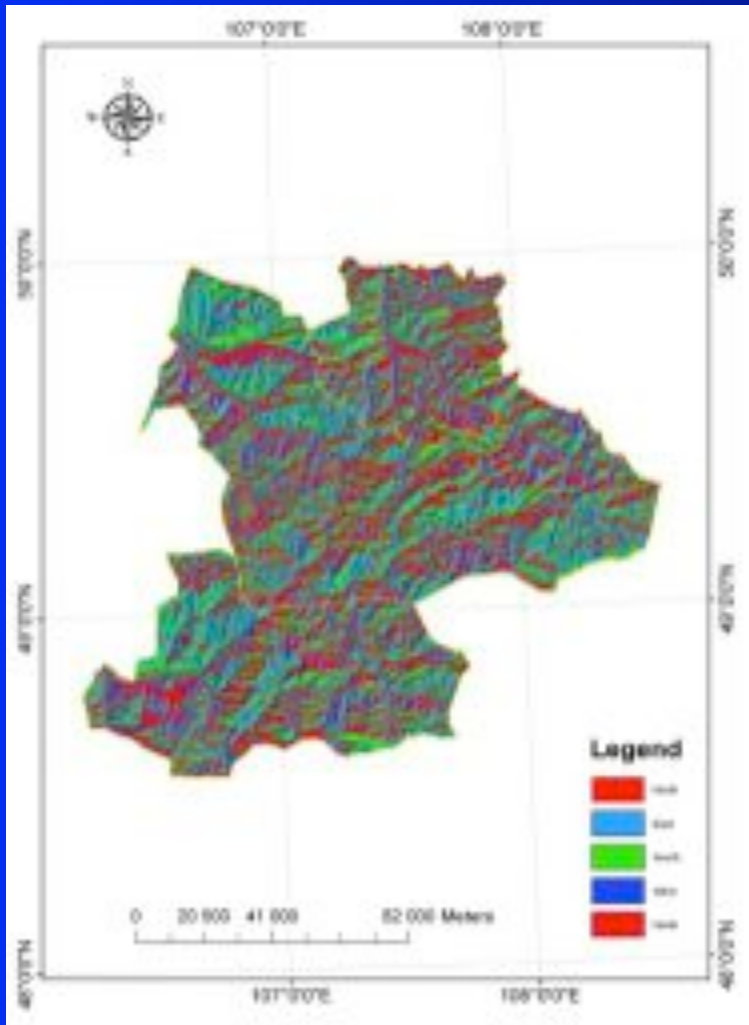
Slope (%)	Classification code	Range
0-5	1	Non-fire
5-10	2	The lowest fire
10-25	3	Low
25-35	4	Middle
35-100	5	High

Analysis

Digital Elevation Model (DEM)-30m

Aspect classification form

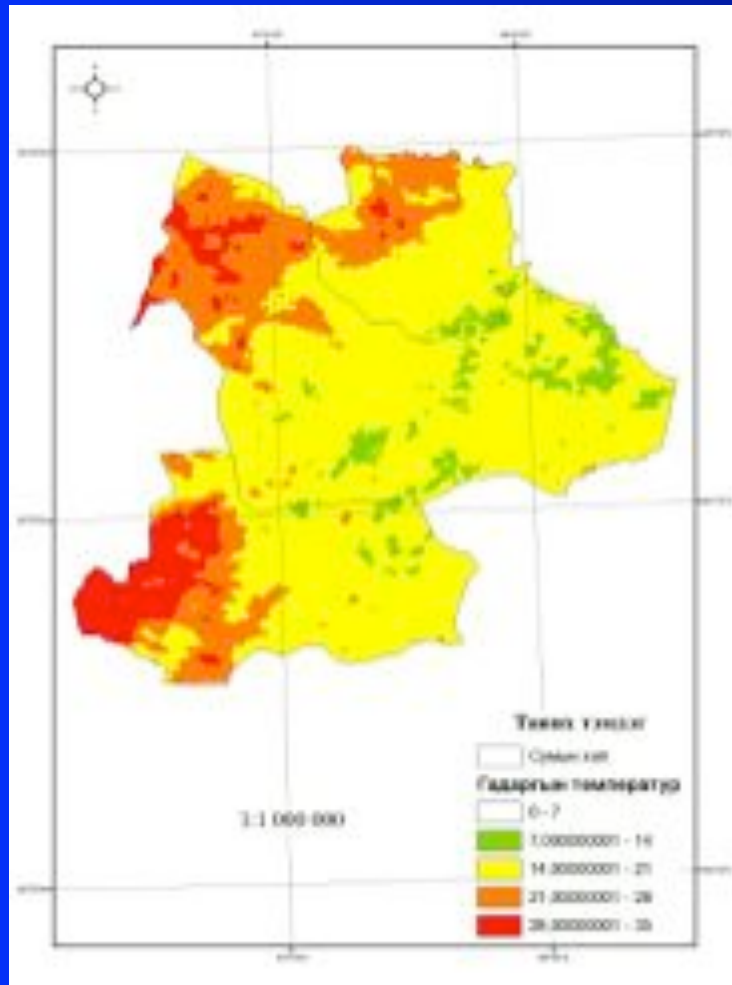
Aspect (°)	Classification code	Range
North (315-45)	1	High
East(45-135)	2	Middle
South(135-225)	3	Low
West(225-315)	4	Non fire



Aspect map

Analysis

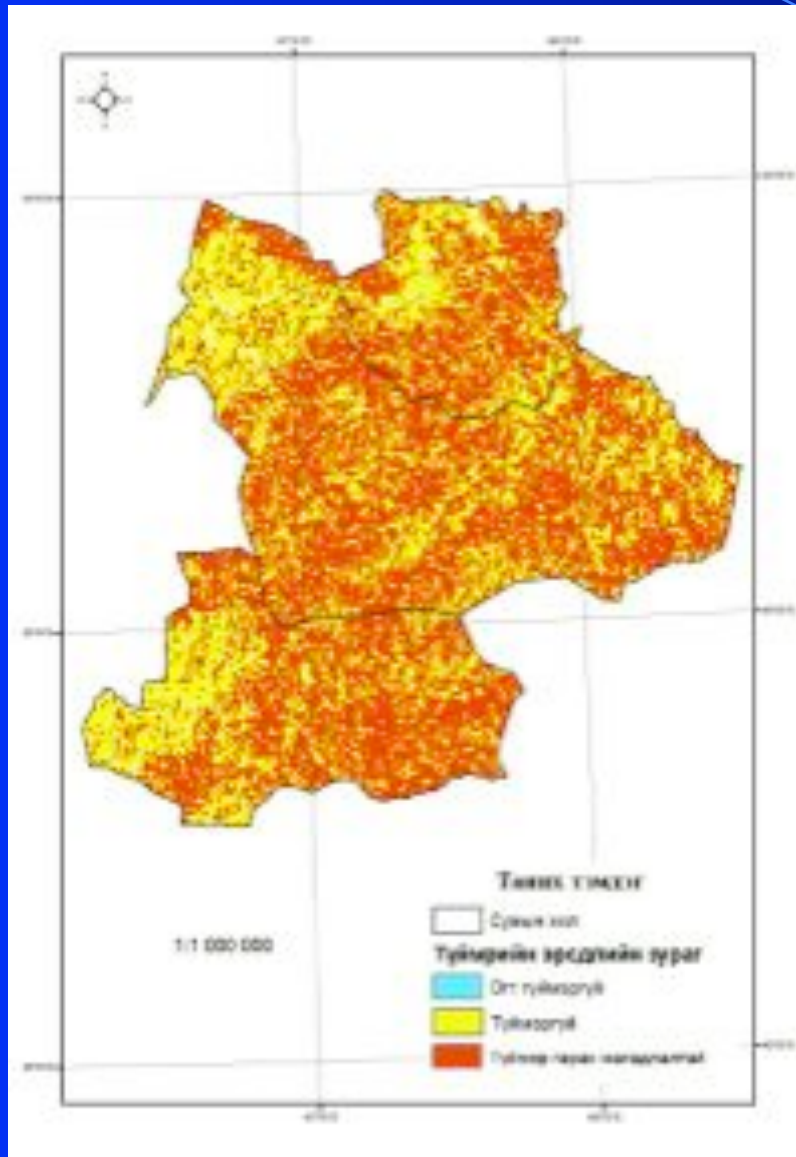
- Surface temperature - To mapping a surface temperature I was used MODIS (Moderate Resolution Imaging Spectroradiometer) satellite data.



Surface temperature classification form

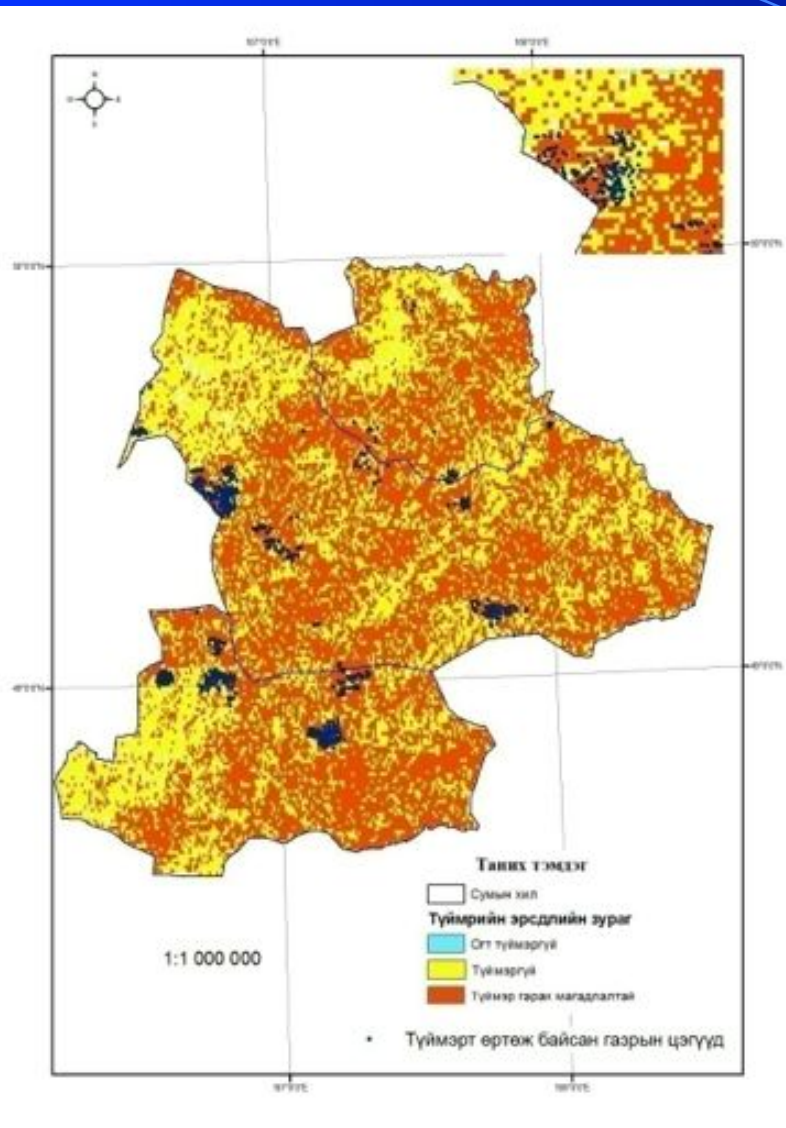
Surface temperature(°C)	Classification code	Range
0-7	1	The lowest
7-14	2	Low
14-21	3	Middle
21-28	4	High
28-35	5	The highest

Analysis



- Probability to occur a fire field is 57.3% of total study area.
- Red color is forest fire risk area, orange color is non forest fire and blue color is absolutely no forest fire.

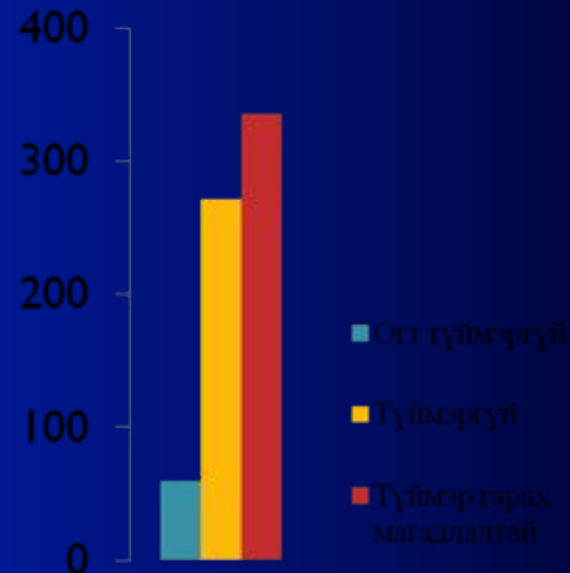
Analysis



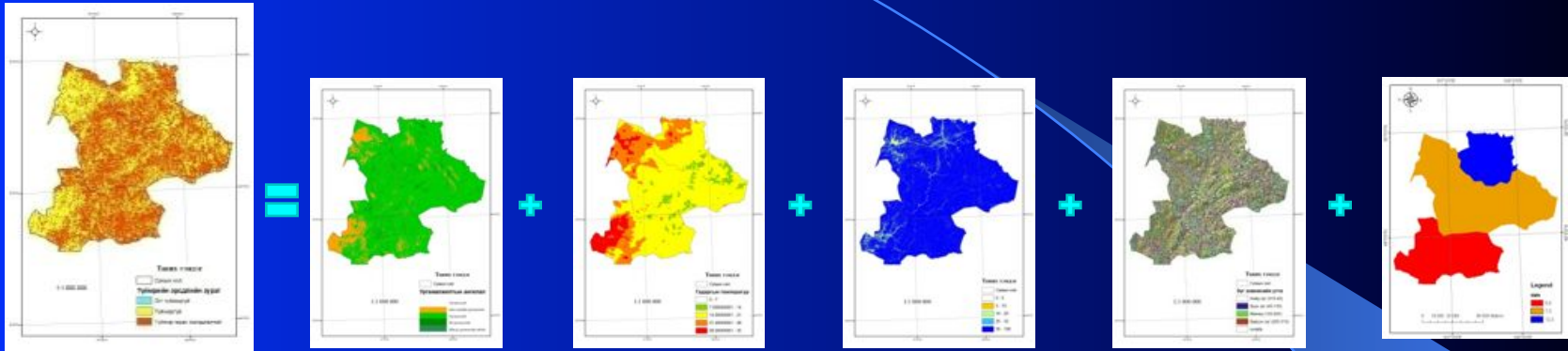
Fire risk map with points of incurred to fire.

Fire risk map

Classification code	Risk range	Points of incurred to fire
1	Absolutely no forest fire	60
2	Non forest fire	271
3	Forest fire risk area	336



Result map



$$FFR = EVI + TMP + ASP + SLP + PRE$$

Historic Fire Regime Prediction Model

EVI-Enhanced Vegetation Index

ASP-Aspect

SLP-Slope

TMP-Surface Temperature

PRE-Precipitation

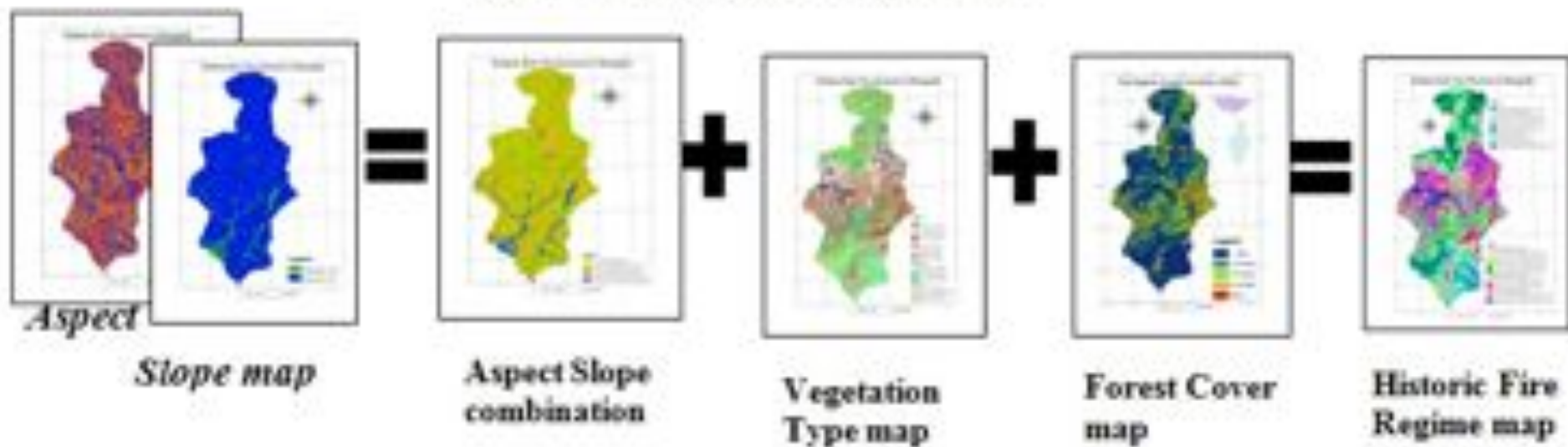
Results

- Forest fire risk area is 57.3% of the total study area
- The forest fire risk area and points of incurred to fire were compared is the 54.1% from the total area.

TEST SITE-2 TUV Province

The aspect map, slope map, vegetation type map and forest cover map were used for developing historic fire regime map. From the historic fire regime map it can be seen that spatial distribution indicates that fires are intensified as one goes towards North East of the study area.

Figure 2 The Historic Fire Regime map



Mongolian forestry information and training program dissemination sites:

Website:

www.forestry.gov.mn



Website:

www.biology.num.edu.mn



Website:

www.icc.mn



Website:

geodata.mne-ngic.mn



National Agency
of Forestry

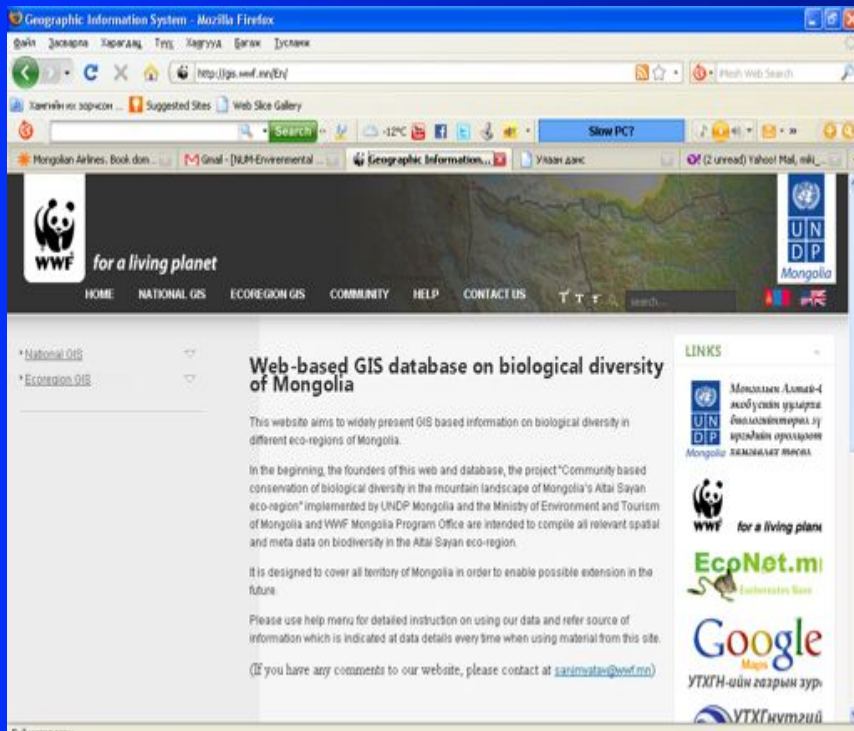
School of Biology
and Biotechnology, NUM

Environmental Information
Center

Mongolian forestry information and training program sites:

Website:

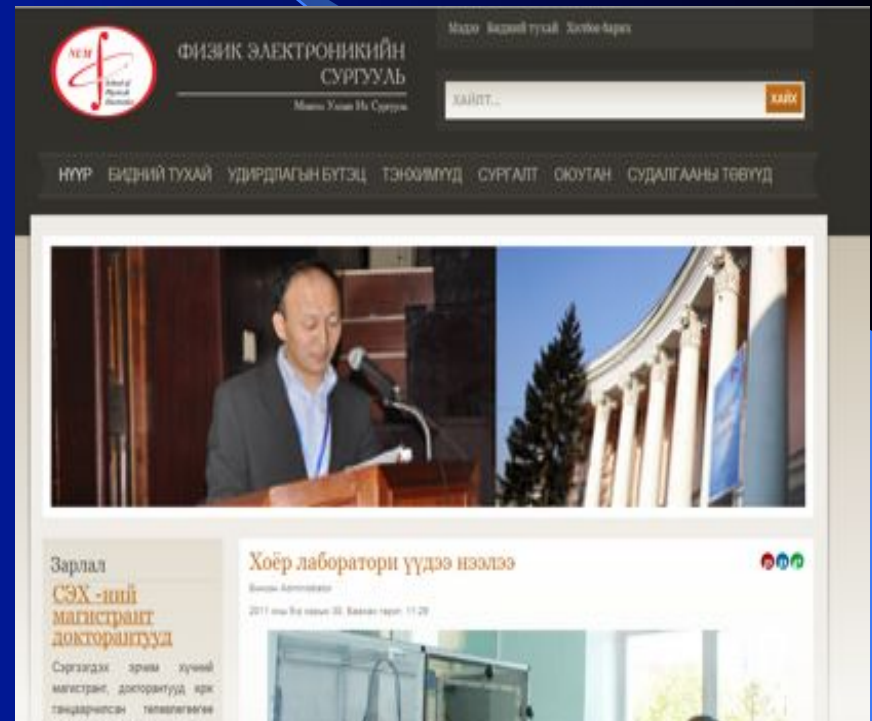
<http://gis.wwf.mn/>



World Wild Foundation
(WWF) in Mongolia

Website:

www.spe.num.edu.mn



NUM-ITC-UNESCO laboratory for
Remote Sensing and GIS, School of
Physics and Electronics, NUM

Discussion

- To share the experiences from other countries in regional network
- To apply modern methodologies in forest fire monitoring
- To educate young generation in experienced country in the field of advanced forestry management
- To organize summer school next year ?

*Special thanks for the APN support
and
Conference Organizers*