Early warning for *dzud* disaster

B. Erdenetsetseg, N. Mungunchimeg and Ts. Bat-Oyun

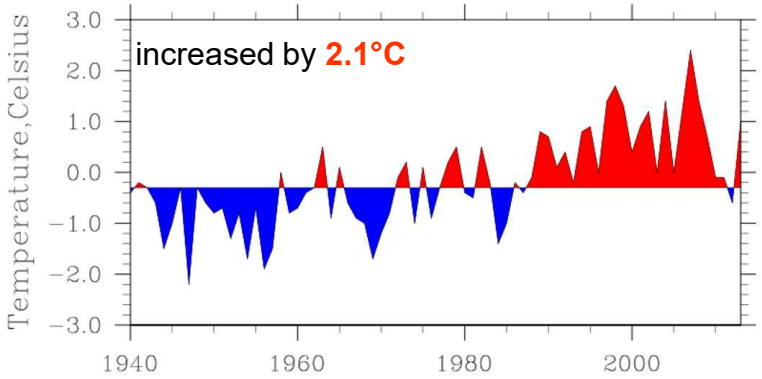
Information and Research Institute of Meteorology, Hydrology Environment (IRIMHE), Mongolia

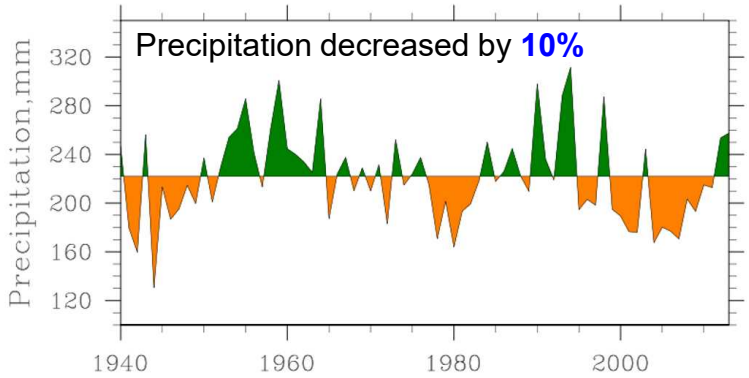
Ulaanbaatar, Mongolia
2019.11.6

INTRODUCTION

- Pastoral nomadic animal husbandry is a key economic sector in Mongolia, vulnerable to climate.

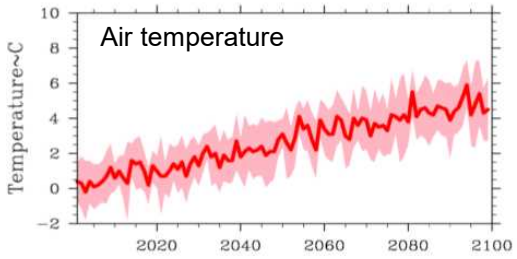
Air temperature changes (1940-2015)

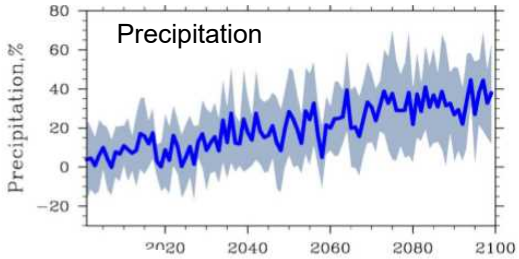




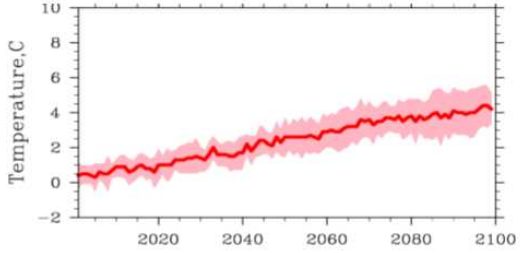
In future:

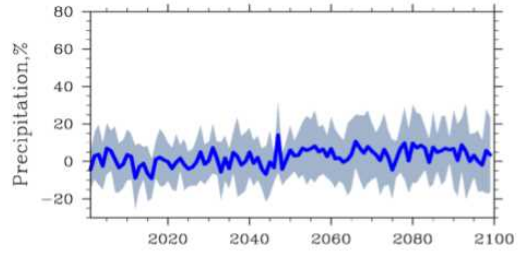
Winter season





Warm season





П.Гомболүүдэв, (Ph.D)

- Ongoing global climate change has led more threats in rangeland health condition and livestock farming, increasing their vulnerability which has been already vulnerable under country's dry and cold climate.

Defining *dzud*

Dzud is unusual weather (extreme cold) and/or land-surface conditions (lack of pasture and deep snow/ice cover, cannot access dried grasses under deep snow) that prevent livestock pasture accessibility & availability, resulting **massive livestock loss** during winter-spring.

Drought/Lack of pasture

+

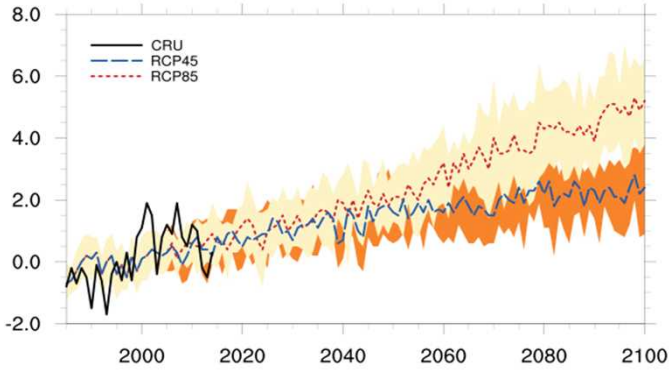
Deep snow/Cold

=

***Dzud*/Livestock mortality**

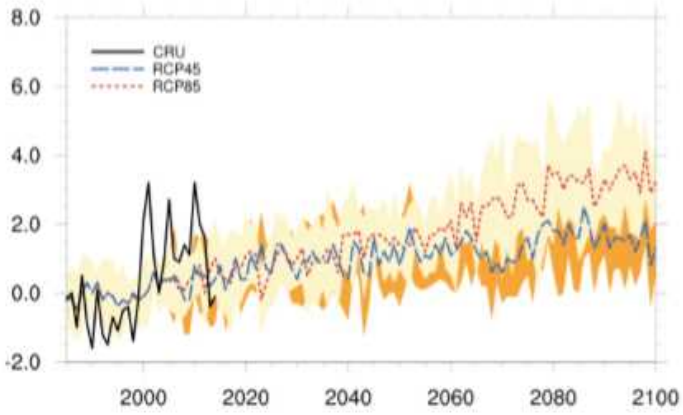
Intensity of drought and *dzud*: present and future

Interannual variation of **drought index** compared to climate period (1986-2005)



- Intensity of drought is expected to increase constantly.

Interannual variation of ***dzud*** **index** compared to climate period (1986-2005)

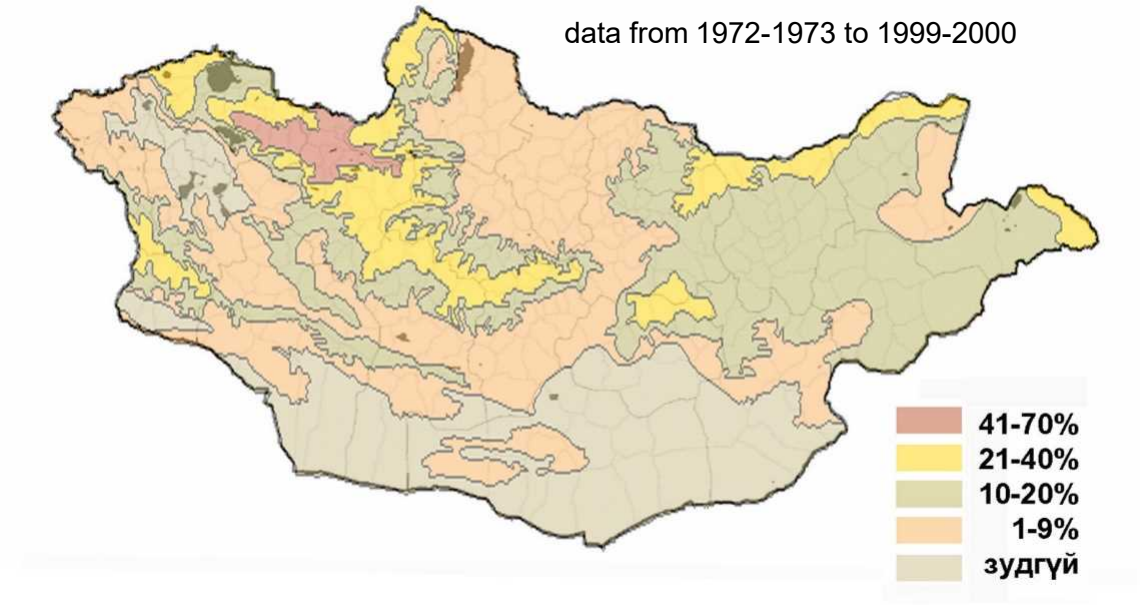


- An increase of intensity of *dzud* as dominantly dependent on summer drought condition.

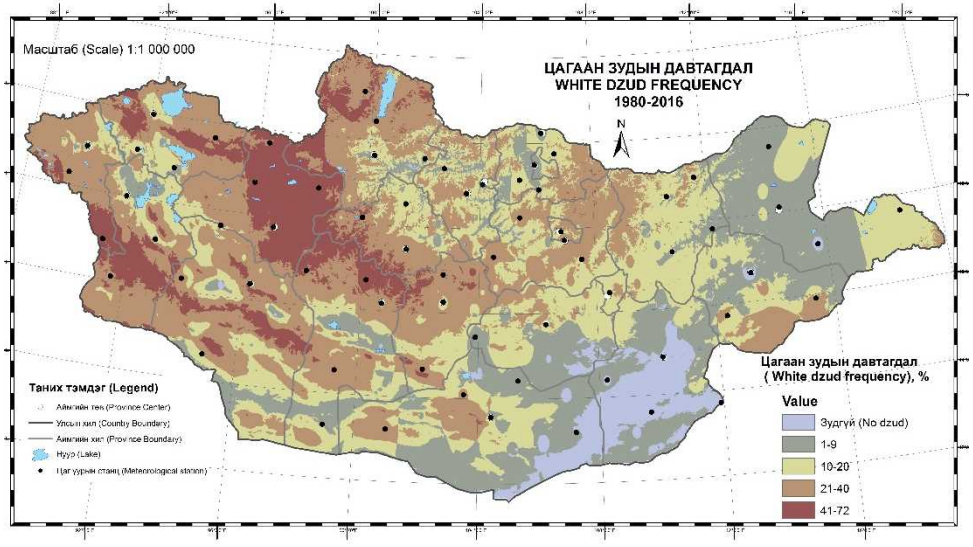
TNC, 2018

Dzud frequency

data from 1972-1973 to 1999-2000



data of 1980-2016

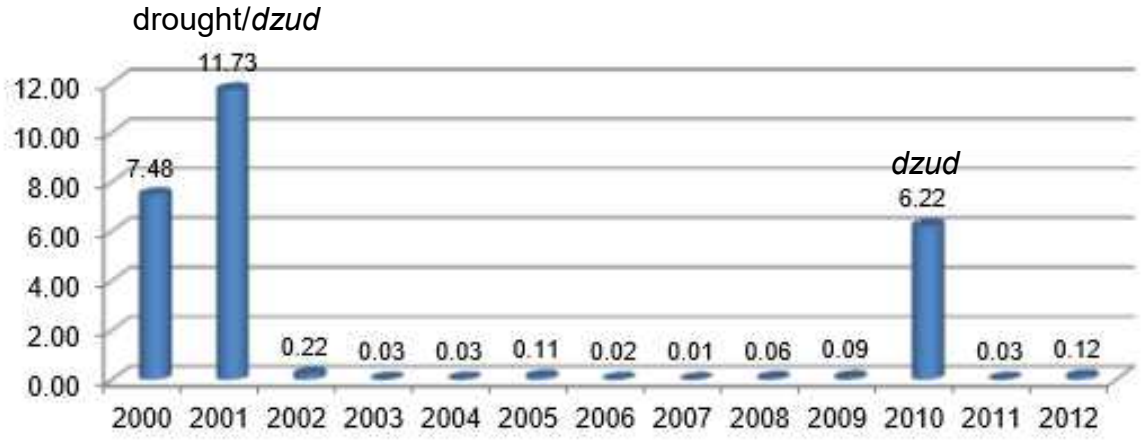


Even though winter temperature is increasing frequency and intensity of *dzud* are increasing because of increase of winter precipitation.

by L.Natsagdorj and J.Dulamsuren, 2001, Mungunchimeg, B.Erdenetsetseg, L.Natsagdorj

Dzud damages

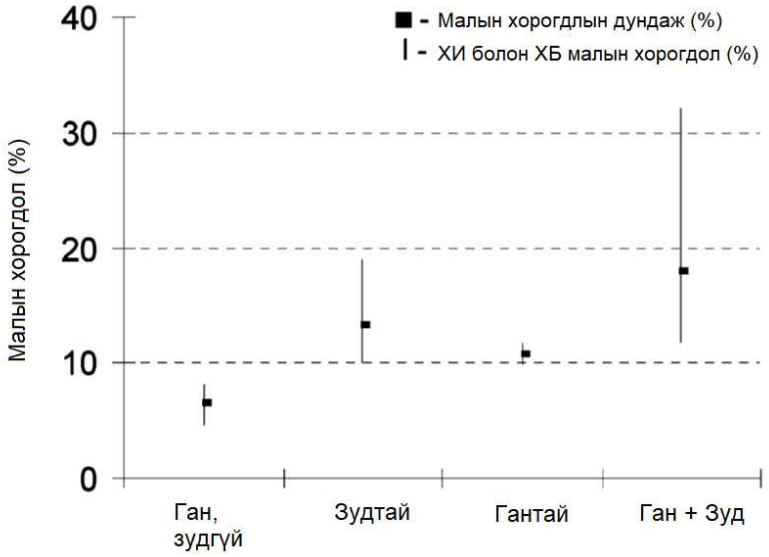
Percentage of damages caused by disasters in the nation's GDP



(fires are not included)

Source: TNC

Dzud is the highest impact disaster in Mongolia.



Mortality is highest in a *dzud* year followed by drought (Begzsuren *et al*., 2004).

Enhancing/strengthening science-based early warning system of *dzud* is highly required for **disaster reduction** through

early preparedness

and

taking management actions.

Since 2015, Information and Research Institute of Meteorology, Hydrology and Environment (IRIMHE) under the National Agency for Meteorology and Environmental Monitoring is producing a *dzud* risk map.

Methodology for *dzud* risk map

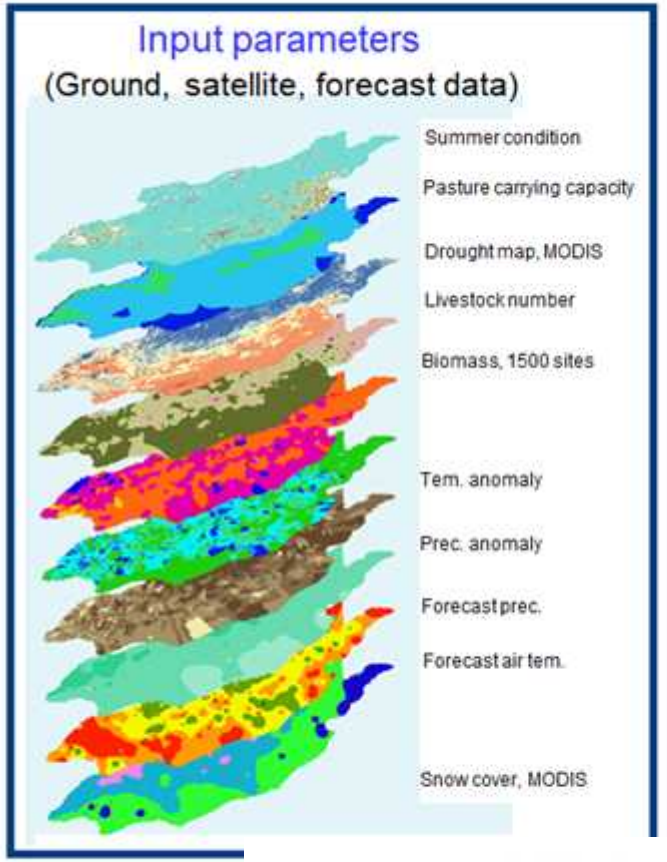
Multi-Criteria Decision Analysis

id	layer name	Rank	Numerator	Weights	0-100 scale
1	Summer condition	3	9	0.09	9
2	Pasture carrying capacity	2	10	0.10	10
3	Livestock number	3	9	0.09	9
4	biomass/1500 site	2	10	0.10	10
5	Anomal precipitaion	5	7	0.07	7
6	Anomal temperature	5	7	0.07	7
7	Drought index/MODIS	4	8	0.08	8
8	Snow depth	1	11	0.11	11
9	Snow cover/MODIS	3	9	0.09	9
10	Air temperature forecast	2	10	0.10	10
11	Precipitation forecast	1	11	0.11	11
			101	1.00	100

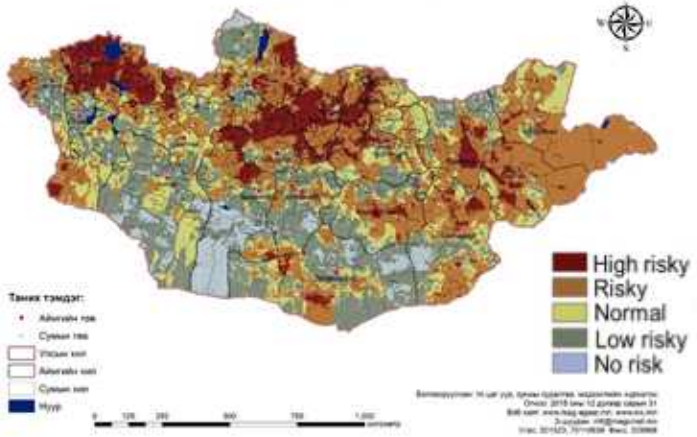
$$Numerator = \sum_{k=1}^{n} (n - r_k + 1)$$

$$W_i \frac{(n - r_k + 1)}{\sum_{k=1}^{n} (n - r_k + 1)} \quad W_i = 1$$

- determine the criteria
- determine the weight of each parameter
- ranking/numerating



Dzud risk map



Developed by: N.Elbegjargal, B.Erdenetsetseg, N.Mungunchimeg, IRIMHE

Pasture carrying capacity (every mid-Aug)

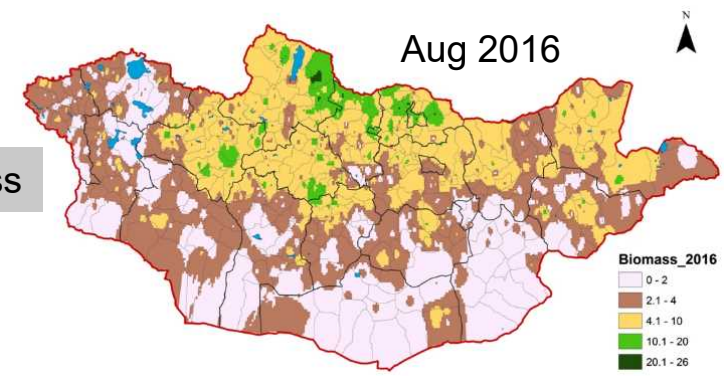
$$C = \left(\frac{N}{\frac{Y_1}{Y_2 * T} * S} \right) * 100\%,$$

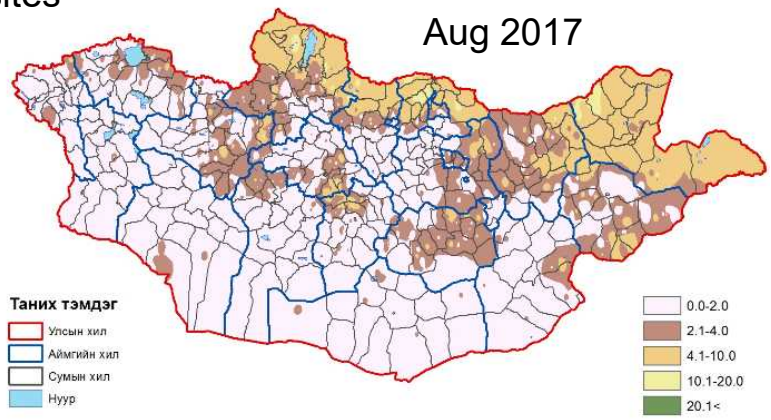
Government Resolutions, 2000

C: pasture carrying capacity (%)
N: number of livestock (sheep unit)
Y1: biomass (kg/ha)
Y2: daily intake per sheep (kg/day)
T: winter duration (day)
S: pasture area (ha)

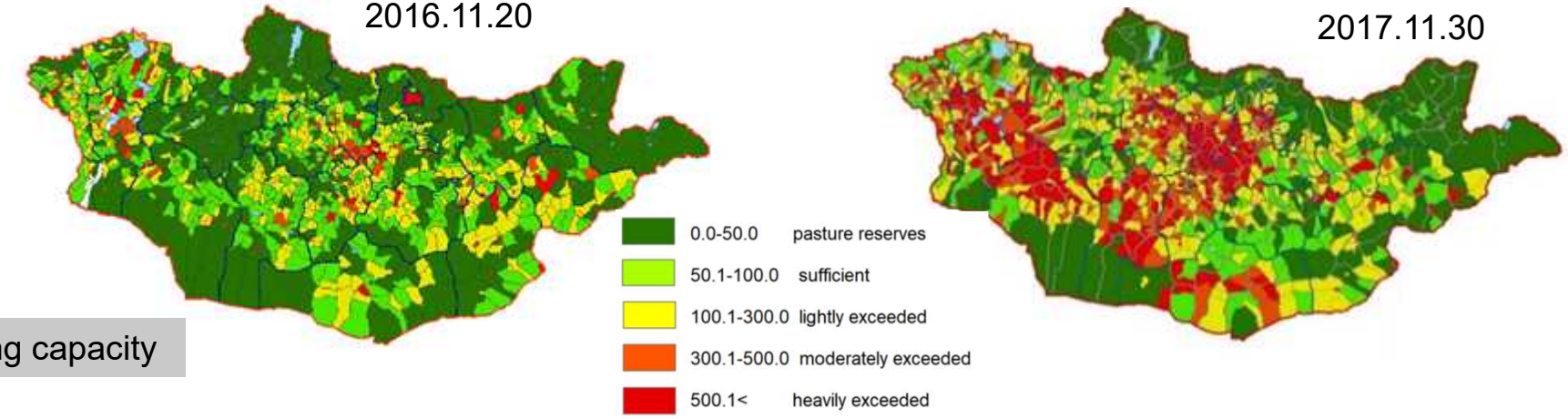
Base information: 1) biomass 2) number of livestock from 1500 sites

Biomass





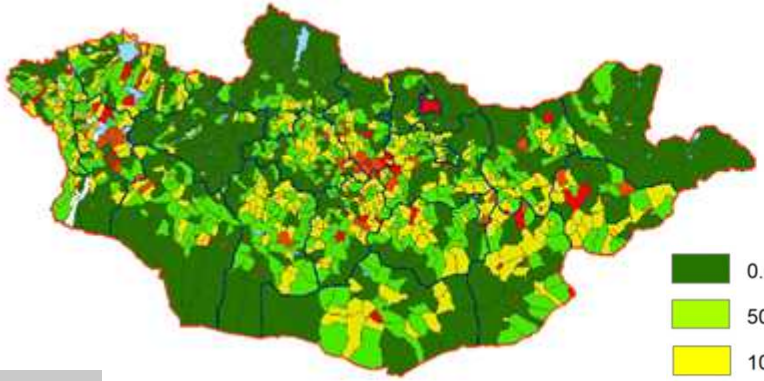
Carrying capacity



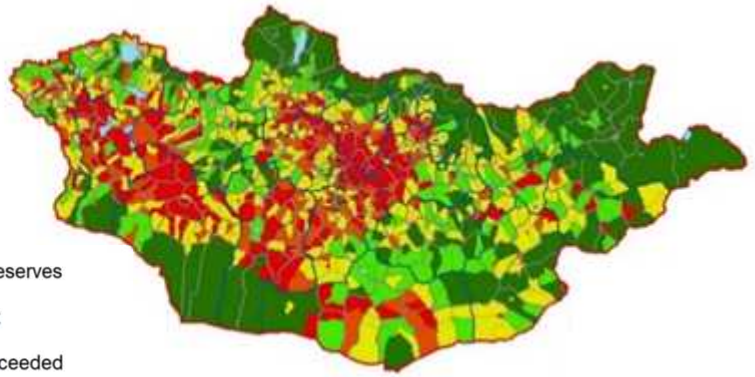
Dzud risk maps

Carrying capacity

2016-2017



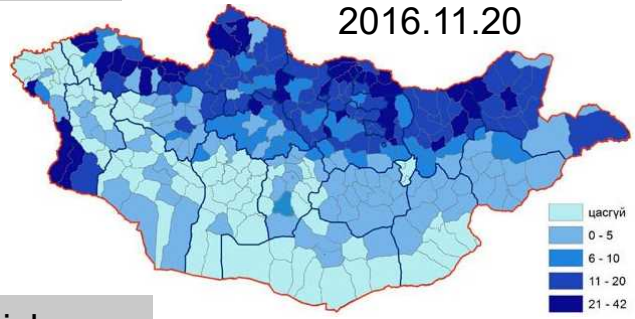
2017-2018



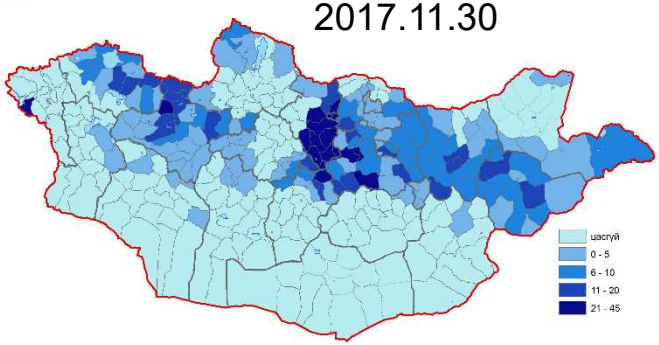
0.0-50.0 pasture reserves
50.1-100.0 sufficient
100.1-300.0 lightly exceeded
300.1-500.0 moderately exceeded
500.1< heavily exceeded

Snow depth

2016.11.20

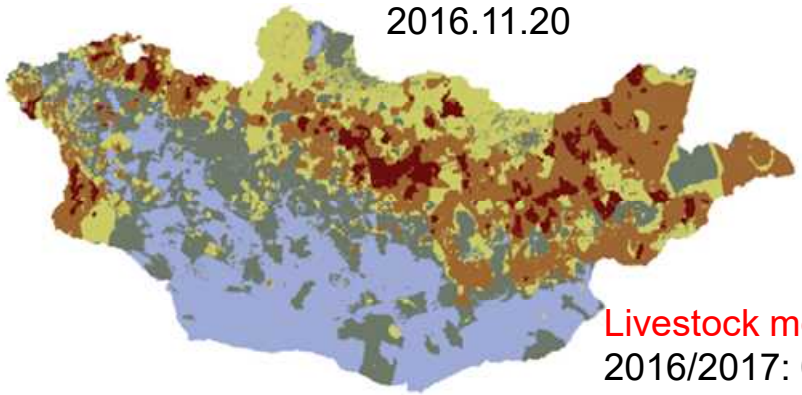


2017.11.30

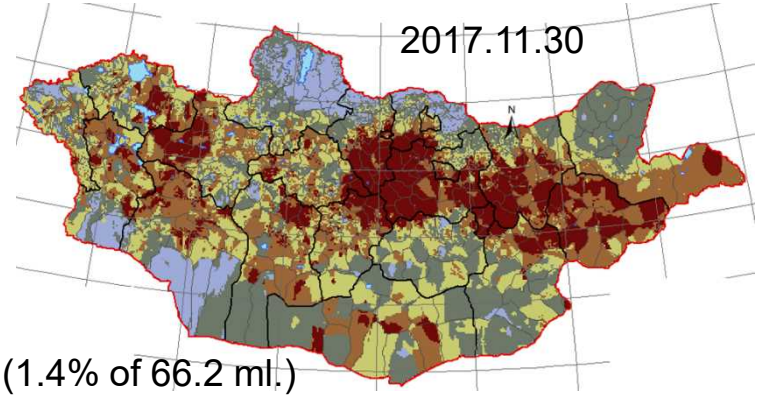


Dzud risk map

2016.11.20

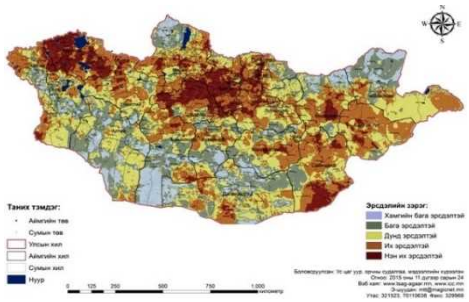


2017.11.30

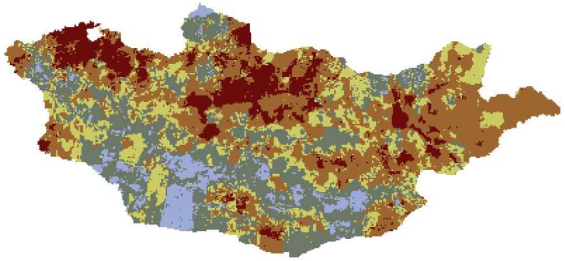


Livestock mortality:
2016/2017: 0.9 ml. heads (1.4% of 66.2 ml.)
2017/2018: 2.6 ml. heads (3.9% of 66.5 ml.)

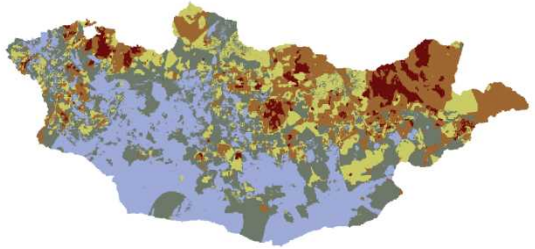
Dzud risk map is on-demand product



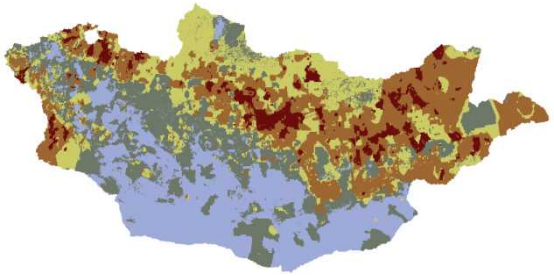
2015-11-20



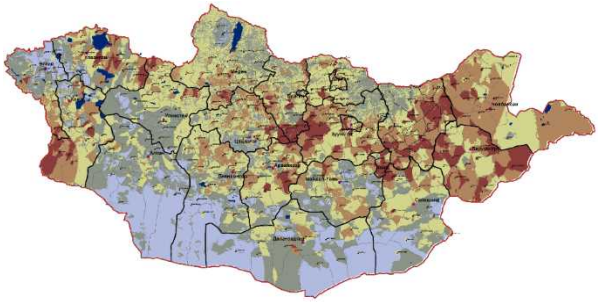
2015-12-31



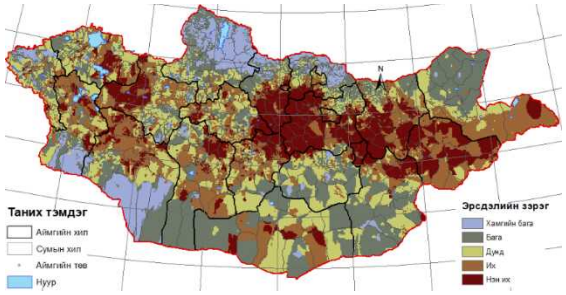
2016-11-10



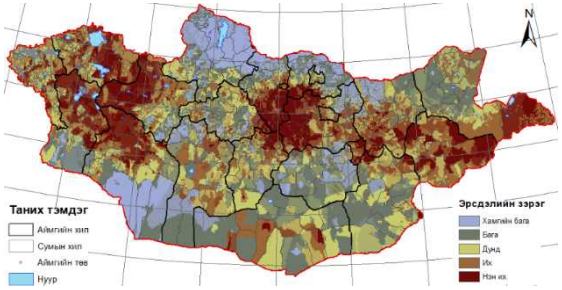
2016-11-20



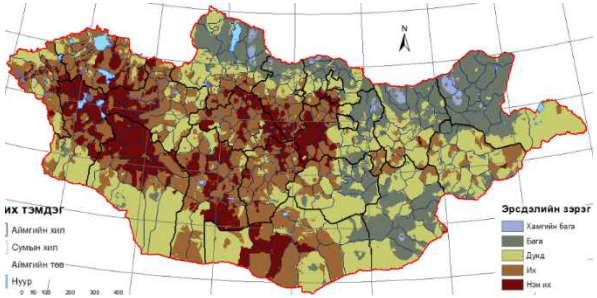
2017-01-20



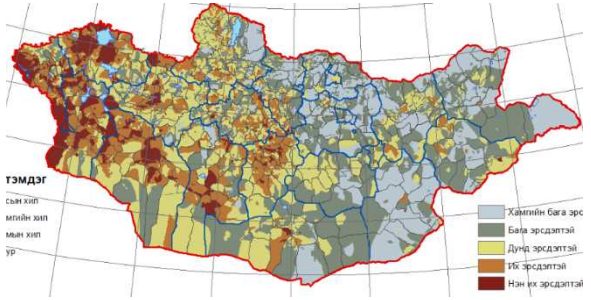
2017-11-30



2017-12-20

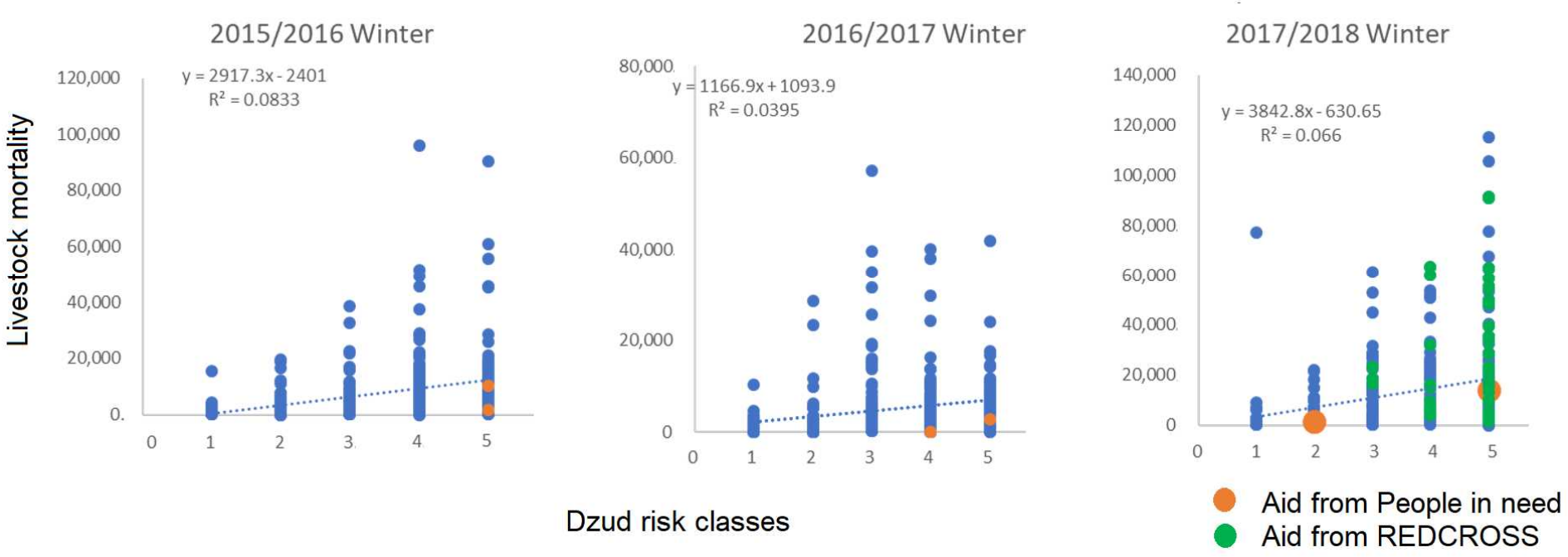


2018-01-10



2018-11-20

Validation: *Dzud* risk and Livestock mortality



by N.Mungunchimeg, IRIMHE

Livestock mortality highly corresponded with *dzud* risk condition and international aid.

Disseminating information and Application

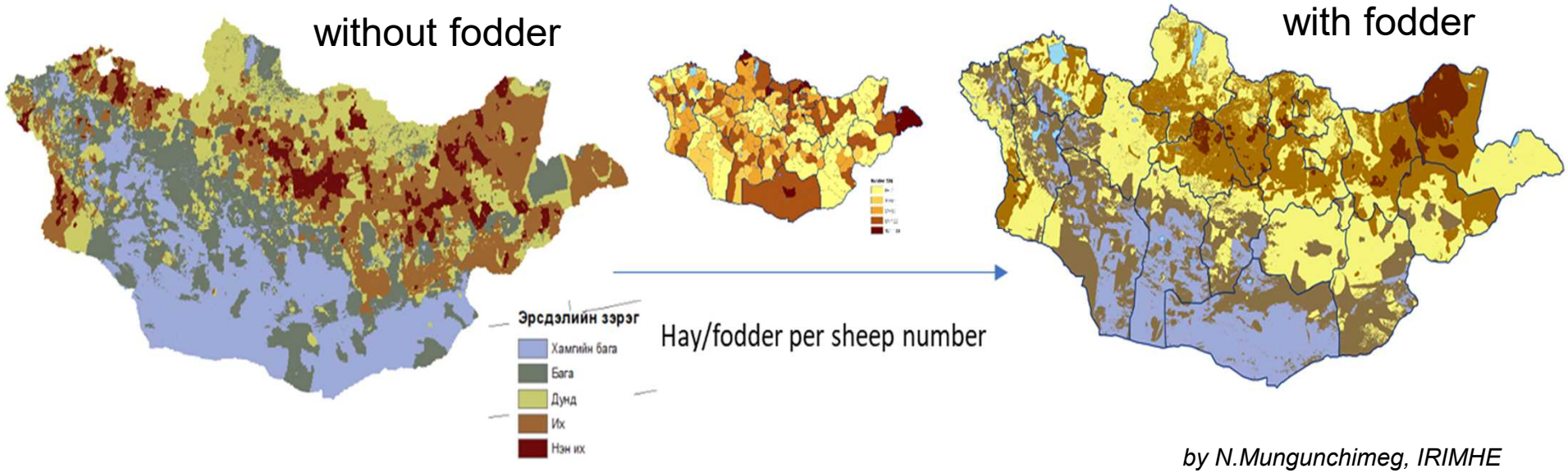
Governmental organizations taking efficient management actions (keeping livestock number within carrying capacity, coordinate *otor* movement and allocate hay/fodder etc.)

International Aid/Financial support

(cash, goods, animal-care kit and medicine, warm clothes and etc) for vulnerable herders comes from Red cross, Mercy Corps, FAO, UNDP, People in need, Save the Children, World Food Program

Recent challenges to improve *Dzud* risk map

Comparison of *dzud* risk map with and without fodder/hay information



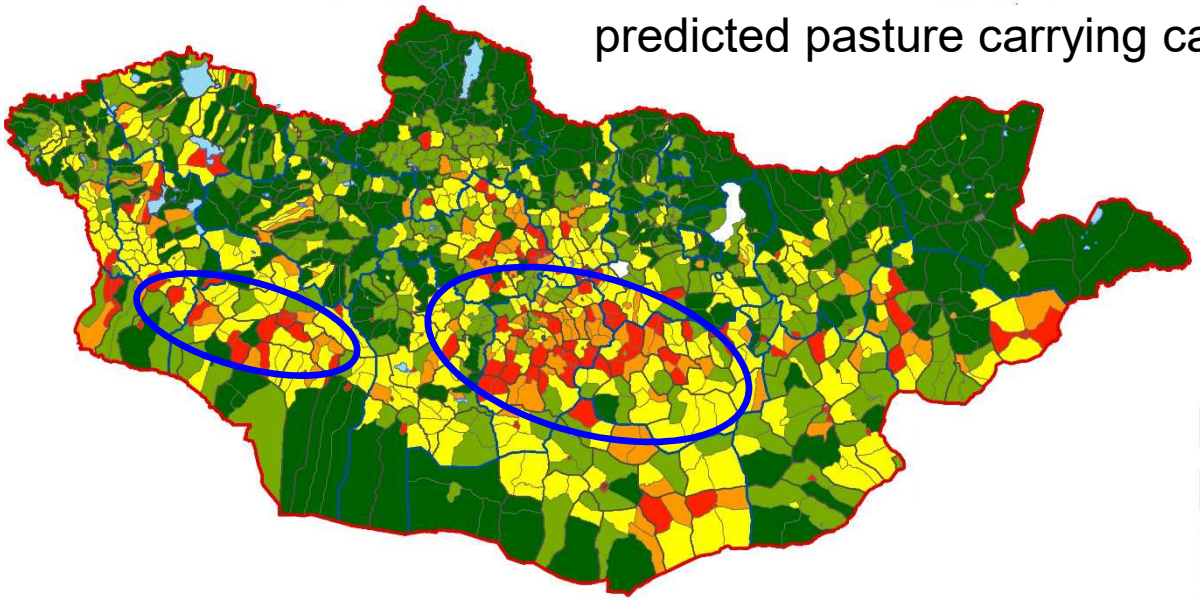
by N.Mungunchimeg, IRIMHE

As including fodder in the map, the risky area is decreasing.

Well preparation of fodder/hay is important to alleviate/reduce *dzud* risk.

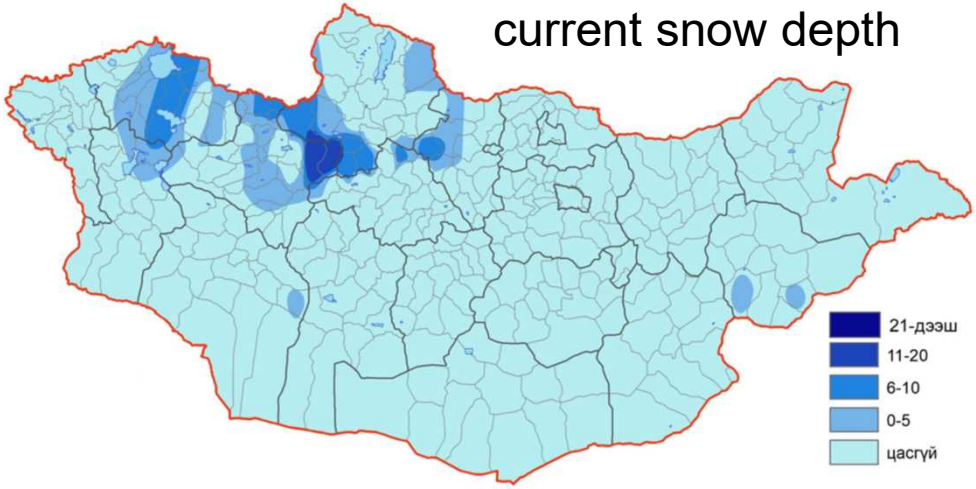
Winter Outlook for 2019/2020 based on carrying capacity and current condition (snow depth)

predicted pasture carrying capacity (summer condition)



0.0-50.0	pasture reserves	(40%)
50.1-100.0	sufficient	(24%)
100.1-300.0	lightly exceeded	(23%)
300.1-500.0	moderately exceeded	(7%)
500.1<	heavily exceeded	(6%)
	haven't measured biomass due to river flood	

current snow depth



- Possibly: this winter likely to be not severe in most area of Mongolia.
- Black *dzud* may occur in some regions

Conclusions

- *Dzud* risk map is useful science-based information which based on unique nationwide and widespread meteorological network data. International and national organizations are evaluated that using the predicted map governmental organizations taking efficient management actions to *dzud* and in result disaster risk is decreasing.

- Challenging to improve quality of dzud risk prediction including socio-economic information.

- In future strengthening disaster risk governance and coordination across policy makers, institutions and international organizations are highly required.

Thank you for your attention

Dzud: Classifications

Zud Form	Description	Climatic Criteria
Tsagaan (white) *zud*	Results from high snowfall that prevents livestock from reaching the grass. Herders used to leave the *zud* area if the area was small. Can cause a very serious disaster if it covers a large area. *Tsagaan* is the most common and disastrous form of *zud*.	Long lasting: large amount of snowfall in the beginning of winter. Short lasting: large amount of snowfall at the end of winter.
Khar (black) *zud*	Occurs when lack of snow in grazing areas leaves livestock without any unfrozen water supplies where wells are not accessible. Both human and animals suffer from lack of water to drink. This form usually happens in the Gobi Desert region.	Very little or no snowfall in winter. No winter forage on pasture because of drought in summer. No winter forage on pasture due to overgrowth in number of voles (*Microtus brandti*) and grasshoppers or increased incidence of forest and steppe fire.
Tumer (iron) *dzud*	Occurs when snow cover melts and refreezes to create an impenetrable ice-cover that prevents livestock from grazing.	Short rapid warming in wintertime (3–7°C higher than monthly mean temperature) followed by return to sub-freezing temperatures.
Khuiten (cold) *zud*	Occurs when air temperature drops to very low levels for several consecutive days. Extreme cold temperatures and strong freezing wind prevent animals from grazing; the animals expend most of their energy in maintaining their body heat.	Air temperature falls by 5–10°C lower than the monthly mean.
Khavsarsan (combined) *zud*	A combination of at least two of the above phenomena occurring at the same time.	
Touvaryin zud	Geographically widespread white, black, iron or cold *zud* combined with overcrowding of livestock and migration of livestock over certain territory that results in overgrazing and depletion of pasture land resources.	Geographically widespread *zud*.

Source: Vulnerability of Mongolia's Pastoralists to Climate Extremes and Changes, AIACC project, UNEP, 2008