



CLIMATE CHANGE STUDIES IN MONGOLIA

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PROGRESS REPORT

Project name	POTENTIAL IMPACTS OF CLIMATE CHANGE AND VULNERABILITY AND ADAPTATION ASSESSMENT FOR GRASSLAND ECOSYSTEM AND LIVESTOCK SECTOR IN MONGOLIA
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Country	MONGOLIA
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Executing Organizations:	Global System for Analysis, Research and Training (START), Third World Academy of Sciences (TWAS) United Nations Environment Programme (UNEP)

A. SUMMARY

Project management: Organized two SSC meetings in which discussed the project implementation, study results of the 2002 activities, synthesis report of 2002, and work plan for 2003 activities.

Planned national workshop have not been held due to local circumstances and postponed until September.

Project implementation: Research activities have been divided into three main groups. The first group is working on sensitivity vulnerability analysis on natural resources such as water resources, snow cover, permafrost and pasture capacity and livestock. This group also is preparing input attribute data for vulnerability maps on study sectors. The second group analyzed the last summer field survey results of western Mongolia and some economic issues for Vulnerability of the ecosystem to climate change. The third group is completed the case study on drought occurred in 2002 summer.

B. DESCRIPTION OF TASKS

The brief description will be given in the order of tasks. The main study focus of this year is to make vulnerability and future climate change impact assessment for Grassland Ecosystem and Livestock Sector in Mongolia

TASK 1: MAJOR RESEARCH

Selection and preparation of the appropriate climate change scenarios: The GSM's outputs as *HadCM3*, *CCGM3*, *CSIRO* evaluated against the observed data for 1960-1990 in order to test the performance of these models. The evaluation results of the *HadCM3*, *CCGM3*, *CSIRO* are given in Table 1.

Table 1. Comparison of observed and calculated data of climate change scenarios

Model	Temperature	Observed	Model result	Standard deviation	Variations	Error
1. HadCM3	Annual mean	0.66	-0.44	1.32	1.75	1.13
	Summer mean	17.02	16.22	1.46	2.14	0.79
	Winter mean	-17.55	-18.42	3.21	10.03	0.92
2. CGCM3	Annual mean	0.66	-7.06	4.78	22.88	7.63
	Summer mean	17.02	12.16	3.39	11.55	4.75
	Winter mean	-17.55	-27.06	6.76	45.4	9.44
3. CSIRO	Annual mean	0.66	-0.86	3.25	10.54	1.54
	Summer mean	17.02	19.18	3.33	11.06	-2.16
	Winter mean	-17.55	-18.02	5.27	27.27	0.53

According to the results the HadCM3 performs well compared to the observed climate data. These studies mainly have been done last year but due to some doubtful results the performance tested again. The team decided to use all three outputs of GCM with family line of A2, B2 for future climate scenarios for the periods of 2010, 2015, 2020, 2050, and 2080. Annual, maximum and minimum temperature trends obtained from HadCM3 scenario are shown in Figure 1, 2, and 3.

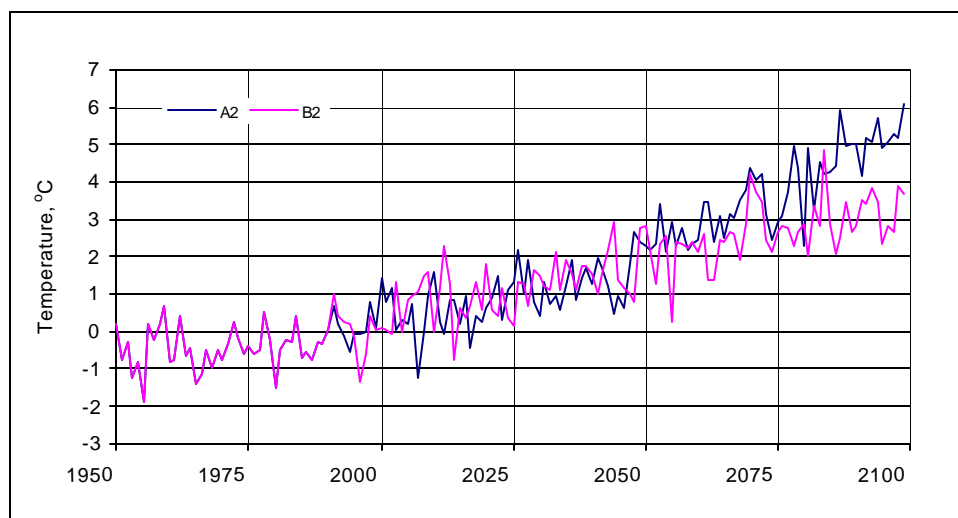


Figure 1. Annual temperature trend estimated by HadCM3

HadCM3 projects greater warming in summer season than in winter for the coming 100 years in Mongolia.

The primary effort have been done to test the RegCM3 regional climate change scenario. This scenario was tested for only July and the result shows very good shape with observed data.

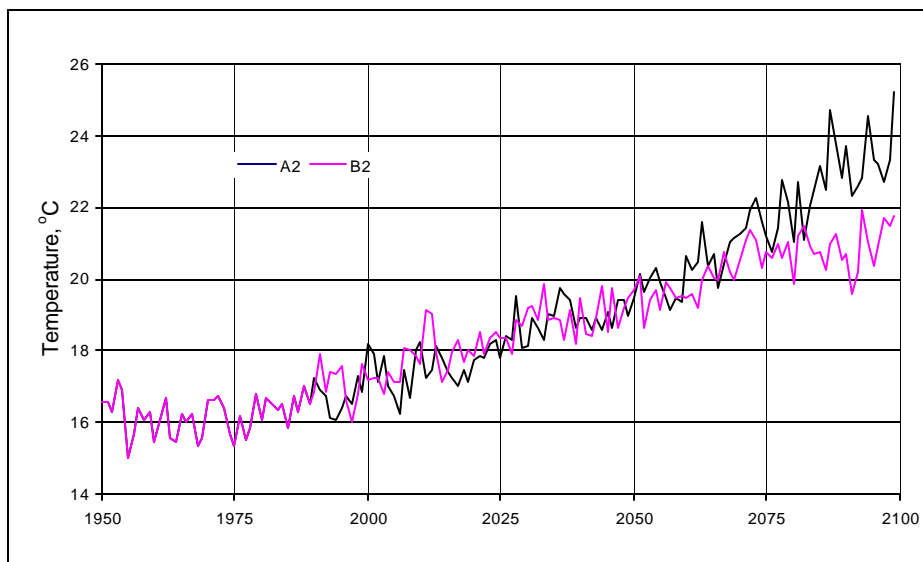


Figure 2. Summer temperature trend estimated by HadCM3

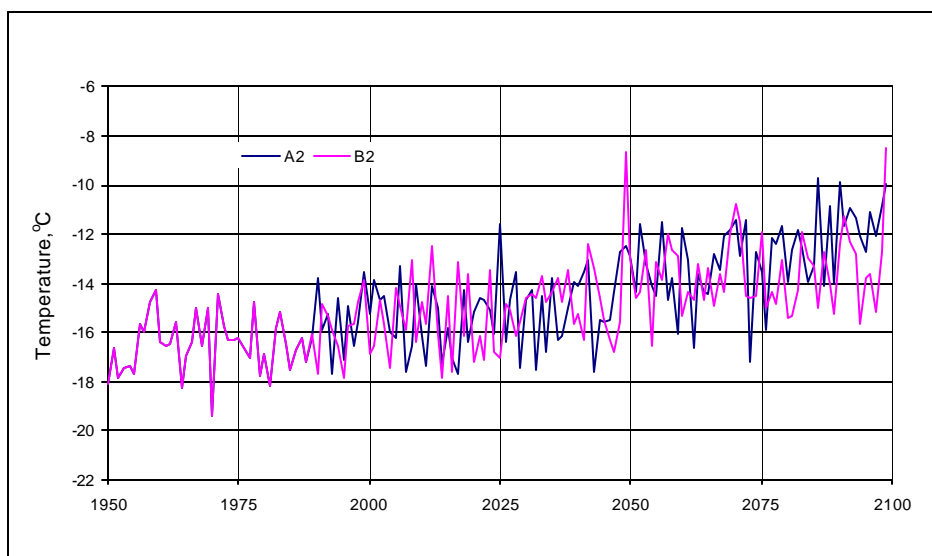


Figure 3. Winter temperature trend estimated by HadCM3

Experts and contractors: Natsagdorj, Gomboluudev and Ganbaatar.

Sensitivity analysis: Hypothetical (i.e. usually put in the framework of the sensitivity analysis by applying an ensemble of potential climates) or uniform changes in temperature (ΔT) and

precipitation (%P) are used to test the sensitivity of various sectors to climate change. Uniform scenario means annual changes in temperature and precipitation and in their combinations, with the expectation that they cover range of plausible future climates. In our study these changes have taken as +1,2,3°C and 5°C increase in temperature and \mp (10%, 20%) in precipitation.

This scenario is good in that it is able to generate a family of tables that will give insight into the sensitivity of the given sectors to climate variations. For the time being the sensitivity analysis completed in water resources, pasture and animal husbandry sectors only.

Water resources, snow cover and permafrost: The selected 20 rivers have been investigated how the river run off could be changed under changed temperature and precipitation. Then the river run off changes was averaged for the entire basin.

With the set of hypothetical scenarios we have generated a series of results that gave insight in the sensitivity of the basin flows to climate variations (Table 2).

Table 2. River run off sensitivity to changed temperature and precipitation.

		Changes in precipitation				
		P=0%	P-10%	P-20%	P+10%	P+20%
Changes in temperature	Internal drainage basin					
	T+0	0.0	-7.5	-20.2	21.2	37.3
	T+1	6.1	-5.9	-17.3	26.2	40.0
	T+2	3.7	-8.9	-20.2	21.3	36.3
	T+3	0.2	-12.1	-22.8	17.0	30.6
	T+5	-13.1	-21.7	-30.1	-3.2	6.2
	Arctic Ocean Basin					
	T+0	0.0	-12.5	-22.3	12.8	27.4
	T+1	-3.8	-14.1	-23.5	9.1	22.9
	T+2	-9.3	-18.4	-27.2	1.9	14.5
	T+3	-13.5	-21.6	-29.0	-3.0	7.9
	T+5	-22.3	-17.6	-39.4	-16.7	-8.6
	Pacific Ocean basin					
	T+0	0.0	-20.3	-29.3	17.7	31.2
	T+1	-15.1	-26.9	-36.9	5.0	21.2
	T+2	-20.7	-31.9	-40.1	-5.5	8.2
	T+3	-23.1	-31.6	-42.1	-9.8	6.1
	T+5	-33.2	-37.1	-42.0	-22.9	-12.8

As can be seen from Table 2 if annual precipitation drops by 10%, while the temperature remains constant, the average river flow reduces by 7.5%, 12.4% and 20.3% in the Internal Drainage Basin, the Arctic Ocean Basin and the Pacific Ocean Basin, respectively. If, besides the precipitation drop, average temperature increases of 1°C, 2°C, 3°C, and 5°C are taken into account, an additional flow reduction is expected. In other words, it appears that for each °C temperature increase, there is at least 2% of annual flow decrease.

As intuitively expected, river runoff is much more sensitive to the precipitation changes than to the temperature changes, i.e. the impact of precipitation changes is substantially greater than the impacts of temperature fluctuations.

Because of no model that could access the sensitivity of lake level some regression analysis have been done as a function of inflowing river run off.

Since the snow study is first effort in this project as a source of water resources for animals as well as one of the grazing criteria for winter pasture, it takes a lot of time to collect data and process the data into electronic form. We analyzed the snow cover in last year study and in the first half of these year we studied the snow depth. As a result of increased winter precipitation snow depth in eastern and southern part of the country tends to increase slightly but the trend statistically is not significant.

Experts and contractors: Batima, Batnasan, Erdenetsetseg, Tuvshinjargal and Tumerbaatar.

Past and present climate change Impact assessment on pasture, grassland resources: The sensitivity of pasture productivity to uniform changes in temperature and precipitation have been assessed at 37 sites.

According to this analysis plant aboveground biomass decreases with increased temperature. The rate of plant biomass changes in each 10% of precipitation change are much greater than the rate of changes in each °C temperature increase i.e. aboveground biomass is more sensitive to changes in precipitation than temperature (Table 3).

Table 3. Aboveground biomass sensitivity to changed temperature and precipitation.(in percentage)

Temperature changes						
Ecosystem	T+1	T+2	T+3	T+4	T+5	
Altai mountain	-4.0	-7.8	-11.4	-15.7	-19.9	
forest steppe	-6.3	-14.3	-23.9	-34.7	-44.1	
Gobi desert	-1.6	-4.4	-7.4	-10.7	-14.9	
steppe	-5.5	-12.5	-20.8	-29.1	-37.7	
Precipitation changes						
	P-30%	P-20%	P-10%	P+10%	P+20%	P+30%
Altai mountain	-48.1	-32.6	-15.8	17.7	34.9	52.2
forest steppe	-37.0	-24.3	-11.9	12.1	22.9	33.0
Gobi desert	-48.1	-32.3	-21.3	20.2	39.0	58.0
steppe	-39.3	-26.0	-12.7	12.3	24.1	35.4

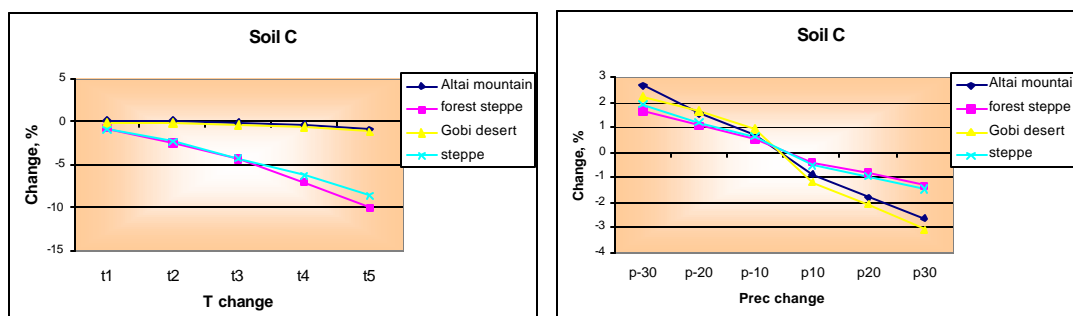
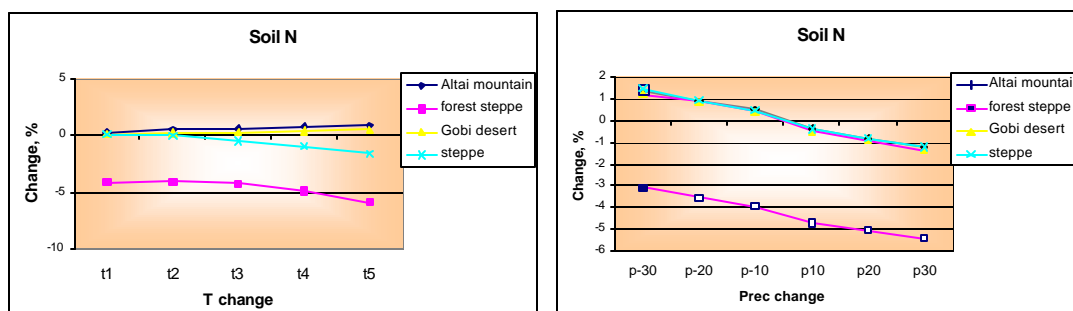
Table 4 illustrates the sensitivity of aboveground biomass to climate variations. As can be seen from this Table aboveground biomass in the forest steppe still will be decreased when air temperature increases by 3°C and above even under increased precipitation by 20%.

Series of tables/results have been generated for net primary production, C:N ratio, soil organic carbon, soil organic nitrogen as well. Sensitivity of net primary production and C:N to temperature and precipitation changes have the same pattern as plant aboveground biomass.

Soil organic carbon and soil organic nitrogen have been decreasing with increased temperature and precipitation and have been increasing when precipitation decreased (Figure 4 and 5).

Table 4. Aboveground biomass change, (in percentage)

		Temperature changes			
		T+0	T+1	T+3	T+5
Precipitation changes, %	Forest steppe				
	P+0%	0.0	-6.3	-23.9	-44.1
	P-10%	-11.9	-18.1	-35.5	-53.9
	P+10%	12.1	5.3	-12.7	-33.8
	P+20%	22.9	16.5	-2.3	-24.8
	Steppe				
	P+0%	0.0	-5.5	-20.8	-37.7
	P-10%	-12.7	-18.4	-32.0	-47.8
	P+10%	12.3	6.9	-9.4	-27.5
	P+20%	24.1	18.8	2.1	-17.1
	Altai mountain				
	P+0%	0.0	-4.0	-11.4	-19.9
	P-10%	-15.8	-19.4	-25.6	-33.4
	P+10%	17.7	13.6	5.1	-4.0
	P+20	34.9	30.7	21.8	11.5
	Gobi desert				
	P+0%	0.0	-1.6	-7.4	-14.9
	P-10%	-21.3	-18.8	-23.9	-30.5
	P+10%	20.2	16.8	9.6	1.4
	P+20%	39.0	35.1	26.5	17.5

**Figure 4. Changes of soil C with changes of temperature and precipitation****Figure 5. Changes of soil N with changes of temperature and precipitation**

Experts and contractors: Bolortsetseg, Erdenetuya, Khudelmur

Animal husbandry: The sensitivity of ewe weight to changed climate have been done for uniform changes of temperature and pasture biomass changes but not uniform changes in precipitation. Eight sites that represent three different pasture ecosystems have been studied.

The result shows that ewe weight projected to decrease in the steppe and high mountain region at increased temperature even pasture biomass will increase. In the steppe ewe weight projected to be decreased by 1.8-7.2 kg at increased temperature by 1⁰C-5⁰C when pasture biomass remains unchanged. There is some small increase could be expected in the Gobi-Desert at increased pasture biomass when temperature increases by 1-2⁰C. Thus, temperature rise has dominant role in ewe weight.

Table 5. Ewe weight changes with changed temperature and pasture biomass.

Natural region	Changes of air temperature, C ⁰	Pasture biomass changes ,%						
		-30%	-20%	-10%	0	10%	20%	30%
Partially wooded steppe	0	-2.9	-2.8	-2.7	0.0	0.3	0.5	0.8
	1	-4.7	-4.6	-4.5	-1.8	-1.5	-1.3	-1.0
	2	-7.1	-7.0	-6.9	-4.2	-4.0	-3.7	-3.5
	3	-9.2	-9.1	-9.0	-6.4	-6.2	-6.0	-5.7
	4	-9.4	-8.7	-7.3	-6.8	-6.5	-6.6	-6.2
	5	-9.8	-9.2	-8.6	-7.2	-6.9	-6.8	-6.4
High mountain	0	-3.0	-2.9	-2.8	0.0	0.2	0.5	0.7
	1	-5.0	-4.8	-4.7	-2.0	-1.8	-1.5	-1.3
	2	-7.2	-7.1	-6.9	-4.3	-4.1	-3.9	-3.6
	3	-8.1	-8.0	-7.8	-5.3	-5.1	-4.9	-4.6
	5	-9.5	-8.7	-8.1	-6.6	-6.2	-6.0	-5.6
Gobi and Desert	0	-2.6	-2.5	-2.4	0.0	0.3	0.5	0.7
	1	-2.6	-2.5	-2.4	0.0	0.3	0.5	0.7
	2	-2.7	-2.6	-2.5	-0.1	0.2	0.4	0.6
	3	-3.0	-2.8	-2.7	-0.3	-0.1	0.1	0.4
	4	-3.1	-3.1	-3.0	-0.4	-0.2	-0.1	0.2
	5	-4.0	-3.7	-3.1	-0.8	-0.5	-0.1	0.0

Some regression analysis have been done on animal productivity as a function of weight. Since the productivity depends on weigh and productivity tends to decrease too.

Experts and contractors: Bayarbaatar, Tuvaansuren

Some socio-economic and policy issues: Recently, Mongolia is divided into five regions for the purpose of the economic development: Western, Khangai, Central, Eastern and Ulaanbaatar. The regions differ by their economic development. For instance, GDP per capita in the western region is 2.5 times lower than in Ulaanbaatar city (Figure 6).

The study on living standarts (1998) showed that there were 850,000 poor people in the country, of which 26% was living in Ulaanbaatar, 31% - in aimag centers and other cities, and 43% - in rural areas (Figure 6). Poverty level is related to unemployment level. There are also big differences in health services and education opportunities between the rural areas and Ulaanbaatar city.

We have developed integrated assessment index of economic and social development taking account GDP per capita, education level, average living age, unemployment, energy supply, transportation level, human development index etc. (Tsedendamba 1999). The economic and social development level of the regions greatly differ (Table 6). The Western region turned out to be the least developed, followed by the Eastern, Khangai and Central region. Ulaanbaatar city's development index was almost three times higher than the Central region, indicating a big difference in development level between Ulaanbaatar and rural areas. Thus, economic and social development of the rural area, especially the least developed regions would be key issue to increase their adaptive capacity to climate change.

Figure 6. GDP per capita in different economic regions (in US\$)

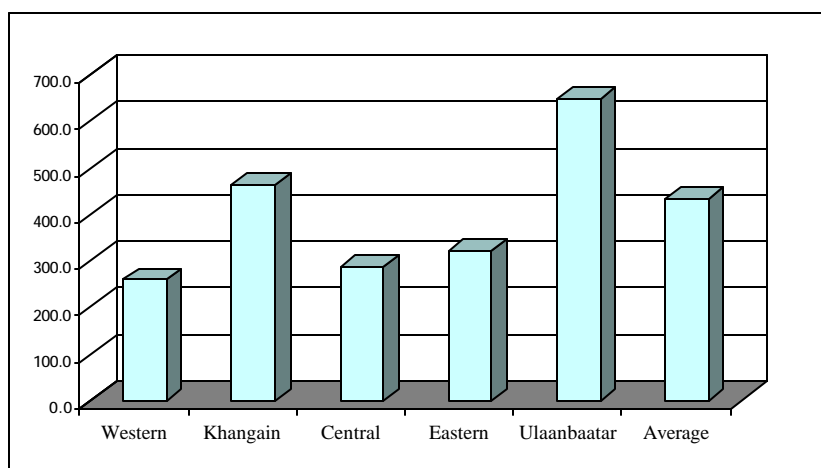


Table 6. Integrated assessment index of development levels for the regions

Regions	Western	Eastern	Khangai	Central	Ulaanbaatar
Assessment Index	1.0	1.5	2.4	2.8	7.5

The difference in economic and social development between urban and rural areas is causing a “big migration” from rural areas into Ulaanbaatar and central region. For example, 3615 people (641 households) moved from Uvs aimag to the Central region. The consequences of this migration are:

- Livestock density is increasing near Ulaanbaatar and central region, causing ecosystem degradation due to overgrazing;
- Human density in rural areas is decreasing and “brain drain” is occurring.

Food supply and vulnerability of the regions: Mongolia produces 257,700 ton meat (7.6 million of livestock), 3% of which are camel, 13% - horse, 17% - goat meat, 35% - beef and 32% - mutton. The Western region produces 28.7%, the Khangai region – 38.1%, the Central region – 20.3% and the Eastern region – 12.9%. Almost 8% of the produced meat goes for the export and the rest is used for the internal supply.

Mongolia produces 377.3 million liter milk, 2.6% of which are camel, 10% - horse, 2.5% - goat, 84.4% - cow and 0.5% - sheep milk. The Western region produces 19.9%, the Khangai region – 42.3%, the Central region – 18.4% and the Eastern region – 19.4%.

Meat supply level in the country is 66.5% (Table 77). Ulaanbaatar city has the lowest level of meat and meat products supply compared to rural areas. Flour supply level is uneven cross the regions. The Central region has the best supply level in flour (Table 8). Mongolia was able to meet fully demands in flour before 1990, however the agriculture supported by subsidies of the Soviet Union started to fail during the transition period. Now we can't meet the population's demand in flour supply even importing it.

Table 7. Demand and supply of meat and meat products for the population

Regions	Demand, thousand tons	Supply, thousand tons				Supply level, %
		National	Export	Import	Total	
Western	50.32	41.75	-	-	41.75	82.9
Khangai	66.51	56.30	-	0.10	56.40	84.8
Central	53.45	51.79	5.0	0.04	46.83	87.6
Eastern	24.18	24.40	3.0	-	21.40	88.5
Ulaanbaatar	94.38	67.16	9.0	0.15	58.31	61.7
Total	288.84	241.4	17.0	0.29	224.69	77.8

Table 8. Demand and supply of flour and flour products for the population

Regions	Demand, thousand tons	Supply, thousand tons				Supply level, %
		National	Export	Import	Total	
Western	45.36	1.25	-	18.22	19.47	42.9
Khangai	59.84	13.6	-	23.87	37.94	63.4
Central	48.08	25.9	-	19.08	44.98	93.5
Eastern	21.76	4.15	-	8.79	12.94	59.4
Ulaanbaatar	84.94	23.1	-	34.84	57.94	68.2
Total	259.98	68.0	-	104.8	172.8	66.5

Experts and contractors: Tsedendambaa

TASK 2. VULNERABILITY OF THE RANGELAND ECOSYSTEMS TO CLIMATE CHANGE (prepared by Chuluun)

The group's goals were to investigate the past climate change effects on plant biomass, phenology and functional groups, and also resilience of pastoral networks against climatic extreme events. We had following interrelated hypothesis:

Hypothesis 1. Plant biomass in the Mongolian grasslands has been decreasing due to spring drying trend (increase in temperature by 1.4-1.5⁰C and decreasing precipitation by 17%, mostly in May during the last 60 years).

Hypothesis 2. Cleistogenes squarosa, only common warm-season C4 plant in the typical steppe region, has been increasing in dry part of the typical eastern steppe due to seasonal patterns of climate change (spring drying trend and increasing of summer precipitation trend by 11%, mostly in August during the last 60 years) and advanced trend of plant onset in the eastern steppe of Mongolia. Spring drought would inhibit the C3 plants growth, but will favor C4 plant growth along with the August precipitation increase trend (summer precipitation increased by 11%, mostly in August during 1940-1998). Also longer growing season (the plant onset was advancing in the most of Eastern Steppe during 1980s as our RS

study showed) without much change in total precipitation would benefit to increase of C4 plants.

Hypothesis 3. Biannual plants, semi-shrubs and shrubs have been increasing in the steppe-desert and desert-steppe regions due to spring drying and August rainfall increasing trend. Those plants have better access to late summer rainfall and shrubs are more persistent to spring droughts. The steppe-desert appears to be more vulnerable than desert-steppe, especially if it is heavily grazed.

Hypothesis 4. One of adaptation mechanisms to reduce vulnerability of pastoral society to climate change with increase in frequency and intensity of extreme events is to strengthen their traditional informal institutions as an internal mechanism to cope with climate variability. We had a hierarchy of nested traditional pastoral institutions: *Hot ail* (several households who share their resources), *neg golyghan* (people from one river) and *neg nutgiinhan* (people from one living territory). *Hot ail* structure re-emerged after privatization in many parts of Mongolia. Recently, mainly *neg golyghan* (people from one river) have started self-organizing into cooperatives.

Climate change impact on plant productivity, composition and phenology: Generally, plants in the Mongolian rangelands are often both stress and disturbance (grazing) tolerant. Plants in the northern parts of the Mongolian rangelands have better cold-stress tolerance, but plants in the Gobi region should have better drought tolerance.

Thus, we hypothesized that dry steppe (especially the dry end of the steppe region) would be more vulnerable than desert steppe to climate warming (spring-drying trend with increasing temperature and decreasing precipitation) in Mongolia, hence the desert-steppe plants have better survival traits than plants in the steppe region.

These rangelands have been grazed for few thousands of years by domestic animals-keystone species, thus we can expect that grazing-tolerant plant species became pre-dominant. However, grazing pressure varies in different ecosystems. Direct application of the non-equilibrium rangeland ecosystems theory (Ellis & Swift 1988) shows that non-equilibrium conditions may prevail in regions where long-term average precipitation (threshold level) 175 mm or below. This includes the Gobi region and dry part of the steppe region. This means that in this part of the country there wasn't tightly coupled interaction between livestock and vegetation. Thus, we can expect that plants in the southern parts of the country don't have good tolerance to grazing and increased grazing might result in ecosystem degradation. To sum up, the dry part of the steppe region is the most vulnerable to global warming (drought) and intensive grazing.

Climate change effects on ecosystems:

- The steppe-desert region located in the southwestern parts of the Turgen-Kharhiraa mountains have over-month delayed plant onset trends during the decade of 1982-1992. It has been approved by discussion with the local herders, especially by Davaajav, Chairman of Hovd sum, Uvs aimag. Meadows located in northeastern parts of the Turgen-Kharhiraa mountains and also high mountain tundra have advanced green-up trend due to warming;
- Semi-desert steppe (*Stipa Klemenzii* + *Asterothamnus heteropappoides* + *Anabasis brevifolia*) and desert steppe (*Stipa glareosa* + *A. heteropappoides* + *Ajania achilleoides*)

and *Convolvulus Gortschakovii* + *A. brevifolia* + *S. Klemenzi*) in the southern parts of the Khan Khohii mountains have delayed plant onset response to climate change. In contrary, dry steppe (*Stipa Krylovii*), mountain meadows (*Carex duriuscula* + *Kobresia Bellardii*) and forest areas located in the northern parts of Khan Khohii mountains had advanced green-up between 1982-1992. Probably, climate warming is causing advanced green-up in any place where the moisture is sufficient for plant growth in early spring. It was true for desert steppe located in Pennsville of the Khyargas lake (*A. brevifolia* + *Reumuria soongarica*) and sand dunes Boorog Deliin Els (*Elymus giganteus* + *Hedysarum fruticosum* + *Artemisia Klemenzi*) located on the Russia-Mongolia border.

- Extensive areas of desert steppe, steppe desert and dry steppe regions located in the western and southern parts of the Khangai mountains have delayed plant onset response to climate change between 1982-1992. Some parts of dry steppe were heavy degraded by grazing and have potential to be desertified if intensive use is continued. For example, dry steppe (*S. Krylovii* + *Cleistogenes squarrosa* + *Caragana leucophloea*) located on sandy lands south from Nariin Gol river of Zavhanmandal sum of Zavhan aimag was heavy degraded by grazing. *Caragana* shrubs were grown in colonial form and on sand mounts due to sand movements. *S. Krylovii* + *Cleistogenes squarrosa* communities were growing on these mounts, but *C. squarrosa* communities have been growing in hollow parts making mosaic structure.
- Another example of ecosystem degradation was total conversion of mountain meadow species by community (*Artemisia adamsii* + *Artemisia frigida* with 65% cover of *Parmella vagance*) on the top of the western Khangai mountains (2218 m). Nearby there were only *Salsola collina* dominated community. Both these plant communities were formed as result of overgrazing (due to closeness to winter shelter) by livestock and rodents *Lasiopodomis Brandtii*. Heavy soil erosion occurred blowing out all fine-textured parts only leaving sand and shovels. Thus a back change into original ecosystem state could take a long time and even the change could be irreversible.
- Shargyn Govi's river system has two kinds of ecosystems: inter-mountain (*Tamarix rusimosa* + *Lycium rutenica* + *Micropeplis archenoides*) and meadow (*Elymus dagistachis* + *Phragmites communis* + *Kalidium folium*). All these ecosystems give advanced onset trend due to warming. This place has sufficient moisture for early greening-up due to warming.
- Dry steppe in the northern slopes of the Altai mountains (*Allium polyrrizum* + *Stipa Krylovii* + *Chenopodium album*) are giving advanced greening-up due to warming and presence of moisture in early spring.
- Alag Khairhan mountain's southern slopes have following types of ecosystems along the gradient: mountain dry steppe (*Agropyron cristatum* + *Stipa Krylovii* + *Chenopodium album*), desert steppe (*Artemisia gobica* + *Stipa glareosa*) on foothills and (*Artemisia gobica* + *Stipa gobica*) in the valley. All these ecosystems have delayed plant growth signal. These ecosystems are very vulnerable to warming. Dominant plants in the dry steppe were aging and the desert steppe in the southern part of the Alag Khairhan mountain used to be meadow, but it has been drying. It is an example how mountain system could be vulnerable to global warming.
- The second year survey in the central parts of the country (the last year survey was conducted with the NSF collaborative project) showed that monitoring of ecosystem dynamics in large regions is possible. One example, west from Mandalgovi site showed different dynamics during these two years: there was not much *Cleistogenes* sp. in 2001 (*A. frigida* was dominant specie at that time. Generally, *A. frigida* had), however, they

became dominant sp. in 2002. The survey dates might made some differences. 2001 survey was made on July 31, but 2002 survey was made on August 24. *Cleistogenes* sp., warm season grass's growth cycles are later than cool season grass's.

Vulnerability, biocomplexity and resilience of pastoral systems: This study was conducted at different spatial and administrative scale such as region, aimag, sum and pastoral community. In this report, we included our research results at regional, sum and community levels.

Strengthening herder's communities as key to achieving less vulnerability and greater resilience to climate change: The following are lessons learnt in the area of community strengthening activities in Mongolia:

- Herders were eager to come together or launch collective actions for different reasons ranging between simple gatherings especially among younger members /*khot ails* and families meet rarely compared to the socialist period of collectives/ and deep cooperation on productive activities such as launching SME projects
- Strengthening herding communities empower people to take their own initiatives for development thus contributing to the distribution of development resources more evenly in favor of the rural area and the poor
- For simplicity and less requirements for the establishment and low transaction costs for running NGO form is liked more by herders
- Transparency and accountability of activities among communities especially those associated with funding is crucial for further strengthening newly established herders institutions
- Promoting cooperative development requires the improvement of the existing legislation especially, the law on co-operatives
- Capacity building of newly established formal institutions of herders in the areas of community management, planning of activities, basic accounting and SME project development is crucial for making them sustainable in the long-term

Study of Bugat sum response to climate change:

- The plant growth has advanced green-up trend in the northern slope of the Alag Hairhan Mountains due to spring warming with early snow melting. The mountain dry steppe, desert steppe on foothills and in the valley all have delayed plant growth signal. These ecosystems are very vulnerable to warming. Dominant plants in the dry steppe were aging and the desert steppe in the southern part of the Alag Khairhan mountain used to be meadow, but it has been drying.
- The Alag Hairhan mountain system is very vulnerable to climate change. The mountain's plant productivity and animal weight are decreasing. It could serve as an example site of vulnerable to global warming mountain system.
- Some spontaneous adaptation measures such as improve livestock quality, migration of the herders from the region to the central region of the country, building cooperatives etc. are happening. However, migration has negative side due to brain-drain problem.
- Relatively conservative land use practices are kept in the region. Also relative welfare level of the local herders supports the traditional pastoral movement.

Socio-economic survey among the herders in the western part of Mongolia:

A short summary of the socio-economic survey among the herders is presented here:

- Decrease in PPT;
- Increase in dust storm;
- Increase in drought frequencies;
- Plant height and production are decreasing & plant cover is reducing;
- Changes in plant species composition;
- Animals can't gain enough weight and fat;
- Animal size is reducing.

We may highlight that these changes are interlinked with each other. Decreased precipitation in early growing season is leading to spring drought and low plant productivity that contribute to increased dust storms. Animals can't gain enough weight and fat due to decreased plant productivity both in spring and summer. A long-term decreasing trend in plant biomass might be causing a reduction of animal size and weight.

Experts and contractors: Chuluun, Bolortsetseg, Sanjid, Enkh-Amgalan

TASK 3: CASE STUDY (prepared by Oyun)

Planned activities:

We planned the following activities for the first half of this year:

1. To continue the case study on drought with detailed socio-economic survey in order to clarify its impact on animal losses, primary meat and milk production, food structure and livelihood of herders' households on the example of selected *aimags* (province) and *sums* (county).
2. To exercise impact, vulnerability and adaptation assessment on the example of particular hazardous events and particular *sums* of selected *aimags* via participatory approach with both experts and community involvement
3. To continue pasture vegetation and livestock study
4. To continue policy research on long, mid and short term development of livestock sector in changing environment and climate
5. To continue partnership development with practical implementation of joint projects with climate change components

Summary of Activities & Outputs

1. Data collection: Two primary data collection exercises were carried out:
 - A sample survey of herders livelihoods and experiences of climatic conditions; and
 - An expert-assessment of hazard, vulnerability, risk and management quality for different localities, assessed through a participatory approach with local government officials
2. Desk survey:
 - Reviewed documents on Mongolia development strategy and policy

- Surveyed literatures in field of climate change, natural disaster, impact, vulnerability and risk assessment in connection with the livestock sector, grassland ecosystem and herder's livelihood and poverty
 - Surveyed publications of UN and its agencies, and the Mongolia State Statistical Department to review indicators and indices commonly used for socio-economic study & assessment
3. We developed a methodology and questionnaires for surveys of herders and *sum* (bag) governors. The questionnaire for herders has 49 questions (core-28, supporting-13 and passport data – 7) and for *sum* governors 15 questions (core-10, supporting-1, passport data-4). In tables below is shown structure of questionnaire.

Table 8. Herders Questionnaire Structure

No.	Question number	Contents
1	1, 2, 3, 4	If herders observed climate change and variation what impacts were on their livelihoods.
2	5, 6	List of impacts from natural environment and weather events on herders' households assets and income, and assessment of these impacts with some scoring
3	7, 8, 9, 10	What are particular losses from the last few years drought and <i>dzud</i> disaster and what was relief activities, aids and healthcare from local government, professional organizations and donors
4	11	Data to assess household members labor capacity
5	12, 13, 15	To clarify seasonal specific of animal breeding and herders livelihood
6	14	Data of last 5 years animal losses to correlate with weather condition
7	16, 17	Data for assessment of herders households economic capacity
8	19, 20, 21	To assess access to and content of weather forecasting, hazard warning information
9	22	Measures to reduce risk to lose herders assets (animals)
10	23	Access to drinking water
11	24, 25, 26, 27,	For analysis of education of herders children
12	29, 30	To clarify healthcare to herders
13	31	Measures for adaptation to climate change and variability
14	32, 33	Participation in different projects related to herders livelihoods and natural environment and climate change
15	34-40	Passport data of surveyed herder
16	41, 42	Open questions
	43-49	Herders households food structure and seasonal distribution

Table 9. *Sum* (bag) Governor's Questionnaire Structure

No.	Question number	Contents
1	1, 2, 3, 4	Passport data of surveyed official
2	5, 6	<i>Sum</i> (bag) population and poor households (last 5 years)
3	7, 8	Observed change in natural environment and climate in area of <i>sum</i>
4	9, 10	Criteria of assessment for and causes to be poor
5	11	<i>Sum</i> (bag) livestock head, structure, losses (last 5 years)
6	12-15	Related to policy and recommendation

4. Detailed study of impacts of drought and its follow-up hazardous events with social survey questionnaire: The questionnaire aims to gather data for the last 5 years, as Mongolia livestock sector is under impact of natural disasters (consequent drought and *dzud* phenomenon), and lost more than 10 million animals – one third of year 1999 total (see table below).

Table 10. Head of livestock lost in drought and dzud disaster

Year	Number of affected <i>aimags</i> and <i>sums</i>	Number of lost <i>animals</i> (million head)
1999-2000	157 <i>sums</i> of 15 <i>aimags</i>	3,4
2000-2001	98 <i>sums</i> of 17 <i>aimags</i>	4,2
2001-2002	114 <i>sums</i> of 8 <i>aimags</i>	2,4
2002-2003	60 <i>sums</i> of 11 <i>aimags</i>	more than 0,4

A detailed study and environmental database has been compiled for the last 12 months - from June 2002 to May 2003, during what consequent natural hazardous events such as drought, extreme hot and cold, flood, forest fire, *dzud* and epidemic diseases have occurred and affected livestock sector and herders' livelihood.

Primary data collection carried out through questioning of 364 herders households and 41 local officials of 11 *sums* of Dundgobi, Zavkhan and Bulgan *aimags* (see Table 11). More attention is given to impacts of climatic variability to herders' assets and income, food structure. Data entry and processing started with SPSS software. Primary

Table 11. Surveyed herders in the *sums*

Aimag name	<i>Sum</i> name	Number of questioned herders and local officials	Per cent of total <i>sum</i> and <i>aimag's</i> herders' households
Zavkhan	Tosonstengel	25	2.8%
	Do'rvoljin	32	6.5%
	Aldarkhaan	37	5.5%
	Local officials	18	
	<i>Aimag</i> total	112	1.0%
Dundgobi	Erdenedalai	71	5.3%
	Ulziit	34	5.8%
	Gurvansaikhan	30	6.2%
	Local officials	11	
	<i>Aimag</i> total	146	1.8%
Bulgan	Bulgan	19	5.8%
	Bugat	24	6.2%
	Teshig	32	5.5%
	Local officials	6	
	<i>Aimag</i> total	81	1.0%
Total		364	

Socio-economic data for selected *sums* were collected and briefly described. Sample of primary results of survey is given on the example of Tosontsengel *sum* of Zavkhan *aimag* (see Annex 1).

5. The environmental and the social (gained from the herders' and Governors' Survey) data sets were cross-tabulated to provide linked environmental and household impact assessments. This would enable impact patterns to be highlighted, risk factors to be deduced – and hence conclusions and policy recommendations to be put forward.
6. An expert-assessment of risk and disaster management at *sum* level was conducted through a participatory approach with 16 local government officials of Khentii *aimag* on the example of O'mnodelger *sum* for drought, *dzud*, hazardous windstorm, and epidemic diseases. Results of the this survey are the followings:
 - a. Primary data collection with questionnaire from *sum* officials, initial analysis and draft report

- b. Impacts and lessons learnt from past natural hazardous events
 - c. Assessment and forecasting of risk, based on local socio-economy and summer weather forecasting
 - d. Mapping of risky areas for each of 5 type of hazardous events, and location of *sum* population and livestock.
 - e. Risk management plan with cost estimation and possible financing mechanisms
 - f. Draft recommendation
7. Studies on livestock were conducted at *sum* level with detailed consideration of seasonal variation of animal husbandry. Mongolia traditional 24 seasons with continuation of 13-15 days were more appropriate to natural system dynamic as well as to animal husbandry. We scored firstly the year-around activities of animal husbandry according to intensity secondly temperature, snow and rainfall anomaly, and snow and dust storm according to positive and negative impacts then cross-tabulated with 24 seasons. And now is working to assess each year by unfavourable condition to cross tabulate with animal losses in order to define the most appropriate assessment indices and indicators.

Experts and contractors: Oyun, Togtokh, Bizya, Manibazar, Bagmid, Enkhbayar and Batbayar, Baatar

Capacity building

There have been training on use and application of ArcView for some experts that are working on vulnerability map.

Climate Change scenario expert Gomboluudev have participated in the Workshop on the Theory and Use of Regional Climate Models, that held in Trieste, Italia, on 26 May to 6 June 2003. As a result our team is able to develop regional climate change model for Mongolia and to test the results under this project activities.

C DESCRIPTION OF DIFFICULTIES ENCOUNTERED AND LESSONS LEARNED

There was some difficulties in using the newly developed methodologies/different indexes on vulnerability assessment. Methodology seems work but the results were not good enough to make certain conclusion. So we spent a lot of time on this study.

D DESCRIPTION OF ANY CONNECTIONS OR INTERACTION BETWEEN YOUR AIACC PROJECT AND THE PREPARATION OF NATIONAL COMMUNICATIONS UNDER THE UNFCCC FOR COUNTRIES RELEVANT TO YOUR PROJECT.

This project initially was planned to prepare the adaptation part. Thus the results of our project will be the direct input to adaptation part of the second national communication.

E DESCRIPTION OF TASKS TO BE PERFORMED IN THE NEXT EIGHT-MONTH PERIOD

Even though, there have been done a lot of studies on vulnerability assessment using the vulnerability indexes, which have been developed during the last year study some of the results were rather confusing so this part of the study will be verified.

Main study of this year is vulnerability and future climate change impact assessment. Thus the research will follow the work-plan given in Annex A of the project agreement and second half of the year will focus on future climate change impact assessment using different climate change scenarios such as HadCM3, CCGM3, CSIRO and test the regional climate change scenarios. Planning to develop number of vulnerability maps.

There will be field survey in three locations (western, central and eastern region of the country), which will study pasture plant capacity, inventory of water resources and survey of adaptation option to climate change based on participatory approach.

F ANTICIPATED DIFFICULTIES IN THE NEXT EIGHT-MONTH PERIOD

Do not see any difficulties in research. It is difficult to see the anticipated difficulties in management.

G ATTACH ANY DRAFT OR FINAL PAPERS OR OTHER OUTPUTS OF THE PROJECT PRODUCED DURING THE REPORTING PERIOD

The attached paper have been written during the reporting period. There are number of papers in Mongolian and will send when completed.

H TRAVEL

We have visited the climate-animal observation site that have been established in Bulgan *sum* of Umno-Gobi *aimag* last year. The site have been moved from the Bulgan *sum* to the location at 25 kilometre distance from *aimag* center because of local circumstances and easiness to get professional advise and support from officers (meteorologist and zoo-meteorologist) of the Centre for Meteorology, Hydrology and Environment monitoring of Umnogobi *aimag*.