# Climate Change Effect on grasshopper (*Agrididae*) and Brandt's vole (*Microtus brandtii Radde*) in Mongolia

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Some harmful species of grasshoppers distribute in Bayan-Ulgii, Khovd, Gobi-Altai, Bayankhongor, Arkhangai, Uvur-Khangai, Bulgan, Khentii, Dornod, in dry them populations can reach extremely high values, exceeding 150-500 per 1m^2. In Mongolian rangeland grasshoppers had been increased years 1929-1934, 1946-1948, 1954-1956 since the year 1921
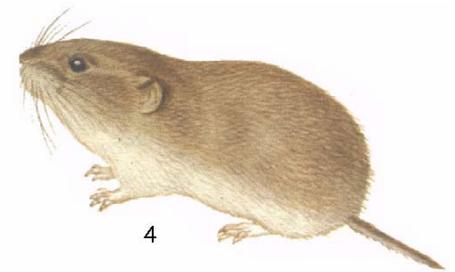
In Mongolia, one development cycle /from egg to adult/ common grasshopper requires 159.9^{0}C
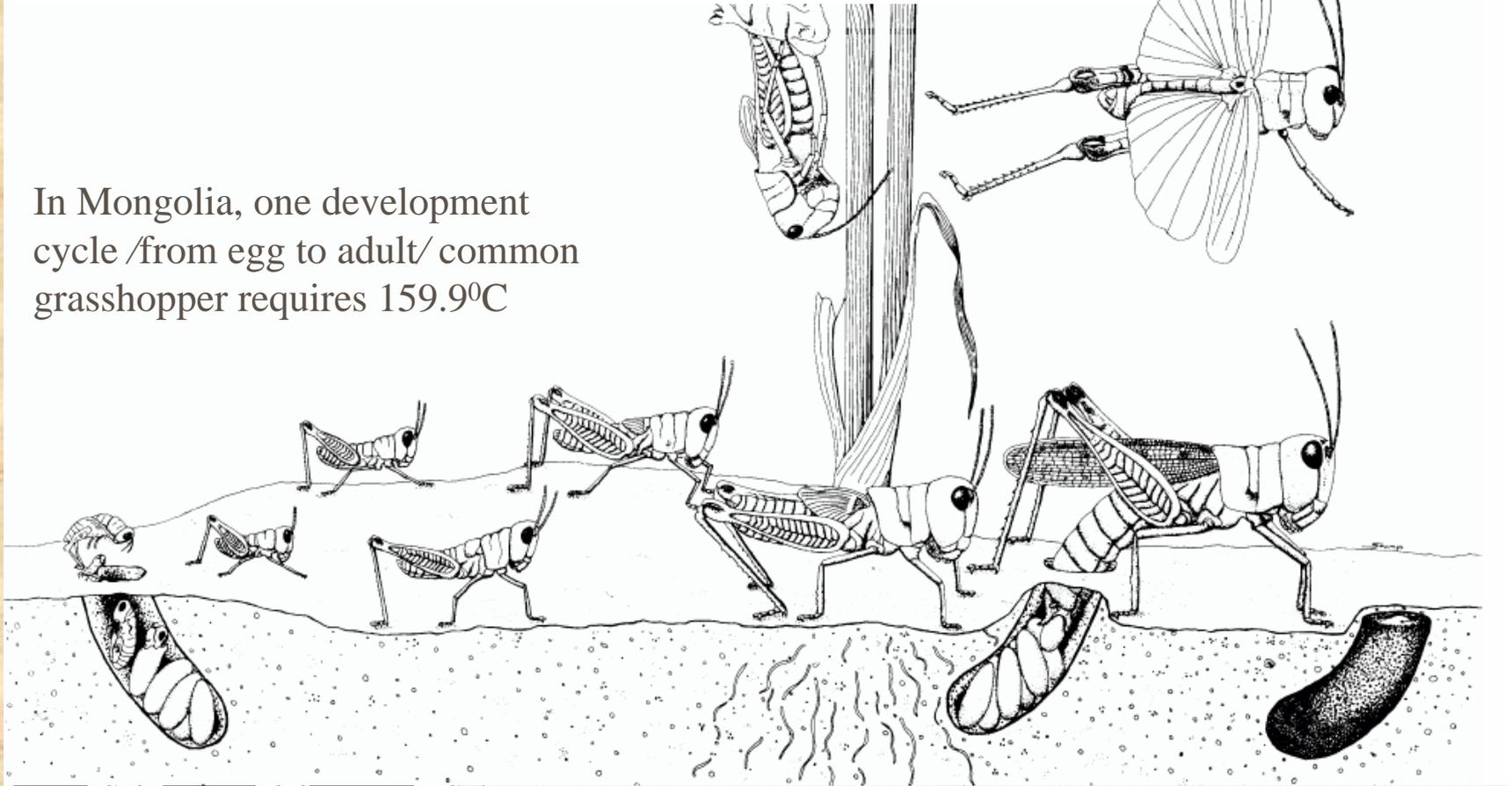
Spring air temperature become 10^{0}C
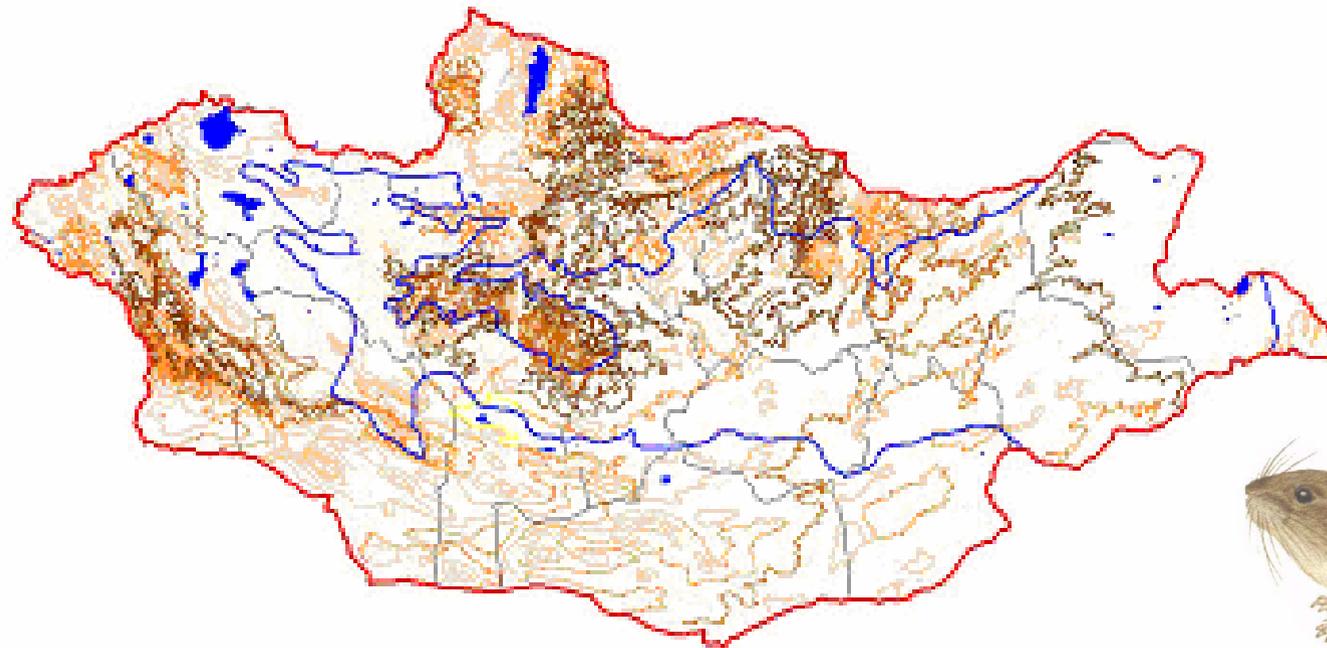
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Brandt's vole is a harmful species of pest rodent, which are known to increase in drought years. Brandt's vole had been increased in years 1941-1943, 1956-1957, 1963-1965, 1971.1973, 1981-1985, 1990-1991, 1999-2001 periods.

At the present time about 60 kinds of rodents are distributed over Mongolia. Brandt's vole is more harmful rodent and distributed mostly in the Eastern and Central steps and in some area of the Western Mongolia. Total area of Brandt's vole is 40 million square km2

Data

We used monthly average temperature of 0.5X0.5 degree grid area for 1961-1990, results of climate change scenarios such as monthly temperature for period 2010-2029, 2040-2069, 2070-2099 /version A2 of CO_2 concentration of model HADCM3/, distribution map of Brandt's vole and drought for 1991-2000.

Method

1. **1. The heat effect:**

$$Dp(T-Th)=Dd$$

Dd-Thermal constant, Dp-Development period, T-Environment temperature, Th-threshold temperature

2. Threshold temperature, Th: Below which no further development of the pest is expected. Threshold temperature is differ according to species.

3. Thermal constant, Dd: thermal constant is the accumulated degrees above threshold temperature for completion of one generation. It known as the remainder index or growing degree-day. For finding threshold and thermal constant it must be known the development period of insect in two different environment temperature.

4. Effective temperature, *Te*: This is temperature that helps development period above threshold temperature. It can be find the number of generation of multivoltine pests by use the total effective temperature.

5. Number of development cycle, *B=Dd/Te*

6.Calendar day of stable warming and cooling in spring, autumn,

Spring: $S = \dfrac{k-a}{b-a} \times d + 15$ Autumn: $S = \dfrac{a-k}{b-a} \times d + 15$

S-days of stable warming and cooling, *k*-selected level of unit temperature, *a*-monthly average of air temperature or unit temperatures of two sides at the *k* level, a-unit temperature not become on level, b-unit temperature pass on level, esp. $a < k > b$

Results

1. Climate change effect on grasshoppers

Years	hatch day	decease day	Live days	*Te*	*B*
1961-1990	143	261	118	599	4
2010-2029	136	262	126	818	5
2040-2069	131	267	136	1004	6
2070-2099	123	274	151	1390	9

currently the grasshoppers is to hatch in 143rt day of spring /23 March/, in to decease 261st day of autumn /18 September/ and them live continues total 118 days, in on summer have 4 development cycle. Might be the development cycle will increase 5 in 2010-2029, 6 in 2040-2069, 9 in 2070-2099 periods.
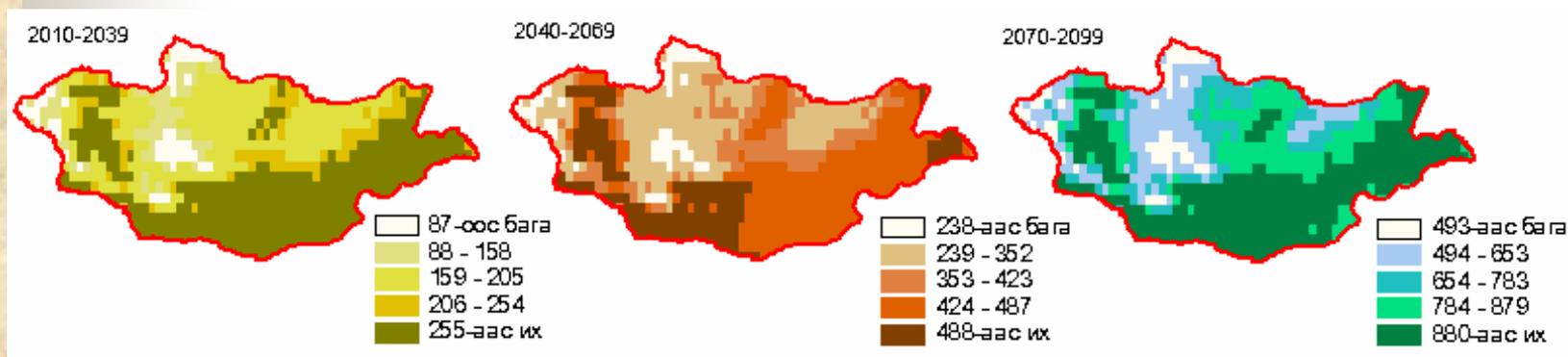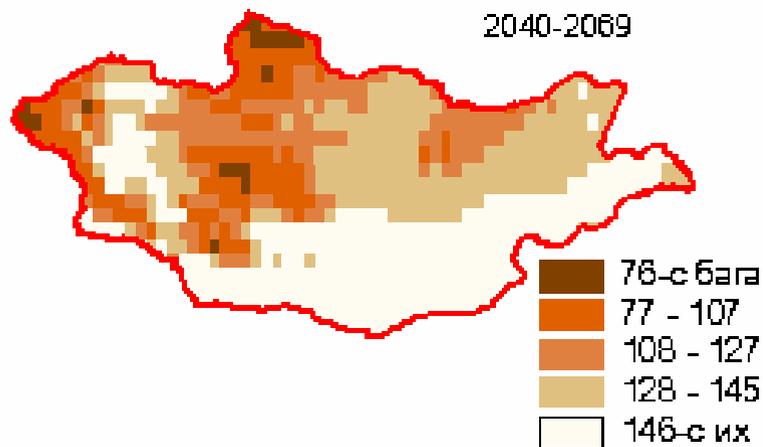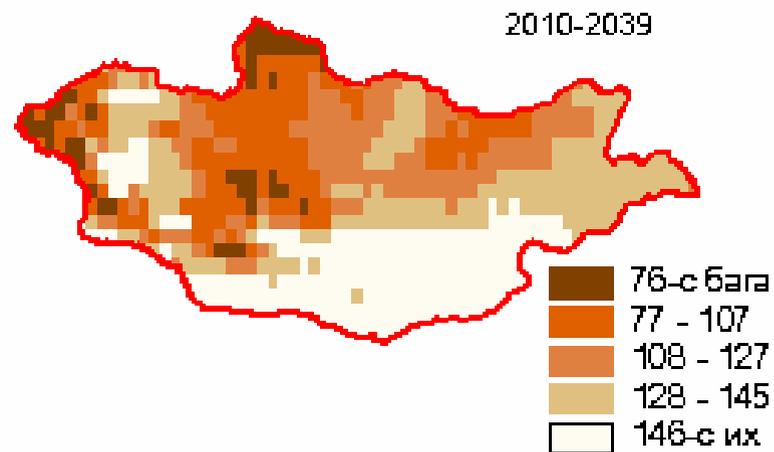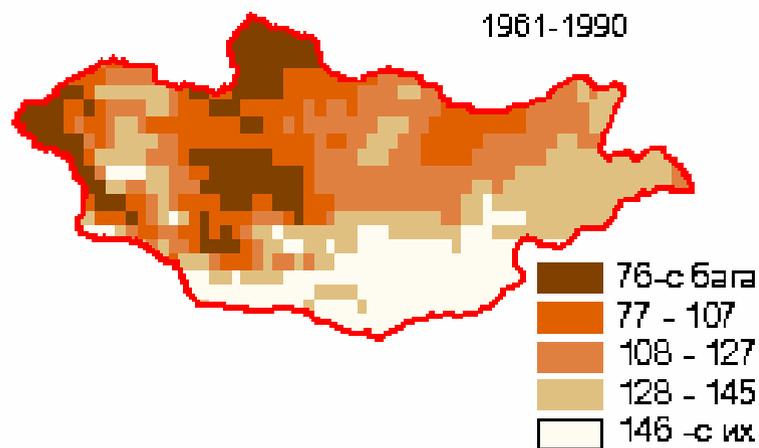

Fig 4. Sum of active temperature above 10^0C in years 2010-2029, 2040-2069, 2070-2099 periods
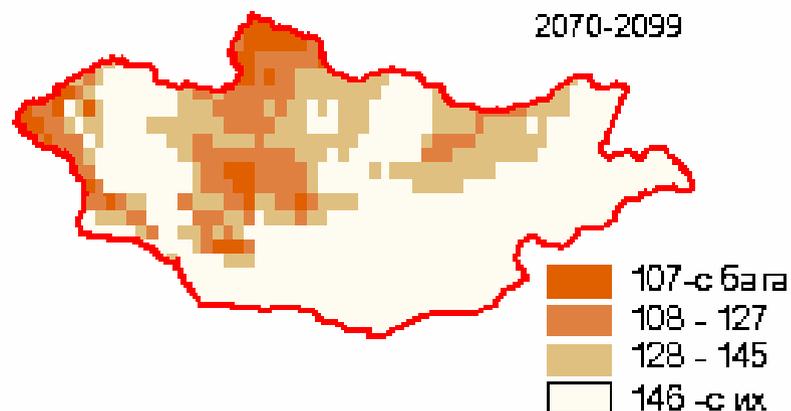
Grasshoppers to live average days
in years 1961-2000, 2010-2029, 2040-2069, 2070-2099 periods

2. Climate change effect on breeding time Brant's vole

Generally, the period of Brant's vole breeding is from the end of April to the end of August and it lasts 5-5.2 months. In a summer a female bear normally 3-4 times gives a breed. During a breed she gives 8-14 whelps. The starting and finishing day of Brant's vole breeding depend on climate and environment condition [Avirmed, D., 2000]

We studied temperature of Brant's vole breeding dates. The study shows, the Brant's vole to breed when air temperature is above 8^{0C}. i.e. Breeding of Brant's vole continue from spring 80C to autumn 8^{0C}
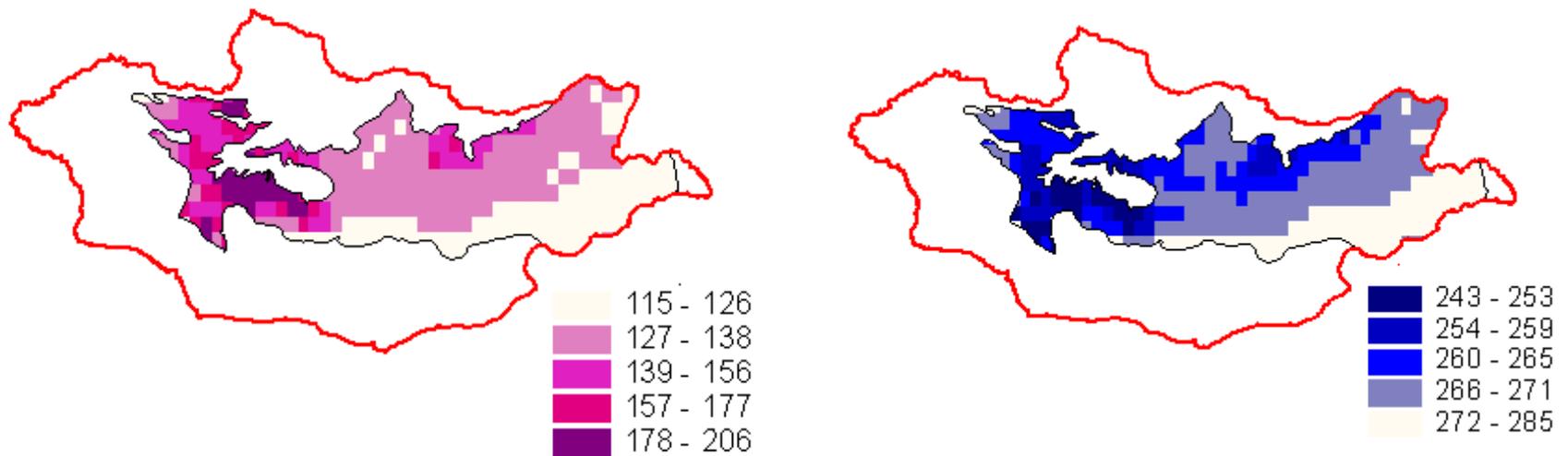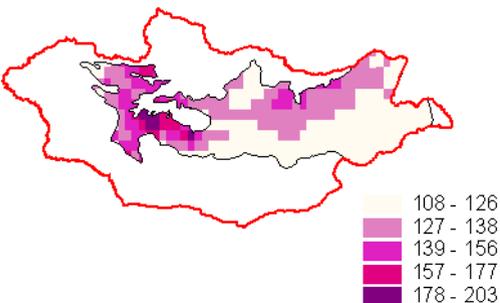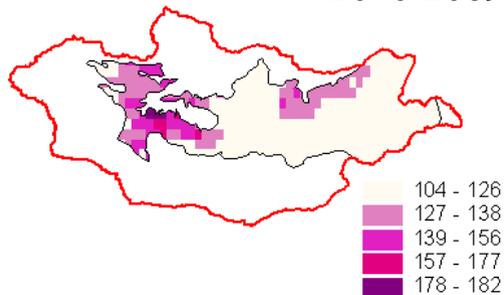
Fig 6. Starting and finishing days of breeding of Brant's vole /1961-2000/

The Brant's vole breeding days will change and increase from 5.5 to 6.2 months in years 2010-2039, 2040-2059, 2070-2099 period
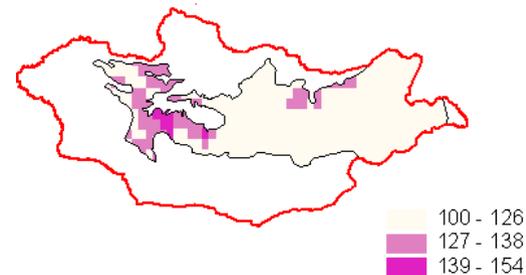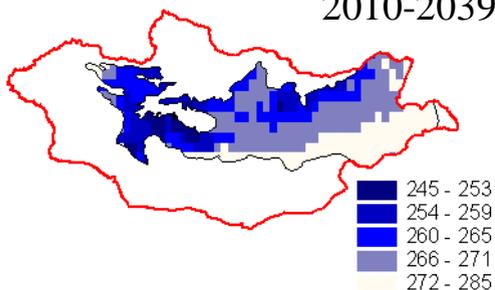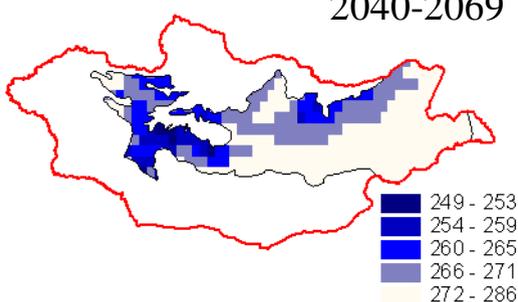

Fig 7. The starting day of Brant's vole breed in
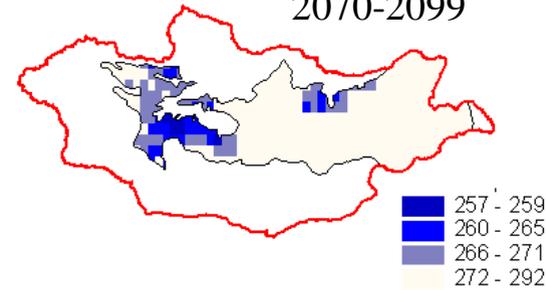years 2010-2039, 2040-2059, 2070-2099

Fig 8. The finishing day of Brant's vole breed in
years 2010-2039, 2040-2059, 2070-2099

Summary

Currently the grasshoppers is hatch in 143rt day of spring /23 March/, in 261st day of autumn /18 September/ and them develop continues total 118 days, a summer have 4 development cycle. Perhaps the development cycle will increase 5 in 2010-2029, 6 in 2040-2069, 9 in 2070-2099 periods.

Hatching of the grasshoppers will occur early in years 2010-2029, 2040-2069, 2070-2099 periods, according here the damage will early start in future.

Currently the Brant's vole breeding continue 5 month, but it will change and increase from 5.5 to 6.2 months in years 2010-2039, 2040-2059, 2070-2099 period.

THANK YOU FOR ATTENTION