Effect of Grazing on Net Primary Production of a Mongolian Grassland Ecosystem

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Background

- **Approximately 75% of Mongolian total area is covered with grassland and shrubland, which are grazed by domestic livestock all the year around (Maria E. Fernandez-Gimenez, 1999).**

- **Net Primary Production (NPP) is an important component in carbon cycle. Aboveground net primary production (ANPP) is directly related to grazing capacity of grassland.**

- **Plant growth and defoliation dynamics are difficult to monitor in grazed rangeland (White, 1984). So simulation is a helpful approach for studying a grazed grassland ecosystem.**

Objectives

- **To analyze the effect of grazing on a grassland ecosystem by using a simulation model (Sim-CYCLE *grazing*)**

- **To estimate the stocking rate of grassland in Kherlen Bayaan-Ulaan (KBU) by Sim-CYCLE *grazing***

Study site

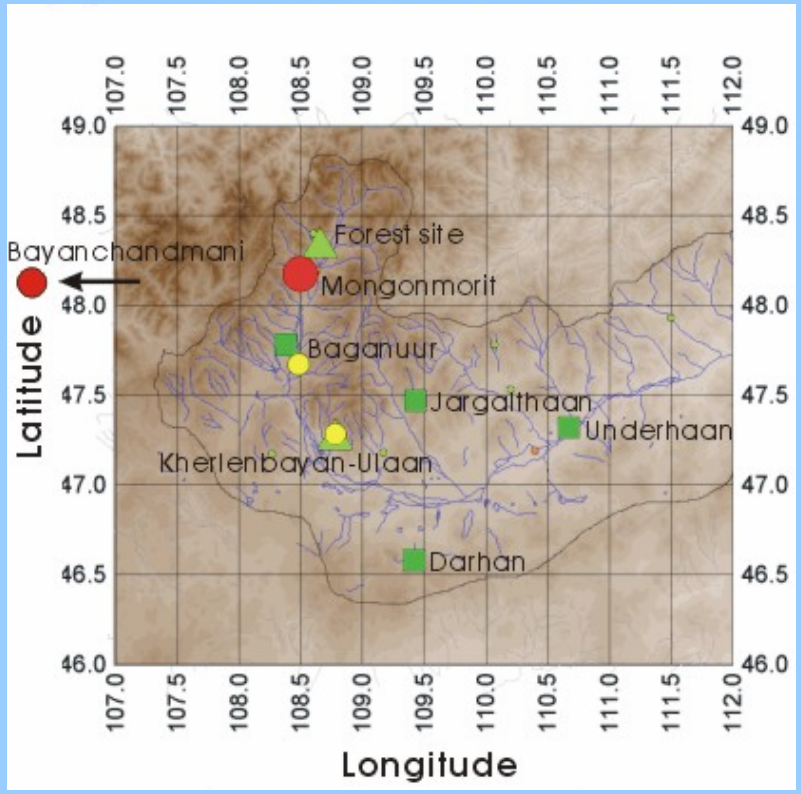
Kherlen Bayaan-Ulaan(47º28′N, 108º78′E)

Altitude: 1300m

Annual precipitation: 202mm

Annual mean temperature:1.4 ℃

Vegetation: semi-arid steppe, dominant species are *Stipa krylovii, Artemisia frigida, Cleistogenes squarrosa.* C4 plant species occupy about 10% of total biomass.



Model description (1)

Characteristics of Sim-CYCLE model (Ito and Oikawa, 2002):

- **Process-based model**
- **Compartment model**

WE=WP+WS

$WP=WP_F+WP_C+WP_R$

$WS=WS_L+WS_H$

$$GPP_{INS} = \int_0^{LAI} PCdLAI$$

LAI: leaf area index

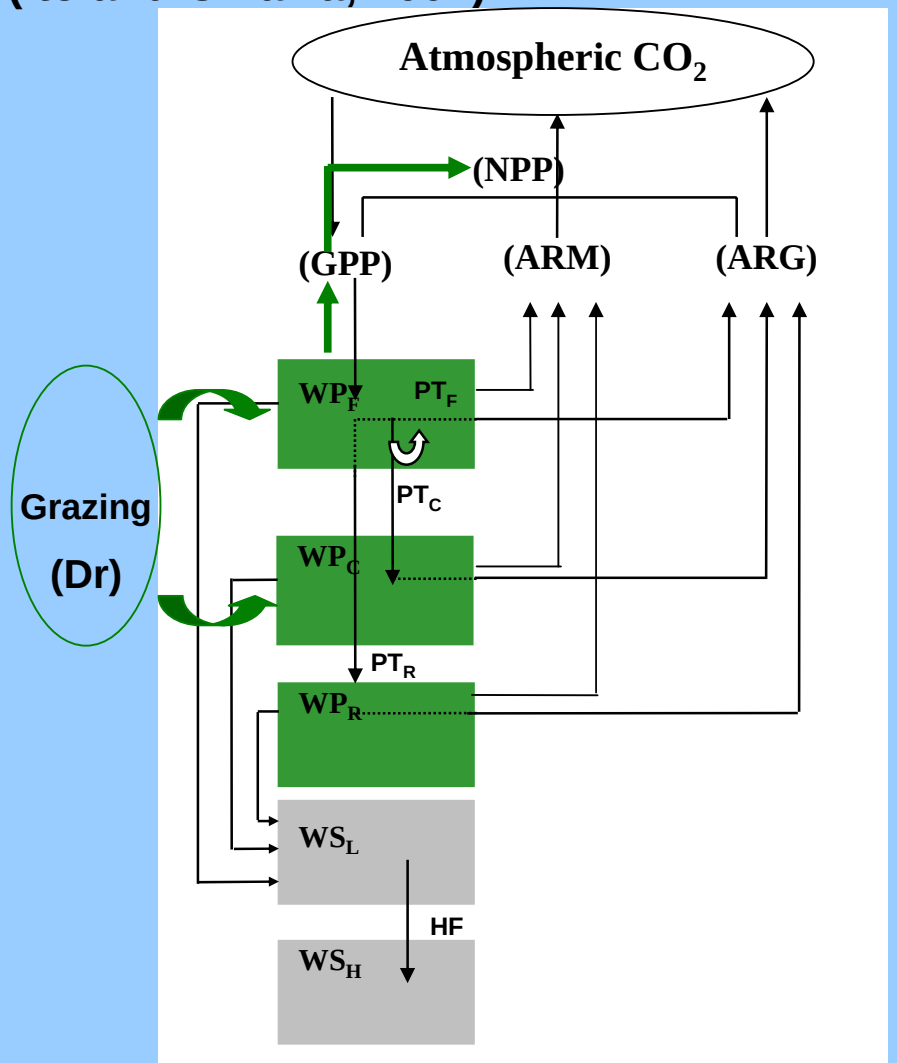
PC: photosynthetic rate

NPP=GPP-ARM-ARG

$=\Delta W$+Litterfall+Dr

Dr: Defoliation rate

(kg ha^{-1} d^{-1})



Model description (2)

Defoliation sub-model (Seligman N.G., 1992)：

$$D_r = E * S_r((WP_F + WP_C) - (WP_F + WP_C)_u)$$

(0<Dr<Sr，Dx)

Dr: Defoliation rate (kg ha^{-1} d^{-1})
E : Grazing efficiency of livestock (ha d^{-1} per sheep)
Sr: Stocking rate (sheep ha^{-1})
$(WP_F+WP_C)_u$: Residual aboveground biomass unavailable to the livestock (kg ha^{-1} dry matter)
Dx: Satiation consumption rate of the livestock (=2.4kg dry matter d^{-1} per sheep)

Model description (3)

About the defoliation sub-model:

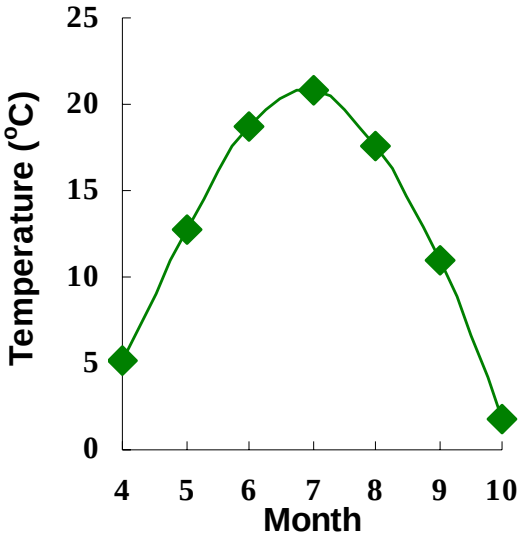
- Animal is regarded as “negative” consumer.
- Effect of grazing was simulated from June to September.
- Grass evenly distribute vertically and horizontally.
- Grasses have not been divided into palatable and unpalatable species.
- Forage intake is limited to green leaf and stem.
- Plant growth depends on soil water, and other soil nutrients are regarded as non-limiting.

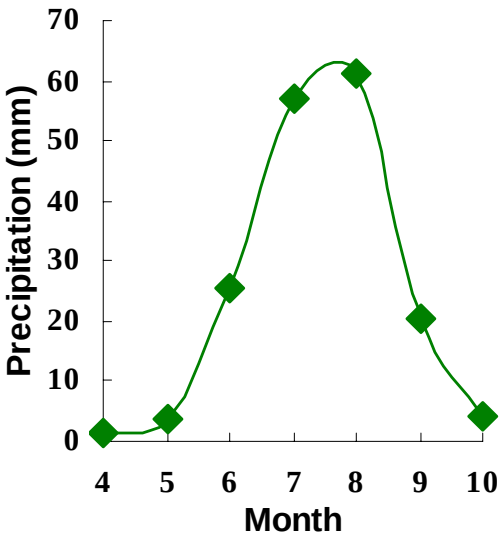
Model description (4)

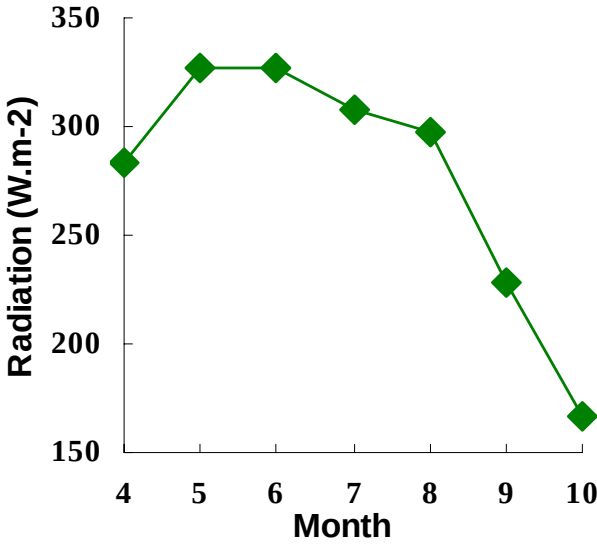
Time step: Monthly

Model input

Temperature **Precipitation** **Radiation**







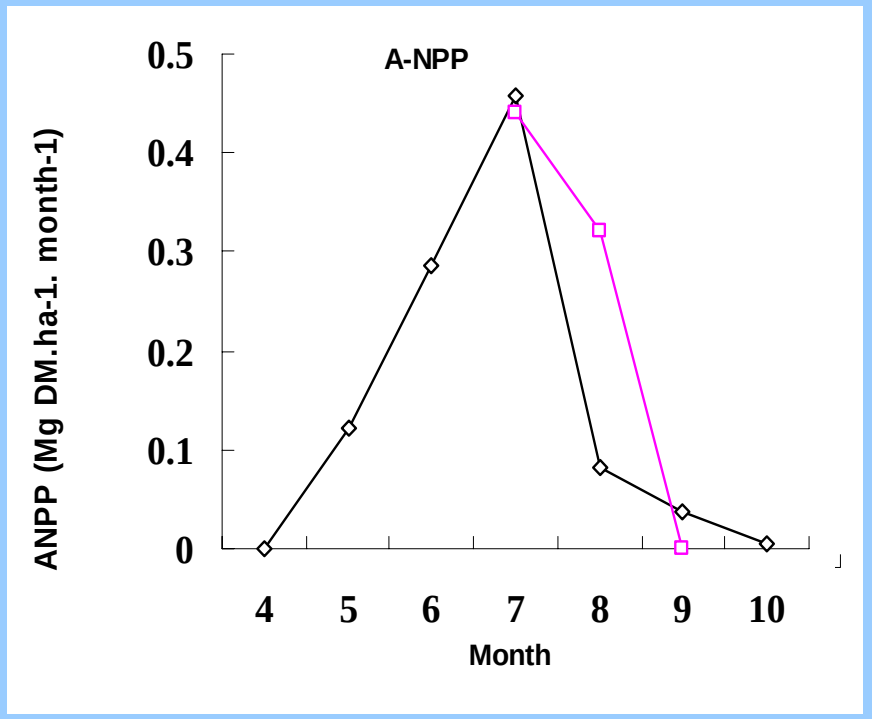
Model output

Monthly changes of LAI, biomass, GPP, NPP etc.

Results and discussion (1)

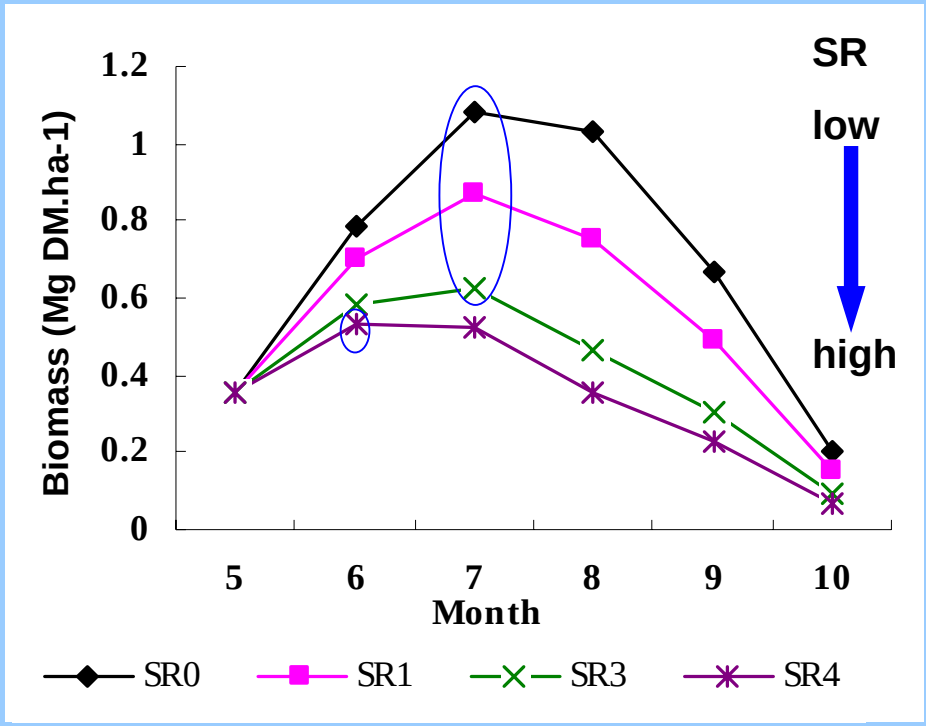
Model validation

◇ *Simulated* ◇ *Measured (Urano et al. 2004)*



Results and discussion (2)

Effect of grazing on aboveground biomass



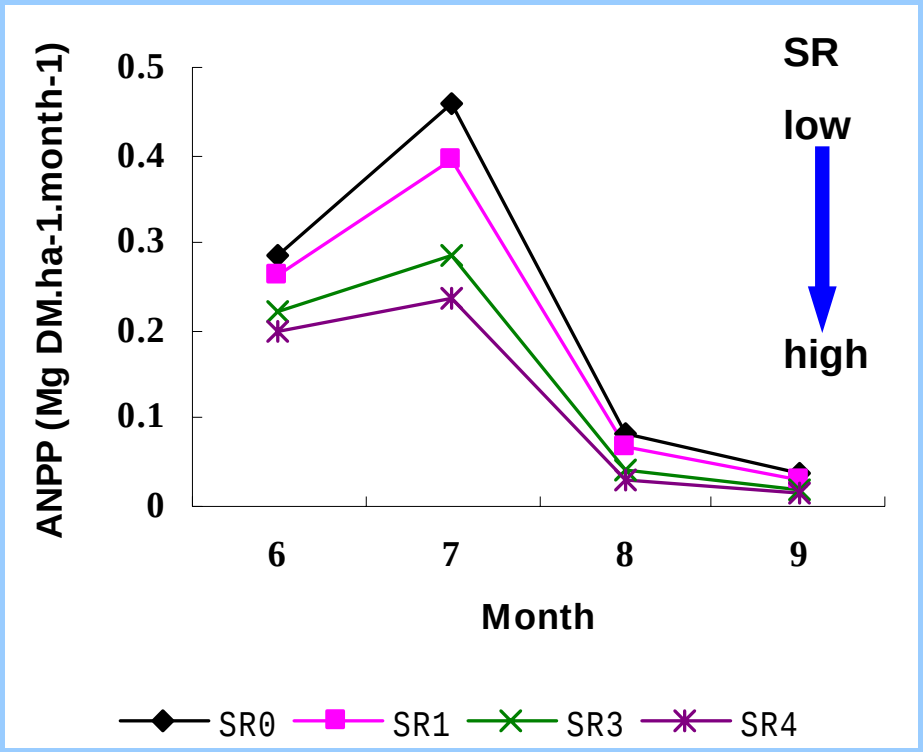
SR: Stocking rate (sheep ha-1)

SR	Biomass *max* (Mg DM.ha-1)	Decrease (%)
0	1.09	0
1	0.87	20
3	0.63	42
4	0.53	51

Month	Precipitation	Temperature
6	26	20
7	57	22
8	61	19

Results and discussion (3)

Effect of grazing on ANPP

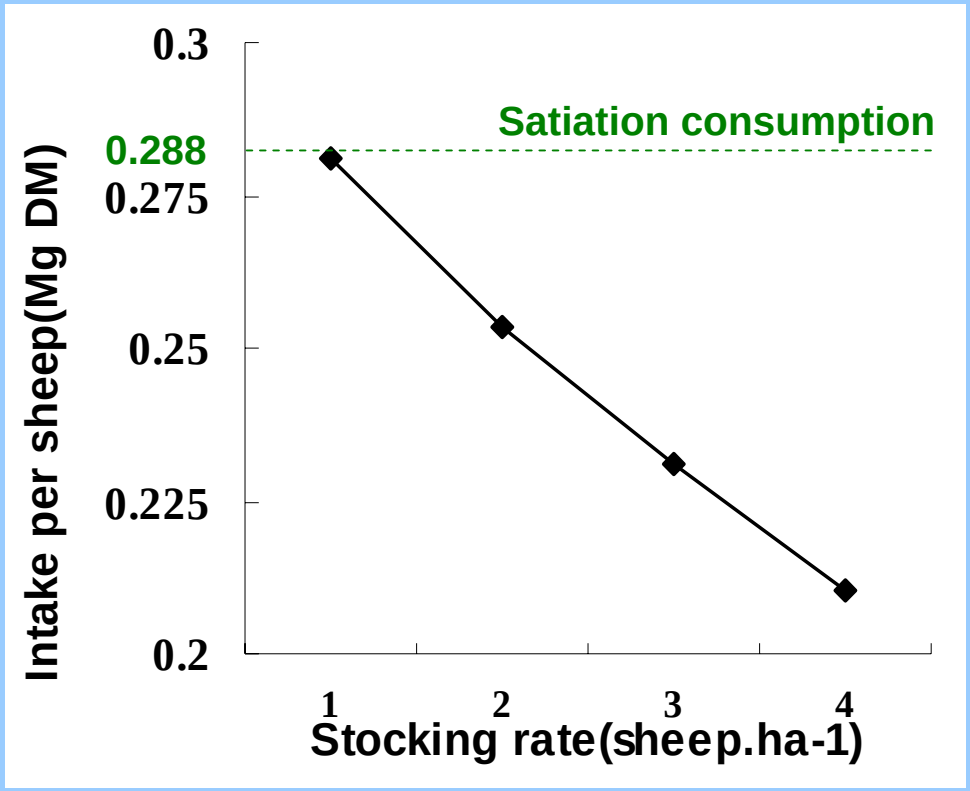


SR: Stocking rate(sheep.ha-1)

SR	ANPP *Max* (Mg DM.ha-1.month-1)	Decrease (%)
0	0.46	0
1	0.40	13
3	0.29	37
4	0.23	50

Results and discussion (4)

Intake per sheep in growing season



Conclusion

A new simulation model, Sim-CYCLE *grazing* estimated the following features:

- **Aboveground net primary production (ANPP) will decrease with increasing stocking rate**

- **The stocking rate of KBU grassland in growing season should not be higher than 3 sheep or sheep equivalent per hectare**

Acknowledgements

This study has been supported by a CREST project (The Rangelands Atmosphere-Hydrosphere-Biosphere Interaction Study Experiment in Northeastern Asia) of JST. The authors are thankful for the helpful discussion and suggestion provided by Dr. Mo Wenhong and Dr. Wang Qingeng.

Thank you!