

# A New Methodology for the Evaluation of Ecological Characteristic of the Camel

## - A case Study of Climate Change and Breeding of Camel -

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**Abstract:** Kazakhstan dry steppe is one of important pasture lands of breeding of dromedary camels. In this study, we analysis the behavior patterns and habitat use of dromedary camels based on satellite (GPS) tracking data and to clear the relationship between an increase in the camel farm and climate change. The herdsman's (or Owners) is decision the pastureland use by year-to-year rainfall. They are also known how to control the different grazing lands by the dry season and the rainy season in the same year. Camel's behavioral pattern was different in the dry season and the rainy season. The result shows, the average value of the moving speed in the pastures of spring (rainy season) is  $2.81 \pm 1.64$  km / h, and the average value of the grazing speed is  $0.324 \pm 0.241$  km / h in same season. In addition, the average value of the moving speed in the pastures of the summer (dry season) is  $4.85 \pm 0.1278$  km / h, and the average value of the grazing speed is  $1.027 \pm 0.128$  km / h in dry season. More of the moving speed and deviation value of grazing speed Both the dry season, the variation is large, it can be seen that the movement speed is also nearly twice of the rainy season. However, 50% core area (MCP, Minimum Convex Polygon) of home range of grazing area in has been shown to be more of the rainy season, because we finding that in dry season the main food resources of camel is tree leaves and tree branches or shrubs. Recently, lot of studies shows indicated that continuous herbivory pressure has a positive effect on plant performance and biodiversity, known as “grazing optimization.” In this study, we established three sites of the different pasturage pressure and investigated relationship between pasturage pressure and the Simpson's Index of Diversity (D-value) based on field observations (measurements), GPS tracking and stocking of camels. We analytically examined a hypothesis of grazing optimization in which herbivory improves the photosynthetic ability of individual plants. We examined plant performance under various herbivory pressures and considered the evolution of plant phenology in response to a given herbivory pressure.

**Key Words:** Behavior pattern of camels, Camel Farm, grazing optimization theory, Kazakhstan, Satellite tracking of camels.

## 1. Introductions

In recent years the number of dromedaries in Kazakhstan has increased. Along with the dissolution of the Soviet Union in 1991, the Republic of Kazakhstan became independent, the great division of labor was abolished, food production was mainly due to consumption of its own people, breeding livestock production greatly exceeded demand, and the number of heads began to decline, reaching the smallest scale from 1999 to the 2000. Although there are differences depending on the type of livestock, the number of breeding heads is on a recovery trend, among which the rate of increase in the number of breeding cattle is remarkable. The reason for this is that as a national policy, fermented milk of camels (Shubat) is recommended as a healthy natural green food and preferential treatment such as subsidies. In addition, for famers, it is better to keep camels than breeding horses, sheep's, cattle and goats because it is more economical and profitable.

Camellia meat, hair, milk have been traditionally used in Kazakhstan since long ago. Shubat is preferred by a wide

range of age groups, and there are many news reports that it is healthier (FAO, 2011). For example, Mr. Otemis Ata's, the owner of the study target farm of this study, used to run a horse pasture in the past, but it has become unprofitable and can be profitable after conversion to a camel pasture. Furthermore, it is clear that camel is a highly valuable livestock in Kazakhstan (Kazakh dry steppe), as large-scale camel ranch breeding more than 3,000 camels in Almaty is on an increasing trend. Second, camels are known to have a high ability to adapt to climate change (Hoshino *et al.*, 2015).

The camel has palatability to a wide range of grasses such as grasses, woody plants, shrubs, trees, spinous trees within the range of several centimeters to several meters, all the plants in the desert to leaves, twigs and trunks are eaten at the same time, it is known as a domestic animal with "high adaptability to dry climate" because it has similar palatability and digestibility to dry grass and fresh grass regardless of dry and rainy seasons. Also, the camel has been known to be no damage to grasslands and soils, as the sole of the foot is softer and the stride is long than other livestock such as sheep, goat, and cow, horse, etc. (Gallacher *et al.*, 2006).

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Kazakhstan dry steppe is one of important pasture lands of breeding of dromedary camels. Kazakh dry steppe located in the middle of the three terrain categories of the Republic of Kazakhstan has a very dry weather from June to October, so it is more suitable for breeding of camels than other livestock, and large-scale camel ranch is being built one after another region (Hoshino *et al.*, 2015). In addition, in order to maintain the high productivity of the pasture and sustainable use at the same time, the local ranchers managers use the ranches properly according to the rainy season and the dry season and use it for livestock. However, reasonable explanation and scientific basis for this land use method have not yet been issued.

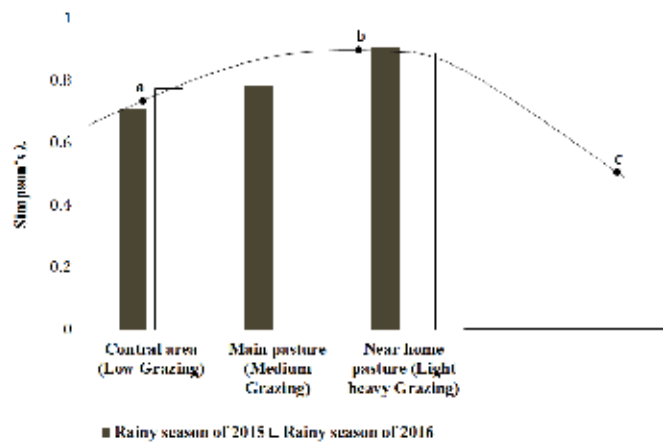
Based on the above, this study field investigated and satellite tracking and stalking of behavior pattern of dromedary in the rainy season and dry season, and measurements of vegetation coverage, vegetation phonology and plants species diversity.

**2. Methodology**

This study conducts GPS satellite tracking and stalking survey on behavior in dromedary farm, then identifies the predominant species of pastureland in the ranch and the palatable plants of the camel and compares the difference between the behavior pattern and the use of food resources of camels in rainy season and dry season. Recently, lot of studies shows indicated that continuous herbivory pressure has a positive effect on plant performance and biodiversity, known as “grazing optimization” (Milchunas *et al.*, 1998; Hayashi *et al.*, 2007; Hoshino *et al.*, 2008, Yong-Hai *et al.*, 2014). In this study, we established three sites of the different pasturage pressure and investigated relationship between grazing intensity and the Simpson’s Index of Diversity ( $\lambda$ -value) and Shannon’s H index based on field observations (vegetation survey), GPS tracking and stalking of camels. We analytically examined a hypothesis of grazing optimization in which herbivory improves the photosynthetic ability of individual plants. We examined plant performance under various herbivory pressures and considered the evolution of plant phenology in response to a given herbivory pressure.

**2.1. Grazing optimization theory**

The relationship between grasses and grazers is a complex one influenced by a number of biotic and abiotic factors. Some researchers and theorists have argued that grazing, on the whole, has a negative influence on plant biomass as a result of repeated defoliation. Advocates of the grazing optimization hypothesis have argued for the opposite. Providing there is an intervening period of growth, removal of vegetative tissues



**Fig. 1. Relationships between grazing pressure and species diversity showing the point (a) is in low grazing pressure area are response to compensatory growth model and in point (b) is medium grazing pressure area response to intermediate grazing optimization model and in point (c) is in heavy grazing pressure area are response to overgrazing model. Where, the bar graphics shows the plants species diversity index of Simpson’s  $\lambda$  of the control area, the pasture of the rainy season on the south side and the light-overgrazing side in near the owner’s house in rainy season during 2015 and 2016.**

to a certain proportion of their initial level is rarely translated into a commensurate proportional reduction in the final yield of those or other plant tissues. Plant responses to herbivory and defoliation are certainly species specific, as some species have developed stronger compensatory mechanisms in the face of constant evolutionary pressure. Additionally, plant responses may depend “on plant developmental stage at the time of defoliation” (McNaughton, 1983; Karban, 1989).

“Grazing Optimization theory” that as shown in **Figure 1**, since the point (a) is within the special protected area or inside of the fence, artificial disturbance cannot be seen, for that reason, some plants species grow first and use lot of spaces become dominant species, and other plants species become difficult to growing. So, the plant diversity at the point (a) was decreases. At point (c), overgrazing is caused by heavy grazing pressure, some species disappear due to the decrease of the whole biomass, and species diversity declines. Therefore, at point (b) of the optimum grazing point, with proper grazing pressure, expansion of dominant species is suppressed and high variety diversity is maintained. At this point plant species have higher adaptability to various climate conditions. In Fig, 1, the bar graphics shows the calculated plants species diversity index of Simpson’s  $\lambda$  of the control area, the pasture of the rainy season on the south side and the light-overgrazing side in near the owner’s house in rainy season during 2015 and 2016 from vegetation survey data. The diversity index was high near the house despite being in a mild overgrazing state. Near the house, the tramping of domestic animals is high, and the mother’s camel with a one year old child camel and the two year old camel often use the grassland near the house. But in

Fig. 1 we find in near house also it not overgrazing. Fig. 1 result shows the pasture land degenerates in overgrazing, but on the contrary, by receiving suitable grazing pressure, the diversity of species of plant community is preserved. The pasture land starts to decline when left untouched without grazing.

## 2.2. Diversity Indices

Biodiversity is one of the primary interests of ecologists, but quantifying the species diversity of ecological communities is complicated. In addition to issues of statistical sampling, the rather arbitrary nature of delineating an ecological community, and the difficulty of positively identifying all of the species present, species diversity itself has two separate components: (i) the number of species present (species richness), and (ii) their relative abundances (termed dominance or evenness) (Nagendra, 2002; Magurran, 2004). In this study, we evaluate grassland adaptability to various climate conditions based on Shannon's  $H'$  and Simpson's  $\lambda$  in study sites.

*Shannon index:* The idea behind this index is that the diversity of a community is similar to the amount of information in a code or message. It is calculated in the following way:

$$\text{Shannon's } H' \quad H' = \sum_{i=1}^s P_i \ln P_i \quad (1)$$

Where,  $p_i$  is the proportion of individuals found in species  $i$ . For a well-sampled community, we can estimate this proportion as  $p_i = n_i/N$ , where  $n_i$  is the number of individuals in species  $i$  and  $N$  is the total number of individuals in the community. Since by definition the  $p_i$ 's will all be between zero and one, the natural log makes all of the terms of the summation negative, which is why we take the inverse of the sum.

*Simpson's index:* Since evenness and dominance are simply two sides of the same coin, their measures are complimentary. Simpson's index is based on the probability of any two individuals drawn at random from an infinitely large community belonging to the same species:

$$\text{Simpson's } \lambda \quad \lambda = 1 - \sum_{i=1}^s (P_i)^2 \quad (2)$$

For example, with the case of plant communities A and B, the number of species of communities A and B is the same 5-species, and community A is evenly distributed, and the coverage per species was also 20%. However, in community B, some dominant species accounts for 85% of the whole community coverage. If so, the diversity index of Simpson's  $\lambda$  of community A is 0.80 and community B is only 0.34; in the same way, the diversity index of Shannon's  $H'$  of community

**Table 1. Comparison of palatability plant of the dry season and rainy season during 2014 -2015.**

Ranking	Rainy season	Dry season
1	<i>Taraxacum officinale</i>	<i>Agropyron desertorum</i>
2	<i>Agropyron desertorum</i>	<i>Phragmites communis</i>
3	<i>Malcolmia hispida</i>	<i>Eurotia ceratoides</i>
4	<i>Descurainia sophia</i>	<i>Alhagi pseudoalhagi</i>
5	<i>Petrosimonia sibirica</i>	<i>Zygophyllum fabago</i>

A is 1.61 and community B is only 0.76, It has been found that the diversity index doubles.

## 3. Results and Discussions

### 3.1. Seasonal change of palatable plants in camels

**Table 1** shows the priority of palatable plants that were fed by camels in the rainy season and dry season of 2014 and 2015 in study sites. As result shows, in the rainy season, *Taraxacum officinale* which was plentifully filled with water was most eaten by camels, and then many of *Agropyron desertorum* and *Malcolmia hispida* were eaten by camels. The rainy season (from March to May) is the season of camel's childbirth, and the female barracks that gave birth to children are rich in flowering nutrition and think that *Taraxacum officinale* species containing a lot of water is given the highest priority. *Agropyron desertorum* species is an artificial grass. This species is the most widely distributed in the pasture and it is a priority species of the community, therefore the camel randomly eats this grass well.

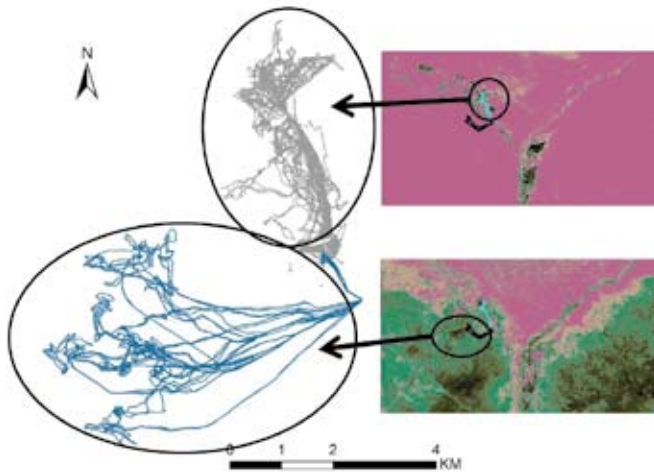
However, autumn (from August to October) is a dry season, plants that had been grown in spring in the same pasture land will end up growing and will die, so the plant community in the pasture will change. Especially *Taraxacum officinale* which flowers were blooming in spring cannot be seen in dry season. But, the *Agropyron desertorum* species of artificial grass that is widely distributed even at this season. *Agropyron desertorum* matured in this period and had a fruit, camels also eaten this species will. In the dry season camels next to eat are *Phragmites communis* of the *Poaceae* family. *Phragmites communis* was growing from spring to autumn and camels were eating when gathering at the waterside. In the dry season camels were also eaten by *Malcolmia hispida* (see Table 1).

### 3.2. Changes in behavior patterns of camels during rainy season and dry season

**Table 2** and **Figure 2** show the satellite tracking result of behavior pattern of camels in the spring pasture and summer pasture areas during rainy season and dry season of 2014 and 2015. In the rainy season, the mean value of the moving speed of the camel is  $2.81 \pm 1.64$  m/s, and the average value of

**Table 2. Comparison of Behavior pattern of dromedary with rainy season and dry season during 2014- 2015.**

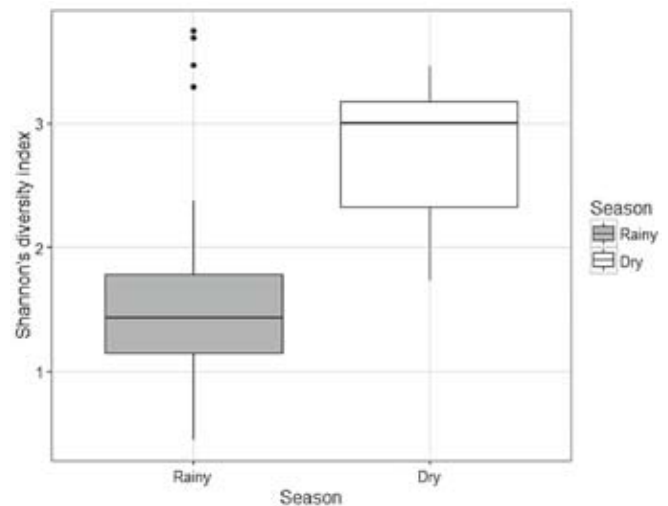
Items	DRY SEASON		RAINY SEASON		Welch's t-test			
	M	SD	M	SD	t	p	df	
AREA* 50% (km <sup>2</sup> )	10.096	7.603	14.958	4.994	3	0.004	53.7	***
AREA 95% (km <sup>2</sup> )	26.232	9.681	26.344	49.893	0.06	0.952	59.5	
LENGTH* (km)	19.099	1.327	21.052	5.131	2.01	0.025	51	*
SPEED* grazing (m/s)	1.027	0.128	0.324	0.241	14.99	2.20E-16	59.2	***
SPEED moving (m/s)	4.853	0.128	2.809	1.64	8.03	5.10E-10	42	***

**Fig. 2. Satellite tracking of behavior of dromedary camels in rainy season and dry season during 2014-2015.**

the grazing speed is  $0.324 \pm 0.241$  m/s. However, in the dry season, the mean value of the moving speed of the camel is  $4.85 \pm 0.1278$  m/s, and the average value of the grazing speed is  $1.027 \pm 0.128$ . The camel is more variable in the dry season than in the rainy season whether it is a moving speed or a feeding speed. Characteristically, it was found that the moving speed of the camel in the dry season is twice the rainy season. This suggested that food resources of camels are limited during the dry season.

**Figure 3** shows the calculation results of the Shannon's  $H'$  diversity index of plants community in rainy season and dry season during 2014 and 2015. Again this result was that plants in the dry season were more diverse than the rainy season. Because, in the rainy season, the dominant species of *Agropyron desertorum* are widely distributed and overwhelmingly distributed in all pasture. When we measure within one square meter of quadrats, the *Agropyron desertorum* grass appears more frequently wherever we measure. At the dry season, the *Agropyron desertorum* withered, instead wetland plants and shrubs such as *Phragmites communis*, *Alhagi pseudalhagi*, and *Zygophyllum fabago* are distributed more frequently, and the diversity index of the plant community is higher in the dry season than in the rainy season.

As shown in **Table 3**, it is a year of heavy rain in 2016, and despite the dry season, rain fell more than usual between June and August. The accumulated rainfall for January to

**Fig. 3. Comparison of the plant communities' diversity index of Shannon's index  $H'$  in rainy season and dry season in camel pasture.**

September in 2016 is 1.59 times the same period in 2015 and 90 mm more than the average rainfall over 1925-2005. The landscape of the pastureland has changed greatly due to heavy rain in 2016. In 2016 summer, Mr. Otemis Ata, pastor of our study site had planned different use of pastureland and different controlling his livestock's (see **Fig. 4**).

Many plants of perennial plants Poaceae and annual plants of Leguminosa are growing on the pastureland on the south side, and it was suitable for camel rainy season use. In addition, the pastureland on the north side is growing of lots of shrubs and trees. It is suitable for use in the dry season of camels. As can be seen in **Fig. 4**, the camels was using pasture on the north side in the dry season of 2015, but in 2016, camels used the same southern pasture as in the rainy season. However, in the dry season of 2016, camels used pasture past far from the rainy season of this year. The aim of the camel was salty plant of *Salsola pestifer* which grew in the rain that fell even in the dry season. In the field survey we were able to confirm that the camel loves *Salsola pestifer* and eating much more.

#### 4. Summary

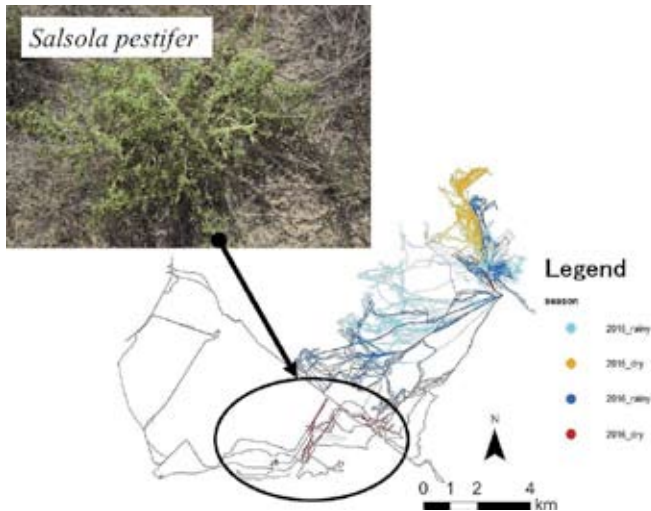
Recently, lot of studies shows indicated that continuous herbivory pressure has a positive effect on plant performance and biodiversity, known as "grazing optimization." In this



**Table 3. Monthly precipitation of Almaty station during 1925-2005.**

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2015	7.8	55.6	79.6	52.1	76.6	16.9	35.4	13.6	16.4	106.7	38.3	21.9	520.9
2016	24.2	38.5	45.4	109.4	164	55.2	66.5	42.3	17	—	—	—	—
Average*	28.6	34.48	65.85	96.66	99.16	57.63	37.52	26	26.36	52.04	50.83	35.65	610.78

(\* Average of 1925-2005)

**Fig. 4. Comparison of footprints of camels in spring (rainy season) and summer (dry season) based on GPS satellite tracking during 2015-2016.**

study, we established three sites of the different grazing intensity and investigated relationship between grazing intensity and the Simpson's Index of Diversity ( $\lambda$ -value) and Shannon's H index based on field observations (vegetation survey), GPS tracking and stalking of camels. We analytically examined a hypothesis of grazing optimization in which herbivory improves the photosynthetic ability of individual plants. We examined plant performance under various herbivory pressures and considered the evolution of plant phenology in response to a given herbivory pressure. We also analysis the behavior patterns and habitat use of dromedary camels, to clear the relationship between an increase in the camel farms and adaptation to various climate or climate change. The herdsman's is decision the pastureland use and control of livestock by year-to-year rainfall. They are also known how to control the different grazing lands by the dry season and the rainy season in the same year. Camel's behavioral pattern was different in the dry season and the rainy season. The result shows, the average value of the moving speed in the pastures of spring (rainy season) is  $2.81 \pm 1.64$  km / h, and the average value of the grazing speed is  $0.324 \pm 0.241$  km / h in same season. In addition, the average value of the moving speed in the pastures of the summer (dry season) is  $4.85 \pm 0.1278$  km / h, and the average value of the grazing speed is  $1.027 \pm 0.128$  km / h in dry season. More of the moving speed and deviation value of grazing speed Both the dry season, the variation is large, it can be seen that the

movement speed is also nearly twice of the rainy season. However, 50% core area (Minimum Convex Polygon, MCP) of home range of grazing area in has been shown to be more of the rainy season, because we finding that in dry season the main food resources of camels is tree leaves and tree branches or shrubs. The results shows the pasture land degenerates in overgrazing, but on the contrary, by receiving suitable grazing pressure, the diversity of species of plant community is preserved. The pasture land starts to decline when left untouched without grazing.

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