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Pasture and Weed Vegetation in Relation to Land Use and Nature Conservation in Northern Pakistan

Makoto Numata

Natural History Museum and Institute, Chiba
955–2 Aoba-cho, Chuo-ku, Chiba 260, Japan

Abstract The structure and dynamics of the pasture vegetation in rangelands and weed vegetation in croplands are surveyed, particularly in Northern Pakistan, in relation to the land use and nature conservation. Domestic animals' grazing and fuel tree collecting are now strictly prohibited, besides some common lands. The phytosociological data on various vegetations were collected in 1988 (Table 1–15), and 1990 (Table 16–37), and the comments for them were given. The characteristics of pastures and weed vegetations were expressed by SDR, SDR', DS, *l*, N, G, F, and Th (see text).

Key words: Degree of succession (DS), nature conservation, north Pakistan, pasture, weed vegetation.

Pakistan is a country far from Japan, and not familiar with us. From the viewpoint of tourists, they are reminded of world-famous Mohenjodaro (Fig. 1) as the relict of the Indus civilization, or Gandala arts shown in the Taxila Museum, or Islamabad as an artificial capital city. There are many historical places which are described in the guide books, and we feel the weight of long historical tradition when we visit decaying ruins and museums.

I visited Pakistan three times (August 1988, December 1989 and July 1990–Figs. 2, 3, Numata, 1989) for ecological studies on pasture vegetation in rangelands and weed vegetation in croplands, particularly in northern region. There is a related project of Man and the Biosphere (MAB) Project No. 3 "Impact of human activities and land use practices on grazing lands: savanna, grassland (from temperate to arid areas) and tundra." There are two reports: Green Report No. 6 (MAB/UNESCO, 1972) and No. 25 (MAB/UNESCO, 1974).

For my study, I was very much obliged by Dr. Noor Mohammad (Director, Range Management and Forestry, National Agricultural Research Center, Islamabad–Mohammad, 1989, Mohammad *et al.*, 1985, 1989, Pakistan Agricultural Research Council, 1989), Dr. A. R. Beg (Forest Botanist, Pakistan Forest Institute, Peshawar–Beg *et al.*, 1985, 1987) and Mr. M. Shabbir Baig (Deputy Director, Soil Survey of Pakistan, Lahore). For identification of plants, Dr. T. Ohba (Vice Director, Natural History Museum and Institute, Chiba) and Dr. A. R. Beg kindly helped me.

From scrubland to forest plantation

The areas of study in August, 1988 were the capital Islamabad, Murree which was a summer resort for the British people, 2,300 m in altitude, Taxila where the old relicts including those of 5 centuries B. C. preserved in the museum, Swat as the foreground of Hindukush and Karakolm, Peshawar close to the border of Afghanistan, and Karachi at the southern coast, and others. I observed the pastures in these areas, and measured some of them.

At first, we visited the C. D. A. (Capital Development Authority) to hear the city planning and its practice, and also we heard the experience of revegetation of 20 years ago by Prof. S. Tabata (the leader of the project "Ecological studies on the urbanization and open space in arid and semi-arid area of Panjab–Gilgit" (cf. Tabata, 1985). Both of them told me the vegetation of 20 years ago in the new capital Islamabad in contact with Rawalpindi was grasslands with scattered shrubs. This savanna-like vegetation seems to be the vegetation under semi-arid conditions. According to the climate table of Rawalpindi in "The Climate of Asia" (Hatakeyama, 1964), altitude, average tempera-

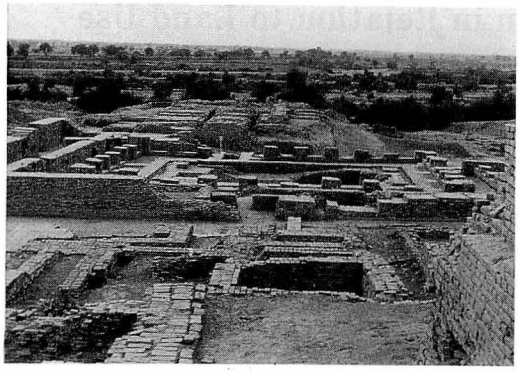

Fig. 1. The old building of Mohenjodaro made of sun-dried bricks has been to crumble.

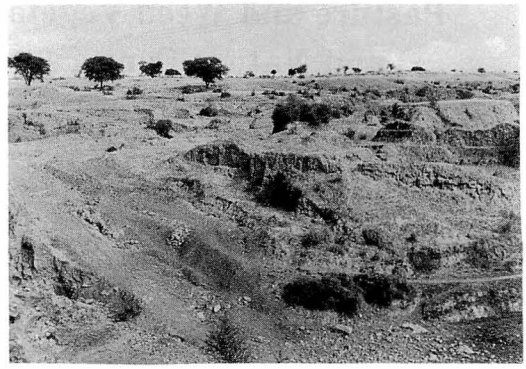

Fig. 3. Semi-arid region in northern Pakistan.

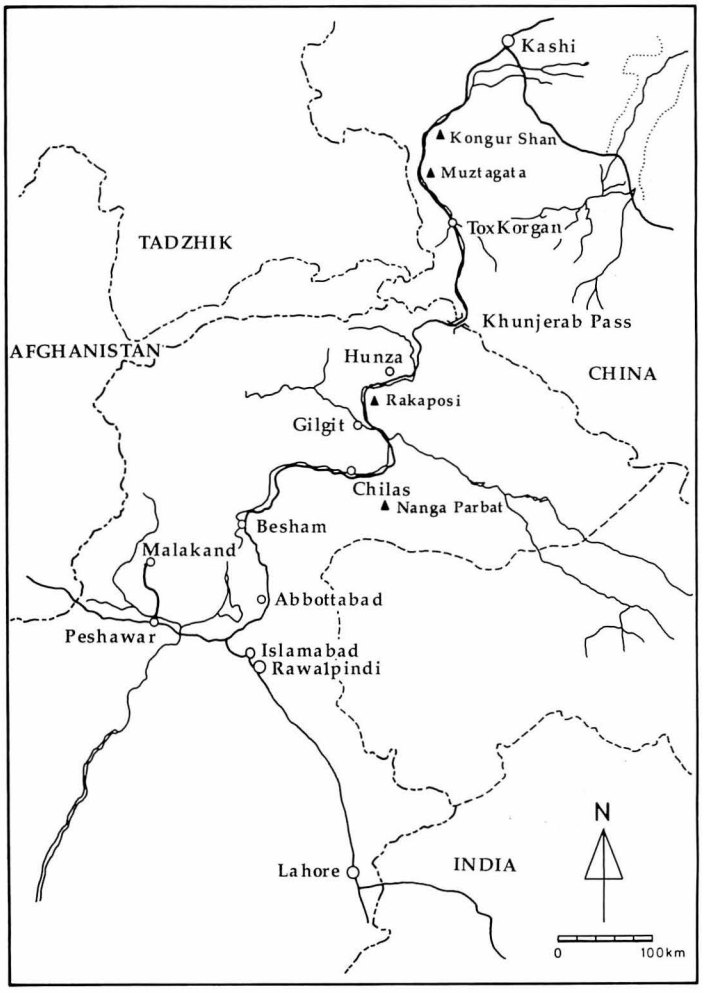

Fig. 2. The route map of ecological survey by the Chiba University team in northern Pakistan (1989).

ture, rainy days, relative humidity at 8:00 a.m. and annual precipitation are 511 m, 21.7°C, 50 days, 61%, and 925 mm which belong to the forest climate.

The C. D. A. explained that there was a strict reserve of protected forest in Islamabad (Fig. 4). Hearing that, I had doubt, because the natural stand there could be a savanna-like vegetation as mentioned above, and asked them that it was a natural forest or not. Then, they answered me that it was, of course, a plantation passing 20–25 years. To maintain this nature reserve, the C. D. A. inhibits private ownership of the forests, and it is protected as a national forest. I asked C. D. A. what is the meaning of "nature conservation"? He answered me that "the nature conservation" is "improving nature by hands". It is a curious definition of the nature conservation, however it is a perfect fit to the nature reserve in Islamabad, but it does not hold true sense in general.

When I asked someone why the former savanna has become a forest, he said that the trees grow, and/or the amount of precipitation has recently increased. We could not agree with these answers. The truth might be that sheep and goats grazed heavily, top buds and young shoots were eaten, and the physiognomy of the vegetation became savanna-like. Particularly, the sheep eats the top of young trees, therefore the influence of grazing seems to be fatal. Moreover, people cut many trees for fuel. For that, animal grazing and fuel collecting are now strictly prohibited. In the case of grazing of cattle, horse and buffalo, the grazing land is regulated, and their grazing is limited to the public land particularly along the railroad tracks. Only such places are allowed for animal grazing.

We saw planting places where each person is responsible for ten places to irrigate two times in the morning and the evening. Though the annual precipitation is 925 mm, it is generally little except for July (205 mm) and August (233 mm) in the rainy season. 15 mm in October and 7 mm in November are really those of the desert climate and irrigation is necessary for growth of saplings. When they grow to trees and forests irrigation is not necessary. Until now the saplings of 20 million trees in the nurseries have been planted, and the survival ratio is said to be 75%.

For the protected forests mentioned above, indigenous species have been used, and exotic tree species have never been used. Cutting of undergrowth has been implemented. Herbicide has never been used, and only hand pulling is used for weeding. Animal grazing is not allowed. These are the main principles for forest management, and then the former savanna-like vegetation has been restored as one type of forest in Islamabad.

This forest is quite different from the so-called forest reserves, however we can understand their intention to create a green space in a city planning under condition of seasonal drought, fuel collecting and animal grazing.

Still now, the smoke is emitted from the chimneys to bake the bricks (Fig. 5). For this purpose, the timber is much used and it might

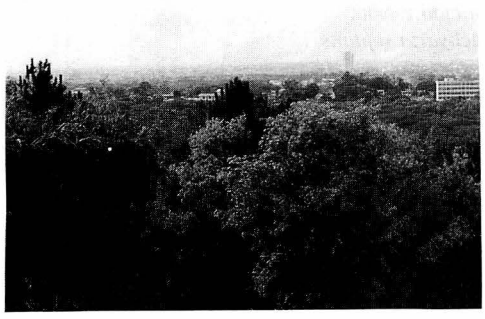

Fig. 4. Transplanted various trees have made a natural-like forest in Islamabad.

Fig. 5. We can find brickyards like this. To bake bricks much wood fuel is used.

have resulted in forest destruction.

Someone says that the amount of precipitation is increasing recently and even in Karachi, we don't have an extremely hot climate. However, support by the actual data is not sufficient. In 1988, the abnormal weather was widely experienced in Japan (too much rain), Europe (cold summer), North America (drought) as well as in Pakistan. The amount of precipitation in Karachi was less than 200 mm and the temperature in June reached 50°C which is pure desert climate, but we experienced a shower during our stay in August. It was said that they did not experienced much rain this year for the past two years.

Nature conservation and its basic surveys

The survey of biota and its conservation is conducted by the Zoological Survey and the Forest Agency of the Government, and "Pakistan Forests, Rangelands and Wildlife" and "The Wild Animals in Pakistan" were published as a form of maps (Government of Pakistan, 1988, Zoological Survey Department, Government of Pakistan, 1988). According to these, 8 national parks, 70 wildlife sanctuaries, 9 wetland reserves, and the distribution of important species of mammals and birds were indicated. Beside these, there are "The Nature of Pakistan—A Guide to The Nature Conservation and Development, No. 1" (Government of Pakistan, 1986) and "Pakistan Foundation for Protection of Animals" (Pakistan Wildlife Conservation Foundation, 1986). A report "The Ecological Basis of Land Use Planning and Resource Management—Agroecological Land Classification" (1988) was published by the cooperation of National Agricultural Research Center, Islamabad, Forest Research Institute, Peshawal and Soil Survey, Lahore. It is also included into Pakistan National Conservation Strategy (1990).

According to Sardar (1989), the major land uses in Pakistan are agriculture, forest and livestock grazing. Out of the total area of Pakistan, 36% are cultivable, 5% are covered by forests, and about 59% are for use of livestock grazing. Rangeland areas are partly controlled by the Forest Department, and mostly collectively owned (common lands), and partly individually owned. The common lands known as "Shamilats" are jointly owned by village or community and are accessible to every one in the community whether he owns or not. Rangelands are heavily grazed and in most cases are abused. They suffer from continuous erosion and desertification. These rangelands provide about 60% of total requirement of feed for sheep and goats, 40% of horses, donkeys and camels, and 5% of cattle and buffaloes. Due to overgrazing and misuse in the past and low technical input, these rangelands are producing only 10–50% of their potential. Therefore, it is paramount importance to develop techniques for range rehabilitation and improvement.

Data on pastures and weed vegetation in northern Pakistan

In this paper, a part of my data is shown as the Tables 1–14 (additional data; Tables 16–37, the summarized Tables 15 and 38). In the Table, the constituent species are listed with SDR (the summed dominance ratio=the relative importance based on height and cover) and l (life span=year). See "Ecology of Grass-

Table 1. Islamabad–Taxila, near a mining place of marble, *Eucalyptus* trees with agaves being planted, buffaloes and milk cows were grazing, vegetation cover=85% (17 August, 1988).

Species	SDR	l
Pennisetum antidotale	100	10
Bothriochloa pertusa	57	10
Fimbristylis sp.	51	10
Dalbergia sisso	51	100
Chrysopogon sp.	50	10
Cynodon dactylon	50	10
Panicum repens	44	10
Brachyaria reptans	44	10
Scirpus sp.	31	10
Lantana sp.	25	10
Rhynchosia minima	19	10
Boerhavia diffusa	19	10
Polygara sp.	14	10
Boraginaceae sp.	13	10
Tribulus terrestris	12	1
Euphorbia chamaecyce	12	1
Rubiaceae sp.	8	10

N (number of species)=17, DS (degree of succession) = 610 × 0.85 = 518.5, G (graminoids) = 47.1, L (legminosae)=11.8, F (forbs)=41.1, l=life span.

Table 2. Taxila, common land near the railway, buffaloes and goats were grazing, vegetation cover=80%.

Species	SDR	*l*
Cynodon dactylon	80	10
Echinochloa colonum	59	1
Brachyaria reptans	36	10
Digitaria ischaemum	36	1
Euphorbia chamaecyce	21	1
Labiatae sp.	21	10
Verbascum sp.	21	10

N = 7, DS = 242.3 × 0.8 = 193.8, G = 57.1, L = 0, Th (annual plant) = 28.6, F = 42.8.

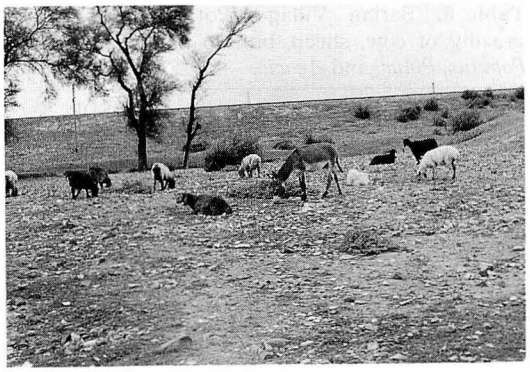

Fig. 6. Along the Indus River, there is a common land for domestic animals' grazing.

Table 3. NARC Project Area (1100 acres) in the suburb of Islamabad, overgrazed and eroded land (private land and common land), two season grazing (spring; February–April, and monsoon season; July–October), 60 Sheep were there, vegetation cover=60%.

Species	SDR	*l*
Dicanthium annulatum	79	10
Cynodon dactylon	60	10
Ziziphus nummularis	51	50
Imperata cylindrica	46	10
Panicum repens	44	10
Acacia modesta	41	10
Acacia nilotica	41	10
Saccharum munja	36	10
Pennisetum antidotale	36	10
Eragrostis sp.	32	10
Cenchrus cilialis	32	10
Panicum ontidokale	31	10
Desmostachya bipinnata	31	10
Bothriochloa pertusa	31	10
Solanum xanthocarpum	26	10
Aristida adscencionis	26	10
Cyperus laevigatus	26	10
Calotropis procera	21	10
Capparis aphylla	21	10
Eleusine indica	17	10
Centrosema pubescens	16	10
Rhynchosia minima	16	10
Chloris barbata	16	10
Tragus berteronianus	14	10
Boerhavia diffusa	14	10
Cyperus laevigatus	14	10
Phaseolus sp.	11	10
Euphorbia chamaecyce	6	1

N=28, DS=460.9×0.6=276.5, G=60.7, L=17.9 F=21.4, Th=3.6.

Table 4. Bhrakha Village near Simli Dam between Islamabad and Murree, buffaloes grazing, vegetation cover=90%, 1200 m in alt.

Species	SDR	*l*
Echinochloa colonum	84	10
Digitaria ischaemum	60	1
Brachyaria reptans	40	10
Fimbristylis dichotoma	37	10
Paspalidium flavidum	36	10
Cynodon dactylon	35	10
Cyperus iria	28	1
Cyperus compressus	28	1
Citrulus vulgaris	26	10
Amaranthus spinosus	26	1
Xanthium sp.	26	1
Erigeron floribundus	26	1

N=12, DS=231.2×0.9=208.1, G=66.7, L=0 Th=50, F=33.3.

Table 5. Weed community in maize field, between Islamabad and Murree, vegetation cover=80%, the height of maize=1.5 m, 1600 m in alt.

Species	SDR	SDR′	*l*
Pennisetum purpureum	100	—	10
Trifolium repens	49	88	10
Artemisia sp.	39	71	10
Lepidium virginicum	31	60	10
Oenothera rosea	29	54	10
Sinapis arvensis	21	39	1
Veronica sp.	15	27	10
Torilis sp.	15	27	10
Galinsoga parviflora	15	27	1

N=9, DS=370.7×0.8=296.6, G=11.1, L=11.1 Th=33.3, F=77.8.

Table 6. Barian Village (Potwar) near Murree, grazing of cow, sheep, buffalo under the forest of *Populus*, *Pinus*, and *Acacia*.

Species	SDR	*l*
Pennisetum purpureum	100	10
Andropogon sp.	90	10
Cynodon dactylon	75	10
Erigeron annuus	52	1
Amaranthus cruenthus	44	1
Oenothera rosea	44	10
Plantago lanceolata	37	10
Medicago lupulina	35	1
Galinsoga parviflora	31	1
Rumex sp.	29	10
Indigofera sp.	29	10
Bupleurum sp.	29	10
Geranium sp.	21	10
Peristrophe sp.	21	10
Galium sp.	21	10

N=15, DS=322, G=20, L=13.3, F=66.7, Th=33.3.

Table 7. A pasture of hilly sheep near Murree, vegetation cover=100%.

Species	SDR	*l*
Themeda triandra	100	10
Andropogon sp.	85	10
Galium sp.	48	10
Carex sp.	44	10
Oenothera rosea	39	10
Astragalus sp.	34	10
Lespedeza variegata	34	10
Gramineae sp.	34	10
Bupleurum sp.	23	10
Taraxacum officinale	21	10
Achillea millefolium	13	10

N=11, DS=431.8, G=36.4, L=18.2, F=45.5, Th=0.

Table 8. A pasture of cow near Peshawar, grazing period: March–September, 19 August, 1988, vegetation cover=100%.

Species	SDR	*l*
Themeda triandra	67	10
Cynodon dactylon	59	10
Andropogon sp.	54	10
Zizyphus mauritiana	51	50
Echinochloa colonum	48	1
Digitaria ischaemum	48	1
Verbena officinalis	42	1
Dactylostenium aegyptium	42	1
Erigeron canadenis	40	1
Pennisetum setaceum	36	10
Desmodium triflorum	29	10
Lespedeza sp.	29	10
Verbascum sp.	26	1
Leguminosae sp.	26	10
Rhynchosia sp.	23	10
Phaseolus sp.	23	10
Cyperus sp.	23	10
Xanthium sp.	20	1
Fimbristylis dichotoma	20	10
Euphorbia chamaecyce	17	10
Boraginaceae sp.	14	10

N=22, DS=239.4, G=40.9, L=22.7, Th=31.8, F=36.4.

Table 9. Takhatii-Bahi town near Malakand pass, cow grazing, patchy vegetation 50%.

Species	SDR	*l*
Cynodon dactylon	75	10
Aristida adscensionis	75	10
Eragrostis sp.	63	10
Cymbopogon jawarancusa	57	10
Boerhavia diffusa	57	10
Chrysopogon montanus	57	10
Chloris sp.	38	10
Panicum repens	38	10
Heliotropium sp.	26	10
Rubiaceae sp.	26	10
Verbena officinalis	26	10
Euphorbia chamaecyce	20	10
Solanum gracilipes	19	10
Erigeron canadensis	4	1

N = 15, DS = 393.5 × 0.5 = 196.8, G = 46.7, L = 0 F = 53.3, Th=6.7.

Table 10. A waterlogged rangeland along the Kabul River at Pashangari, Peshawar, vegetation cover=50%.

Species	SDR	*l*
Saccharum spontaneum	74	10
Tamarix articulata	53	50
Polygonum sp.	51	10
Phragmites communis	41	10
Trifolium repens	35	10
Echinochloa colonum	25	1
Timeroya sp.	25	10

N = 7, DS = 705 × 0.5 = 352.5, G = 28.5, L = 28.5 F = 42.8, Th = 14.2.
There are *Populus euphratica*, *Prosopis cineraria*, *Salvadera oleoides*, and *Acacia milotica* around the rangeland as trees.

Table 11. A waterlogged rangeland sometimes dried along the flood plain (Table 10), silty soil, vegetaition cover=80%.

Species	SDR	*l*
Saccharum bengalense	69	10
Tamarix divica	69	50
Cynodon dactylon	54	10
Typha angusta	48	10
Lippia nudiflora	21	10
Cyperus sp.	13	10
Melilotus parviflora	12	10
Launaea nudicolis	12	10
Medicago sp.	12	10
Boreria manirai	12	10
Vicia sp.	8	1

N = 11, DS = 544.4 × 0.8 = 435.5, G = 27.3, L = 36.4, Th = 9.0, F = 36.4.

Table 12. A rangeland at Kairabad along the Kabul River near the Attock Bridge, vegetation cover=30%, rocky place.

Species	SDR	*l*
Imperata cylindrica	55	10
Dalbergia sisso	51	50
Vitex negundo	51	50
Desmostachya bipinnata	36	10
Alhagi kamelum	36	10

Partly silty, brown-colored soil under waterlogging. N = 5, DS = 1274 × 0.3 = 461.3, G = 20, L = 0, F = 80, Th = 0.

Table 13. Dry pool pasture, periodically waterlogged, vegetation cover=90%, *Sporobolus marginetus* is an indicator of salinity, saline silty loam.

Species	SDR	*l*
Cynodon dactylon	55	10
Desmostachya bipinnata	55	10
Alhagi kamelum	51	10
Scirpus sp.	51	10
Launaea nudicauli	16	10
Cyperus rotundus	15	10
Sporobolus marginetus	12	10

N=7, DS=364.3×0.9=327.9, G=71.3, L=0, Th=0, F=28.6.

Table 14. Margalla National Park, Islamabad. Formally overgrazed area under protection is partly a tallgrass type vegetation. Vegetation cover=60%.

Species	SDR	*l*
Themeda anatra	82	10
Heteropogon contortus	82	10
Chrysopogon montanus	82	10
Apluda mutica	56	10
Dichanthium annulatum	52	1

N=5, DS=614.4×0.6=368.6, G=100, F=0, L=0
Trees are *Acacia modesta*, *Zizyphus mauritiana*, *Cassia fistura*, *Olea ferruginea*, *Pinus roxburgii*, and others.

Table 15. The summarized data of 14 tables. V is vegetation cover (%).

Table	N	DS	G	L	Th	F	V
1	17	518.5	47.1	11.8	11.8	41.1	85
2	7	193.8	57.1	0	28.6	42.8	80
3	28	276.5	60.7	17.9	3.6	21.4	60
4	12	208.1	66.7	0	50.0	33.3	90
5	9	196.6	11.1	11.1	33.3	77.8	80
6	15	322.0	20.0	13.3	33.3	66.7	100
7	11	431.8	36.4	18.2	0	45.5	100
8	22	239.4	40.9	22.7	31.8	36.4	100
9	15	196.8	46.7	0	6.7	53.3	50
10	7	352.5	28.5	28.5	14.2	42.8	50
11	11	435.5	27.3	36.4	9.0	36.4	80
12	5	461.3	20.0	0	0	80.0	30
13	7	327.9	71.3	0	0	28.6	90
14	5	368.6	100.0	0	20.0	0	60

N = number of species, DS = degree of succession, G=graminoids(%) L=legumes(%), Th=annuals(%), F=forbs(%).

lands and Bamboolands in the World" edited by M. Numata (1979), regarding the concepts and methods in grassland ecology.

Comments for Tables 1–14

The degree of succession (DS) covers the range of 200–500 which coincides with the range of the representative pasture vegetation in Japan dominated by *Zoysia japonica* (Numata, 1969, 1979). DS of some pastures is small as in Table 9. The original DS of Table 9 is 394, however the vegetation cover is small, therefore the actual DS is 197.

The quality of pastures is shown by the percentages of graminoids (G) and legumes (L). They have the opposite tendency of the percentage of forbs (F). The percentage of annuals (Th) is higher in weedy vegetation as in Table 5. Table 14 is a special case with G=100 and F=0. This shows a type of rehabilitation of grassland.

Additional data in 1990

The additional data in 1990 are on pastures (Tables 16, 19, 20, 28, 29, 31, 35, 36, 37) and weed vegetation (Tables 17, 18, 21, 22, 23, 24, 25, 26, 27, 30, 32, 33, 34). The crops in the fields I studied were maize, sugar cane, melon, tobacco, okra, onion, red pepper and potato. The

Table 16. A pasture vegetation at Nowshera along the Kabul River, 440 m in alt., vegetation cover = 60%, grazed by 30 sheep and 1 donkey. July 12, 1990.

Species	SDR	*l*
Cynodon dactylon	57	10
Prosopis grandulosa	53	10
Acacia modesta	37	10
Dalbergia sisso	36	100
Zizyphus nummularis	28	50
Boerhavia diffusa	22	10
Portulaca orelacea	18	1
Solanum xanthocarpum	18	10
Brachyaria reptans	16	1
Koeleria sp.	16	1
Mimosa ideae	15	10
Poa sp.	10	10
Amaranthus spinosus	8	1
Euphorbia chamaecyce	7	1
Talinum sp.	4	1

N=15, G=33, L=13, F=53, Th=40, DS=288 (479×0.6).

Table 17. Weeds in a maize field, dried clayey soil, maize seedlings two weeks after sowing, vegetation cover=60%.

Species	SDR	SDR′	*l*
Maize	100	—	1
Cyperus rotundus	56	67	10
Cynodon dactylon	44	75	10
Trianthema polysperma	44	44	1

N=4, G=75, L=0, F=25, Th=50, DS=286×0.6=172.
N=3, G=67, L=0, F=33, Th=33, DS=348×0.6=209.

Table 18. Weeds in a maize field two months after sowing, vegetation cover=70%.

Species	SDR	*l*
Cynodon dactylon	71	10
Desmostachya bipinnata	63	10
Cyperus rotundus	58	10
Convolvulus arvensis	46	10
Echinochloa colonum	45	1
Trianthema polysperma	29	1

N=6, G=67, L=0, F=33, Th=33, DS=409×0.7=286.

Table 19. A pasture along Charsado Road, Peshawar, grazed by 80 buffaloes and 20 cows in the 20 ha area, vegetation cover=60%.

Species	SDR	*l*
Agrostis canina	90	10
Cynodon dactylon	81	10
Eragrostis sp.	60	10

N=3, G=100, L=0, F=0, Th=0, DS=770×0.6=462.

Table 20. A pasture with big plum trees, 10 horses and 5 sheep grazing, vegetation cover=100%.

Species	SDR	*l*
Echinochloa colonum	88	1
Cynodon dactylon	79	10
Brachyaria reptans	69	10
Cannavis sativa	57	1
Cyperus rotundus	48	10
Chenopodium album	42	1
Erigeron canadensis	33	1
Oxalis corniculata	16	10

N=8, G=50, L=0, F=50, Th=50, DS=187.

Table 21. Weeds in a maize field, vegetation cover=100%, Peshawar, July 13, 1990.

Species	SDR	SDR′	*l*
Maize	100	—	1
Echinochloa colonum	56	92	1
Brachyaria reptans	51	48	1
Cyperus longus	30	70	10
Eclipta prostrata	8	18	1

N=5, G=80, L=0, F=20, Th=80, DS=103.
N=4, G=75, L=0, F=25, Th=75, DS=215.

Table 22. Weeds in a sugar cane field, humid black soil, 490 m in alt., weed vegetation cover=15%, Shakadarmor, July 14, 1990.

Species	SDR	SDR′	*l*
Sugar cane	100	—	10
Erigeron canadensis	28	16	1
Cyperus rotundus	27	32	10
Cynodon dactylon	22	65	10
Chondrilla sp.	20	41	10
Lippia nodiflora	11	16	10
Centaurium sp.	10	21	1
Mimosa sp.	8	16	10
Compositae sp.	8	16	10
Euphorbia chamaecyce	8	16	1
Ipomoea sp.	8	16	10
Calystegia sepium	8	16	10

N = 12, G = 17, L = 8, F = 75, Th = 25, DS = 181 × 0.15=27.
N = 11, G = 18, L = 9, F = 73, Th = 27, DS = 203 × 0.15=30.

Table 23. Weeds in a melon field, Rajal town near Takhatii Bahi, dried silty loam, vegetation cover=80%.

Species	SDR	SDR′	*l*
Melon	67	—	1
Dalbergia sisso	51	51	100
Cynodon dactylon	49	67	10
Thesium sp.	42	43	10
Verbena officinalis	42	43	10
Erigeron canadensis	42	43	1
Echinochloa colonum	37	39	1
Chrozophora verbascifolia	33	42	1
Cyperus rotundus	23	27	10
Amaranthus viridis	17	18	1

N=10, G=30, L=0, F=70, Th=50, DS=227×0.8=182.
N=9, G=33, L=0, F=67, Th=44, DS=272×0.8=218.

Table 24. Weeds in a sugar cane field, vegetation cover=100%, Rajal town.

Species	SDR	SDR′	*l*
Sugar cane	100	—	10
Echinochloa colonum	32	84	1
Cynodon dactylon	30	85	10
Cyperus rotundus	19	57	10
Brachyaria reptans	16	47	1
Trianthema polysperma	11	34	1
Chenopodium album	11	34	1
Verbena officinalis	8	26	10
Euphorbia chamaecyce	7	21	1

N=9, G=44, L=0, F=56, Th=56, DS=243.
N=8, G=50, L=0, F=50, Th=63, DS=171.

Table 25. Weeds in a tobacco field, Rajal town, vegetation cover=70%, distance of tobacco plants =130 cm.

Species	SDR	SDR′	*l*
Tobacco	100	—	1
Vigna aconitifolia	27	100	10
Desmostachya bipinnata	27	60	10
Echinochloa colonum	24	90	1
Brachyaria reptans	24	50	1
Leptochloa panicea	22	75	1
Chenopodium album	15	35	1
Trianthema polysperma	14	50	1
Polygonum convolvulus	12	45	10

N=9, G=44, L=11, Th=67, f=45, DS=95×0.7=67.
N=8, G=50, L=13, Th=63, F=37, DS=278×0.7=194.

Table 26. Weeds in an okra field, Takhatii Bahi, vegetation cover=100%.

Species	SDR	SDR′	*l*
Okra	100	—	1
Festuca sp.	16	100	10
Brachyaria reptans	11	63	1
Crotalaria sp.	8	50	1
Leptochloa panicea	8	50	1
Portulaca oleracea	6	28	1

N=6, G=50, L=17, F=33, Th=83, DS=47.
N=5, G=60, L=20, F=20, Th=80, DS=59.

Table 27. Weeds in a maize field at Chilas, 1100 m in alt., July 16, 1990.

Species	SDR	SDR′	*l*
Maize	75	—	1
Erigeron canadensis	51	52	1
Cynodon dactylon	45	75	10
Polygonum hydropiper	39	40	1
Polygonum mite	26	28	1
Cleome gynandra	26	28	1
Oxalis corniculatus	10	11	10

N=7, G=29, L=0, F=71, Th=71, DS=110×0.9=99.
N=6, G=33, L=0, F=67, Th=67, DS=168×0.9=151.

Table 28. A small pasture for cows at the confluence of the Indus River and Gilgit River, vegetation cover=80%.

Species	SDR	*l*
Cynodon dactylon	70	10
Medicago sativa	52	10
Artemisia scoparia	51	10
Bothriochloa ischaemum	46	10
Heliotropium sp.	41	10
Setaria viridis	37	1
Eragrostis maderasperata	31	10
Solanum sp.	31	10
Tribulus terrestris	31	10
Brachyaria reptans	21	1
Gramineae sp.	16	10
Amaranthus viridis	11	1

N=12, G=50, L=8, F=42, Th=33, DS=230×0.8=184.

Table 29. A pasture for cows on the wetland, vegetation cover = 80%, Sukuwar village near Gilgit.

Species	SDR	*l*
Eragrostis pilosa	90	1
Medicago sativa	85	10
Bothriochloa ischaemum	75	10
Digitaria ischaemum	70	1
Artemisia scoparia	65	10
Setaria viridis	45	1
Brachyaria reptans	40	1
Vinutoxicum sp.	33	10
Heliotropium sp.	23	10

N = 10, G = 50, L = 10, F = 40, Th = 40, DS = 306 × 0.8=244.

Table 30. A maize field near Gilgit-Bazar, vegetation cover=100%, July 17, 1990.

Species	SDR	SDR′	*l*
Maize	100	—	1
Trifolium sp.	72	26	10
Cynodon dactylon	38	63	10
Plantago major	36	52	10
Cyperus rotundus	32	67	10
Vigna radiata	26	52	10
Amaranthus viridis	20	39	1
Portulaca orelacea	19	42	1

N=8, G=38, L=25, F=32, Th=38, DS=272.
N=7, G=29, L=14, F=57, Th=29, DS=383.

Table 31. A pasture for cows, Jutal Village at the confluence of Hunza River and Gilgit River, vegetation cover=100%, 1300 m in alt., July 18, 1990.

Species	SDR	*l*
Imperata cylindrica	72	10
Saccharum ravennae	59	10
Cynodon dactylon	48	10
Agrostis canina	43	10
Calamagrostis epigeios	43	10
Poa alpigena	37	10
Cichorium sp.	36	10
Artemisia absinthium	33	10
Rumex scutatus	33	10
Medicago sativa	26	10
Mentha sp.	23	10
Eragrostis pilosa	19	1
Plantago lanceolata	18	10
Sonchus sp.	16	10
Oxalis corniculata	8	10

N=15, G=47, L=7, F=46, Th=7, DS=267.

Table 32. Weeds in a maize field at Hassanabad near Hunza, 2400 m in alt., clayey soil, vegetation cover=80%.

Species	SDR	SDR′	*l*
Maize	63	—	1
Medicago sativa	90	100	10
Trifolium repens	65	75	10
Agrostis canina	65	39	10
Erigeron canadenis	51	51	1
Prunus sp.	51	51	50
Plantago depressa	26	26	10
Gramineae sp.	26	26	10
Equisetum sp.	26	26	10
Umbelliferae sp.	26	26	10
Taraxacum sp.	20	20	10

N = 11, G = 27, L = 18, F = 55, Th = 18, DS = 549 × 0.8=439.
N = 10, G = 20, L = 20, F = 60, Th = 10, DS = 598 × 0.8=478.

Table 33. Weeds in an onion field at Hassanabad, vegetation cover=80%.

Spcies	SDR	SDR′	*l*
Onion	100	—	1
Medicago sativa	32	84	10
Brachyaria reptans	32	83	1
Lepidium sp.	31	53	1
Polygonum arenastrum	26	44	1
Lactuca sp.	21	36	10
Chenopodium album	21	36	1
Plantago depressa	16	28	10
Gramineae sp.	11	19	10
Artemisia sp.	11	19	10
Solanum sp.	11	19	10

N=11, G=9, L=9, F=82, Th=45, DS=112×0.8=90.
N=10, G=10, L=10, F=80, Th=40, DS=227×0.8=182.

Table 34. Weeds in a potato field at Hassanabad, vegetation cover=90%.

Species	SDR	SDR′	*l*
Potato	100	—	10
Poa pratensis	57	100	10
Poa alpigena	37	75	10
Taraxacum sp.	31	40	10
Setaria viridis	28	50	1
Polygonum aviculare	21	28	1
Trifolium repens	16	32	10
Chenopodium album	16	22	1
Brassica campestris ssp. *napus*	16	22	1
Cannavis sativa	16	22	1
Plantago depressa	11	10	10

N=11, G=27, L=9, F=63, Th=45, DS=238×0.9=214.
N=10, G=30, L=10, F=60, Th=50, DS=271×0.9=244.

Table 35. A pasture with aplicot trees, Gulmit, vegetation cover = 100%, 2100 m in alt., July 19, 1990.

Species	SDR	*l*
Digitaria ischaemum	69	1
Avena barbata	51	1
Galinsoga parviflora	41	1
Chenopodium album	40	1
Setaria pallidefusca	40	1
Setaria viridis	40	1
Erigeron canadensis	38	1
Artemisia scoparia	36	10
Triticum aestivum	34	10
Convolvulus scammonia	32	10
Trifolium repens	28	10
Artemisia absinthium	26	10
Taraxacum officinale	26	10
Medicago sativa	22	10
Amaranthus viridis	20	1

N=15, G=33, L=13, F=54, Th=53, DS=159.

Table 36. A pasture for cows, Thakot along the Indus River, 700 m in alt., vegetation cover=70%, sandy soil, July 21, 1990.

Species	SDR	*l*
Tragus racemosus	69	10
Artemisia scoparia	52	10
Cannavis sativa	52	1
Eragrostis maderaspatana	46	10
Lespedeza variegata	40	10
Chrozophora verbascifolia	40	1
Adianthum sp.	29	10
Desmodium sp.	28	10
Labiatae sp.	21	10
Heliotropium sp.	21	10
Fimbristylis dichotoma	21	10
Cyperus sp.	14	10
Gramineae sp.	14	10
Oxalis corniculata	14	10

N=14, G=36, L=7, F=57, Th=14, DS=270×0.7=189.

pasture types almost belong to the *Cynodon dactylon–Imperata cylindrica* belt in Eastern Nepal (Numata, 1965). In the summarized table (Table 38), the characteristics of weed vegetation are shown in the cases including and excluding the crop, such as N=9, G=44, L=0, F=56, Th=56, DS=243, and N=8, G=50, L=0, F=50, Th=63, DS=171 in Table 24.

The comments for the data from Tables 16–37 surveyed in July, 1990

The data of N, G, L, F and Th are comparable to those from Table 1 to Table 14. DS (the degree of succession) was calculated in two cases including a crop (DS) and not (DS') in Table 17, 21, 22, 23, 24, 25, 26, 27, 30, 32, 33, and 34. For example, DS of weed vegetation in Table 17 is 172 (286) including a crop and 209 (348) not including a crop. In the former example, 286 is DS based on SDR including maize and 172 is based on SDR of only weed vegetation excluding maize. I tried the comparison of

Table 37. A pasture at Khanpur for cows, buffaloes, horses, and sheep, 15 ha with big shade tree of *Ficus religiosa*, vegetation cover = 90%, July 21, 1990.

Species	SDR	*l*
Cynodon dactylon	81	10
Echinochloa colonum	63	1
Boerhavia diffusa	57	10
Brachyaria reptans	38	1
Malvastrum colomandelianum	32	10
Cyperus rotundus	26	10
Tragus racemosus	19	10
Amaranthus viridis	19	1
Euphorbia chamaecyce	13	1
Polygonum sp.	8	1
Euphorbia sp.	8	1

N=11, G=46, L=0, F=54, Th=55, DS=209×0.9=188.

DS and DS' in croplands of Eastern Nepal (Numata, 1965). Similar cases are included from Table 1 to Table 14. The cases in Tables 16, 18, 19, 20, 28, 29, 31, 35, 36, and 37 showed the calculation of DS for pastures.

Considerations for Fig. 7 on the characteristics of pastures and Fig. 8 on the characteristics of weed communities

Here, the histograms of the number of species, degree of succession and G+L (%) were mainly considered on pastures in Northern Pakistan (Fig. 7). It is comparable to the data on the conditions of semi-natural pastures from 380 m to 2860 m in Eastern Nepal (Numata, 1983, 1986). There, the number of species is 6–22, DS is 89–424 and forage % (summed total of SDR of grazed species/summed total of SDR of constituent species)×100 is 5.3–66.9. Comparing DS—Frequency histogram of Eastern Nepal (Fig. 9) with DS—No. of Stands histogram (Fig. 7), the number of stands of pioneer stage or the like is abundant in Pakistan. It means that pastures in Pakistan are more degraded than those in Nepal. However the pasture condition judged by the G+L (%) histogram is not so degraded compared with judgment by the DS histogram.

Regarding the weed communities in croplands (Fig. 8), the number of species is not so many, but a half of them are annuals, and others are perennials. In DS histogram of weed vegetation, pioneer species and the like should be naturally many, and some of them have higher DS. The Th histogram fairly corresponds with DS histogram. The Forbs histogram shows a normal distribution. These distribution types of weed vegetation will be changed by the hand-weeding. The distribution of DS in pastures in Pakistan does not show a good condition compared with that of Nepal (Fig. 9, Numata, 1988), but the distribution of G+L (%) is rather good for grazing.

Table 38. The summarized data of the additional tables (Table 16–37).

Table	N	G	L	F	Th	DS	V
16	15	33	13	53	40	288 (479)	60
17	4	75	0	25	50	172 (286)	60
17	3	67	0	33	33	209 (348)	60
18	6	67	0	33	33	286 (409)	70
19	3	100	0	0	0	462 (770)	60
20	8	50	0	50	50	187	100
21	5	80	0	20	80	103	100
21	4	75	0	25	75	215	100
22	12	17	8	75	25	27 (181)	15
22	11	18	9	73	27	30 (203)	15
23	10	30	0	70	50	182 (227)	80
23	9	33	0	67	44	218 (272)	80
24	9	44	0	56	56	243	100
24	8	50	0	50	63	171	100
25	9	44	11	45	67	67 (95)	70
25	8	50	13	37	63	194 (278)	70
26	6	50	17	50	83	47	100
26	5	60	20	40	80	59	100
27	7	29	0	71	71	99 (110)	90
27	6	33	0	67	67	151 (168)	90
28	12	50	8	42	33	184 (230)	80
29	10	50	10	40	40	244 (306)	80
30	8	38	25	62	38	272	100
30	7	29	14	67	29	383	100
31	15	47	7	46	7	267	100
32	11	27	18	55	18	439 (549)	80
32	10	20	20	60	10	478 (598)	80
33	11	9	9	82	45	90 (112)	80
33	10	10	10	80	40	182 (227)	80
34	11	27	9	63	45	214 (238)	90
34	10	30	10	60	40	244 (271)	90
35	15	33	13	54	53	159	100
36	14	36	7	57	14	189 (270)	70
37	11	46	0	54	55	188 (209)	90

N = number of species, DS = degree of succession, G=graminoids (%), L=legumes (%), F=forbs (%), Th=annuals (%), V=vegetation cover (%).

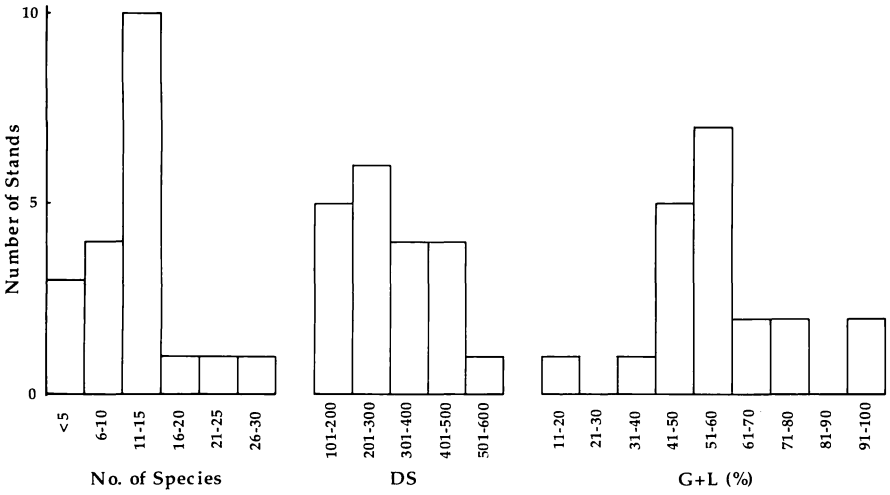

Fig. 7. Characteristics of pastures.

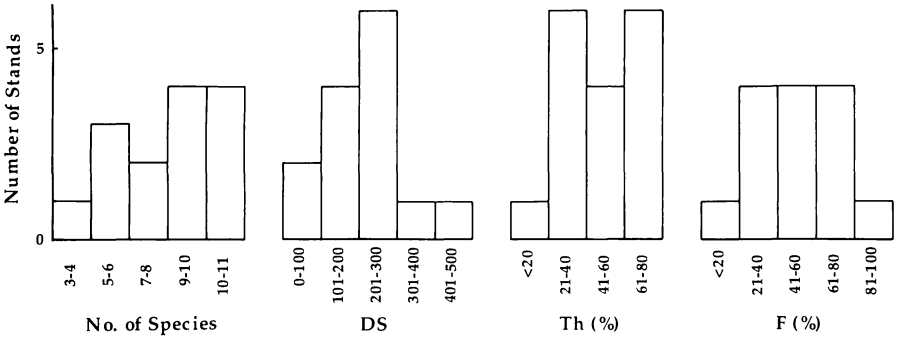

Fig. 8. Characteristics of weed communities.

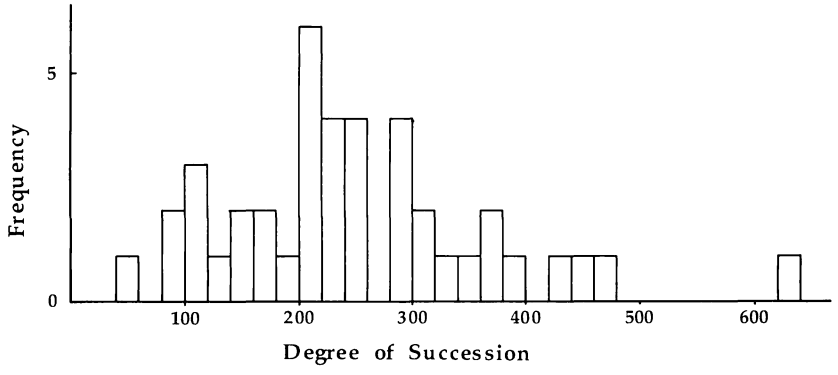

Fig. 9. Frequency distribution of DS of pastures in Eastern Nepal (Numata, 1988).

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パキスタン北部の放牧地および雑草植生

沼田　眞

千葉県立中央博物館
〒260 千葉市中央区青葉町 955-2

パキスタン北部の野草地の放牧地植生と農耕地の雑草植生を土地利用と自然保護との関連で調査を行なった．そこでは共用地以外では家畜の放牧や燃料用の樹木の伐採は厳禁されている．上記植生の植物社会学的データは1988年（表1–15）と1990年（表16–37）に調査され，それらに対する見解を述べた．植生の指標としてはSDR, SDR′, DS, *I*, N, G, L, F, Th などによったが，詳細は本文を参照されたい．