International Journal of Ecology and Environmental Sciences 49: 399-409, 2023
ISSN: 2320-5199 (Online); https://doi.org/10.55863/ijees.2023.2746

Investigation on Situation of Habitat and Allocation of Time Budget of Wild Water Buffalo *Bubalus arnee* (Kerr, 1792) in Koshi Tappu Wildlife Reserve, Nepal

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ABSTRACT
The study was conducted with main purpose to state the existing situation of habitat Wild Water Buffalo in the regards of land use and vegetation and to explore the allocation of diurnal time in different activities in Koshi Tappu Wildlife Reserve, Nepal. The Wild Water Buffalo categorized as endangered species on the IUCN Red list, restricted to south and Southeast Asia. For the estimation of land utilization freely available satellite imagery Landsat-5 TM (2011), Landsat-8 OLI-TIRS (2015) and Landsat-8 OLI-TIRS (2021) were used. Some circular plots were designed for vegetation studies. The behaviour was observed by focal animal sampling method. Most of the land was covered by agriculture (62.37%), followed by grassland (20.57%) and by water (4.79%) in buffer zone. In core zone mostly area covered by grassland (56.62%) then by sand (18.35%) and by water (10.97%). A total of 15 species of trees, 17 species of shrubs and 61 species of grasses and herbaceous plants were found in its preferred habitat. Common plant known to be eaten by Wild Water Buffalo were found as 3 species of tree, 4 species of shrub and 25 species of grasses. It was remarked that the time spent for grazing was 42%, followed by resting (30%), wallowing (11%), moving (9%) and for other activities (8%). It can be recommended to expand the area of Koshi Tappu Wildlife Reserve for the sustainable conservation of this species.

Key words: Dominant, Forest, Grassland, Grazing, Important Value Index

INTRODUCTION

Wild Water Buffalo has been listed as Endangered in the IUCN red list since 1986 and included in CITES under Appendix III (Kaul et al. 2019). The binomial name *Bubalus arnee* for the Wild Water Buffalo as valid for the taxon and most authors had adopted (Gentry et al. 2004). In 2021 its population has increased significantly and reached up to 498 individuals with 221 adult male, 162 adult female, 48 semi-adults and 67 calf (NTNC 2021). The growth rate of is 12.9% to the comparison of previous count. The last count was held in 2018 that had counted 441 individuals (KTWR 2018). Now a days they are limited to small habitat in scattered populations in Nepal, India, Bhutan, Myanmar (Aryal et al. 2011). There are questions concerning the genetic integrity of the remaining populations in western Thailand, Cambodia, and Sri Lanka. Feral populations also occur in a number of other places, including as Australia, Argentina, and the Arabian Peninsula (Kaul et al. 2019).

The translocation of 15 Wild Water Buffaloes in old Padmapur of Chitwan National Park (CNP) made the distribution of this species in two Protected Areas of Nepal (DNPWC 2020).To establish alternate population of Wild Water Buffalo, 15 Wild Water Buffaloes (12 from KTWR and three from Central Zoo, Kathmandu) were translocated at old Padampur of CNP in 2017.

Wild Water Buffaloes are dependent on water resources, and they spend a lot of time wallowing in rivers. They are more common in riverine grasslands, marshes, and swamps. It prefers swampy floodplain with tall elephant grass and scrubby woodland forest in the vicinity. It also generally prefers the sunlight intensity during the winter. Open short grasslands, the forests, and the agriculture fields provide them shelter.

Since it is a threatened taxon, its conservation is challenging, however, the population is increasing. Why is it limited only on the bank of river Koshi, what types of land cover is there, which plants exists there and how are Wild Water Buffalo managing the

time are major research questions. There should be good understanding about its habitat and behaviour because they are crucial factors for the sustainable conservation and management. Some research works have been done regarding with this threatened taxon in Nepal but only few researches were found on the base of habitat and behaviour. This study aims to analyze the present situation of habitat and time budgeting for the activities of Wild Water Buffalo in Koshi Tappu Wildlife Reserve. It is hoped that this research work will support to find the next alternative habitat or point out the need of expansion of Koshi Tappu Wildlife Reserve.

MATERIALS AND METHODS

Study area

Koshi Tappu Wildlife Reserve (KTWR) is located partly in province 1 and partly in Madhesh province of Eastern Nepal. It is located within 86º55'15' to 87º05'02" E longitude and 26º33'57" to 26º43'40" N latitude. In the beginning, the reserve was just 65 square kilometers (km^2) in size, and it was first established in the Sunsari district, east of the Koshi River in 1976. Later, in 1978, it was expanded to 175 square kilometers by encompassing the Koshi River and the western alluvial floodplain as well as a portion of Nepal's Sunsari, Saptari, and Udayapur districts.

The nearly rectangular reserve measures 17.5 km north-south and 10 km east-west in size. In 2004, a buffer zone was established, spanning 173 km^2. between 86º53'41" and 87º06'32" E longitude and 26º33'58" and 26º43'42" N latitude. It currently includes two municipalities from the Saptari district, one from the Udaypur district, and one both urban and rural municipality from the Sunsari district (Fig. 1). Koshi Tappu was designated as Nepal's first Ramsar site, the wetland of international importance under the Ramsar conservation on 17th December, 1987 A.D. to achieve conservation and sustainable number of wetlands (KTWR 2018).

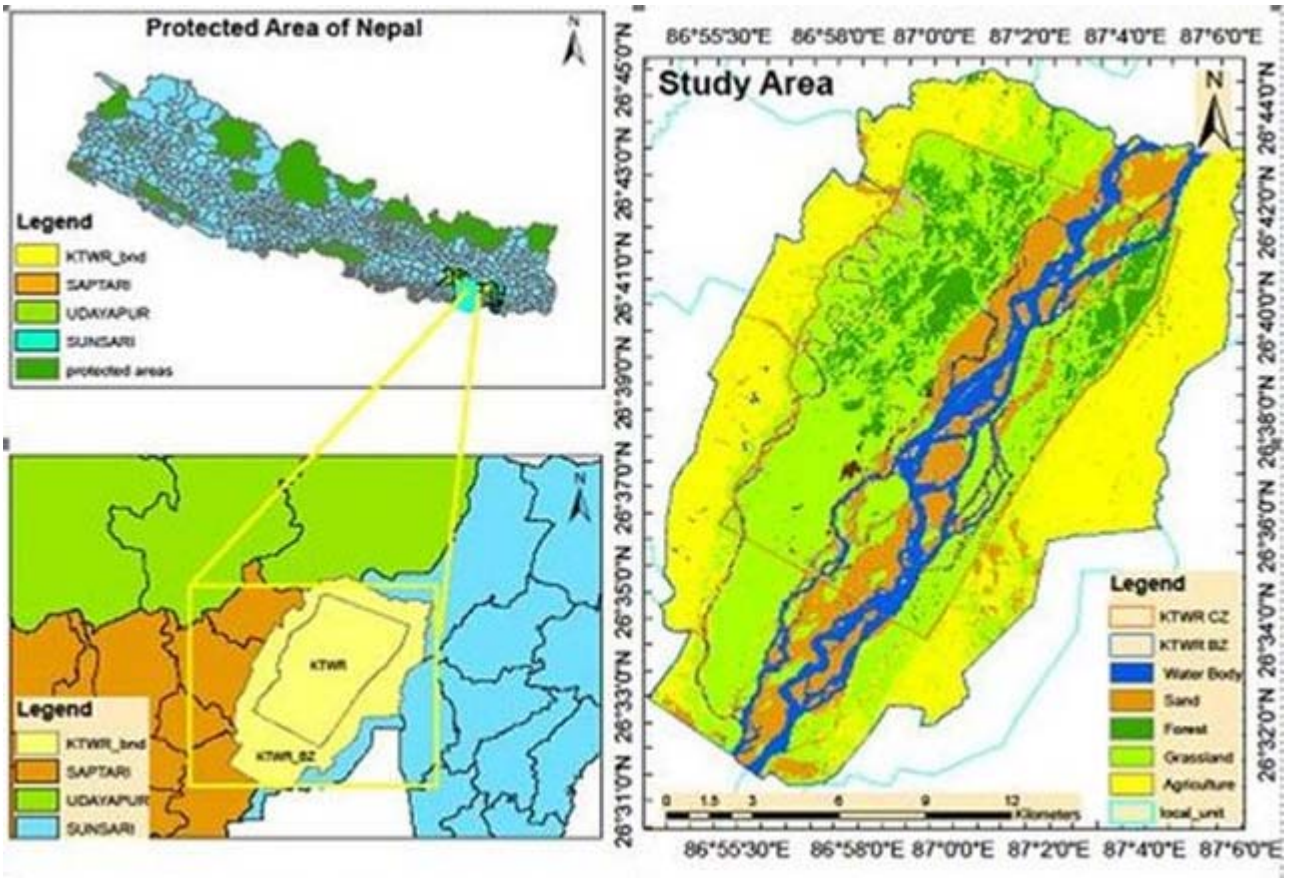

Figure 1. Map of study area Koshi Tappu Wildlife Reserve

Materials used

Binocular (Vortex Optics Diamondback 8x42), Digital Camera (Canon SX430 IS), GPS (Garmin eTrex 10), Data sheet, Measuring tape, Stationeries were used in study work.

Data collection methods for habitat

The data collection of habitat utilization land cover of KTWR were analyzed by the use of freely available and downloaded ArcGIS 10.4 and for the vegetation data, grids were prepared in KTWR including both core and buffer zone. Grids of 2x2 km were prepared for the whole reserve including buffer zone area. Total number of grids was 104 (Fig. 2).

Only 5.2% of the plots in the intended grid were randomly chosen for the inventory. 18 circular plots were included in one grid, which had them positioned diagonally from the grid's west-north to south-east corner. The distance between the plots was around 150 meters. To collect data on the vegetation, circular plots were utilized (Poudel and Mandel 2019). To gather information about the trees, plots with a 10 m radius were employed. Plots with a radius of 5 m were used to gather data on shrubs, and plots with a radius of 1 m were used to gather data on grasses.

Characteristics like local name, scientific name, DBH (Diameter on Breast Height) and height were recorded for trees, their DBH were measured using diameter tape. Information like local name, scientific name and crown cover for each plant species were collected. Similarly, in every circular plot vegetation type were also collected.

Some of the plant species which were not identified on the spots were snapped, hand plucked and collected and they were identified scientifically with the aids of local people, literatures and experts. The unidentified plants were taken to Department of Botany, Post Graduate (Degree) Campus, Biratnagar for identification. Vegetation sampling

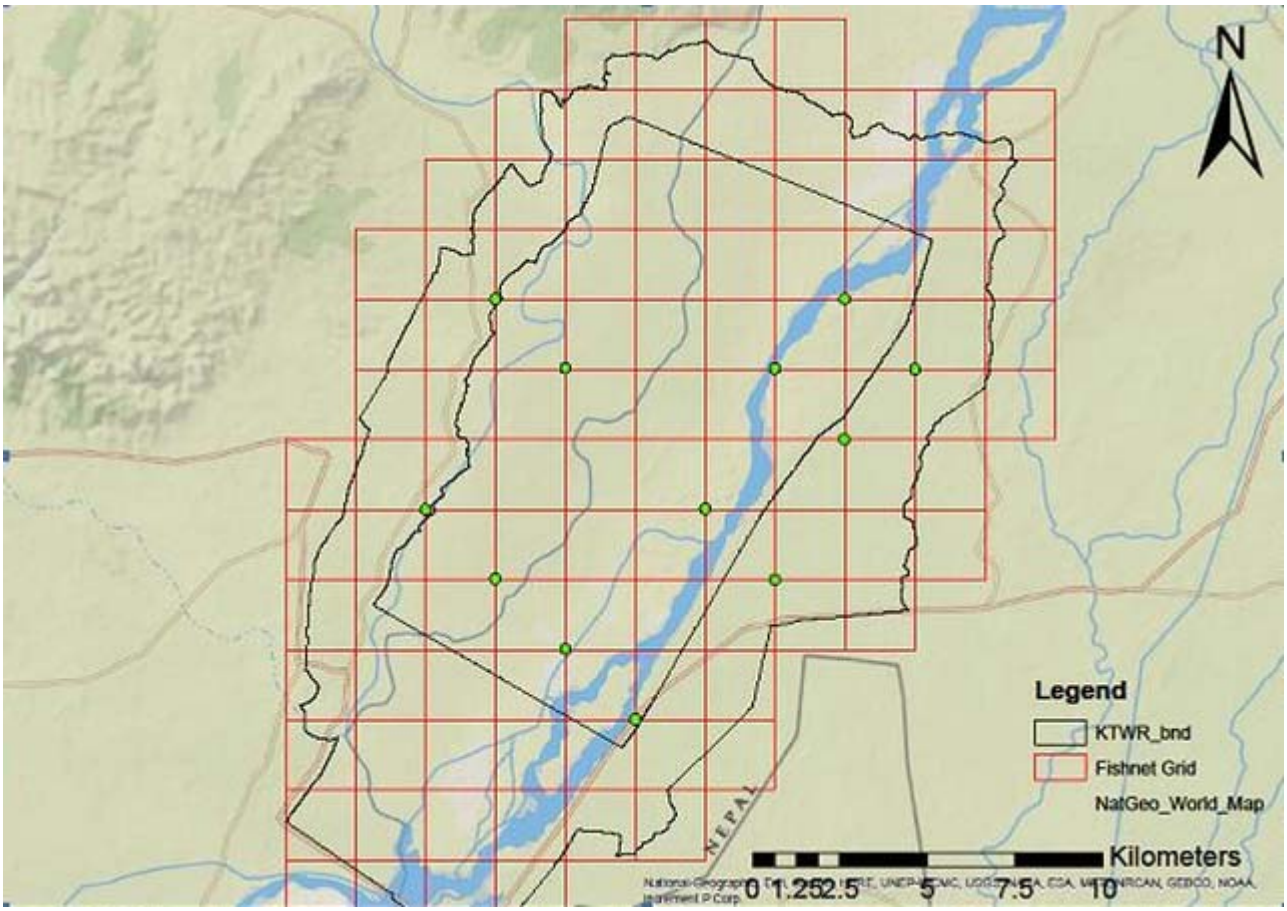

Figure 2. Prepared grids in core and buffer zone of KTWR

and analysis were done in December 2020 to February 2021, in winter season.

Data analysis for vegetation

Vegetation analysis was done by using MS Excel software and calculations were done according to the methods suggested by (Zobel et al. 1987). Prominence values of each species of shrubs and herbs were analyzed by multiplication of mean percent covers of particular species with square roots of its frequency (Sharma et al. 2012, Yadav et al. 2013).

Observation of plants eaten by Wild Water Buffalo

They were observed by direct ocular observation on field visit. By following focal animals it was made clear which plants they were feeding.

Focal animal sampling

Focal animal sampling technique was performed using the protocol described by Altmann (1974) and also followed by (Chalise 2003) to record the social and ecological behavior of the Wild Buffaloes. Selection of focal animal was random for each session of observation. Adult male and female Wild Water Buffaloes were chosen as the main animal for sampling because they have an impact on how others go about their daily lives. The adult focal animals were marked by one or two white chevron (Stripes) marks on the underside of the neck. They exhibited white hocks and white tips of tail. The next markings were fine white markings around the eyes and along the sides of the nose and mouth. Adult male had dark back, thicker and shorter horn but female have upwardly directed horn. For focal animal monitoring, a typical session lasted six hours, with one sampling session per day. To Complete a full session of whole day (12 hour), half day (6 hour) for first day session and half day (6 hour) for next day session. Time schedule for session was between 6:00am to 12:00am of first day and 12:00am to 6:00pm of next day. During the observations, the activities of a focal animal was recorded in 60 minutes continuous watching (Altmann 1974). Observations were recorded for 30 days or 180 hours (10 days in each month, from Dec 2020 to Feb 2021). The physiological state (Li 2009) of the individual also affects behavioral behaviour, and this was taken into account in the daily routines of Asian Wild Buffalo. It is broadly divided and further regrouped into five major categories of maintenance behaviour and some non-maintenance behaviour. The maintenance behaviours included aggression, social play, sexuality, moving (moving, running), resting (standing, sitting, lying, sleeping), and wallowing. The non-maintenance behaviour comprises other activities such as social interactions and territorial activities, including fighting, drinking, grooming, etc.

RESULTS

Land cover pattern in Koshi Tappu Wildlife Reserve

On the basis of satellite image by using ArcGIS 10.4 land cover and land use type of Koshi Tappu Wildlife Reserve and its buffer zone were analyzed. In Buffer zone the maximum land area of reserve was occupied by the Agriculture (62.37%) and least by forest (1.25%). But in core zone of wildlife reserve, grassland was found maximum (56.62%) and agricultural land was found as least (1.66%). In totality, grassland cover was maximum (37.26%) and water body was found as least (7.65%) (Table 1, Fig. 3).

Vegetation types in Koshi Tappu Wildlife Reserve

We analyzed the habitat of Wild Water Buffalo in the designed study area. There were 276 plots in all that were surveyed. Among these, 92 plots were used to get data on shrubs, 92 plots were used to gather information on trees, and 92 plots were used to gather information on grasses and herbaceous plants. The survey plots' varying altitudes ranged from 71 to 91 meters. The three main vegetation types were identified from the entire KTWR area. They were forest (Sissoo-Khair and mixed riverine forest), shrub-land, and grassland. Four major vegetative communities were identified in this study based on the phyto-sociological analysis. They were grassland, mixed riverine forest, shrubland, and Sissoo-Khair woodland. On the basis of plot location, a large proportion of KTWR area was covered by grassland (both tall and short) followed by Sissoo-Khair forest and only the smallest proportion was covered by shrub land. In sampled plots 51 out of 92 from grass land was found to occupy the highest portion of the

Table 1. Land cover type (km^2) of core zone and buffer zone of KTWR

Land cover	Buffer Zone		Core Zone		Total	
	Area (km^2)	%	Area (km^2)	%	Area (km^2)	%
Agriculture	107.53	62.37	2.46	1.66	109.99	34.23
Forest	2.15	1.25	18.49	12.43	20.64	6.424
Grassland	35.46	20.57	84.28	56.62	119.74	37.26
Sand	19.01	11.03	27.31	18.35	46.32	14.41
Water body	8.27	4.79	16.32	10.97	24.59	7.65
Grand Total	**172.42**	**100**	**148.86**	**100**	**321.28**	**100**

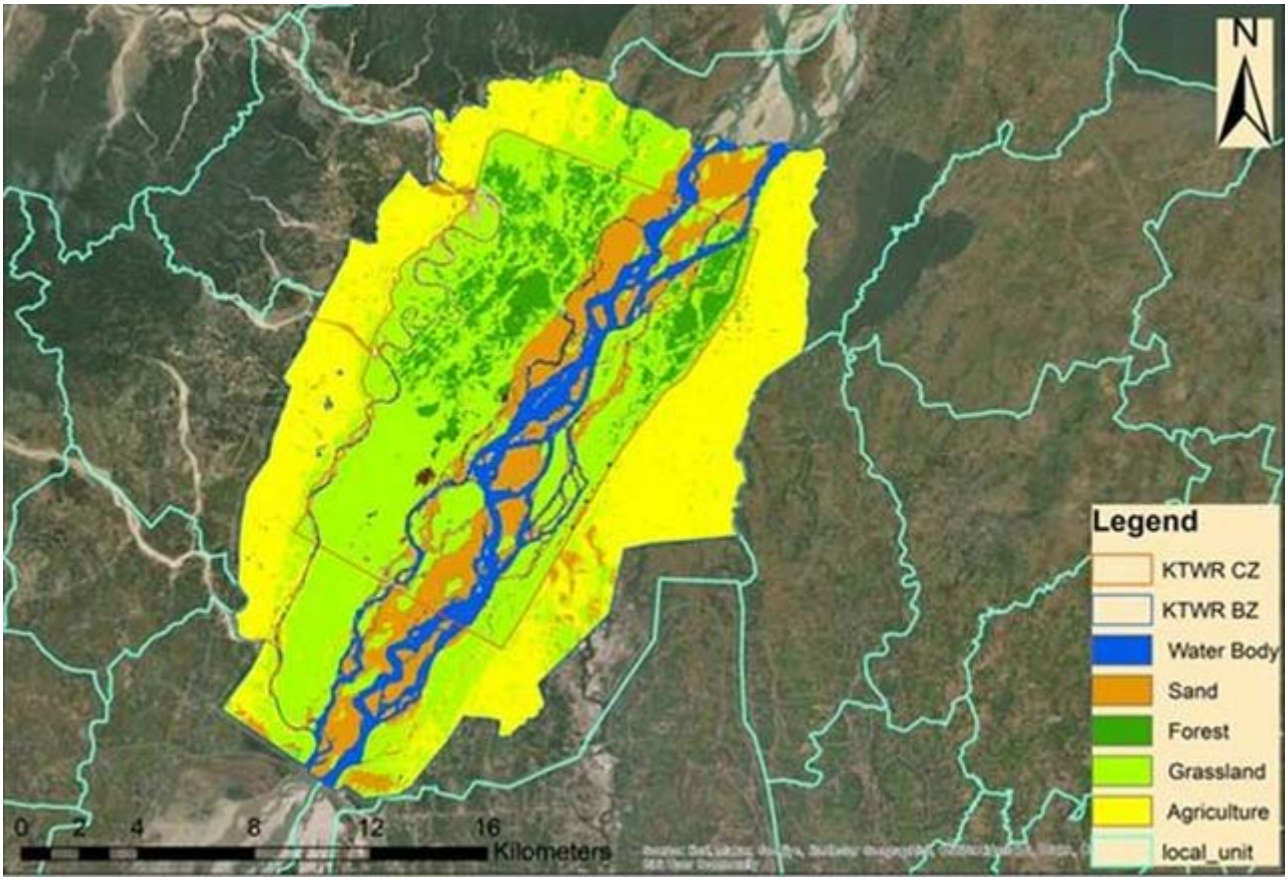

Figure 3. Land cover type of core zone and buffer zone of KTWR.

study area in KTWR, 22 out of 92 from Sisso-khair forest which were predominant in the eastern part of Reserve, 16 out of 92 mixed riverine forest was mostly found in the southern and western part of the reserve and 13 out of 92 from shrubland. Figures 4 and 5 indicates that the largest area of the reserve was occupied by grassland (55.44%) followed by Sisso-khair forest (23.92%), mixed riverine forest (17.40%) and shrub land (3.27%).

Plant species recorded from Koshi Tappu Wildlife Reserve and its buffer zone

Tree species

All total 15 species of tree were recorded out of which the dominant species was Sisso *(Dilbergia sisso*) in Sisso-khair forest and mixed riverine forest (with IVI of 66.56). The relative frequency, relative density and relative basal area and also IVI of all 15 species of tree is expressed in the table below in Table no. 2.

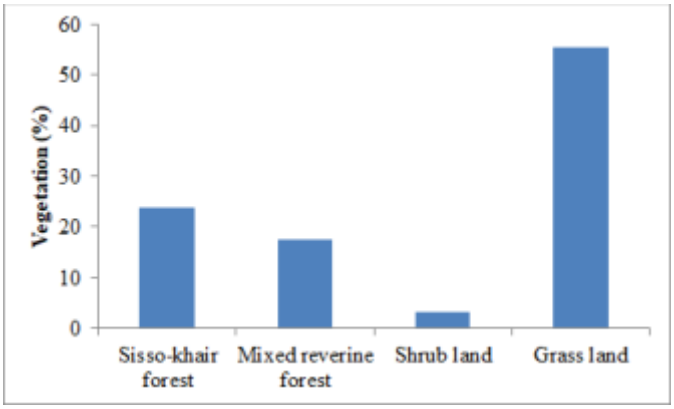

Figure 4. Vegetation type of Koshi Tappu Wildlife Reserve

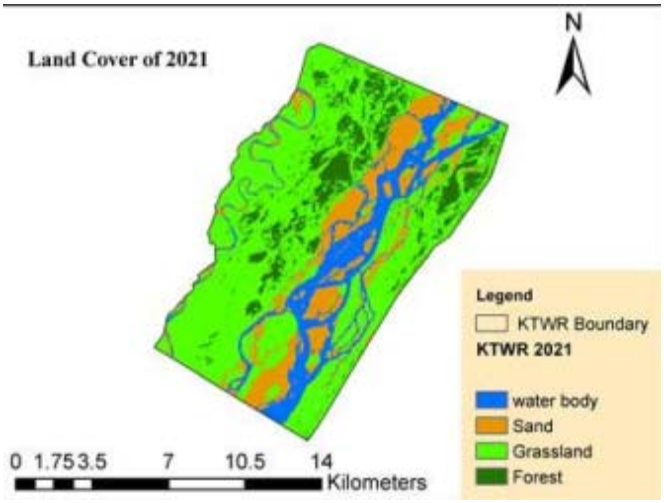

Figure 5. Grassland and forest cover in Koshi Tappu Wildlife Reserve

Table 2. Important Value Index (IVI) of tree species in study area

Scientific Name	RD	RF	RBA	IVI
Acacia catechu	20.69	19.79	21.85	62.33
Acacia hispide	4.83	5.21	7.1	17.14
Albiziz chinesis	2.76	3.13	4.26	10.15
Artocarus lakoocha	0.69	1.04	1.34	3.07
Azadirachta indica	0.69	1.04	0.36	2.09
Bombax ciebo	11.72	16.67	7.33	35.72
Dalbergia sisoo	24.82	15.62	26.2	66.64
Eucalyptus	3.45	4.17	4.55	12.17
Garuga pinnata	0.69	1.04	0.63	2.36
Mangifera indica	2.76	3.13	2.65	8.54
Phyllanthus	2.07	2.08	2.08	6.23
Psidium guajava	0.69	1.04	0.6	2.33
Syzygium cumini	9.66	10.42	11.43	31.51
Terminalia chebula	1.38	2.08	1.61	5.07
Trewia nudiflora	13.1	13.54	8.01	34.65

Shrub species

A total of 17 species of shrubs were found in the different vegetation type of KTWR. Bayer (*Ziziphus mauritiana)* had the maximum Prominence Value (PV) 104.95 followed by Banmara (*Lantana camera)* (PV 69.45) and Seto aank (*Colotropis procera*) with 18.71, respectively (Table 3). The mean percentage cover of *Ziziphus mauritiana, Lantana camera* and *Colotropis procera* were 28.17, 17.02 and 8.27% respectively and frequency were 13.89, 16.66 and 12.03%, respectively (Table 3).

Herbaceous and grass species

A total 61 species of herbaceous and grass species were found in the different vegetation type of KTWR. Siru (*Imperata cylindrica)* had maximum PV 321.7 followed by Kans (*Saccharum spontaneum)* with PV 113.22 and Dubo (*Cynodon dactylon*) PV 56.13, respectively. The mean percentage cover of *Imperata cylindrica, Saccharum spontaneum* and *Cynodon dactylon* were 38.35, 17.54 and 8.51%, respectively, and frequency were 70.37, 41.66 and 43.51%, respectively (Table 4).

Plant species that Wild Water Buffalo are reported to eat (grazed, browsed or eaten)

Along the designed plots, the forage species were collected in core zone of KTWR. It was recorded that 32 species of fresh plants being eaten by Wild Water Buffalo. Crop raiding was not noticed during the study. Among 32 species 25 were herbecious (*Mikania micrantha, Typha elephantine, Diplazium esculentum, Euphorbia hirta, Cynoglossum zeylanicum, Hemarthria compressa, Achyranthes aspera, Centella asiatica, Oxalis comiculata and Ageratrum conyzoides)* and grasses (*Saccharum spontaneum, Imperata cylindrical, Vetiveria zizanioides, Cynodon dactylon, Tamarix dioca, Phragmites karka, Eleusine indica, Cyperus rotundus, Marsilea minuta, Sida rhombifolia, Mimosa pudica, Cyrysipogon aciculatus, Desmostachya bippinata, Brachiaria distachya* and *Sacchrum bengalenis*), 4 species were shrubs (*Zizyphus mauritiana, Sida rhombifolia, Callicarpa macrophylla and Ziziphus rugosa*) and 3 species were trees (*Dalbergia sissoo, Acascia catechu* and *Bombax ceiba*).

Table 3. Prominence value of shrubs

Scientific name	Prominence value
Ageratrum conyzoides	11.06
Callicarpa macrophylla	1.11
Chromoleana odorata	5.75
Colotropis procera	28.71
Datura metel	18.55
Jatropha curcas	5.53
Lantana camera	69.45
Maesa chisia	0.55
Mimosa pudica	20.32
Murraya koenigii	1.66
Pogostemon benghalensis	5.53
Thespesia lampas	0.55
Thevetia beruviana	1.56
Xanthium stratium	4.69
Ziziphus incurve	6.7
Ziziphus mauritiana	104.95
Ziziphus rugosa	2.35

Table 4. Prominence value of herbs and grass species in study area

Scientific name	Prominence value
Achyranthes aspera	0.57
Agerathum conyzoides	1.8
Amaranthus viridis	0.06
Arundo donax	0.04
Bidens pilosa	0.17
Brachiaria distachya	0.1
Brassica	0.1
Centella asiatica	0.2
Chenopodium ambrosiodes	0.17
Clerodendrum viscosum	1.08
Colocosia esculenta	0.06
Cynodon dactylon	56.13
Cynoglossum zeylanicum	4.19
Cyperus compressus	0.1
Cyperus exatatus	0.1
Cyperus rotundus	0.04
Cyrysipogon aciculatus	0.32
Dendrocalamus	0.23
Dennstaedtia appendiculata	13.6
Desmodium trifolium	0.06
Desmostachya bippinata	1.44
Diplozium esculentum	0.4
Dryopteris cochleata	4.27
Equisentum debile	0.29
Eupatorium adenophrum	0.36
Eupatorium odoratum	0.28
Euphorbia hirta	0.04
Gouania leptostachya	1.19
Hemarthria compressa	0.17
Imperata cylindrica	321.7
Ipomea carnea	0.28
Kyllinga brevifolia	0.42
Leersia hexandra	0.06
Lens culivaris	1.8
Leptachloa chinensis	0.06
Leucus indica	0.09
Mikenia mikrantha	0.38
Mimosa pudica	0.86
Mussa sapientum	0.59
Oxalis comiculata	0.1
Parthenium hysterophorus	0.17
Persicaria barbata	0.1
Phragmites	0.4
Phragmites karka	0.1
Pistia stratiotes	0.04
Pteris vittata	0.1
Rabdosia lophanthoides	0.56
Saccharum spontaneum	113.22
Sacchrum bengalenis	0.43
Scopria dulcis	0.86
Senna tora	0.09
Sida rhombifolia	0.09
Solanum nigrum	0.1
Spilanthes iabadicensis	0.1
Steria pumila	1.71
Tamarix dioca	19.36
Thelypteris dentate	0.04
Typha domingensis	0.04
Typha elephantine	20
Vernonia cinerea	0.1
Vitiveria zizanioides	18.2

Behavioral activity of Wild Water Buffalos in KTWR

Total duration of focal sampling of Wild Water Buffalos was 180 hours in winter season. Mostly Wild Water Buffalos were found in eastern part of Koshi River. Vegetation types in this region were mixed riverine forest, Khair-Sisso forest and

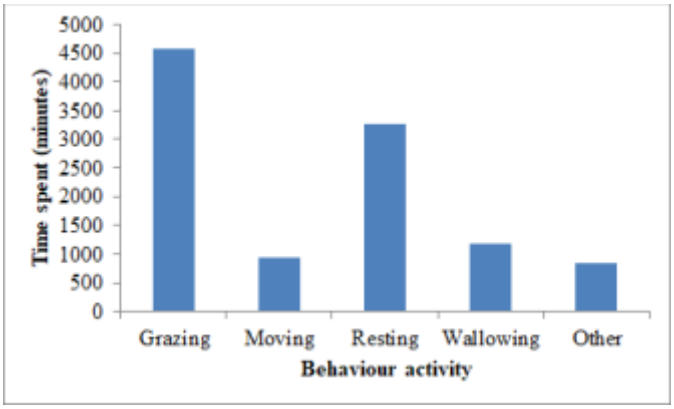

Figure 6. Time spent (in minutes) by Wild Water Buffalos in KTWR

Grassland. The data for the time spent on different activities such as grazing, moving, resting, wallowing and other activities are shown in Figure 6.

Through the observation of three month period (10 days in each month) activities in winter season of Wild Water Buffalos in Koshi Tappu Wildlife Reserve were recorded. It showed that the time spent for major activities like grazing was 4573.35 minutes (42%), followed by resting 3261.48 minutes (30%), wallowing 1187.34 min (11%), moving 943.56 min (9%) and for other activities 853.04 min (8%).

DISCUSSION

This research work recorded that in buffer zone the maximum land area of reserve was occupied by the agriculture (62.37%) and least by forest (1.25%). But in core zone of wildlife reserve, grassland was found maximum (56.62%) and agricultural land was found as least (1.66%). In totality, grassland cover was maximum (37.26%) and water body was found as least (7.65%). Regarding with the land cover pattern Chettri et al. (2013) studied spatiotemporal land cover change of koshi Tappu for 34 years. They recorded that forests have been reduced by 94% from their original state of the year 1976. The situation of grassland was found increased by 79% in the duration of 34 years. Swamp and marshes were also remarkably decreased. Forest (5.4%), grassland (17.1%), swamp (18.1%), river (52.4%), and agricultural land (7.0%) were the different habitat categories in Koshi Tappu. The natural vegetation of the reserve wass primarily dominated and distinguished by mixed deciduous riverine forest,

Figure 8. Wild Water Buffalo grazing in KTWR

which covers the majority of the land area (Dahal et al. 2009).

Our work found that the largest area of the reserve were occupied by grassland (55.44%) followed by Sisso-khair forest (23.92%), mixed riverine forest (17.40%) and shrub land (3.27%). With the concern of vegetation type in the previous study, (Sah 1997) found 2.9% of mixed riverine forest in his study in KTWR. The total area of mixed riverine forest was found increased from 2.9% to 17.40% in 2021 from the current study. According to the same research, the findings described that there were all total 514 species of plants which comprised 12 species of gymnosperm and 502 species of angiosperm. Kandel et al. (2018) had categorized the vegetation type of KTWR in to four types. They were Sissoo-Khair, mixed riverine, shrubland and grassland.

In case of plant species occurrence, we recorded a total 15 species of tree, out of which the dominant species was Sisso *(Dilbergia sisso*) in Sisso-khair forest and mixed riverine forest (with IVI 66.56). A total of 17 species of shrubs were found in the different vegetation type. Bayer (*Ziziphus mauritiana*) had the maximum Prominence Value (PV) 104.95. A total 61 species of herbaceous and grass species were found in the different vegetation type of KTWR. Siru (*Imperata cylindrica)* had maximum PV 321.7. The spatial and temporal distribution of grassland assemblages is primarily influenced by fluvial processes but also by fire, cutting and grazing (Peet et al. 1999). In Koshi Tappu

Wildlife Reserve area 66 wetlands were recorded and 66.67% of which were impacted by invasive plants species. The most abundant invasive species were *Echhornia* and *Ipomoea* (Pandey et al. 2020). Thapa et al. (2020) found that in KTWR *Shorea robusta* was the dominant tree species with the IVI of 129.07.

In the context of food plants of Wild Water Buffalo, it was recorded that 32 species (25 herbs, 4 shrubs and 3 trees) of fresh plants being eaten by Wild Water Buffalo. Crop raiding was not noticed during the study. Bawri and Saikia (2014) recorded total of 183 food plant species of Wild Water Buffalo. These species were belonged to 47 families among them (37%) of total species belonged to Poaceae family, followed by Euphorbiacea (4.9%), Solalnaceae and Cucurbitacea (4.3%) and the rest of the 43 families constitute about half of the food plant species of Wild Water Buffalo. Out of recorded 183 species of food plants 20 species were cultivated in the periphery of the park and are mainly eaten during monsoon and winter seasons. Regmi and Chalise (2019) found that on grazing land and rarely grazing land 35 plant species were recorded among them three species of plants were trees, six shrubs and 18 grasses. The next research has built the list of 24 plant species which were food of Wild Water Buffalo. Among them six species were shrubs, two herbs and 16 grasses. Shrestha et al. (2020) found that 54 plant species as being foraged by Wild Water Buffalo. There was temporal fluctuation in number of food plants. It might vary due to differences in study period.

In the regards of behaviour study we recorded the time budget for different activities as grazing (42%), resting (30%), wallowing (11%), moving (9%) and for other activities (8%). Bawri and Saikia (2014) found that by the using scan sampling, diurnal activity of all herds showed that much more time was allocated to feeding activity, than other activities. The Wild Water Buffalo in Kaziranga National Park (KNP), India spent a maximum of 48.12% time on feeding activities. Rest of time they devoted to moving 21.71%, resting 10.89%, standing 10.26%, and minimum of 9% in wallowing activities. Rai and Chalise (2014) found that Wild Water Buffalo spent 50% of the time for grazing. It was about five hours and 45 minutes of average diurnal time (11hours and 30 minute).

The research performed by two authors in 2019 showed that grazing was 53.85%, resting was 28.48% and wallowing was 11.07% by scan sampling (Regmi and Chalise 2019). Shah et al. (2017) found that they spent more time for searching food and grazing. It was followed by resting and wallowing, whereas the lowest number of individuals was recorded on sleeping. Moreover, in the morning, the maximum time was to be used for grazing and searching of food. It was followed by the evening and lowest in the daytime. It might because of low temperature, calm and no disturbances in morning time. During day a huge number of domestic and feral animals were seen grazing in the habitat of Wild Water Buffalo. The highest time spent on wallowing was observed during daytime although it was observed in the morning and the evening as well. Sleeping, fighting and mating were observed only in the morning rather than the day and evening. It was because of their activeness in every activity in the morning.

CONCLUSION

The study was conducted from October, 2020 to February, 2021 in Koshi Tappu Wildlife Reserve, Nepal with the aim to investigate the present situation of habitat of Wild Water Buffalo in the regards of land use pattern and vegetation. It also had the objective to explore the diurnal time budgeting for different activities. The data collection belonging to existing situation of land cover in the habitat of Wild Water Buffalo in KTWR was done by the use of ArcGIS 10.4. The vegetation was sampled and analyzed by designing grids of 2 x 2 km for the whole reserve and buffer zone area. Circular plots were designed for the vegetation study. Vegetation analysis was done following the methods and formulas suggested by (Zobel et al. 1987). The time budgeting was studied by applying focal animal sampling method.

In buffer zone the maximum land area of reserve was occupied by the agriculture and least by forest. But in core zone of reserve, grassland was found maximum and agricultural land was found as least. In totality, grassland cover was maximum and water body was found as least. It gave the clear picture that the largest area of the reserve was occupied by

grassland followed by Sisso-khair forest, mixed riverine forest and shrub land. It was concluded that the habitat consist of combination of forest, grassland and availability of water. Totally 15 species of trees, 17 species of shrubs and 61 species of herbs made the habitat more diversified, stable and suitable for Wild Water Buffalo. Among them Wild Water Buffalo fed upon only 32 species of plants. The Wild Water Buffalo used maximum time for grazing which was followed by resting and least time for moving. From the study it can be concluded that both core and buffer zones are suitable for Wild Water Buffalo. This species is limited in Koshi Tappu, it may because of composition of water, land, grassland and vegetation. It can be recommended the buffer zone should be merged in reserve immediately. Instead of seeking new habitat of this species in Nepal it would be better to expand the area of Koshi Tappu Wildlife Reserve.

ACKNOWLEDGEMENT

We would like to thank Department of National Park and Wildlife Coservation (DNPWC) and KTWR for providing permission to do this study. We are grateful to Prof. Dr. Damodar Thapa Chhetry, Head of the Department of Zoology, Post Graduate Campus, Tribhuvan University, Biratnagar for his encouragement and suggestions. Deeply Acknowledge to Prof. Dr. Tej Narayan Mandal, Department of Botany, Post Graduate Campus, Biratnagar to identifying plants and help analyzing vegetation data. Mr. Bist wills to acknowledge Idea Wild, USA for providing GPS and Binocular as small equipment grants for this research.

Authors' contribution: The first author developed research design, conducted field work and prepared rough manuscript. The second author developed the concept of research, went for field work and finalize the manuscript.

Conflict of interest: The authors declare that we do not have any conflict of interest.

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Received:12th October 2022
Accepted: 18th November 2022