PROJECT PROPOSAL

ADDRESSING MANAGEMENT ISSUES OF KAZIRANGA TIGER RESERVE, ASSAM

भारतीय वन्यजीव संस्थान
Wildlife Institute of India

TITLE OF THE PROJECT	**ADDRESSING MANAGEMENT ISSUES OF KAZIRANGA TIGER RESERVE, ASSAM**
NAME AND ADDRESS OF THE PROPONENT	Wildlife Institute of India, Post Box: 18, Dehra Dun.
PROJECT COORDINATOR	Dr. S.A. Hussain Scientist G Wildlife Institute of India, Dehra Dun
PROJECT CO-COORDINATOR	Dr. Ruchi Badola Scientist G Wildlife Institute of India, Dehra Dun
NAME OF COLLABORATING AGENCIES	National Tiger Conservation Authority (NTCA) Government of India Field Director, Kaziranga Tiger Reserve Government of Assam
DURATION OF THE PROJECT	3 years
TOTAL BUDGET OUTLAY	**Component 1:** **INR 75,64,010**
	Component 2: **INR 80,30,000**
	Component 3: **INR 1,83,40,000**
	TOTAL: **INR 3,39,34,010**

Hussain

4th October 2016

(S.A. Hussain, Ph.D.)
Scientist G & Head
Dept. of Landscape Level Conservation
Planning and Management

CONTENTS

ADDRESSING MANAGEMENT ISSUES OF KAZIRANGA TIGER RESERVE, ASSAM

EXECUTIVE SUMMARY

The Kaziranga Tiger Reserve (KTR) is one of the best managed Protected Areas in India. The decades of conservation efforts in the Reserve and its surrounding areas have secured the large mammal populations in the entire Kaziranga – Karbi Anglong Landscape (KKAL). This landscape is home to nearly 70% of Assam's tigers, about half of Assam's elephant population (close to 2500 elephants) and close to 90% of the India's rhinoceros population (more than 2000 Rhinoceros), making the area critical for conservation of wildlife and their habitats. With the increasing wildlife populations in the KTR, there is a need to further strengthen the conservation efforts in the region to maintain the integrity of the Reserve as a source and surrounding areas as sink. In KKAL, the movement and recolonization of large mammals, such as tiger, elephant and rhinoceros, has been obstructed due to the fragmentation of habitat by expanding human habitation, agricultural areas, tea gardens and development activities leading to instance of human - wildlife negative interaction in the region.

Species invasion is considered as one of the major threats to biological diversity. A large proportion of area in KTR has been affected by the invasion of exotic weeds such as *Mikania* and *Mimosa* spp. Also, there is increasing evidence of invasion by native woody species such as *Bombax ceiba* in the Park. Such invasions are affecting the integrity of the wet grassland habitat in terms of productivity of the palatable species for herbivores.

The creation of the Tiger Reserve and improved protection measures taken by the Forest Department has boosted the conservation value of the area in terms of increased wildlife population and overall habitat status. However, it has also affected the Protected Area - People relationship. The proposed creation of an Eco-sensitive Zone around the Reserve has created doubt in the minds of people, who have shown strong resentment towards the Forest Department and the Local administration. This is an obstacle in attaining the conservation goals envisioned while creating the Tiger Reserve and may be detrimental to future conservation objectives.

This proposal aims to address the above mentioned three issues that are affecting the conservation in the region. The project has three components. Component 1 will address the people - protected areas issues, Component 2 will deal with management of invasive species and Component 3 will deal with strengthening of dispersal Corridors connected to the surrounding landscape. The total outlay of the project is INR 3,39,34,010 for a three years period.

FINANCIAL REQUIREMENT AT A GLANCE

COMPONENT WISE FINANCIAL REQUIREMENT (INDIAN RUPEE)

COMPONENTS	MANPOWER	EQUIPMENT	OPERATIONAL	CONSUMABLES	TRAVELS	INSTITUTIONAL CHARGES	TOTAL
COMPONENT 1	3240000	110000	427400	2500000	300000	986610	7564010
COMPONENT 2	3628000	418609	752000	1834000	350000	1047391	8030000
COMPONENT 3	7728000	4770000	462727	3322000	390000	1667273	18340000
TOTAL	**14596000**	**5298609**	**1642127**	**7656000**	**1040000**	**3701274**	**33934010**

Fax

ANNEXURE 1

F. No. 1-3/2008-PT (Vol. IV)
Government of India
Ministry of Environment, Forest & Climate Change
National Tiger Conservation Authority
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B-1 Wing, 7th Floor,
Paryavaran Bhawan,
CGO Complex, Lodhi Road,
New Delhi-110003
Tel. No. +91 11 2436 7837-42
Fax: +91 11 2436 7836
E-mail: aig3-ntca@nic.in

Dated: 17.08.2016

To,

Dr. S. A. Hussain,
Scientist G and PI, DST Project,
Wildlife Institute of India, Dehradun

Sub: Management issue of Kaziranga Tiger Reserve and the priority applied research by the Wildlife Institute of India- reg.

Sir,

This has reference to Director, Kaziranga Tiger Reserve's letter No. KNP/FG. 647/WII/Research dated 10.05.2016 on the subject cited above, copy of which is also endorsed to ADG (PT) & MS (NTCA).

In the aforesaid context, I am directed to request you to kindly interact with Kaziranga Tiger Reserve authorities and come up with a management oriented project for consideration of this Authority.

Yours faithfully,

(Dr. Vaibhav C. Mathur)
Assistant Inspector General of Forests (NTCA)

Copy to:

1. The Chief Wildlife Warden, Assam.
2. The Field Director, Kaziranga Tiger Reserve, Assam.

GOVERNMENT OF ASSAM
DEPARTMENT OF ENVIRONMENT & FOREST
OFFICE OF THE DIRECTOR, KAZIRANGA NATIONAL PARK AND TIGER RESERVE
BOKAKHAT, ASSAM

No. KNP/FG.647/WII/Research Dated 10/05/2016

To,
Dr. S. A. Hussain
Scientist G and PI of the DST Project
Wildlife Institute of India,
Chandrabani, Dehra Dun.

Subject: Management issues of Kaziranga Tiger Reserve and the priority applied research by the Wildlife Institute of India – reg

NTCA
DIARY NO. 2189
DATE 23.5.16
ADG(PT)
IG(NTCA)
DIG(NTCA)

Sir,

This is with reference to the meeting held on April 7, 2016 at this office regarding the management of Kaziranga National Park and Tiger Reserve. We appreciate the research work conducted by the Wildlife Institute of India and support provided to us time to to time in dealing with management issues of the Reserve. It is requested that the report on the socioeconomic component of the project "Biomass productivity of the wet grasslands of the Kaziranga and its use by large herbivores" may kindly be submitted to us. The data can be utilized for management of the ecodevelopment programme in the fringe villages. Further, I would request you to kindly take up a full fledged research project on ecodevelopment and addressing livelihood issues of the fringe villages including north bank of the Kaziranga landscape. We have revived the ecodevelopment committees and now we need to strengthen them.

In recent years camera trapped tigers from Kaziranga Tiger Reserve have been photo captured in Orang and Nameri. Besides, our camera trap data suggest a stable tiger population in the Reserve though there is increasing evidence of tiger successfully breeding and contributing to population. We need to know the dispersal route and forest connectivity of the Reserve to ensure long term survival of the tiger in the Kaziranga – Karbi Anglong Landcscape. I would request that you may take a study on population dynamics and dispersal of tiger in the landscape.

सत्यमेव जयते

You are kindly aware that the wet grassland habitat in the Reserve are now getting affected due to invasive species such as Mikenia, Mimosa, Rosa; and most recently the Bombax species has invaded grasslands particularly in Western Range . You may take up a study for suggesting measures for improving the habitat condition in the Park.

The Department is suffering from financial crunch and will not be able to financially support such studies though these are our priorities.

Enclo : Copy of excerpts of KNP Management plan.

(Field Director)
Kaziranga Tiger Reserve

Copy for kind information to:

1. Principal Chief Conservator of Forests (WL), Basistha, Guwahati-781029
2. ADG (Project Tiger) & Member Secretary, National Tiger Conservation Authority, B-1 Wing, 7th Floor, Paryavaran Bhawan, CGO Complex, New Delhi 110003
3. Director, Wildlife Institute of India, Chandrabani, Dehra Dun
4. Divisional Forest Officer, Eastern Assam Wildlife Division,Bokakhat,Assam

(Director)
Kaziranga Tiger Reserve

COMPONENT 1

PROMOTING COMMUNITY PARTICIPATION IN CONSERVATION AND CONFLICT RESOLUTION IN THE FRINGE VILLAGES OF KAZIRANGA TIGER RESERVE, ASSAM

भारतीय वन्यजीव संस्थान
Wildlife Institute of India

Title of the project	**PROMOTING COMMUNITY PARTICIPATION IN CONSERVATION AND CONFLICT RESOLUTION IN THE FRINGE VILLAGES OF KAZIRANGA TIGER RESERVE THROUGH ECODEVELOPMENT**
Name and address of the Principal Investigator	Dr. Ruchi Badola, Scientist G Department of Ecodevelopment Planning and Participatory Management, Wildlife Institute of India, Post Box: 18, Dehra Dun. E-mail: ruchi@wii.gov.in
Name and designation of Co-Principal Investigator	Dr. S.A. Hussain, Scientist G Department of Landscape Level Conservation Planning and Management, Wildlife Institute of India, Post Box: 18, Dehra Dun. E-mail: hussain@wii.gov.in
	Shri Ajay Srivastava, IFS & Scientist G Department of Ecodevelopment Planning and Participatory Management, Wildlife Institute of India, Post Box: 18, Dehra Dun. E-mail: ajay@wii.gov.in
Name of Collaborating Agencies/Collabrators	1. Shri Sanjay Kumar, IFS Deputy Inspector General of Forest, National Tiger Conservation Authority (NTCA), Government of India B-1 Wing, 7th Floor, Paryavaran Bhawan, CGO COmplex New Delhi 110003, E-mail: dig-ntca-mef@nic.in
	2. Nishant Verma, IFS Deputy Inspector General of Forest, National Tiger Conservation Authority (NTCA), Government of India B-1 Wing, 7th Floor, Paryavaran Bhawan, CGO COmplex New Delhi 110003, E-mail: dig2-ntca@nic.in
	3. Dr. Vaibav Mathur, IFS Assistant Inspector General of Forest, National Tiger Conservation Authority (NTCA), Government of India B-1 WIng, 7th Floor, Paryavaran Bhawan, CGO COmplex New Delhi 110003, E-mail: aig3-ntca@nic.in
	3. Shri Raja Ram Singh, IFS Assistant Inspector General of Forest, National Tiger Conservation Authority (NTCA), Government of India B-1 WIng, 7th Floor, Paryavaran Bhawan, CGO COmplex New Delhi 110003, E-mail: aig1-ntca@nic.in
	4. Field Director, Kaziranga Tiger Reserve. Assam State Forest Department, Government of Assam E-mail: dir.kaziranganp@gmail.com
	5. Shri Rabindra Sharma, Research officer, Kaziranga Tiger Reserve, Assam State Forest Department, Government of Assam. E-mail: kaziranga@gmail.com
Duration of the project	3 years (36 months)
Total budget outlay	INR 75,64, 010

SUMMARY

Protected areas are a cornerstone of global conservation strategies but their effectiveness is threatened by the intensification of land use in surrounding areas, which isolates the protected areas and damages their ecological function. When designing protected areas, an understanding of the relationship between local people and protected areas is critical. It is, particularly, vital to understand the conservation attitudes of the local communities, the historical use of protected area resources by the local communities, issues of land tenure, and the nature and cause of current conflict between the people and protected areas. The creation of the Kaziranga Tiger Reserve in 2007 and the improved protection measures taken by the Forest Department have boosted the conservation value of the area in terms of increased wildlife population and overall habitat status. However, it has adversely affected the Protected Area - People relationship. Further, the proposed creation of an Eco-sensitive Zone around the Reserve has created doubt in the minds of people, who have shown strong resentment towards the Forest Department and the Local administration. This is an obstacle in attaining the conservation goals envisioned while creating the Tiger Reserve and may be detrimental to future conservation objectives. This proposal aims to improve the relationship between the local communities and the Forest Department through the initiation of eco-development programmes and the development of alternate livelihood options. The primary objectives are to (a) Examine the patterns of interaction between the local communities and the protected areas with reference to resource dependency and human wildlife conflict, (b) Develop site-specific strategies for aligning local people' livelihoods with conservation priorities of KTR by examining their perception, attitudes and aspirations, (c) Identify and revive the existing formal and informal community level institutions or create new institutions to elicit the participation of local community, and d) Initiate and institutionalize the process of micro planning for conflict resolution and development of alternate livelihoods in select villages. The total outlay of the project is INR 75,64,010 for a three years period.

INTRODUCTION

Protected areas are a cornerstone of global conservation strategies (Stoner et al. 2007, Gaston et al. 2008) but their effectiveness is threatened by the intensification of land use in surrounding areas, which isolates the protected areas and damages their ecological functions (Hansen and DeFries 2007). When designing protected areas, an understanding of the relationship between the local communities and protected areas is critical. It is, particularly, vital to understand the conservation attitudes of the local communities, the historical use of protected area resources by the local communities, issues of land tenure and the nature and cause of current conflict between the people and protected areas. In many parts of the world, the conflict between local people and wildlife is probably the most serious problem faced by PAs. Conservation attitudes of the local communities living adjacent to protected areas are strongly influenced by problems with wildlife (Newmark and Leonard 1991, Newmark et al. 1993) and have been a source of long-standing conflict between local people and protected areas (Matzke 1975, 1976).

Since the United Nations Conference on Environment and Development held in Rio de Janeiro, in 1992, several attempts have been made to link PA management with developing sustainable livelihoods options for the local communities (Naughton-Treves et al. 2005). The underlying notion has been that the cost of conservation borne by the local communities would be offset by the monetary benefits derived from conservation activities, thereby minimizing the potential negative attitudes of the local communities towards conservation (Spiteri and Nepal 2008, Wells and Brandon 1992). Creation of PAs, especially parks that completely ban extractive resource use, has left forest dependent communities with few alternatives making them hostile towards conservation (Badola 1999, 2000, Brockington et al. 2006). Various community based conservation programmes, like Integrated Conservation and Development Programme (ICDP), have tried to mainstream these communities into the conservation of PAs, to improve their well-being and increase their stakes in PA conservation (Larson et al. 1992, Hughes and Flintan 2001).

The Convention on Biodiversity (CBD) recognizes the desirability of equitable benefit sharing from sustainable use of biological diversity. The primary objective of the Strategic Plan for Biodiversity, 2011-2020, is to conserve biodiversity and enhance its benefits for people. The Strategic Plan comprises of a shared vision, a mission, strategic goals and 20 targets, known as the Aichi Targets. The Aichi Targets reinforce CBD's goals by increasing the coverage of PAs and devising innovative schemes for sustainable and equitable alternative livelihoods for the forest dependent communities (CBD, 2011). In many developing countries, there are disputes related to the small contribution of PAs in sustaining the livelihoods of the local communities living adjacent to these areas compared to other land use practices This difference in contribution cause local communities to have a negative attitude towards wildlife conservation.

The Kaziranga Tiger Reserve (KTR) is one of the largest unmodified and undisturbed natural landscapes. It is situated on the southern bank of the pristine Brahmaputra River floodplains, in the foothills of the Mikir - Karbi Anglong range in the Nagaon and Golaghat districts of the state of Assam. The entire Kaziranga landscape has been formed by the alluvial deposits of the Brahmaputra River. The smaller tributaries of the Brahmaputra River, mainly Dhansiri and Difloo, originate in areas that receive heavy rainfall, *viz.,* Nagaland and the Karbi Anglong hills, and carry large amount of silt during the monsoon every year due to flooding. The area, formed by silt or sediment deposition, is colonized by *Saccharum* spp. and other grass species as soon as the landmasses stabilize. It has been observed that before the succession of other pioneer tree species could start on such landmasses, erosion takes place. Though data from geological studies is rare, it can be speculated that numerous channels of the Brahmaputra River, flowing through the area in the past, transformed into '*Beels*' (water bodies/lakes) of various sizes and depth by silt/sediment deposition. This process of erosion and accretion is still going on along the Northern Boundary of KNP.

Kaziranga, originally notified as a Reserve Forest in 1908, is among the oldest conservancy in the country established for the conservation of the Indian one-horned rhinoceros. It was declared as a Game Reserve in 1916, opened to tourists in 1938 and declared as a Wildlife sanctuary in 1950. Kaziranga was notified as a National Park in 1974 under the Assam National Park Act, 1968, making it the single largest protected area in the North-east Brahmaputra valley. In 1985, due to its outstanding conservation value, the Kaziranga National Park (KNP) was inscribed on the UNESCO World Heritage List of 'Convention Concerning the Protection of the World Cultural and Natural Heritage' (Mathur et al. 2005).

The Government of Assam notified a number of Additions to KNP in order to secure corridors for migration of wildlife and escape routes in case of high flooding and to include the river islands, locally known as '*chapories'*, in Brahmaputra to compensate for loss of park area due to erosion. There were six Additions, 1st and 4th Additions falling in the Kaliabor sub division of Nagaon District, 2nd, 3rd and 5th Additions falling in the Bokakhat sub division of Golaghat District and the 6th Addition in the Sonitpur District. The total area of the originally notified park, together with all its six Additions, is around 884.43 km^2. KNP with its additions was declared a "Tiger Reserve" in 2007. The core area of Kaziranga Tiger Reserve (KTR) comprises of the originally notified KNP and the 1st, 2nd, 3rd and 5th Additions to KNP and has a notified area of 482.03 km^2, while the buffer area consists of the 4th and 6th Additions to KNP, Panbari RF, Kukarakata RF, Bagser RF, Laokhowa and Bura Chapori Wildlife Sanctuary and has a notified area of 573.85 km^2.

Park-People Relation

The status of Kaziranga as a National Park, Tiger Reserve and UNESCO world heritage site has limited the rights and activities of local communities inside the reserve. Additionally, the Forest Department is working towards conserving the forest and its resources and has restricted the local communities from extracting the resources. This has led to conflict between the Park management and local communities. Further, the proposed creation of the Eco-sensitive Zone around the Reserve has increased the conflict between the local communities and the Forest Department and Local administration. This is an obstacle in attaining the conservation goals envisioned while creating the Tiger Reserve and may be detrimental to future conservation objectives.

The KTR is surrounded by a large constituency of villages. The southern side of KTR has two important townships *viz.* Bokakhat in the Golaghat district on the east and Kaliabor in the Jakhlabandha block of Nagaon district on the west, that constitute 127 villages. Similarly, on the northern side, there are the emerging townships of Biswanath, Halem and Gohpur that constitute around 285 villages. People living on the periphery of the southern and northern boundaries of KTR depend upon both agriculture and forest resources for their livelihood. The 1st Addition is occupied by grazers while the stable chapories of the 6th Addition area are encroached by graziers and cultivators (Kushwaha 2008). The main communities residing in the region are the Mishing, Karbi and Nepali tribes, the Muslims and the Assamese, who form the largest community. These communities are primarily dependent on agriculture for their subsistence. The Mishing community is one of the major tribal communities in the area and their socio-economic condition is poor. Apart from agriculture, which is their principal source of livelihood, they also rear livestock like buffaloes and pigs to supplement their income. There are Karbi villages in the western part of the zone of influence whose livelihood is also agriculture oriented. They also collect herbs and building materials from the reserve forests. The Nepali community consists mainly of graziers. The Muslim communities are also mainly dependent on agriculture with some of them resorting to illegal fishing, a major concern for the Park managers.

A study conducted by the Wildlife Institute of India (WII) on the southern side of Kaziranga has established some baseline information on the impact of the activities of the local communities on the Tiger Reserve. The study suggests that the southern (N=29) and northern (N=2) sides of the Reserve is subjected to very high anthropogenic pressure in terms of resource extraction.

During the dry season, villagers often use the Park for livestock grazing, which affects the amount of forage available for the mega herbivores. Such infiltration of domestic cattle also increases the risk of spread of disease among wild animals, as most of the cattle are not properly immunized. There is also a risk of losing genetic distinctness among the wild buffaloes due to entry of domestic buffaloes into the Park. The riverine stretch towards the north has a large number of *khutis* (domestic buffalo camps) and temporary fishing camps on the *chapories* or char (Choudhury 2004).

The local communities residing in the zone of influence are facing several problems:

- Abolition of the traditional access to forest resources in the Protected Area.

- Annual floods that cause tremendous hardship to the local communities and force them to collect resources illegally from the Park.
- Poor economic status of villagers forces them to indulge in illegal activities such as biomass collection from the Protected Area.
- Poor education and awareness resulting in lack of sensitivity among the people towards wildlife as is seen during the floods. During flooding, when animals are forced to go out of the Park in search of higher grounds; crop raiding, human death/injury and damage to houses and properties by the wild animals occur, which lead to increased instances of poaching and incidental mortalities.

Due to the aforementioned activities of the local communities and the restrictions placed by the Forest Department, hostility has increased between the local communities and the park management, which could be detrimental to the conservation goals. Therefore, there is need to develop and improve the Park-people relationship for the successful protection of KTR. Reduction of dependency on forest resources, by developing alternative livelihood for the forest dependent communities and improving existing livelihood activities through value addition of goods conventionally traded by local communities, is an effective approach for strengthening the local economy and the relation of these communities with the Park management. To achieve this, existing local institutions will be revived and constituted as Eco-development Committees (EDC). Establishment of EDCs will give local communities a direct say in conservation activities, keeping in mind their role as resource users, and will form the basis of Participatory Action Research in the area.

OBJECTIVES

Keeping in view the above background, the proposed objectives are to:

1. Examine the patterns of interaction between the local communities and the protected areas with reference to resource dependency and human wildlife conflict.
2. Develop site-specific strategies for aligning local people' livelihoods with conservation priorities of KTR by examining their perception, attitudes and aspirations.
3. Identify and revive the existing formal and informal community level institutions or create new institutions to elicit the participation of local community.
4. Initiate and institutionalize the process of micro planning for conflict resolution and development of alternate livelihoods in select villages.

METHODOLOGY

Both primary and secondary data will be used for the study. The sample villages will be chosen on the basis of reported higher forest dependency of local communities, severe negative human-wildlife interface, people-park management conflicts and low socio-economic status of the villagers. The information will be collected from the Forest department, Revenue department and published literature. Focus group discussions with key government departments and local people will be carried out.

Objective 1: Examine the patterns of interaction between the local communities and the protected area with reference to resource dependency and human wildlife conflict.

The data on the socioeconomic status of the local communities and their dependency on forest resources will be collected in three stages (Hussain and Badola 2003) through interview based semi-structured questionnaires, review of secondary information, collection of information from local offices and participant observation method (Sinha and Badola 2006, Badola and Silori 1999). In first stage, a reconnaissance survey will be conducted in the study area to gain first-hand knowledge about the major forest types, locations of villages, pattern of dependence on forest resources etc. Secondary data regarding access to facilities such as Primary Health Centres, schools, transportation, fuel distribution centres, types of roads, livestock information, land utilization, demographic profile of the villages, location and distribution of villages with respect to forest and their dependency on forests for fuel wood, fodder, non-timber forest products etc. will be collected.

Secondly, based on the reconnaissance survey and secondary data, villages for primary data collection will be identified using hierarchical cluster analysis (HCA) (Gavin and Anderson 2007). In selected villages, data on demographic, social and ecological aspects will be collected. The information on dependence pattern of households collected during interviews will be validated by conducting seasonal entry point monitoring and participant observation method (Badola et al. 2014).

Information on instances of human-wildlife interface will be gathered by triangulation *viz.* forest department reports and records, formal and informal discussions and personal interviews with the villagers and by visiting the site of incident. Satellite imagery and ground truthing will be used to gather information on landscape descriptors (Rood et al. 2008). Resource use categories and incidences of human wildlife interaction will be delineated using satellite images and GPS. This exercise will provide existing and predictable spatial distribution of pattern of resources use and human wildlife interaction in the area (Naughton-Treves 1997, Naidoo and Ricketts 2006, Mackenzie and Ahabyona 2012).

Objective 2: Develop site-specific strategies for aligning local people' livelihoods with conservation priorities.

Similar interview based questionnaire survey will be conducted, as mentioned in the above objective, but emphasis will be given on the attitude and perception of local communities towards conservation. In addition, focus group discussions will be held to understand the awareness level, attitude and perception of local communities towards wildlife, protected area and current management regime. Participation from all the social and economic classes will be ensured. Questionnaire will include both open and close ended questions as it will help in generating holistic information on the attitude and understand the actual need and requirement of local communities. This information will be further used to develop sustainable and effective livelihood strategies for the villagers of KTR.

Questionnaire will be tested in the field and correction will be incorporated accordingly to avoid the personal and respondent biasness which occur by a propensity of people to choose the first option provided in the questionnaire (Sodhi et al. 2010).

Objective 3: Identify and revive the existing formal and informal community level institutions or create new institutions to elicit participation of local community.

Following Ostrom et al. (1994) and Ostrom (2009), institutional analysis will be carried out to identify the formal and informal institutions. Villages and forest dependent families within villages, identified in the reconnaissance and questionnaire surveys, will be stratified into different groups based on their resource use intensity and socio-economic status. Workshops and interactive meetings will be organized with the identified groups and through dialogue, major questions and actions will be decided. In such meetings, the proposal of creation or revival of community level institutions (CLI) will be presented. Existing self-help groups (SHG), or women's group will be identified and constituted as Eco-development committees (EDC), as was done in the Greater Himalayan National Park (Mishra et al. 2009). Micro plans will be made for these identified villages and livelihood activities will be initiated through these CLIs. CLIs in the nearby areas will be visited to learn about their strengths and weaknesses. Formal and informal discussion sessions will be held with experienced SHG leaders. Through a number of meetings, an initial organizing committee will be formed with people who share interest and tasks will be decided for each member. CLIs, thus created, will provide a much needed link between the forest department and the local communities. A feedback and evaluation mechanism will be created for measuring the success of the activities carried out through these institutions (Ostrom et al. 1993, Webb and Shivakoti 2008). Also, micro-financing schemes will be initiated to empower the communities and make them self-reliant.

Objective 4: Initiate and institutionalize the process of micro planning for conflict resolution and development of alternate livelihoods in select villages.

Information generated through the three step survey, as mentioned under objective one, will provide an understanding of the current occupational pattern and the livelihood aspirations. This information will be used for identifying locally suited and conservation oriented alternative livelihood options for the region. The information generated on institutional arrangements will also assist in identifying few target villages, the second objective. Also, the Biodiversity Management Committees (BMCs), if constituted within the proposed study sites, will be taken up for the initiation and institutionalization of benefit sharing, as per rules laid down by Assam Biodiversity Board, and benefit sharing mechanisms, as per guidelines laid down by MoEFCC (2014). A feedback and evaluation mechanism will be created for measuring the success of the activities carried out through these institutions (Ostrom et al. 1993, Webb and Shivakoti 2008). Micro-financing schemes will also be initiated to empower the communities and make them self-reliant.

EXPECTED OUTPUTS AND DELIVERABLES

1. A better understanding of the nature and quantum of resource dependency issues that are causing conflict. Improved understanding on the mindset of the local communities, with specific regard to conservation efforts and reduced access to forest resources, for formulating strategies for the management of KTR.
2. A spatial distribution of intensity of human wildlife conflict in the landscape.
3. Culturally acceptable alternate livelihood options to foster positive attitude among the local communities towards conservation and KTR management. It would also improve their economic status without hampering the conservation goals.
4. Revival of existing or traditional institutions and village level Institutions will strengthen the social ties.
5. Micro-plans for selected villages will be prepared for implementation by the Forest Department.

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PROPOSED PROJECT OUTLAY (INDIAN RUPEES)
COMPONENT 1

BUDGET HEAD	Rate (INR)	Unit	Year 1 (INR)	Year 2 (INR)	Year 3 (INR)	Total (INR)
MANPOWER						
Project Fellow (@ Rs. 25000 + HRA 20% + Other Allowances)	35000	2	840000	840000	840000	2520000
Field Assistants	10000	2	240000	240000	240000	720000
TOTAL MANPOWER	**45000**	**4**	**1080000**	**1080000**	**1080000**	**3240000**
EQUIPMENTS AND CAPITAL						
GPS	10000	2	20000	0	0	20000
Digital camera with accessories	30000	1	30000	0	0	30000
Laptop	60000	1	60000	0	0	60000
TOTAL EQUIPMENTS	**100000**	**4**	**110000**	**0**	**0**	**110000**
OPERATIONAL						
Workshop and consultative meeting	-	-	60000	60000	50000	170000
Base camp establishment & maintenance	7150	-	85800	85800	85800	257400
TOTAL OPERATIONAL		**0**	**145800**	**145800**	**135800**	**427400**
CONSUMABLES						
Contingency, basic camping equipment and miscellaneous	-	-	200000	50000	50000	300000
Hiring of Field vehicle per month		2	600000	400000	400000	1400000
POL		-	300000	300000	200000	800000
TOTAL CONSUMABLES			**1100000**	**750000**	**650000**	**2500000**
TRAVEL						
Accommodation & travel	-	-	200000	50000	50000	300000
TOTAL TRAVEL		**0**	**200000**	**50000**	**50000**	**300000**
TOTAL (A)			2635800	2025800	1915800	6577400
Institutional charges @15% (B)			395370	303870	287370	986610
GRAND TOTAL (A+B)			**3031170**	**2329670**	**2203170**	**7564010**

COMPONENT 2

MANAGEMENT OF INVASIVE SPECIES IN WET GRASSLANDS OF KAZIRANGA TIGER RESERVE, ASSAM

भारतीय वन्यजीव संस्थान
Wildlife Institute of India

PROJECT PROPOSAL FOR FUNDING SUPPORT	
Title of the project	**MANAGEMENT OF INVASIVE SPECIES IN WET GRASSLANDS OF KAZIRANGA TIGER RESERVE, ASSAM**
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	5. Shri Rabindra Sharma, Research officer, Kaziranga Tiger Reserve, Assam State Forest Department, Government of Assam. E-mail: kaziranga@gmail.com
Duration of the project	3 years
Total budget outlay	INR 80, 30,000

SUMMARY

Species invasion is considered as one of the major threats to biological diversity. A large proportion of area in Kaziranga Tiger Reserve (KTR) has been affected due to the invasion of exotic weeds like *Mikania micrantha, Rosa acicularis* and *Mimosa invisa*, which may lead to the reduction in the available biomass for large herbivores like the Greater Indian one horned rhinoceros (*Rhinoceros unicornis*). There is also an increasing evidence of invasion by native woody species, such as *Bombax ceiba*, in the Park. Such invasions are affecting the integrity of the wet grassland habitat in terms of productivity of the palatable species for herbivores. The present study aims to develop techniques for eco-restoration of wet alluvial grasslands and control alien invasive species from KTR. The major objectives are to (a) examine the extent of wet grassland areas affected by the exotic as well as native invasive plant species in KTR, (b) develop strategies to eradicate the invasive species in the Reserve by developing innovative tools and techniques, (c) demonstrate restoration of the degraded grassland habitats by adopting pilot restoration sites, and (d) conduct training and capacity building programmes for the frontline staff of the Forest Department to promote scientific management of invasive species. The total outlay of the project is INR 80,30, 000 for a three years period.

INTRODUCTION

Biological invasion is considered as one of the most serious anthropogenically mediated ecological perturbation that is threatening native biodiversity, preventing natural ecological succession and changing the community structure and composition, besides impacting ecosystem services across the globe (Love et al. 2009). Invasive species can be any plant, animal, or pathogen that is non-native to an ecosystem that has recently entered the new area and is spreading at a rapid rate. In other words, it is defined as "*species whose introduction and/or spread outside their natural past or present distribution threaten biological diversity*" (CBD 1992). The common characteristics of Invasive species include rapid reproduction and growth, high dispersal ability, phenotypic plasticity (ability to adapt physiologically to new conditions) and ability to survive on various food types and in a wide range of environmental conditions (CBD 1992). In fact, the Convention on Biological Diversity (CBD 1992) recognizes biological invasion as the second most important causal factor for the loss of biological diversity in natural ecosystems across the world, and thus, the management of invasive alien weeds in any ecosystem is critical for the conservation of biological diversity.

One of the solutions to this problem is to target select invasive species and develop a well-planned strategy to eradicate them from the ecosystem and restore the habitat.

Natural grasslands are formed in regions where climatic and edaphic factors prohibit growth of trees (Clements et al. 1939). The annual floods have shaped the structure and functions of the wet grasslands of the Ganga and Brahmaputra flood plains. Most of these grasslands are highly productive and dynamic. Hence, they are pre-climax (Champion and Seth 1968). Maintenance of these mid successional grasslands, especially as a wildlife habitat to protect some of the key grassland species, depends upon careful planning and management of these grasslands (Rodgers et al. 1988, Rahmani et al. 1997). Therefore, conservation and management of grassland habitat in the Indian subcontinent is a major challenge for the managers of protected areas.

KAZIRANGA TIGER RESERVE

The Kaziranga Tiger Reserve (KTR) is one of the largest undisturbed natural landscapes. It is situated on the southern bank of the Brahmaputra River, in the foothills of the Mikir Karbi Anglong range in the Nagaon and Golaghat districts of Assam. The entire Kaziranga landscape has been formed by the alluvial deposits of the Brahmaputra River. The smaller tributaries of the Brahmaputra River, mainly Dhansiri and Difloo, originate in areas that receive heavy rainfall, namely Nagaland and the Karbi Anglong hills, and carry large amount of silt during the monsoon season every year due to flooding. The area, formed by silt or sediment deposition, is colonized by *Saccharum* spp. and other grass species as soon as the landmasses stabilize. Sometimes, it has been observed that before the succession of other pioneer tree species could start on such landmasses, erosion takes place. Though data from geological studies is rare, it has been suggested that numerous channels of the Brahmaputra River, flowing through the area in the past, transformed into '*Beels*' (water bodies/ lakes) of various sizes and depth by silt/sediment deposition, which later turns in to wet grasslands.

About 64% area of Kaziranga, particularly the western Bagori range, is occupied by wet grasslands that include both tall and short grass communities. Rowntree (1954) classified the grasslands of Assam into two plant communities, i.e. (i) *Imperata – Saccharum – Themeda* and (ii) *Alpinia – Phragmites- Saccharum*. The former develops on higher well drained lands whereas the latter develops on the recent alluvial deposits by the rivers on the flood plains, where *Bombax ceiba* and *Albizia procera* are common tree associates. Tall grasslands consist mainly of *Saccharum* spp*., Saccharum ravennae, Arundo donax, Phragmites karka, Imperata cylindrica, Neyraudia reynaudiana*. These grasses occupy newly formed areas along the river course and wetlands along with *Tamarix dioica* (Vasu and Singh 2015).

History of Kaziranga Tiger Reserve

Kaziranga, originally notified as a Reserve Forest in 1908, is among the oldest conservancy reserves in the country for the conservation of the Vulnerable Indian one-horned rhinoceros that had an estimated population of not more than 20 pairs in 1905. It was declared as a Game Reserve in 1916, opened to tourists in 1938 and declared as a Wildlife sanctuary in 1950. Kaziranga was notified as a National Park in 1974 under the Assam National Park Act, 1968, making it the single largest protected area in the North-east Brahmaputra valley, Bio-geographical Province 9A. In 1985, due to its outstanding conservation value, the Kaziranga National Park (KNP) was inscribed on the UNESCO World Heritage List of "Convention Concerning the Protection of the World Cultural and Natural Heritage", under criteria N (ii) and N (iv) (Mathur et al. 2005). The KNP with its additions was declared a "Tiger Reserve" in 2007.

The area of Kaziranga in 1908 was 228.82 km^2. Due to certain Additions and deletions in 1911, 1913 and 1917, the net area of Kaziranga increased to 433.12 km^2 in 1917. Haldibari was added in 1967, taking the total notified area to 433.73 km^2. To afford better protection, additional areas such as the left bank of the Mori Difloo, Mori Dhansiri, Garumarajan and parts of Sildubi PGR were added in the preliminary notification issued in 1969. When Kaziranga was declared a National park in 1974, its notified area was 429.93 km^2. The reduction in net area can be attributed to the constant erosion by the Brahmaputra River that formed the northern boundary of the park, on its south bank.

The Government of Assam had notified a number of Additions to KNP in order to secure corridors for migration of wild animals and escape routes in case of high flooding and to include the *chapories* (River Island) in Brahmaputra to compensate for loss of park area due to erosion. There were six Additions, 1st and 4th Additions falling in the Kaliabor sub division of Nagaon District, 2nd, 3rd and 5th Additions falling in the Bokakhat sub division of Golaghat District and the 6th Addition in the Sonitpur District. The total area of the originally notified park, together with all its six Additions, is around 884.43 km^2. The core area of Kaziranga Tiger Reserve (KTR) comprises of the originally notified KNP and the 1st, 2nd, 3rd and 5th Additions to KNP and has a notified area of 482.03 km^2, while the buffer area consists of the 4th and 6th Additions to KNP, Panbari RF, Kukarakata RF, Bagser RF, Laokhowa and Burachapori Wildlife Sanctuary and has a notified area of 573.85 km^2.

PROBLEMS AND ISSUES

Grasslands are highly dynamic ecosystems encompassing all natural and semi-natural pastures, woodlands, scrubs and steppe formation dominated by grasslands and grass like plants (Blair et al. 2014, Vasu and Singh 2015). The wet alluvial grasslands of KTR form important key habitats for many globally threatened and rare species of mammals, birds and reptiles. In recent years, this unique ecosystem is declining drastically due to changes caused by erosion, anthropogenic pressure and invasion by invasive species like *Mimosa invisa*, *Mikania micrantha* and *Rosa* sp. The invasion on the grassland by these species is reducing the availability of quality forage for the herbivore assemblage of KTR. About 43% of KTR has already been degraded by two species of Mimosa belonging to family Mimosaceae, *viz. M. diplotricha* and *M. invisa* (Vattakkavan et al. 2002, RFRI 2011, Vasu and Singh 2015). The two species entwine with the tall grasses such as *Saccharum* spp., up to several metres high, resulting in the destruction of tall grassland habitats as well as hampering the free movement of wild animals. Mimosin, a harmful toxin present in *Mimosa* spp., is known to affect herbivore population, particularly ruminants (Mathur et al. 2005). *Mimosa* spp. invasion started in the grasslands of the Bagori Range (western range) of the park in the mid-1990s and later spread all over the park (Vasu and Singh 2015). They spread mostly through the dispersal of seed, which is facilitated by vehicular movements and annual flooding, coupled with high soil moisture condition and favorable temperature for its growth and regeneration in the park (Lucia et al. 2004). They are fast growing as indicated by its high regeneration status, ranging between 270 and 780 individuals per sq meter (RFRI, 2011). Same as *Mimosa* spp., many other plant species like *Mikania micrantha, Rosa acicularis, Chromolaena odorata* and *Ipomoea carnea* have been identified as invasive species that are severely affecting the integrity of the park in terms of productivity potential and species structure and composition. In recent years, *Bombax ceiba*, though native to the flood plains of India, has become invasive in many areas of the Park, especially in the Bagori range. Controlling the proliferation of invasive species and management of habitat in order to sustain its productivity is a growing challenge for the Park Management.

As a part of management practice, controlled burning has been carried out every year by the forest department to discourage the growth of tree saplings and invasive species so as to maintain the forage quality for herbivores. However, this management intervention has not been helpful, especially in the case of proliferation of various weeds, like *Mimosa diplotricha, M. invisa, Mikania micrantha, Rosa acicularis, Chromolaena odorata* and *Ipomoea carnea*. To address and control the problem of species invasion, it is important to develop scientific management techniques and methods that directly help in restoring and maintaining the ecological and biological integrity of the affected habitats in the park. The major constraint in management of the park is the lack of scientific data on invasive species and the effect of different management practices.

ECOLOGICAL RESTORATION OF WET GRASSLANDS

Restoration refers to returning a degraded habitat back to its pre-existing condition or as close to natural conditions as possible (Lewis 1990). Knowledge of the principles and techniques for wetland creation and restoration is one of the qualifications required of modern landscape managers. Two basic principles are involved in restoration, firstly, an understanding of wetland ecology and principles (e.g. hydrology, biogeochemistry, adaptations and succession) and, secondly, managers dealing with restoration must resist the ever present temptation to over engineer by attempting either to channel natural energies that cannot be channeled or to introduce species that the landscape or climate do not support.

This study aims to restore the sites invaded by invasive species in the wet grasslands of KTR. In some areas of the reserve, the invasion is to such an extent that it has changed the community structure of the habitat, thereby, making it unfavorable to the huge assemblage of animals surviving on it. The best strategy is to introduce, by seeding and planting, as many choices as possible to allow natural processes to sort out species and communities in a timely fashion (Mitsch and Gosselink 2000). The changes in soil properties and hydrological regime, time elapsed under intensive management, together with ever-increasing distances from propagules, make it unlikely for disturbed grassland ecosystems to revert back to species-rich wet grassland vegetation without intervention (Manchester et al. 1999).

Keeping this in view, present study proposes to develop innovative scientific methods for the eradication of invasive species *viz. Mimosa diplotricha, M. invisa, Mikania micrantha, Rosa acicularis, Chromolaena odorata* and *Ipomoea carnea*, in order to improve different management regimes related to grassland communities. The study will also provide baseline information on sound scientific tools and techniques for better management and conservation of the different grassland habitats of KTR.

Mimosa invisa: It is a fast growing; thorny, perennial shrub with angular branching stems that become woody with age. Once established, it becomes difficult to control. Their seeds are typically dispersed in two ways — carried downstream during floods or transported by animals or machinery. Moreover, it is reported to be poisonous to herbivores and considered to be one of the most serious alien invasive species (IUCN/ISSG database). The invasion of Mimosa has emerged as a major threat in KNP (Vattakkavan et al. 2002).

Mikania micrantha*:* It is a perennial creeping climber known for its vigorous and rampant growth. It grows best where fertility, organic matter, soil moisture and humidity are high. It damages or kills other plants by cutting out the light and smothering them and competing for water and nutrients. A native of Central and South America, it was introduced to India after

World War II to camouflage airfields. Once established, it spreads at an alarming rate, readily climbing and twining on any vertical support, including crops, bushes, trees, walls and fences. It is believed that the plant releases substances that inhibit the growth of other plants (IUCN/ISSG database).

Chromolaena odorata: It is a perennial shrub species native to Neotropical America, stretching from Southern Florida to the upper drainage basin of the Amazon in Southern Bolivia. IUCN's Invasive Species Specialist Group has identified it as one of the hundred worst invaders. It is considered as an alien invasive species, particularly in Rhinoceros habitat (Lakher et al. 2011).

Ipomoea carnea: It is commonly known as Pink Morning Glory and is of American origin. This flowering plant can be easily grown from seeds that are toxic and can be hazardous to herbivores (USDA database). It is considered as an alien invasive species, particularly in Rhinoceros habitat (Lakher et al. 2011).

Rosa acicularis: It is a medium to tall shrub rose, commonly known as prickly wild rose, found in the northern regions of Asia, Europe and North America. It is considered as an alien invasive species, particularly in rhinoceros habitat (Lakher et al. 2011).

Bombax ceiba: It is a native cotton tree with large red flowers. The genus *Bombax* is native to India, tropical southern Asia, northern Australia and tropical Africa. Recently, in the western range of KTR, this tree species has become invasive, invading the grassland in an alarming proportion. It is changing the habitat of the tall grassland area by hampering the growth of native grass species and affecting the grassland productivity.

OBJECTIVES

In view of the above discussion, the following objectives have been put forward for the present study:

1. To examine the extent of wet grassland areas affected by the exotic as well as the native invasive plant species in Kaziranga Tiger Reserve (KTR).

2. Develop strategies to eradicate the invasive species in the Reserve by developing innovative tools and techniques.

3. Demonstrate restoration of the degraded grassland habitats by adopting pilot restoration sites.

4. Conduct training and capacity building programmes for the frontline staff of the Forest Department to promote scientific management of invasive species.

METHODOLOGY

Objective 1: To examine the extent of wet grassland areas affected by the exotic as well as the native invasive plant species in KTR.

Sites will be selected on the basis of degree of invasion as reported by the KTR authorities and accessibility. To examine the extent of exotic species as well as native invasive plants, sites will be identified based on the moisture gradient, as these sites have different inundation regimes. In each regime, 3-4 sites will be selected and in each site 20 m x 20 m permanent plots will be laid to see the patterns of invasion of tree species and four 5 m x 5 m plots (in corners) for tree saplings and seedlings along with invasive shrub and herb species will be laid. In each site, two belt transects of size 1 m X 500 m will be randomly laid and on each transect ten segments of size 1 m x 1 m, with a gap of 30 m between two segments, will be laid to see the distribution of invasive plant species (Bezbarua et al. 2003). Percentage cover of grass, herb and shrub and sapling and seedling will be recorded to derive the extent of invasion.

Additionally, RS & GIS approach using LISS IV image along with the use of DEM, aspect and cloud cover will be done to get the extent and area coverage of different invasive species followed by field surveys based on model based distribution assessment. For statistical assessment, software R will be used and distribution mapping will be done through Maxent/GARP suitability modeling.

Objective 2: Develop strategies to eradicate the invasive species in the Reserve with innovative tools and techniques.

Seasonally flooded grasslands are subject to varied period and degree of inundation. The seeds, seedlings and saplings have different response to the inundation regime. Flood plain grasslands are often composed of a mosaic of plant communities controlled by the hydrological regimes. Flooding during monsoon and drying in winter and summer trend is characterized by increased species diversity, a greater abundance of competitive species and fewer typical wetland plants. The prolonged dry period often induce the establishment of certain woody vegetation such as *Bombax ceiba*. The different invasive species will be subjected to different inundation regimes at the seedling and sapling stages in order to study the effect of annual flooding in KTR. Three adjacent plots of 10 m X 10 m will be constructed and treated with different inundation regimes. This experiment will help in understanding the spread of invasive species in response to the different inundation regimes occurring in the Reserve due to variation in rainfall and flooding regime. Additionally in experimental areas, manual removal of invasive species will be carried out in different moisture regimes. Once priority areas are identified and assessed, a systematic removal program will be conducted for different levels and priority of invasion.

Objective 3: Demonstrate restoration of the degraded grassland habitats by adopting pilot restoration sites.

The following techniques will be used (Love et al. 2009) to remove the identified invasive species: (a) Hand pulling, (b) Slashing/ chopping of stems, (c) Burning, and (d) Manual grubbing with substantial removal of the root system, especially during early monsoon and immediately after monsoon.

Hand Pulling: With the help of an axe the entire plant will be uprooted, especially young plants in species like *Mikania* sp and *Mimosa* spp.

Slashing/ chopping of stems: This method is mainly used for the removal of woody species like *Bombax, Ipomea* and *Rosa*, wherein the entire stem of the plant is slashed, uprooted and chopped with the help of an axe.

Burning: “Controlled” or "prescribed" burning will be used to reduce invasive and woody plant density and competition, stimulate the growth of native plants, return nutrients to the soil, promote germination of dormant seeds and enhance wildlife habitat. As the name suggests, "controlled" or "prescribed" burnings are carried out only under specific weather and fuel-related conditions that ensure an effective burning and the safety of the burning crew and the surrounding area.

Manual grubbing with substantial removal of the root system: Entire root system will be removed by digging. For highly invaded sites, complete eradication technique will be used i.e. cutting the main tap root of the plant beneath the ‘coppicing zone’ (transition zone between stem base and rootstock). This method of removal involves the engagement of 2–3 individuals, working as a unit. For active restoration programme, plantation of native grass species will be encouraged at select severely degraded sites. Plantation of native plant species will be done from seedlings and seeds of grasses developed in nurseries. After plantation, the area will be fenced so that it can be protected from any form of disturbance, including grazing by wildlife, till the plantations are established (Love et al. 2009).

Objective 4: Conduct training and capacity building programmes for the frontline staff of the Forest Department to promote scientific management of invasive species.

For post-management monitoring, different forest staff will be trained and training workshops will be conducted to address and improve the management techniques of the grasslands. Continuous monitoring of the site is advised with regenerating individuals removed at a vulnerable stage. Weeding will be continued if young plants are detected. This monitoring will have to be annual and at least for the duration of 5 years, as Ramaswamy (2014) found that plants regenerate after two years of continuous management. The reinvasion of that site has to be stopped by managing each site. A manager must keep in mind that none of these methods are likely to achieve complete eradication as seed sources are often located in surrounding agricultural, urban or forest areas as well. Hence, even after most of the invaded areas are restored, it is essential to periodically monitor the sites, which will be achieved through the forest guard capacity building approach.

EXPECTED OUTPUT AND DELIVERABLES

The study is relevant for the scientific management of eastern wet-alluvial grasslands of KTR. This study will help in developing:

- A geographical approach that will provide potential areas of distribution where invasiveness of an alien species is suspected.
- Preventive risk assessments and alternative management practices based on geographical attributes to conserve the native biodiversity.
- Early detection of spread by invasive alien species.
- Pilot restoration of important grassland habitats degraded by invasive species
- Trained frontline staff for controlling invasive species.

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PROPOSED PROJECT OUTLAY (INDIAN RUPEES)

COMPONENT 2

BUDGET HEAD	Rate (INR)	Unit	Year 1 (INR)	Year 2 (INR)	Year 3 (INR)	Total (INR)
MANPOWER						
Project Fellow (@ Rs. 25000 + HRA 20% + Other Allowances)	35000	2	840000	840000	840000	2520000
Field Assistants	7000	4	336000	336000	336000	1008000
Occasional Labour and miscellaneous	-	-	50000	25000	25000	100000
TOTAL MANPOWER	**42000**	**6**	**1226000**	**1201000**	**1201000**	**3628000**
EQUIPMENTS AND CAPITAL						
Weeding Hoe, Hedge Shear, Axe, Sickel, and other hand tools.	-	-	100000	100000	0	200000
Chain Saw	25000	2	50000	0	0	50000
GPS	20000	2	40000	0	0	40000
Digital camera with accessories	30000	2	60000	0	0	60000
Laptop	68609	1	68609	0	0	68609
TOTAL EQUIPMENTS	**135000**	**8**	**318609**	**100000**	**0**	**418609**
OPERATIONAL						
Earthernwork, Green house etc	-	-	300000	100000	50000	450000
Training Workshop	-	-	25000	0	25000	50000
Base camp establishment & maintenance	7000	-	84000	84000	84000	252000
TOTAL OPERATIONAL	**7000**	**0**	**409000**	**184000**	**159000**	**752000**
CONSUMABLES						
Stationary	-	-	50000	50000	50000	150000
Contingency, basic camping equipments and miscellaneous	-	-	50000	25000	25000	100000
Hiring of Field vehicle per month	25000	1	300000	300000	300000	900000
POL	19000	-	228000	228000	228000	684000
TOTAL CONSUMABLES	**45000**	**2**	**628000**	**603000**	**603000**	**1834000**
Travel & Field visits						
Accommodation and travel	-	-	70565	120696	158739	350000
TOTAL TRAVEL	**-**	**0**	**70565**	**120696**	**158739**	**350000**
TOTAL (A)		**16**	**2652174**	**2208696**	**2121739**	**6982609**
Institutional Charges @ 15% (B)			397826.1	331304.4	318260.9	1047391
GRAND TOTAL (A+B)			**3050000**	**2540000**	**2440000**	**8030000**

COMPONENT 3

CONNECTING THE DOTS: FINDING DISPERSAL CORRIDORS FOR TIGERS IN KAZIRANGA – KARBI ANGLONG LANDSCAPE




भारतीय वन्यजीव संस्थान
Wildlife Institute of India

Title of the project	**CONNECTING THE DOTS: FINDING DISPERSAL CORRIDORS FOR TIGER IN KAZIRANGA – KARBI ANGLONG LANDSCAPE**
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Duration of the project	3 Years
Total budget outlay	INR 1,73,50,000

SUMMARY

The scale of biodiversity loss and its causes require conservation efforts at the landscape level. In the face of global threats, large-landscape conservation has become established as a science-based response to large scale habitat fragmentation and degradation. Connectivity among habitats and populations is considered a critical factor determining a wide range of ecological phenomena. Preserving and restoring connectivity has become a major conservation priority, and conservation organizations are investing considerable resources to achieve these goals.

The Kaziranga - Karbi Anglong Landscape (KKAL) is situated within the Indo-Burma biodiversity hotspot. In recent years, this landscape is getting increasingly fragmented due to establishment of human settlements, increasing biomass demand, expansion of agriculture practices, networks of roads and railways and other developmental activities. The vision for this biodiversity-rich and culturally-diverse landscape is to ensure that large mammals, especially tigers, elephants and rhinoceros, persist in connected ranges with minimal human-wildlife conflict. The Kaziranga Tiger Reserve (KTR) is the largest protected area complex in this landscape. The decades of conservation efforts, primarily in Kaziranga and its surrounding areas, have secured the large mammal populations in the Reserve. However, with the increasing wildlife populations in the KKAL, there is a need to strengthen the conservation efforts in the sinks so as to maintain the appropriate metapopulation dynamics of the large mammals.

For this study, we intend to work out a subordinate landscape within KKAL, comprising of KTR and surrounding Protected Area complexes. The main aim of this project is to measure the structural diversity of KKAL, identify patches that act as movement corridor or have potential to facilitate large mammal movement and identify critical points along these corridors with high probability of negative human-wildlife interface. The following objectives have been set forth, (a) Delineate possible corridors linking KTR with surrounding landscape and Intra spatial connectivity that maintain the gene flow of large mammals in KKAL, (b) Assess the biophysical conditions of these corridors and connectivity in terms of their structure and composition (habitat quality), (c) Examine the functionality of these corridors in terms of their suitability for maintaining dispersal of large mammals, especially tigers, in order to maintain metapopulation dynamics, (d) Identify critical points along the corridors with high probability of negative human-wildlife interface, and (e) Develop mechanisms to minimize human – wildlife conflict in the landscape through community involvement and innovative conflict resolution techniques. The total outlay of the project is INR 1,73,50,000 for a three years period.

INTRODUCTION

The scale of biodiversity loss and its causes require conservation efforts at the landscape level. Among the major drivers of modern species loss are changes in land use that result in habitat loss, degradation, and fragmentation (Sodhi et al. 2009). These processes and other human impacts operate at a larger scale (Fahrig and Merriam 1994, Lambeck and Hobbs 2002). As a result, isolated local-scale efforts to solve a conservation problem are often ineffective (Gutzwiller 2002). Thus, in recent years more focus has been given to planning conservation at larger scales (Millspaugh and Thompson 2009, Trombulak and Baldwin 2010).

Designing management actions to promote the viability of species requires a good understanding of the potentially complex spatial dynamics of the populations and their potential interactions with multiple threats. In the face of global threats, large-landscape conservation has become established as a science-based response to large scale habitat fragmentation and degradation. Large landscape conservation advances the concepts of ecological integrity and connectivity, wildlife corridors and comprehensive landscape conservation.

Connectivity is, on a general level, the degree to which the spatial pattern of scattered habitat patches in the landscape facilitates or impedes the movement of organisms (Taylor et al. 1993). The persistence of spatially structured populations is strongly related to the connectivity of the landscape (Hanski and Ovaskainen 2003). If the connectivity of the landscape is too low, sub-populations get isolated and, for instance, the possibility of recoveries following local extinction decreases, since successful recolonization is dependent on the dispersal of species throughout the landscape (Hanski 1994, Bascompte and Sole 1996, Hanski and Ovaskainen 2003). On the other hand, even if habitat fragmentation has decreased the number of large coherent patches of habitat in the landscape, a sufficiently high level of connectivity may still provide for sufficiently large areas of reachable habitat, as seen by species capable of moving from patch to patch (Lundberg and Moberg 2003). Thus, management and planning should take these and other aspects of landscape connectivity into account in order to provide ecologically functional and resilient landscapes, for instance, designing natural reserves (Bengtsson et al. 2003, Lee and Thompson 2005, Bodin and Norberg 2007).

A corridor is a distinct component of the landscape that provides connectivity. Wildlife corridors specifically facilitate the movement of animals, while other types of corridors may support connectivity for plants or ecological processes. Although the term is frequently used synonymously with corridor, linkage refers to broader regions of connectivity important to maintain ecological processes and facilitate the movement of multiple species. Connectivity is defined as “the degree to which the landscape facilitates or impedes movement.” Permeability is essentially synonymous with connectivity, referring to the degree to which regional landscapes, encompassing a variety of natural, semi-natural and developed land cover types, are conducive for movement. Nutrient flows, energy flows, predator-prey relationships, pollination, seed dispersal and many other ecological processes require landscape connectivity. Connectivity includes both structural and functional components.

Structural connectivity refers to the physical relationship between habitat patches, while functional connectivity describes the degree to which landscapes actually facilitate or impede the movement of organisms and processes. Ecological connectivity supports the movement of both biotic processes (animal movement, plant propagation, genetic exchange) and abiotic processes (water, energy, materials) and can be species or process specific.

Connectivity among habitats and populations is considered a critical factor determining a wide range of ecological phenomena, including gene flow, metapopulation dynamics, demographic rescue, range expansion and maintenance of biodiversity (Ricketts 2001, Moilanen and Nieminen 2002, Calabrese and Fagan 2004, Moilanen et al. 2005, Crooks and Sanjayan 2006, Damschen et al. 2006, Fagan and Calabrese 2006). Preserving and restoring connectivity has become a major conservation priority, and conservation organizations are investing considerable resources to achieve these goals (Beier et al. 2006, Kareiva 2006).

The Kaziranga-Karbi Anglong Landscape (KKAL) is situated within the Indo-Burma biodiversity hotspot. The KKAL is spread over 25,000 km^2, south of the Brahmaputra River in Assam, touching the neighbouring states of Meghalaya and Nagaland in north-eastern India. In recent years, this landscape is getting highly fragmented due to establishment of human settlements, increasing biomass demand, expansion of agriculture practices, networks of roads and railways and other developmental activities. The vision for this biodiversity-rich and culturally-diverse landscape is to ensure that large mammals, especially tigers, elephants and rhinoceros, persist in connected ranges with minimal human-wildlife conflict. The Kaziranga Tiger Reserve (KTR), the biggest protected area complex (PAC) in this landscape is connected with the rest of the landscape through four corridors, namely Panbari, Haldhibari, Amguri and Kanchanjhuri, which are facing anthropogenic pressures. The decades of conservation efforts, primarily in Kaziranga and its surrounding areas, have secured the large mammal populations in the Reserve. This landscape is home to nearly 70 per cent of Assam’s tigers, about half of Assam’s elephant population (2500 elephants) and close to 90 per cent of India’s rhinoceros population (more than 2000 Rhinoceros), making the area critical for the protection and conservation of wildlife and their habitats.

With the increasing wildlife populations in KKAL, there is a need to strengthen the conservation efforts in the sinks so as maintain the appropriate metapopulation dynamics of the large mammals in the region. This is especially important for the large ranging mammals. In KKAL, the movement and recolonization of other large mammals, such as tiger, elephant and rhinoceros, has been obstructed due to the fragmentation of habitat in terms of human habitation, agricultural areas, tea gardens and development activities leading to large scale human-wildlife conflict in the region.

Recent monitoring of tiger in the landscape suggests approximately 13 tigers / 100 km square area in the Kaziranga Tiger Reserve (Jhala et al. 2015). As is evident from the Camera trapping exercise conducted by the Forest Department, there is frequent movement of tigers between source and sink, which has enhanced the tiger population in the landscape; however, such dispersal corridors are not defined in terms of their structural and functional aspects. Despite the immense conservation significance of KKAL, its dynamics in terms of structural and functional aspects are not understood. The main aim of this project is to measure the structural diversity of KKAL, identify patches that act as movement corridor or have potential to facilitate large mammal movement, especially tiger, and identify critical points along these movement corridors with high probability of negative human-wildlife interface for improved conservation planning.

For this study, we intend to work out a subordinate landscape within KKAL, comprising of KTR including all the Additions, Loakhowa Wildlife Sanctuary, parts of Karbi – Anglong hills in the South Bank of Brahmaputra River, Orang Wildlife Sanctuary, Bura Chapori Wildlife Sanctuary and Nameri Tiger Reserve in the North Bank. We will use existing monitoring data of the source population to derive the demographic status of the population in the landscape. The following objectives have been set forth:

OBJECTIVES

1. Delineate possible corridors linking the Kaziranga Tiger Reserve with surrounding landscape and intra-spatial connectivity that maintain the gene flow of large mammals in the Kaziranga - Karbi Anglong Landscape.

2. Assess the biophysical conditions of these corridors and connectivity in terms of their structure and composition (habitat quality).

3. Examine the functionality of these corridors in terms of their suitability for maintaining dispersal of large mammals, especially tigers, in order to maintain metapopulation dynamics in the Kaziranga - Karbi Anglong Landscape.

4. Identify critical points along the corridors with high probability of negative human-wildlife interface.

5. Develop mechanisms to minimize human – wildlife conflict in the landscape through community involvement and innovative conflict resolution techniques.

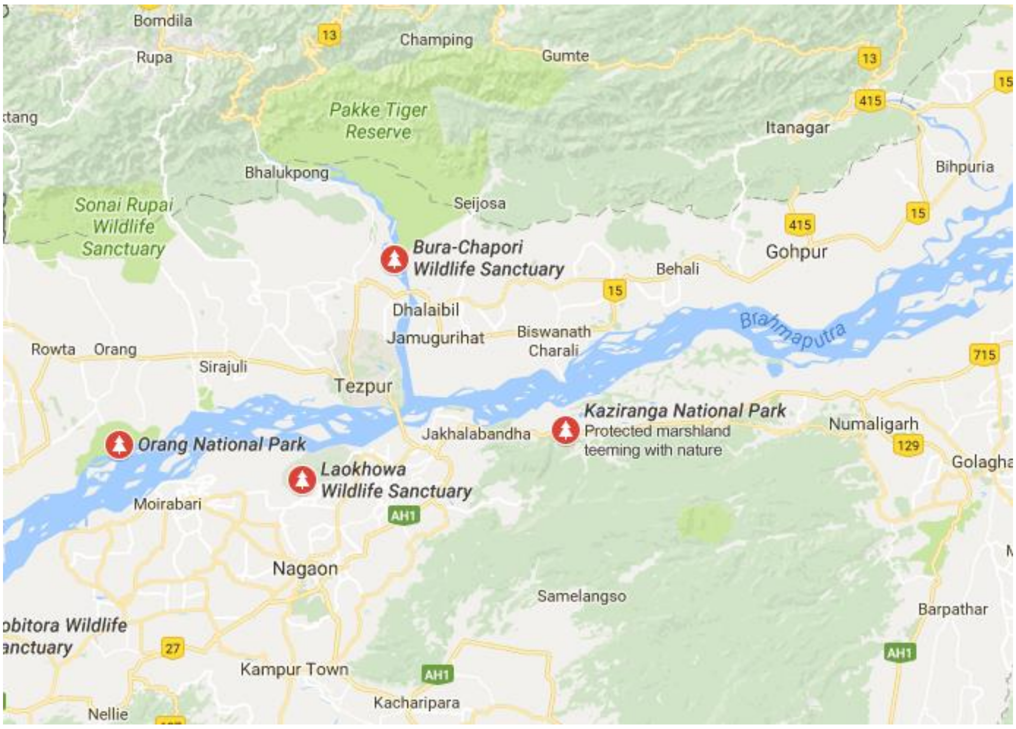

Figure 1. Map showing Kaziranga – Karbi Anglong Lanscape and location of Kaziranga Tiger Reserve.

METHODS

Objective 1: Delineate possible corridors linking the Kaziranga Tiger Reserve with surrounding landscape and –intra-spatial connectivity.

IRS LISS 4 Satellite data will be used for the land use/land cover (LULC) analysis using ERDAS/ ArcGIS software. Ecologically meaningful landscape metrics would be generated from the LULC. We will use the circuit theory to model landscape connectivity. Individual habitat patches will be assessed in relation to their impact on different aspects of the landscape's connectivity. We will derive the criticality of individual patches based on the quality of its structure and composition and probability of its performance to act as a movement corridor for tiger so as to provide the geographical distribution of the patches, with high scores on different measures of centrality, and suggest a multispecies analysis using species-specific network representations of fragmented landscapes.

Objective 2: Assess the biophysical conditions of these corridors and connectivity in terms of habitat quality.

We will assess the quality of each patch/ identified corridor through ground truthing by lying plots of appropriate size depending upon the type of habitat for assessing its quality, including vegetation structure and other geomorphological parameters. The various disturbance parameters will be scored from 3 to 1 based on the degree or intensity of disturbance. Presence or absence of carnivore species in an area might not have a direct link with these parameters. The different parameters will be selected on the basis of disturbances per se, such as, (a) Presence of domestic livestock, (b) Selective Logging history, (c) History of shifting cultivation, (d) Trapping signs/ hunting/ fishing / grazing intensity, (e) Proximity to human settlements and (f) Developmental activities like hydroelectric projects, construction of roads and monoculture crop cultivation etc.

Objective 3: Examine the functionality of these corridors in terms of their suitability for maintaining dispersal of large mammals, especially tigers.

We will use camera traps and molecular analysis of scats at select inter and intra spatial corridors to derive the probability of patches acting as a movement corridor. Additionally satellite tracking of dispersing tigers may also be carried out for identification of active corridors. We will develop species distribution models (SDM) for tiger using the 1) generalized linear model (GLM) (McCullagh and Nelder, 1989), 2), the maximum entropy model (MaxEnt) (Phillips et al. 2006) and 3) the resource selection probability function (RSPF) (Lele and Keim, 2006) to predict the suitability of the patches/ corridor as possible dispersal habitats for tigers. The SDMs will be developed using R (R Development Core Team), a free software for statistical computing and graphics.

Objectives 4: Identify critical points along the corridors with high probability of negative human-wildlife interface.

We will use graph-theoretical modeling approach to landscape connectivity (Etrada et al. 2008) to assess and differentiate the importance of individual habitat patches in relation to their impact on different aspects of the landscapes' connectivity. A graph is a set of nodes (or vertices) and links (or edges) such that each link connects two nodes; it may be used for quantitatively describing a landscape as a set of interconnected patches (Ricotta et al. 2000, Urban and Keitt, 2001 and Jordan et al. 2003). Nodes represent patches of suitable habitat surrounded by inhospitable habitat (non habitat) (Urban and Keitt, 2001). The existence of a link between each pair of patches implies the potential ability of an organism to directly disperse between these two patches, which can be considered as connected. We will use the classical Circuit Theory (McRae et al. 2008) to determine the opposition of a type of corridors that may impede movement of tigers and other large mammals. Based on this, we will identify critical points along the corridors with high probability of negative human-wildlife interface or the areas that are unsuitable as a corridor. Areas along the identified corridors, where the density of current is very high across a narrow corridor, will be treated as pinch points/bottleneck in connectivity.

Objective 5: Develop a mechanism to minimize human – wildlife conflict in the landscape through community involvement and innovative conflict resolution techniques.

At each of the identified critical points along the corridors, we will mobilize community resources through the Forest Department and by establishing effective community institutions, such as Eco-development Committees, for minimizing human wildlife conflict.

EXPECTED OUTPUT AND DELIVERABLES

The project will generate an updated Land Use – Land Cover (LULC) profile of the Kaziranga Tiger Reserve and the surrounding protected area complex, including all the Additions and Loakhowa Wildlife Sanctuary, parts of Karbi – Anglong hills in the South Bank of Brahmaputra River, Orang Wildlife Sanctuary, Bura Chapori Wildlife Sanctuary and Nameri Tiger Reserve in the North Bank. It will generate a corridor atlas suitable for large mammal movement and identify bottle necks where management inputs will be required for minimizing humam – wildlife conflict and facilitate movement of large mammals.

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PROPOSED PROJECT OUTLAY (INDIAN RUPEES)
COMPONENT 3

BUDGET HEAD	Rate	Unit	Year 1	Year 2	Year 3	Year 4	Total
MANPOWER							
Project Fellow (@ Rs. 28000 + HRA 20% + Other Allowances)	35000	4	1680000	1680000	1680000	1680000	6720000
Field Assistant	7000	3	252000	252000	252000	252000	1008000
TOTAL MANPOWER		**7**	**1932000**	**1932000**	**1932000**	**1932000**	**7728000**
EQUIPMENTS AND CAPITAL							
Camera traps (including accessories)	18000	130	2340000	0	0	0	2340000
Satellite GPS Collars	400000	4	1600000	0	0	0	1600000
Satellite imageries	-	-	500000	0	0	0	500000
Binoculars	-	-	20000			0	20000
Field gear – Rucksack, sleeping bag, tent, poncho, wind cheater, jackets	-	-	50000	0	0	0	50000
GPS	15000	4	60000	0	0	0	60000
Digital camera with accessories	25000	4	100000	0	0	0	100000
Laptop	50000	2	100000	0	0	0	100000
TOTAL EQUIPMENTS			**4770000**	**0**	**0**	**0**	**4770000**
OPERATIONAL							
Satellite tagging operation	-	-	100000	25000	25000	0	150000
Base camp establishment & maintenance	Lump sum		100000	100000	100000	12727	312727
TOTAL OPERATIONAL			**200000**	**125000**	**125000**	**12727**	**462727**
CONSUMABLES							
Contingency	-	-	109091	47000	47000	15000	218091
Batteries for camera traps	-	-	100000	48000	48909	15000	211909
Final report publication	-	-	0	0	100000		100000
Hiring of Field vehicle per month	18000	2	432000	432000	432000	432000	1728000
POL per month	18000	-	216000	216000	216000	216000	864000
GIS Database		-	200000	0	0	0	200000
TOTAL CONSUMABLES	-	-	**1057091**	**743000**	**843909**	**678000**	**3322000**
TRAVEL							
Accommodation & travel	-	-	150000	100000	90000	50000	390000
TOTAL TRAVEL			**150000**	**100000**	**90000**	**50000**	**390000**
TOTAL			**8109091**	**2900000**	**2990909**	**2672727**	**16672727**
Institutional Charges	10%		810909	290000	299091	267273	1667273
GRAND TOTAL			**8920000**	**3190000**	**3290000**	**2940000**	**18340000**