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Ministry of Environment and Forests

Bangladesh Forest Department

Dudpukuria-Dhopachari Wildlife Sanctuary Management plan

2015 - 2025

FINAL VERSION

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Acronyms

ACF	Assistant Conservator of Forest
AIGA	Alternative Income Generating Activities
ANR	Assisted Natural Regeneration
BFD	Bangladesh Forest Department
BFRI	Bangladesh Forestry Research Institute
BO	Beat Officer
BRAC	Bangladesh Rehabilitation Assistance Committee
C	Celcius
CBD	Convention on Biodiversity
CBO	Community Based Organization
CCF	Chief Conservator of Forest
CHT	Chittagong Hill Tracts
CM	Co-Management Council
CMC	Co-Management Committee
CMO	Co-Management Organisation
CPG	Community Patrol Group
CREL	Climate Resilient Ecosystems and Livelihoods
DDWS	Dudpukaria-Dhopachari Wildlife Sanctuary
DFO	Divisional Forest Officer
FAO	Food and Agricultural Organisation of the United Nations
FCC	Forest Conservation Club
GIS	Geographical Information System
GoB	Government of the People's Republic of Bangladesh
ha	hectare (2.47 acre)
HEC	Human-Elephant Conflict
HH	Household
HYV	High Yield Variety
IBA	Important Bird Area
IPAC	Integrated Protected Area Co-Management
LS	Lump Sum
MIST	Management Information System Tracking
mm	millimetre
MTT	Management Tracking Tool
n.a.	not applicable
NGO	Non-Governmental Organisation
NP	National Park
NTFP	Non-timber forest products
NWC	National Wildlife Centre
PA	Protected Area
PAP	Project Affected Persons
PF	Peoples Forum
PM	Pour Memoire (for memory)
RF	Reserved Forest
RIMS	Resources Information Management System
RO	Range Officer
RS	Remote Sensing
SMART	Spatial Monitoring and Reporting Tool
SMART	Specific, Measurable, Achievable, Replicable and Time-bound
SRCWP	Strengthening Regional Cooperation and Wildlife Protection project
Tk	Taka
UNDP	United Nations Development Programme
UNFCCC	United Nations Convention on Climate Change
VCF	Village Conservation Forum
WCPA	World Commission on Protected Areas
WNCC	Wildlife and Nature Conservation Circle

Executive summary

8. The purpose of this management plan is to direct the management and development of Dudpukuria-Dhopachari Wildlife Sanctuary, in terms of objectives, strategies and actions. The vision and strategy presented are based on an analysis of the key values and threats of this sanctuary. This Management Plan is the prime guiding document for other plans in relation to Dudpukuria-Dhopachari WS. This plan focuses on management of the area covering all relevant aspects. Although the plan is extensively dealing with issues such as public relations, awareness, education, policy and research, the document itself is not meant as a tool in those fields to keep its scope clear. Other plans and documents may be required to elaborate these issues.

9. The management plan takes into account (a) current practices of forest management in Bangladesh, (b) recent developments toward co-management under the new Wildlife Act (2012) and (c) international standards following the Convention on Biodiversity and Bangladesh' commitments in that regard. The World Commission on Protected Areas' "Guidelines for Management Planning of Protected Areas" have been used as a template.

Protected area description

10. Dudpukuria-Dhopachari Wildlife Sanctuary (DDWS) is located in the Rangunia and Chandanisch Upazilas. It is close to Chittagong in the southeast of Bangladesh, but accessibility is poor due to bad roads and rivers obstructing direct access. The landscape is characterized by hills, valleys and numerous permanent streams and covered mainly by developing secondary Dipterocarp forest. Soil is sandy to sandy loam. With a monsoon climate, the area receives abundant rainfall and it is frequently exposed to serious climate hazard such as cyclones.

11. This relatively small protected area (4717 ha) can be classified under Category IV of the international IUCN classification of protected areas, but it has not been listed under any international agreement related to biodiversity conservation. The area was in the past very rich in wildlife, including mega-fauna. However, due to habitat destruction, unsustainable hunting and habitat fragmentation, many of the larger species are disappearing from the area. Nevertheless, some medium large animals such as barking deer, wild boar and several smaller carnivores still live in the area, as well as many bird (over 200), reptile and amphibian species, and even elephants visit DDWS seasonally. The vegetation is very rich with over 600 plant species. Reserved Forest partly surrounds DDWS, but encroachment is also present in the north and south.

12. Around 30,000 people live in the Impact zone around the sanctuary depending partly on its resources. Despite the natural beauty, not many tourist visit DDWS as other protected areas have easier access.

13. BFD manages the sanctuary through 2 Range offices, 3 Beat officers with a total of 12 field staff. Since 2009 a Co-Management organisation has been formed in both Dudpukuria

and Dhopachari covering several representation levels from the communities around DDWS. These structures includes Community Patrolling Groups with a total of 98 members play an important role in the monitoring of resource utilization in the Impact, Buffer and Core Zone, in close collaboration with BFD.

Ecological and socio-economic values

14. Although DDWS is missing some of the charismatic animals of the past, the biodiversity is still significant compared to many other protected areas in Bangladesh. With its high botanical diversity the sanctuary and its surrounding areas provide important products to local populations and play as such an important role for their livelihood. Important species with regard to conservation are hoolock gibbons, leopard cat, binturong, and white-cheeked partridge. Elephants visiting the sanctuary seasonally can be considered as a flagship species. Despite the beauty of the area and its interesting biodiversity, not many tourists enjoy the area yet due to limited accessibility. Other important ecological services provided by DDWS are its contribution to watershed protection and to climate change mitigation through carbon fixation.

Management issues

15. The main challenges for the management are increasing forest conversion around the sanctuary which threatens its connections to the greater landscape of the Chittagong Hills and CHT, and consequently reduces the viability of wildlife populations such as elephants and hoolock gibbons. Communities around the sanctuary depend more or less on forest resources and some encroached villages and cultivated land are found. Furthermore, forest fire, livestock and other unsustainable resource utilization practices degrade the habitat inside and around the sanctuary. Climate change is an additional threat which directly may affect habitat and survival conditions for biodiversity, as well as indirectly by further increasing human pressure due to migration from lower parts of Bangladesh to the hills. People as well as managers of DDWS are also confronted with increasing conflicts with wildlife, particularly elephants due to decreasing wildlife habitat. Tourism development may constitute a future threat to DDWS. The current capacity of BFD is not adequate to deal with all these management issues.

Vision and management objectives

16. The management plan aims at maintaining the sanctuary as a biodiversity stronghold in the Chittagong Hills, while conserving ecosystem services for the benefits for local populations and future generations, sustaining livelihood and climate change resilience. The management objectives of the plan are:

(1) Protect and maintain physical, biological and aesthetic features of Dudpukuria-Dhopachari Wildlife Sanctuary as part and example of typical Chittagong Hills and Chittagong Hill Tract forest ecosystem;

(2) Improve livelihood and resilience of communities to natural hazard including climate change and human-wildlife conflicts;

(3) Realizing and utilizing the Sanctuary's potential as venue for responsible tourism based on wildlife, educational, cultural and aesthetic appeal;

(4) Integrating the Wildlife Sanctuary into local and regional development process engaging local stakeholders to ensure wider acceptance of the Sanctuary's values;

(5) Improving the BFD's staff welfare, motivation and capabilities.

Zoning

17. The management prescriptions and measures of the plan are oriented in the different habitats and locations of the area on the basis of a zoning plan which has been elaborated in the scope of the Bangladesh Wildlife Act (1912) and international guidelines. The following zones are proposed:

(1) Core zone with subzones (a) Special and/or unique values zone, (b) Primitive/ wilderness zone, (c) Limited development zone, (d) Intensive development/services zone, and (e) Rehabilitation zone;

(2) Buffer zone with subzones (a) Traditional and indigenous use zones, (b) Rehabilitation zone, (c) Limited development zone, and (d) Intensive development/services zone;

(3) Corridor zone;

(4) Impact zone.

Management actions

18. A 5-year workplan is elaborated to realize the management objectives. The workplan involves the following components:

1. Management of the physical environment
   - Zoning
   - Boundary demarcation
   - Resolving tenure and encroachment issues
2. Management of biological components
   - Biodiversity conservation
   - Connectivity management
   - Forest management
   - Control of livestock
   - Release of animals in the sanctuary
   - Surveillance

3. Sustainable resource management interface landscape
   - Conservation awareness
   - Implementation of co-management
   - Landscape development fund
   - Reduction of dependency on forest resources
   - Sustainability and resilience to environmental hazard
   - Reduction of wildlife-human conflict
   - Capacity building
4. Responsible tourism development
   - Tourism management
   - Entry fee collection
   - Facilities and infrastructure
   - Tourism impact reduction
   - Promotion and awareness
5. Reinforcement of protection administration
   - Improving mobility
   - Office facilities and staff accommodation
   - Equipment
   - Staff capacity and performance

Monitoring and review

19. The purpose of monitoring is to assess the effectiveness and efficiency of the activities and the achievement of the management objectives. The results of monitoring and evaluation may be used to adapt the strategies to improve the management performance. The monitoring and evaluation plan provides for the annual review of operational plans, a five year work plan and an overall review period of the management plan of 5 years.

20. Monitoring involves measuring indicators related to the management context (e.g. threats), management performance, results achievement, outcome and impact. Biological monitoring is particularly required of birds, mammals (especially elephant) and the vegetation in order to assess status of biodiversity and changes related to threats and management measures. Management performance monitoring is done by reporting on implementation and achievement of the annual operational plan and five year work plan. To enhance field monitoring (surveillance and biodiversity) the relevance of the application MIST-patrolling will be investigated. Data collection and reporting needs to be consistent with the Management Effectiveness Tracking model which BFD considers to adopt.

1 Introduction

1.1 Purpose of the management plan

21. The purpose of this management plan is to present a clear vision on the management and development of Dudpukuria-Dhopachari Wildlife Sanctuary, including the management objectives, strategies and actions required for the realization of these. The vision and strategy are based on an analysis of the key values and threats of this sanctuary. The management strategy presented is flexible to cater for unforeseen contextual changes and innovative practices during the implementation period of the plan by adopting a cyclic and adaptive approach.

22. This Management Plan is the prime guiding document from which other plans for Dudpukuria-Dhopachari WS flow, and this plan takes precedence in case of inconsistency. To ensure the "management scope" of the document, other functions of this document such as public relations/awareness, education, policy analysis and research are limited to the essential minimum. Related documents to the Management Plan may include more detailed zoning plans, visitor and business plans to guide its implementation as well as more specific species plans and status reports. Additionally, separate resource descriptions, policy documents, press releases on management activities and/or information documents on the sanctuary may have to be produced. The plan indicates the requirement of such studies and documents as needed.

1.2 Location of Dudpukuria-Dhopachari Wildlife Sanctuary

23. The location of Dudpukuria – Dhopachari WS is 290 km south of Dhaka, 80km south – east of Chittagong and 20km north of Bandarban. Geographical location is 22^{o} 09’ to 22^{o} 22’ north latitude and 92^{o} 05’ to 92^{o} 10’ east longitude (To be checked)

24. The northern boundary of the sanctuary is formed by Rangunia; the eastern boundary by Kohalong Union Parishad of Bandarban, Rangamati-Bandarban road, and the Sangu Block up to Sangu river; the southern boundary by South-Sangu river; the western boundary by Lalutia Beat of Dohazari range and Borguni Beat of Patya Range.

1.3 Constitution

25. Dudpukuria- Dhopachari Wildlife Sanctuary formerly a part of the reserved forest of Chittagong South Forest Division. It was declared as Dudpukuria-Dhopachari Wildlife Sanctuary (1909 ha, 4717 acre) on 6th April, 2010 by the Ministry of Environment and Forest by notification no. MoEF/For-Sec-02/02Wildlife Sanctuary/11/2010/209 dated 06/04/2010 under the power given under section 23(I) 0f Bangladesh Wildlife (Preservation) (Amendment) Act 1974.

26. The forest is under the jurisdiction of Khurusia and Dohazari Forest Range of Chittagong (South) Forest Division. According to Bangladesh Wildlife (Preservation), (Amendment) Act of 1974, any kind of killing, hunting, or trapping of any wildlife, agricultural activities, living or entering into the sanctuary of any persons or destruction to the sanctuary habitat are strictly prohibited.

1.4 Past management system and management plans

27. Scientific forest management in this sub-continent was started in 1865. A separate forest department was created for Bengal in 1876. Chittagong Forest Division was the first division created in Bangladesh by the British ruler in 1872. In those days, forests were managed primarily for revenue collection under the control of Revenue Department. Only valuable trees were extracted from the forest to get more revenue. Then a forest management plan or work plan is prepared for each forest division. This management plan guides forest manager to manage forest or to perform day-to-day work in the forest. This plan spells out where to cut trees, how much to cut and what to plant to cover up the cleared up forest etc. on annual basis. In 1930s, the system of management was modified to clear felling supported by artificial regeneration or plantation,

28. In 1920, the first comprehensive working plan (1922-'23 to 1942-'43) was developed for Chittagong and Chittagong Hill Tracts. After that a 10-year term Working Scheme (1943-'44 to 1952-'53) has been developed in 1941 separately for Chittagong and Chittagong Hill Tracts. In 1950, a working plan (1950-51 to 1969-70) for Chittagong Forest Division.

29. In 1990, according to the Government's decision, the logging from the forests stopped. Since then, there is no more working plan is in place. Lastly, in 2010, Dudpukuria Dhopachari Wildlife Sanctuary was declared as Protected Area but no management plan was prepared.

1.5 Management planning approach

1.5.1 Institutional context

30. According to the Wildlife Act (2012), "*The Government may, for each sanctuary, prepare a management plan in accordance with the manner prescribed by rule*"[1]. In practice, elaborating a full management plan takes time; the whole process can easily take one year, but effectively engaging all stakeholders can take even more time.

31. Protected area management planning cannot ignore earlier and current standards and initiatives in Bangladesh, in the wider region and at international level. Synergy needs to be sought with these standards and initiatives, duplication avoided and inconsistency avoided regarding policies and approaches. Particularly national standards regarding (a) forest

[1] Rules for PA management planning are under preparation by SRCWP

management planning and (b) co-management have to be taken into account as well as (c) national strategies in the frame of the Convention on Biodiversity (CBD) implemented through the National Biodiversity Strategy and Action Plan (GoB 2005), and (d) other international agreements related to biodiversity conservation. Obviously, the plan follows all applicable policies and legislation of Bangladesh, as indicated in the sections on strategy and implementation where applicable.

1.5.2 Forest Management Planning

32. In the 1980s, procedures for Forest management planning were reviewed by the "Assistance to the Forestry Sector Project" (UNDP/FAO) resulting in a Forest Management Plan Manual (Balmforth 1988). As the focus of this planning approach is on forest, trees, forest management and exploitation, it is not directly appropriate for protected area management where management is supposed to emphasize conservation of biodiversity and wildlife in a natural setting. Nevertheless consistency with the characteristics of this model will facilitate adoption of protected area management planning in the routines of BFD. Some elements of this traditional forest management planning system require to be adapted in order to comply to a more up-to-date approach of integrated and sustainable management of natural resources, particularly:

- "*Forest and land base components*" need to be replaced by "*Biological, physical and socio-economical components*";
- "*Forest management objectives*" need to be widened to more holistic objectives covering all ecosystem services of the area in relation to the biodiversity conservation and development priorities of Bangladesh.

33. The Forest Management Plan Manual proposes a 10 year review cycle for the Management Plan with a 5-year review cycle for the Working Plan and an Annual Plan of Operations. A similar management cycle can be adopted for the Dudpukuria-Dhopachari Wildlife Sanctuary Management Plan (section 8.9, page 74).

1.5.3 Co-management planning

34. Co-Management of protected areas is a policy target of Bangladesh under strategy 9 of the NBSAP (GoB 2005). The new Wildlife Act (2012) includes provisions for the participation of local stakeholders in the management and benefits of protected areas under Article 21: *(1) The Government may introduce co-management system for proper utilization, conservation and management of natural resources of the sanctuary involving forest department, minor ethnic community living in the forests or local community on participatory basis to ensure active participation of all the parties therein. (2) The Government may, for the purpose of sub-section (1), constitute a committee named as co-management committee and may specify terms of reference of such committee.*

35. The Nishorgo Support Project (NSP) and the Integrated Protected Area Co-management Project (IPAC) have developed a consistent approach over a longer period with regard to engaging stakeholders in sustainable natural resources management and the development of co-management of protected areas. The focus of these plans emphasizes however the role of forest dependent communities in conservation, but not so much the management of biodiversity in the context of national and international conservation priorities. Therefore the elements related to co-management of the Nishorgo approach are considered as much as possible within the context of the requirements set by biodiversity conservation priorities.

36. Although the co-management approach can contribute significantly to sustainable management of natural resources and biodiversity conservation as a result of improved stakeholder collaboration and benefit sharing, the development of co-management also requires also to be followed critically. Based on current experiences in Bangladesh, some specific issues of concern are:

- co-management organizations and the motivation of its members appear usually dependent on external financial resources rather than self-sustenance and intrinsic motivation;
- apart from being a mechanism for shared resource management, co-management may be used as a vehicle for donor agendas, which may confuse the prime objectives of the co-management system;
- local politics and individual interests may strongly influence the functioning of co-management organizations and play an important role in the selection of its members;
- so far co-management organizations appear hardly to follow a strategic plan (management plan), even when existing;
- protected area management plans need to address national and international responsibilities with regard to biodiversity conservation, which have, however, often a low priority at local level;
- responsibilities of the co-management organization and the role of FD field staff need to be clear to all actors in a co-management system.

37. Under IPAC, separate Co-Movement Organisations for Dudpukuria and Dhopachari have been established and Co-management Plans developed. The plans have not been endorsed by BFD.

1.5.4 International policy context

38. Bangladesh has ratified the Convention on Biodiversity (CBD) in 1992. Strategy 9 of the National Biodiversity Strategy and Action Plan (GoB 2005) formulated following the signing of this convention reads "*Enhance Protected Area management, recognizing the benefits of collaboration with local communities in their management (co-management)*", which includes that protected areas should be managed in keeping with the Ecosystem Approach

as defined by the Conference of the Parties to the Convention on Biological Diversity (Decision V/6) which can be summarised as a strategy for the integrated management of land, water and living resources promoting conservation and sustainable use in an equitable way.

39. Article 8 of the Convention on Biodiversity (CBD) contains among others several specific references to protected area management by encouraging Parties to:

- Establish a system of protected areas or areas where special measures need to be taken to conserve biological diversity;
- Develop, where necessary, guidelines for the selection, establishment and management of protected areas or areas where special measures need to be taken to conserve biological diversity;
- Regulate or manage biological resources important for the conservation of biological diversity whether within or outside protected areas, with a view to ensuring their conservation and sustainable use;
- Promote environmentally sound and sustainable development in areas adjacent to protected areas with a view to contribute to the protection of these areas.

1.5.5 PA management planning framework

40. To match international standards of protected area management planning, the planning procedure for Dudpukuria-Dhopachari WS has adopted international good practices which have been elaborated in the IUCN/WCPA Guidelines for Management Planning of Protected Areas (Thomas and Middleton 2003). The management planning cycle according to this approach includes the following steps:

(1) Pre-planning – selection PA, planning team, scoping, process

(2) Data gathering – issues identification, consultation

(3) Evaluation of data and resources

(4) Identification of constraints, opportunities and threats

(5) Developing of management vision and objectives

(6) Developing of management options, including zoning

(7) Preparation of draft Management Plan

(8) Public consultation of the draft Management Plan

(9) Assessment of submissions, revision, final Management Plan

(10) Approval or endorsement of the Management Plan

(11) Management Plan implementation

(12) Implementation monitoring and evaluation

(13) Review and update of the Management Plan.

2 Description of the protected area

WHAT IS THE STATUS AND MANAGEMENT OF THE ECOSYSTEM ?

2.1 Protection status and authority

41. Dudpukuria–Dhopachari Wildlife Sanctuary is under the administrative control of Divisional Forest Officer, Chittagong South Division.

42. According to the definition of protected areas, Dudpukuria-Dhopachari Wildlife Sanctuary is a Category IV protected area, which *aim to protect particular species or habitats and management reflects this priority. Many category IV protected areas will need regular, active interventions to address the requirements of particular species or to maintain habitats, but this is not a requirement of the category* (Dudly 2008).

43. Category IV protected areas exist in crowded landscapes and seascapes, where human pressure is comparatively greater, both in terms of potential illegal use and visitor pressure. As these usually protect part of an ecosystem, successful long-term management of category IV protected areas necessitates careful monitoring and an even greater than usual emphasis on overall ecosystem approaches and compatible management in other parts of the landscape or seascape.

44. The area is not listed under any international agreement such as Ramsar, World Heritage Sites or Important Bird Areas.

2.2 Geo-physical information

2.2.1 Climate and climate hazard

45. Dudpukuria-Dhopachari has a tropical monsoon climate, characterized by basically four seasons per year: winter (December-February), summer (March-May), monsoon (June-September) and autumn (October-November). The south-west monsoon provides the majority of the average rainfall of about 1,611-3,878 mm. Temperature and humidity ranges from 7.2-38.9°C and 67-88% respectively round the year. Last two decades temperature has changed. The temperature is increased 1.1° C and humidity decreased 1%.

46. DDWS is frequently affected by cyclones and heavy rainfall mostly between May and October. Pre-monsoon north-westerly and cyclonic storms are accompanied by high-speed winds and rains, which do considerable damage to property and biotic life. The International Disaster Database lists 157 cyclones between 1900 and 2009 for Bangladesh, with the three most devastating ones occurring in 1970, 1991, and 1942 (61,000). Floods and cyclones have both direct and indirect repercussions for the forests. In addition to direct destruction, flood- and cyclone-induced migration of the people from lower riparian areas causing

additional stress on forest resources, which DDWS experienced pursuant to the 1963 and 1991 cyclones.

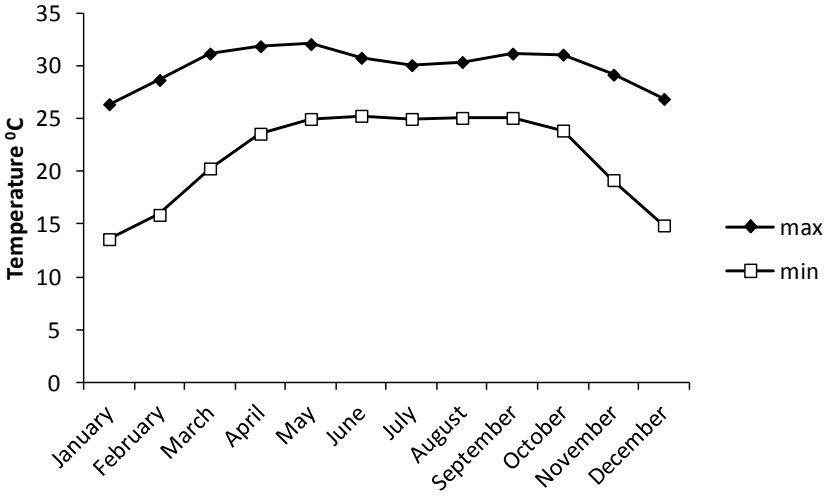

Figure 1. Monthly average maximum and minimum temperature at Dudpukuria-Dhopachari WS (source: weatheronline.com).

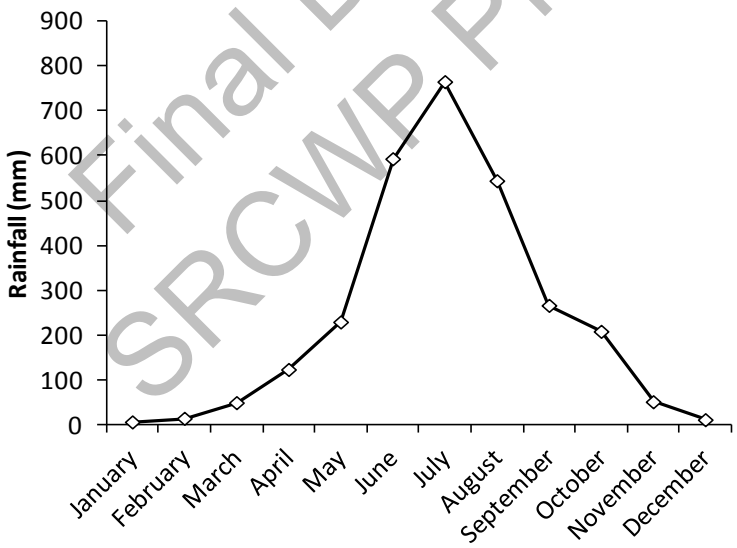

Figure 2. Monthly average rainfall at Dudpukuria-Dhopachari WS (source: weatheronline.com).

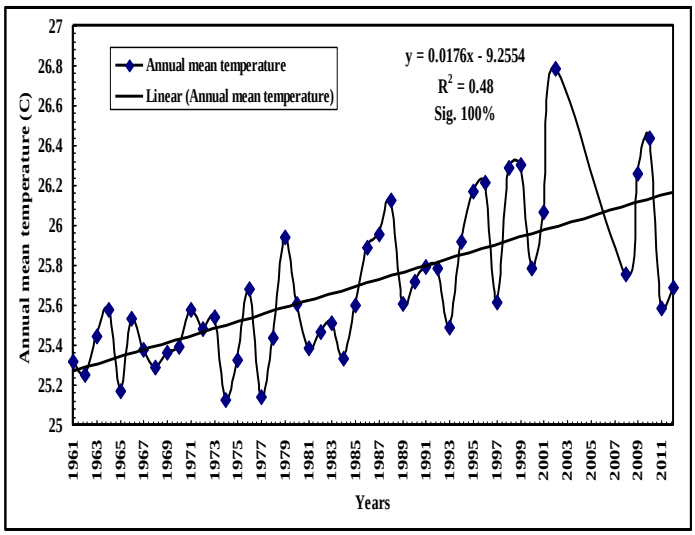

Figure 3. Annual mean temperature change in Chittagong region from 1961 to 2011(source: BMD 2012)

2.2.2 Hydrology

47. The sanctuary is drained by more than 18 creeks and streams, viz Balujhiri, Borguna, Chinkanjhiri, Chekkhani, Dhopajhiri, Dolu, Fuljiri, Gondamara, Jiknay, Khayapara, Lebujhiri, Mayani, Modhuchara, Mongla, Naikhyngiri, Piajam, Poranjurani, and Tamajhiri. Water from adjacent the watershed basin flows along the creeks all year round maintaining the unique biodiversity. The small streams enable drainage of water stagnating in the depressions and valleys in the hilly landscape, which serve as important habitat for flora and fauna, as well as provide drinking water for both human and animal populations. In DDWS local communities cultivate some patches of these fertile lands during the dry season.

48. River erosion is common in the Sangu catchment and consequently, some area of Dhopachari forest near Sangu River has disappeared due to lateral erosion.

2.2.3 Geomorphology and soil

49. About 80% of DDWS is covered by hills (350 m) intersected by numerous creeks, and about 20% is covered with plain lands (about 20% of total area).

50. DDWS is composed of soft sand stone. Soil is sandy to sandy loam. Soils in the high hills are loamy to clayey particularly towards the south and the west. Top soils are rich in humus. The loamy soil permit deeper penetration of tree roots unless obstructed by presence laterritic and placic horizons at shallow depths. Apparently the soil does not show any mineral deficiency or toxicity that may limit the tree growth. Soils in the high hills are extremly drained. The soils in the valleys are inperfectly drained alluvial soils and some vallys are used for dryland agriculture and rainfed transplanted Aman during the kharif season.

51. A recent land cover analysis carried out with data from RIMS distinguished five land cover classes (Table 1, page 24).

Table 1. Land cover classification Dudpukuria-Dhopachari and areas covered in Core zone, Buffer zone and Impact zone (for map see Appendix 2, page 85)

Name	Soil	Vegetation	Land use	Core zone (ha)	Buffer zone (ha)	Impact zone (ha)	TOTAL
Forest	Sandy loam	Dipterocarpus forest	NTFP collection, eco-tourism	2,518	716	192	3,426
Degraded forest	Sandy loam, alluvium	Dipterocarpus forest	NTFP collection, eco-tourism	1,678	1,158	624	3,460
Cultivation	Alluvium	Paddy, tobacco, guava, lemon	crops	568	368	1,062	1,998
Settlement	Sandy loam	Lemon, guava, jack fruit	Habitation, gardens	127	53	285	465
Water	n.a.	n.a.	Navigation, Fishing	12	5	20	37
TOTAL				4,903	2,300	2,183	

2.3 Biodiversity

2.3.1 Flora

52. DDWS is located in the Bio-ecological zone of Bangladesh 9a Chittagong Hills and the CHTs (Nishat et al. 2002). Basically it is tropical mixed evergreen forest, but during the last decades traditional management approaches have completely failed protection, conservation and sustainable management of the forest (Chowdhury 2006).

53. A number of different ecosystems harbouring rich biodiversity can be found, including tropical evergreen and semi-evergreen mixed forests dominated by Dipterocarpus spp; grasslands, bamboo and cane; short and long-rotation plantations; small streams; homesteads and settlements; water bodies and cultivated lands. A total of 608 plant species was found in DDWS of which 182 Tree, 125 Shrub, 200 Herb, 71 Climber, 17 fern, 7 Epiphytes and 6 Parasitic Plants (Hossain et al., 2013). In this sanctuary rare and endangered species are Konok, Mosh, Batna, Pitraj, Teli Garjan, Tejbohol, Tabba, Chapalish, Jam, Agar, Rokton, Chatian, Boilam and Chompa. The sanctuary is most important from a biodiversity perspective. Some of the forests still support natural vegetation, with the top canopy dominant tree species including Tellia Garjon (*Dipterocarpus turbinatus*), Baitta Garjan (*Dipterocarpus costatus*), Sada Garjan (*Dipterocarpus alatus*), Dharmara (*Stereospermum colais*), Civit (*Swintonia floribunda*), Bon Tula (*Bombax insigne*), Bohera (*Terminalia bellirica*) etc. The middle canopy mostly occupied by Bonjamir (*Acronychia*

pedunculata), Kali batna (*Lithocarpus acuminata*), Bormala (*Callicarpa arborea*), Chapalish (*Artocarpaus chama*), Muli Udal (*Pterospermum acerifolium*), Konok (*Schima wallichii*) etc. Assargula (*Grewia nervosa*), Castoma (*Aporusa wallichii*), Gotgutiya (*Protium serratum*), Goda (*Vitex peduncularis*), Harula (*Tarenna campaniflora*), Hiddygach (*Hydnocarpus laurifolius*), Domur (*Ficus hispida*) occupies the lower canopy of the forest. The undergrowth of the forest is mostly occupied by various shrubs, i.e. Goicha Lata (*Calycopteris floribunda*), Melastoma (*Melastoma malabathricum*), Lantana (*Lantana camara*) etc. The important Herbs are i.e. Bonroi (*Costus speciosus*), Jhan-jhuni (*Crotalaria pallida*), Durba Grass (*Cynodon dactylon*), Tokma (*Hyptis suaveolens*), Sungrass (*Imperata cylindrica*); Climbers e.g. Assam Lata (*Mikania cordata*), Lal Kanta (*Caesapinia bonduc*), Alu Lata (*Dioscorea pentaphylla*), and Chotra Pata (*Tragia involucrate*).

54. At present, natural and artificial Garjan plantation is established. This wildlife sanctuaries land changing formation is quite different from other protected areas. According to recent information, the forest coverage has increased, while the area of cultivated land decreased. Comparing 1989 and 2009 forest cover, shows an increased of the forest cover of almost 10.6%. At the same time the forests east and north of DDWS have degraded drastically.

2.3.2 Fauna

55. DDWS has a rich animal biodiversity[2]. Apart from amphibians, mammals, reptilians and birds, 190 invertebrates are recorded in DDWS.

Birds

56. Birds are very well represented in DDWS with 231 recorded species (Feeroz et al. 2012), of which 195 are resident and 36 migratory. Common bird species are among others bronzed drongo *(Dicrurus aeneus)*, red-vented bulbul *(Pycnonotus cafer)*, red-breasted parakeet *(Psittacula alexandri)*, black rumped Flameback *(Dinopium bengalense) and* Indian jungle fowl *(Gallus gallus)*. More rare are grey peacock pheasant (*Polyplectron bicalcaratum*), white-cheeked partridge (*Arborophila atrogularis*), oriental pied hornbill (*Anthracoceros albirostris*), oriental dollarbird (*Eurystomus orientalis*).

Mammals

57. A total of 50 mammals have been recorded in DDWS (Feeroz et al. 2012), such as the Asian elephant *(Elephas maximus)*, golden jackal *(Canis aureus)*, Asiatic wild dog (*Cuon alpineus),* barking deer *(Muntiacus muntjak),* wild boar *(Sus scrofa),* western hoolock gibbon (*Hoolock hoolock)*, and rhesus macaque *(Macaca mulatta)*;

[2] Surveys in the area in November-December 2013 and March 2014 resulted in observation of 6 amphibians, 9 mammals, 11 reptilians and 60 bird species (Appendix 8, page 95).

58. In April 2013, 5 female and 1 male chital have been released in DDWS. One female died later. 17 August 2013, two spotted deer (*Axis axis*) has been released[3] in the presence of a previous Minister of Environment and Forests.

59. Elephant are particularly visiting DDWS in winter.

Herpeto fauna

60. So far, 56 reptile species have been recorded in DDWS (Feeroz et al. 2012). The Elongated tortoise *(Indotestudo elongate),* the only tortoise species of Bangladesh is occasionally found. Asian leaf turtle *(Cyclemys oldhami)* and yellow turtle *(Meronia petersi)* are some of the rare turtles here. Others reptiles such as *Mabuya carinata*, tokay gecko *(Gekko gecko),* ornate flying snake *(Chrysopelea ornate), Cuora amboioensis*, and Bengal monitor *(Varanus bengalensis)*.

61. Amphibians are represented by 25 recorded species such as Asian common toad *(Duttaphrynus melanostictus),* Indian bullfrog *(Hoplobatrachus tigerinus),* and common Indian tree frog *(Polypedates maculates)*.

Fish

62. DDWS has a vast network of creeks directed to the Sangu River. Twenty-two species of fin fish and one crustacean species under 19 genera have been recorded (Feeroz et al. 2012). Among these species, 16 are common and 6 are rare. Some of the common fish are dwarf gourami (*Colisa lalia*), finescale minnow (*Salmostoma phulo*), guntea loach (*Lepidocephalus guntea*), loach (*Nemacheilus sikmaiensis*), minnow (*Oryzias melastigma*), mud eel (*Monopterus cuchia*), spotted snakehead (*Channa punctatus*), spotted barb (*Puntius phutaenio*), stinging catfish (*Heteropneustes fossilis*), ticto barb (*Puntius ticto*), and walking snakehead (*Channa orientalis*).

2.4 DDWS landscape land use and tenure

63. The overall landscape area of DDWS is about 10,308 ha of which 4717 ha is in core zone (the actual DDWS), 2683 ha is in the buffer zone and 2909 ha is in impact zone[4]. Land use includes natural forest, plantations, shrubland, fallow land, cultivated land, water bodies and settlement. Most of the land is degraded, but around 2925 ha of forest plantation has been established by BFD. The area of DDWS estimated by RS is 4875 ha (Table 1, page 24) but the gazetted area of DDWS is 4717. Therefore, the remaining 158.51 ha area will be properly demarcated by FD. The total Landscape area of Dudpukuria Dhopachari Forest is

[3] It should be noted that DDWS does not offer appropriate habitat for chital and this deer species should therefore not be released here.

[4] "Impact zone" refers to the area where people live and cultivate who depend partly on resources from the protected area and who may be also affected by influence from the protected area by for example human-wildlife conflict. This zone is also refered to as "Interface landscape."

estimated 10,308 ha by using remote sensing map. 1467 ha area is not mapped due to lack of available RS data.

64. The land category of the core zone and buffer zone is Reserved Forest and Protected Forest, with the legal title of land ownership held by the Government of Bangladesh through the BFD.

2.5 Cultural and aesthetic information

65. A Buddhist temple is found in the forest inside Dhopachari Range. In the area grows a flower on a tree (Lucharang in local language) which flowers every 12 years according to local sources. The last flowering occurred in 2013.

2.6 Socio-economic information

2.6.1 Population

66. The DDWS landscape is home to five ethnic people, the Tripura, Marma, Bom, Tonchangga and Khayang dwelling in 32 villages with 5047 households and an overall population Co-management area of around 32,000. The rate of education of the villagers is 47.1%. About 72% of the population is Muslims, 10.5% Hindu and 17.5% Buddhist.

2.6.2 Administration and social facilities

67. DDWS is located in two different upazilas (Rangunia and Chandanish) and hence in two different unions (Padua, Dhopachari).

68. Generally, the area has a poor road infrastructure, but some educational and medical facilities are present (Table 2, page 28).

Table 2. Present social facilities in the DDWS area (source: CREL)

Name	Dudpukuria	Dhopachari
Concrete road	15 km	8 km
Unpaved road	20 km	20 km
Educational institution	13	6
Shelter support centre	None	None
Shopping centre	None	3
Police camp	1	1
Hospital	1	1
Post office	1	1
Union council office	2	1
Rubber check dam	1	

2.6.3 Accessibility

69. Despite the relatively short distance to Chittagong, the road connection from this city to DDWS is poor.

70. There are about 28 large (0.5km-2km) and 62 small (less than 0.5km) foot trails inside the forest.

2.6.4 Livelihood and resource users

71. Around 23.5% of the population depends on livestock rearing, 20% on agriculture (paddy), 17% depends on day labour, 17% are involved in vegetable cultivation, 14% depends on the forest, 3% are doing small business, 3% practice handicraft, 1.5% practice fruit cultivation (lemon, guava, banana) and 1% are engaged as a service holder (Table 3, page 28). In Dhopachari part of the landscape, the main crops are lemon, guava and banana.

Table 3. Resource uses of DDWS (source CREL)

Resources	Purpose	Users	Dependency
Fuel wood	HHs consumption and for commercial purpose	Local people, tea stalls, brick fields	High
Timber	Commercial and HH building material	Local people, furniture makers	Low
Sun grass	Commercial and HH thatching material	Local people, local market	Low
Other NTFPs*	Commercial and HHs consumption	Local People	High
Wildlife	Commercial and HHs consumption	Local People	Low
Betel leaf vine cultivation	Commercial use	Local market	Low

* Includes among others bamboo, cane, medicinal plants, fruits, vegetables, dry leaf and grass

2.6.5 NGOs, CBOs and projects

72. Community Development Centre (CODEC)[5] is an NGO that facilitates diversifying livelihoods promotion, life skills development, climate change adaptation, and it is becoming a national advocacy organization. CODEC emphasizes on Integrated Livelihood Approach (ILA), transforming future generation of coastal communities into effective human resources, and agreed policy promotion for sustainable well-beings. CODEC is the implementing partner of CREL in DDWS.

2.7 Current land and resource use

2.7.1 Land tenure

73. Over the past few decades, land cover has changed significantly due to anthropogenic pressures, such as migration, illegal felling, harvesting, conversion of land to agricultural uses and encroachment. The land category of the Core Zone and Buffer Zone of DDWS is Reserved Forest and Protected Forest, with the legal title of land ownership held by the Government of Bangladesh through the BFD.

2.7.2 Forestry

74. At the end of the 19th century, forests were managed primarily for revenue collection under the control of the Revenue Department. Only valuable trees were extracted from the forest to optimize revenue. In 1930s, the system of management was modified to clear felling supported by artificial regeneration or plantation. Since 1990, according to the Government's decision, the logging from these forests has been stopped.

2.7.3 Agriculture

75. The main crop is aman rice. Aman is cultivated in the rainy season (kharif-2). Boro rice is cultivated in only 20% of land suitable for boro cultivation in boro season. Plenty of vegetable is produced in Rabi season and throughout the year. These vegetables include potato, eggplant, cucumber, cabbage, tomato, bean, carrot, and papaya. HYV seeds are usually used. Tobacco is cultivated in Dudpukuria area. Yield of vegetables is relatively good. Yield of Boro and Aman are 3360 to 4200 kg/ha and 2800 to 3360 kg/ha respectively. Use of cow dung in agriculture is very common as most families raise 5-7 cattle. Chemical fertilizers are also used. Farmers usually use HYV seeds. To protect crops from pests, farmers use various chemicals and pesticides (Appendix 10, page 101).

[5] http://www.codecbd.org/

2.7.4 Livestock

76. Little information is available on livestock in the area. A modest estimate of the cheptel in the Impact Zone based on the average number of livestock per family is 5000 cattle and buffalo and 1500 goat (source CREL). This figure needs to be verified as higher totals result from earlier assessments.

2.7.5 NTFP

77. Most of the families (90%) living in this area collect firewood and leaves from the forest. They also collect bamboo, cane, amla and various fruits (e.g. lemon, pineapple, mango, jackfruit, blackberry, guava, papeta and tamarind) from the forest. People extract also timber from the forest, materials for broom making as well as honey from bee hives.

2.7.6 Tourism

78. The number of tourists currently (2014) visiting the sanctuary is low. No entry fees have to be paid and no entry statistics are being collected. Approximately every 12 years large numbers of Buddhist pilgrims visit Dhopachari to search for a flower with religious significance.

79. One rest wooden rest house is available at Dhopachari inside the sanctuary, which is management by BFD primarily for senior staff but also for other visitors. One observation tower has recently been built and a walking trail (1.5 Km) established.

80. Hotels are available at Bandarban town.

2.8 Management and protection system

2.8.1 Institutional setup and geographical layout

81. DDWS is under administrative jurisdiction of Khurusia and Dohazari Forest range under Chittagong South Forest Division. There is no separate administrative set up for the management of the sanctuary, but it is managed by the territorial forest administration. Under the Wildlife Act 2012, the sanctuary is supposed to be managed by the WNCC.

82. The notified area of DDWS is 4717ha (11651 acres). It was proclaimed as Wildlife Sanctuary, comprising four forest block named Dudpukuria (830 ha), Shibchari (8901 ha), Dhopachari (1516 ha) and Mongla (1481 ha). These four blocks presently cover three forest beats namely Dudpukuria, Kamalachari and Dhopachari beat under Khurusia and Dhopachari Ranges. The total landscape area of the PA is about 10308 ha of which 4717 ha core zone (Table 4, page 31), 2682.57 ha buffer zone (Table 5, page 31) and 2909 ha is.

83. The Divisional Forest Officer (DFO) is overall responsible for the management of the PA including administration, protection and improvement of the resources and conservation of biodiversity, environmental management, preparation of budget, and control over all activities within his jurisdiction.

84. The Range Officer (RO) is responsible for management implementation of the sanctuary. He liaises with other related government departments and local NGOs and other organizations for smooth implementation of (co-)management activities. The Forester in Charge of a Beat is responsible for protection and other field activities within his Beat.

85. In 2014, 12 staff has been employed in two Range offices and 3 Beat offices of DDWS (Table 6, page 32).

Table 4. Forest ranges and beats in DDWS

Subdistrict	Forest Range	Forest Beat	Block/Mouza	Area
Rangunia	Khurusia	Dudpukuria	Dudpukuria (Dudpukuria and East Khurusia mouza)	830 ha (2,050 acre)
Rangunia	Khurusia	Kamalachari	Sibchari (East and West Khurusia mouzas)	891 hectares (2,201 acre)
Chandanash	Dhohazari	Dhopachari	Dhopachari (West Dhopachari mouza)	1,516 hectares (3,745 acre)
Chandanash	Dhohazari	Dhopachari	Mongla (Jungle Dhopachari mouza)	1,480 ha (3,656 acre)
Total				4,717 ha (11,651 acre)

Table 5. Buffer zone areas of DDWS

Range	Beat	Block	Area (ha)
Dohazari	Lalutia	Chiringhata	0.2
		Lalutia	246.3
	Sangu	Sangu	935,0
Khurusia	Khurusia	Khurusia	893.6
	Sukbilash	Sukbilash	180.0
Patiya	Borguni	Elahabad (P.F.)	39.0
		Hashempur	0.7
		Sonaichari	72.3
	Srimai	Silchari	203.4
		Srimai	112.0
		Total	2682.6

Table 6. Current protection staffing of DDWS (2014)

Number of current staff	Khurusia Range office	Dhohazari range office	Dudpukuria Beat office	Kamlachari Beat office	Dhopachari Beat office	TOTAL
ACF	0	0	0	0	0	0
Forest ranger	1	1	0	0	0	2
Deputy ranger	0	0	0	0	0	0
Forester	0	0	1	0	0	1
Forest guard	0	1	1	2	4	8
Mali	0	0	0	0	1	1
Cook	0	0	0	0	0	0

2.8.2 Protection infrastructure and logistics

86. At Dudpukuria there is one Sanctuary office, one Beat office cum staff quarter, one Guard quarter (requires repair) and one Malis quarter (requires repair). One Beat office cum staff quarter and one double forest guard quarter are located at Dhopachari. No transport facilities are available.

2.8.3 Resource management

87. Resources inside the sanctuary are managed by BFD through the Beat offices and with support from the Community Patrol Groups which have been created under the Co-management organization (CMO, see section 2.8.4, page 32). Only non-consumptive use of the sanctuaries is allowed by the Wildlife Act (2012). Sustainable resource use is allowed in Reserved Forests which are managed by BFD with assistance and participation of the communities through the CMO. The CMO also plays a motivating and coordinating role with regard to sustainable resource management in the land outside the sanctuary and Reserved Forests (Impact Zone).

2.8.4 Co-Management

88. To assist the management of DDWS and to address the stake of local communities regarding impacts and benefits, two Co-Management Committees have been formed, the Dudpukuria Co-management Committee and the Dhopachari Co-management Committee.

89. The co-management approach has been introduced in DDWS in 2006. Co-management organization is an active organization by which a reserve area and existing biodiversity is conserved following the Co-management approach. This organization is approved by GoB

and formed by local people and government officers who are related with reserve forest area. The related organizations are following (Table 3.1): Co-Management (CM) committee, Co-Management (CM) Council, Village Conservation Forum (VCF), People's Forum (PF) and Community Petrol Group (CPG).

90. CMCs are able to develop Annual Development Plan (ADP) of their own landscapes and PA.

91. The Co-Management Organization of Dudpukuria-Dhopachari was formed on 23th November, 2009 through a Gazette Notification No. "PaBaMa/PoRiSha-4/Nishorgho/105/Sting/2006/398.

92. The establishment of Co-management Committee was formed in Dudpukuria 22 May, 2011 (1st committee), 12 June 2014 (2nd committee) (Table 4.1). The establishment of Co-management Committee was formed in Dhopachari 09 January, 2012 (1st committee), 11 June 2014 (2nd committee) (Table 7, Table 8).

Table 7. Co-Management organization of Dudpukuria (source CREL)

Co-Management Institutions	Establishment	Number	Member	Women	Men
Co-Management (CMC) Committee	22/5/2011, 12/6/2014	01	27	05	22
Co-Management (CM) Council	22/5/2011	01	63	12	51
Village Conservation Forum (VCF)	2010, 2011, 2012	20	580	197	383
People's Forum (PF)	23/2/2011, 19/2/2014	01	40	08	32
Community Petrol Group (CPG)	2011, 2012	04	77	21	56

Table 8. Co-Management organization of Dhopachari (source CREL)

Co-Management Institutions	Establishment	Number	Member	Women	Men
Co-Management (CMC) committee	09/1/2012, 11/6/2014	01	27	03	24
Co-Management (CM) Council	09/1/2012	01	63	12	51
Village Conservation Forum (VCF)	2011, 2012	13	390	190	200
People's Forum (PF)	26/12/2011	01	34	15	19
Community Patrol Group (CPG)	11/12/2011	01	21	-	21
Forest Conservation Club (FCC)	2011	02	45	-	45

2.8.5 Community Patrol Groups

93. In Dudpukuria Dhopachari Wildlife Sanctuary, Community Patrol Group (CPG) is the most significant element of co-management concept. Their main duty is to protect the forest against any criminal activities with the help of forest guards. In CPG man's group and woman's group are separated for their roles and responsibilities in forest management. Women have to duty just near their homes while men have to visit the forest sites away from their residences. Men and women are divided in sub-group for patrolling in different times. In every sub-group, number of man power is 5-6. In Bangladesh Forest Department,

work force is in scarce condition. After organizing of CPG, the condition of forest is now comparatively better and forest crime is reduced remarkably. Local people have joined in CPG mainly for the purpose of forest protection. Apart from that it is providing some additional income.

94. In Dudpukuria 4 and in Dhopachari 1 CPGs are present. They are guided by the Forest Department. From four CPGs, 2 are needed to be continuous patrolling in core zone area of Dudpukuria range and in Dhopachari 1 needed to be patrolling in this core area. At present (2014) Tk 10 is provided per person for patrolling and Tk 100 is proposed to be given to CPG members. A reward system is required for good work for the members to motivate their conservation in the forest.

3 Evaluation of values of the protected area

WHAT ARE THE OPPORTUNITIES AND ASSETS OF THE PROTECTED AREA?

3.1 Biodiversity

95. DDWS one of the less disturbed forests of Chittagong South Forest Division due to its relatively inaccessibility. It is one of the protected areas in Bangladesh with the highest biological diversity with 608 recorded plant species, 190 invertebrate, 23 fishes, 25 amphibians, 56 reptiles, 231 birds and 50 mammals (Feeroz 2012). Due to connection with other forest areas in the Chittagong Hill Tracts some mega fauna can be seen here which can hardly be seen in any part of the country. Common mammals are barking deer and wild boar. Fishing cat, leopard cat, binturong[6], grey peacock pheasant, white-cheeked partridge[7], oriental pied hornbill, oriental dollar bird and king cobra have also been recorded in the area (M. Khan, pers. comm.). Unverifiable records exist of clouded leopard[8], leopard and sambar. Small herds of elephant visit the sanctuary regularly and tracks of Asian black bear were observed in November 2013. The sanctuary is one of the few areas in Bangladesh where Western Hoolock gibbon is found, a species which is globally endangered.

3.2 Livelihood

96. The high biodiversity of the forest offers a wide range of timber and non-timber forest products (NTFP) to forest depending communities around the sanctuary, including Bengali, Tanchangya, Marma and Tripura (Table 9, page 36). Significant numbers of Marma and Tripura live still in the northern part of Dudpukuria and make use of these resources, which is legally allowed outside but not inside the sanctuary.

[6] The binturong (Arctictis binturong), also known as bearcat, is a viverrid native to South and Southeast Asia. It is uncommon in much of its range, and listed as Vulnerable by IUCN because of a declining population trend that is estimated at more than 30% over the last three decades.

[7] White-cheeked Partridge (Arborophila atrogularis), global status: Near Threatened

[8] The clouded leopard (Neofelis nebulosa) is a cat found from the Himalayan foothills through mainland Southeast Asia into China, and has been classified as Vulnerable in 2008 by IUCN. Its total population size is suspected to be fewer than 10,000 mature individuals, with a decreasing population trend, and no single population numbering more than 1,000 adults.

Table 9. Traditional use of plant species found in DDWS indicated as the number of species per forest product category used per life form (Feeroz et al. 2012)

Forest product	Tree	Shrub	Herb	Climber	Fern	Epiphyte	Parasite	TOTAL
Timber	100							100
Fuel wood	33	5		1				39
Food and fodder	128	25	75	7	4			239
Medicine	76	56	74	27	5	1	2	241
Miscellaneous	68	39	53	11	6	5		182
Multiple use	55	4	6					65
Use unknown	14	43	58	29	7	1	4	156
Species/category	182	125	200	71	17	7	6	

3.3 Cultural value

97. Dhopachari is every approximately 12 years a pilgrimage destination for many Buddhists looking for a sacred tree flower.

3.4 Tourism

98. Due to the limited accessibility of DDWS compared to other protected areas in the south-east of Bangladesh, most visitors prefer protected areas such as Himchari NP and Kaptai NP with easy access and infrastructure. As result DDWS has no large crowds of tourists and it has not been turned in a mass tourism site, which means that there is still potential for real "eco-tourism[9]" if the natural characteristics of the area will be maintained.

99. DDWS provides scenic beauty of green hills with natural forest. It has a rich biodiversity, particularly birds and plants. Some specific areas of interest for tourists are the villages of the Marma, Tanchayanga, Tripura, Bom, and Kheyang communities, as well as the Buddhist temple in Dhopachari.

3.5 Watershed protection

100. Because of the accidented landscape and high rainfall, more than 18 perennial streams are draining the sanctuary, providing water to Sangu River in the North and to Karnofuli River in the north. Due to the evergreen dense vegetation, water is well intercepted and erosion is limited (except in cultivated areas) contributing to water conservation despite the relatively low infiltration rate of the soil. Not only the sanctuary's biodiversity is benefiting from watershed protective characteristics of land cover, but also the downstream rural and urban landscapes provisioned with fresh water.

[9] IUCN defines "ecotourism" as "Environmentally responsible travel to natural areas, in order to enjoy and appreciate nature (and accompanying cultural features, both past and present) that promote conservation, have a low visitor impact and provide for beneficially active socio-economic involvement of local peoples."

3.6 Climate change mitigation

101. Natural forests contribute to carbon fixation which is assumed to have a mitigating effect on global warming. Forest degradation, therefore, contributes to global warming, while conversely forest plantation and conservation mitigates climate change. Due to forest plantation efforts DDWS has been contributing to net carbon sequestering during the last few decades, in contrast with other forests in the same area (Table 10, page 37). This result is also related to reduced soil carbon loss due limited encroachments and erosion, which resulted even in a net gain.

102. Successful forest and biodiversity conservation can be used to mobilize funds to support conservation through the carbon credit market (UNREDD 2012).

Table 10. Carbon loss and gain in Dudpukuria-Dhopachari WS in comparison to 5 other forests south-east Bangladesh indicating increase only for DDWS (BFD 2011)

Protected Area	Forest Area (ha)	Annual Forest Carbon Loss (ton/ha)	Annual Soil Carbon Loss (ton/ha)	Total Annual Carbon Loss (ton/ha)	Total Annual Carbon Loss over the Forest Area (ton)
Dudpukuria-Dhopachari	2,653	-245.72	62.14	-183.58	-487,038
Fashiakhali	301	1,113.72	278.13	1,391.85	418,947
Inani	2,249	2,977.41	3,185.91	6,163.32	13,861,307
Medhakachpia	112	41.31	6.12	47.43	5,312
Sitakunda	2,461	-2,343.52	2,521.51	177.99	438,033
Teknaf	1,794	4,872.78	2,914.84	7,787.62	13,970,990

4 Analysis of issues and threats

WHAT ARE THE KEY CONSTRAINTS AND CHALLENGES FOR MANAGEMENT?

103. The principal constraints and threats which form the challenges for the management of Dudpukuria-Dhopachari Wildlife Sanctuary are elaborated in the following sections.

4.1 Land use, tenure and encroachment

104. The boundaries of DDWS are not maintained and encroachment for cultivation and settlements has taken place. No efforts have been made to physically demarcate the boundaries in the field and the situation was exacerbated with heavy biotic pressure on forests and encroachment of forestland.

105. Extending tobacco cultivation is a major factor for deforestation and fragmentation around DDWS. Since fire wood is used for tobacco curing, tobacco production is also responsible for deforestation.

106. Forest encroachment for degraded land (1467.66), settlements (192.43 ha) and agriculture (212.31 ha) is spread inside the PA. Forest is encroached slowly; it is occurring mainly for grazing, NTFPs collection and lemon cultivation. Many times the village elites are directly or indirectly associated with forestland grabbing for establishing homesteads and cultivation. Institutional infringement is common in the buffer zone, for example to establish school, madrassa, graveyard and mosques (Table 11, page 38). In some cases, the encroachment has been regularized in the buffer area by issuing land ownership documents as Khas land. This phenomenon of forest infringement is continuing and needs to be stopped immediately.

107. Particularly in the southern part of the sanctuary valleys are encroached for paddy cultivation while slopes are deforested for ginger, turmeric and lemon, increasing erosion risk.

108. Intrusion of landless people from other parts of Bangladesh in the Dhopachari area accelerates encroachment and increased pressure on resources.

Table 11. Establishment of social institutions in the landscape zones

Types of Institution	Core Area	Buffer zone	Impact zone
Mosque	-	9	12
Mandir	-	2	3
Temple/keying	1	1	5
Grave yard	-	15	5
Madrasha	-	1	3
Primary school	-	3	7
High school	-	1	3
College	-	-	1
Bazar	-	1	2

4.2 Illegal and unsustainable resource extraction

109. Although encroachment has been reduced significantly since the sanctuary has been established and vegetation cover inside the sanctuary is increasing, illegal resource extraction continues. Evidence of illegal extraction was visible in the form of bundles of bamboo and fire wood along forest trails during surveys in March 2014. Illegal use of forest resources is still common in DDWS, including illegal felling and hunting.

110. The population around DDWS depends very much on the forest. The following resources are being used: fuel-wood collection, livestock grazing, fodder collection, bamboo, cane, green and dry leafs, fruits and vegetables, sun- grass, and medicinal plants. Fuel wood collection for household use and brick fields is the main factor of forest degradation, but particularly the destruction/collection of seedlings and saplings, livestock and forest fire are the main factors inhibiting natural regeneration.

111. DDWS is rich in amphibian species, but the mass collection of bull frogs and tadpoles (*Nasirana alticola, Hoplobatrachus tigerinus, and Hylarana leptoglossa*) forms a threat to these populations (Feeroz et al. 2012). Occasionally wild boar and barking deer are hunted by indigenous people.

112. Local people say that both fish diversity and fish populations have declined due to the loss of fish habitats, silting of creeks due to excessive soil erosion, use of pesticides in agriculture (Appendix 10, page 101) and overharvesting of fish during the breeding season.

4.3 Road infrastructure development

113. Improving road infrastructure facilitates the marketing of forest resources and hence it accelerates resource depletion and deforestation. The new road under construction which will connect Dhopachari to the Chittagong-Cox's Bazar road therefore constitutes a major threat to DDWS.

4.4 Livestock

114. The introduction of livestock is prohibited according to the Wildlife Act (2012), but livestock grazing is common and destructive particularly by interfering with forest regeneration. Livestock roams freely in the sanctuary, even at night (Feeroz et al. 2012).

4.5 Habitat degradation and fragmentation

115. Several factors are responsible for habitat degradation, particularly:

- unsustainable utilization of resources by collectors of timber, firewood and NTFPs,

- grazing and browsing by livestock,
- pollution due to agrochemicals (Appendix 10, page 101),
- forest fires, lit every year by resource users to facilitate access to the forest,
- forest conversion by encroachers.

116. Ecosystem services such as provisioning (food, fresh water), regulating services (cyclone and storm regulation, water purification), supporting services (soil formation, nutrient cycling) are negatively affected by habitat degradation, which has a negative impact on wildlife as well as on the communities in the area.

117. Degradation results also in fragmentation of habitat and disconnection of the sanctuary from other areas with remaining natural habitat (Figure 4, page 40), which will lead to disappearance of the larger animals and increasing human wildlife conflicts. Fragmentation is among others driven by the resource needs of the increasing population of the nearby urban centre of Chittagong (Appendix 4, page 87).

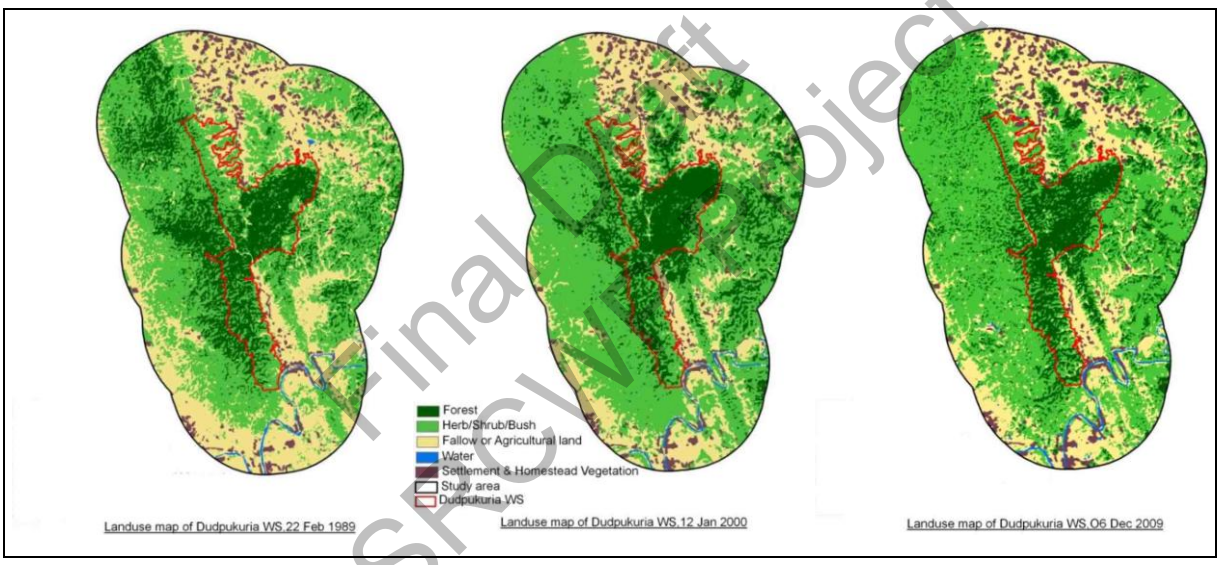

Figure 4. Forest cover degrading outside DDWS and improving inside DDWS from 1989 to 2009 (BFD/IPAC 2011)

4.6 Climate change

118. Climate related disasters such cyclone and storms, excessive rainfall, water logging, and drought occur frequently in the area, bringing at risk livelihoods and human life.

119. Forecasted rising temperatures (Islam 2009) may influence life cycles and habitat suitability of animal and plant species. On its turn these changes may have consequences for the performance of agricultural crops. Habitat changes resulting from climate change may force animals to migrate to other areas. Due increasing fragmentation of landscapes migration is becoming more difficult.

120. Sea level rise resulting from climate change may also induce human migration to higher areas such as the DDWS landscape.

4.7 Wildlife-human conflict

121. Asian Elephant is the largest mammal in this area. Asian Elephants are forest dwelling animals they can be considered as keystone species in the area as their influence on the habitat determines habitat quality for other species, due the impact of elephant browsing as well as their role with regard to seed dispersion.

122. Due to decreasing space for elephants, human-elephant conflicts (HEC) are increasing (Table 12, page 41). Destruction of their habitat, drive elephants increasingly to attack settlements and agricultural fields in search of food. Fragmentation of elephant habitat, food scarcity and increased human activities within the sanctuary and in migration corridors of elephants pose serious challenges for elephant habitat conservation and human elephant conflict management in DDWS.

123. The primary reasons for HEC are cultivation and human settlement in elephant corridors.

124. Other impact of wildlife experienced by people is mainly crop damage due to wild boar, monkeys and birds.

Table 12. Number of Human - Elephant Conflict incidents from May 2010 to October 2014 (source IUCN)

Beats	Crop field	House-hold	Food storage/ other property	Home-stead garden	Commer-cial garden	Human killed/ (No.)	Humans injured	Elephant killed/ injured	Total
Komolachari	51	3	1	4	1		1		61
Khurusia	28			2		1	1		32
Sukhbilas	48	34	4						86
Dudpukuria	20	4		2	1	1			28
Narischa	119	10	1		1	1			132
Chiringa	34	1	1				1		37
Lalutia	1	4	1		2				8
Sangu		1							1
Total	*301*	*57*	*8*	*8*	*5*	*3*	*3*		*385*

4.8 Tourism

125. At present (2014) tourism is constrained due to the poor accessibility of DDWS and better access to other protected areas from Chittagong the main urban centre in the region. Plans exit for road improvement, which may boost the number of tourists. Nevertheless stakeholders have the ambition to develop nature-based tourism under co-management.

Not rarely, tourism in Bangladesh is associated with picnic, loud music and waste disposal inside the protected areas. Therefore, increasing tourism will not only generate more revenues, but it will also lead to more disturbance of the ecosystem by the visitors, which needs to be managed.

126. The current limited number of tourists constitutes also a lack of incentives and sustainable funding for the consolidation of a self-sustaining co-management system.

127. Occasional political conflicts and other law and order problems constitute also a barrier to further tourism development.

4.9 Relation between population and BFD

128. As in most places around protected areas, a certain tension between protection staff and local populations exist due to the feeling of the latter of being excluded from the resources which some of them consider as their own. Due to the history of Co-management development under IPAC, which started in 2006, the relation with between the BFD staff and the local communities is improving and awareness on the need for conservation and sustainable management of natural resources is increasing.

4.10 Staff accommodation and facilities

The following factors constraint the operational capacity and motivation of the Surveillance staff:

- poor accommodation,
- inadequate office space,
- insufficient mobility.

4.11 Lack of information on resources

129. Crucial information for management is very scarce and not shared with all stakeholders. The boundaries of the sanctuary are not clearly mapped; statistics on population and economic activities unreliable, and management related activities such as law enforcement not very accessible. This complicates taking the right management decisions and negotiations in resource and land use conflicts.

5 Vision and objectives

PRIORITY DIRECTIONS TO MOVE AHEAD

5.1 General policy framework

130. According to the NBSAP (GoB 2004), the primary objective of Bangladesh' biodiversity conservation policy is "*to establish conditions to conserve, and wherever necessary, to restore the biodiversity of Bangladesh as an essential component to ensure the wellbeing of the present and future generations, and equitable sharing of benefits*". This involves among others the maintenance and improvement of environmental stability for proper functioning of ecological systems, and ensuring the preservation of the unique biological heritage of the nation as an asset for the benefit of the current and future generations.

131. Strategy 9 of NBSAP states: "*Enhance Protected Area management recognizing the benefits of collaboration with local communities in their management (co-management*)", followed by: "*Practically, protected areas should be managed in keeping with the Ecosystem Approach as defined by the Conference of the Parties to the Convention on Biological Diversity (Decision V/6) which can be summarised as a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way. Co-management of PAs is one of the widely accepted approaches towards its management."*

5.2 Scope and limitations of managing DDWS

132. Dudpukuria-Dhopachari Wildlife Sanctuary is a small protected area which is located in an area of Bangladesh which has a relatively large proportion of remaining forest (Appendix 4, page 87). More than ten protected areas are found in this part of the country and connection to forest areas in Assam and Myanmar is still functional, although wildlife populations are declining due to habitat degradation and fragmentation. Most of these protected areas are too small to sustain the larger wildlife species on the long term. Therefore, an integrated landscape approach is required for the Chittagong Hills and the Chittagong Hill Tracts to manage the entire system of protected areas and interface landscape to maintain connectivity.

133. Effective forest conservation is crucial for sustainable livelihood and resilience against natural hazard such as climate change for local populations. Co-management of forest and natural resources inside protected areas and in the interface landscape between these areas enables to address biodiversity conservation priorities as well as livelihood security for local populations.

134. Beside biodiversity conservation and co-management, the promotion of integrated landuse planning is essential to achieve effective conservation of this landscape on the long term, addressing current threats such as land grabbing and unsustainable land use practices such as tobacco cultivation and cultivation on slopes. Therefore the promotion of alternative livelihood is a crucial element of the conservation strategy.

5.3 Objectives

135. The long term vision of the DDWS management plan is to maintain the sanctuary as part of the greater Chittagong Hills and Chittagong Hill Tracts landscape and its supported biodiversity in such a way that key species such as elephant, hoolock gibbons as well as other threatened species and wildlife significant for the area are preserved, while conserving the ecosystem services for the benefit of local populations and future generations to ensure sustainable livelihood and resilience to environmental hazard, including climate change. Additional to that, the sanctuary should be a show case of a well conserved ecosystem as a source for nature based tourism, education and science. Within this perspective, the following management objectives are proposed for Dudpukuria-Dhopachari Wildlife Sanctuary:

(1) Protect and maintain physical, biological and aesthetic features of Dudpukuria-Dhopachari Wildlife Sanctuary as part and example of typical Chittagong Hills and Chittagong Hill Tract[10] forest ecosystem

- Regulate land use through zoning and zone demarcation of the area, taking into account land value and function as well as crucial and vulnerable habitats of wild species;
- Protect crucial habitats such as resting sites of birds and large trees for monkeys, particularly hoolock gibbon;
- Research, surveys and monitoring of biodiversity resources to understand ecological values, processes and threats;
- Control invasive species, including livestock and other domestic animals in vulnerable habitats;
- Develop and implement effective surveillance and law enforcement.
- Reduce the dependency on the PA by improving livelihood of people by AIGA

[10] Natural habitats associated with Bio-ecological zones as defined by Nishat et al. (2011) are taken as targets for PA conservation strategies. The bio-ecological zone of Chittagong Hills and Chittagong Hill Tract represents a specific zone of the semi-evergreen forest in Bangladesh.

(2) Improve livelihood and resilience of communities to natural hazard including climate change and human-wildlife conflicts

- Resilience to climate change through adaptation;
- Improved watershed management in the sanctuary as well as in the impact zone;
- Reduce Human-Elephant conflict by adapted landuse planning, zoning and effective compensation measures.

(3) Realizing and utilizing the Sanctuary's potential as venue for responsible tourism based on wildlife, educational, cultural and aesthetic appeal

- Develop ecotourism infrastructure;
- Promote ecotourism in urban centres of Bangladesh;
- Support local and private initiatives in the field of ecotourism development;
- Control impact of tourism.

(4) Integrating the Wildlife Sanctuary into local and regional development process engaging local stakeholders to ensure wider acceptance of the Sanctuary's values

- Create awareness among stakeholders including local resource users as well as key actors determining land and resource use, involving also local educational institutes;
- Support further development and capacity building of co-management;
- Develop entry fee collection system for visitors of the sanctuary;
- Develop benefit sharing for local stakeholders;
- Promote of (re)investment in ecotourism development;
- Realize sustainable funding of the sanctuary promoting conservation and local development.

(5) Improving the BFD's staff welfare, motivation and capabilities

- Enhancing office and accommodation facilities for BFD staff;
- Improving logistics and mobility;
- Improving field equipment;
- Training.

6 Zoning plan

HOW TO PLAN MANAGEMENT IN DIFFERENT PART OF THE SANCTUARY

6.1 Zoning in the Bangladesh Wildlife Act (2012)

137. The Bangladesh Wildlife Act (2012) distinguishes and defines the following zones inside and outside protected areas:

- Section 10: “Corridor” means a passage or area in the margin of a protected area through which the wildlife can move from one forest or area to another forest or area and which is declared as corridor through official gazette notification under section 20 of this Act;
- Section 12: “Core zone” means the most important existing forest area within a protected area, which is rich in biodiversity and where extraction of all kinds of forest produces are prohibited for safe reproduction of wildlife and which is managed for regulating entry of visitors and declared as such through official gazette notification under section 20 of this Act;
- Section 27: “Buffer zone” means forest lying in the margin of protected area, except core zone, or degraded forest area adjoining human habitation, where local community people are inclined to harvest forest produce and where there is scope for short rotation participatory forestry in harmony with plant species of the protected area and development of which ensure protection of biodiversity and which is declared as such through official gazette notification under section 20 of this Act;
- Section 36: "Landscape zone" means a public or private area outside the boundaries of designated sanctuary, national park and eco-park that regulates the biodiversity of the protected area and which is managed to maintain similar landscape of the protected area for deterring degradation of the protected area and ensure safe movement of wild animal, and notified as landscape zone under section 20 of this Act ;

6.2 International good practices

138. Zoning inside protected areas is particularly useful for the handling of large multi-purpose and multi-dimensional protected areas, and for providing connectivity between core areas (Lausche and Burhenne 2011). It is also an appropriate tool for accommodating a variety of governance types or mixed tenure arrangements within a single designated protected area. The following types of zones are often applied in protected areas in different parts of the world:

(1) Special and/or unique values zone for particular protection of specific features (biological, cultural, geological) of the protected area;

(2) Primitive/wilderness zone for the full preservation of landscapes and ecosystems;

(3) Limited development zone for the protection of natural areas used for ecotourism, education and research and allowing limited developments (particularly road infrastructure) to facilitate these activities;

(4) Intensive development/services zone for the establishment of for example protected area offices and tourism facilities;

(5) Traditional and indigenous use zones, for sustainable resource utilisation by traditional/indigenous users;

(6) Rehabilitation zone, for restoring degraded habitats through management measures.

139. The concept "Landscape" as defined in the Wildlife Act should not be confused with how "landscape" is to be interpreted in the Landscape Approach as defined by the Convention of Biological Diversity, where "landscape" is considered in a more holistic and dynamic way as an open system made up as a mosaic of different management regimes including protected areas of different conservation categories (Brown et al. 2004; Sayer et al. 2013).

6.3 Zoning in Dudpukuria-Dhopachari WS

140. Zoning in Dudpukuria-Dhopachari WS should take into account both the Wildlife Act and international good practices. The Wildlife Act deals with external zoning while international good practices would contribute more on effective zoning inside the protected area. According the CBD definition, the Dudpukuria-Dhopachari Landscape can refer to the DDWS, its Buffer zones, connections to surrounding landscapes and including the surrounding rural area which has a direct relation with DDWS through resource utilization and human-wildlife interactions.

141. Within the sanctuary boundaries (*Core zone* and encroached land) three optional types of land can be distinguished:

- biologically significant land with secondary forest including streams (*Core zone*),
- encroached and degraded land with the potential of habitat restoration to be restored (*Rehabilitation zone*),
- encroached land not to be restored (status may be changed/reclassified to *Impact zone*)[11].

142. Outside the sanctuary (*Buffer zone* and *Impact zone*) the following zones can be distinguished:

- BFD RF lands managed as forest (*Buffer zone*)

[11] From the conservation point of view resettlement is desirable, but in practice resettlement can only be implemented according to guidelines and regulations in relation to resettlement (Appendix 13, page 79). If resettlement is not an option, it is not advisable to maintain the ambiguous status of that land for an extended period and reclassification should be considered.

- BFD RF degraded or encroached land to be rehabilitated (*Buffer zone*),
- BFD RF degraded or encroached land not to be changed/declassified[4] (*Buffer zone*),
- private lands (*Impact zone*),
- non-BFD public land (*Impact zone*).

143. The following main zones are distinguished in the DDWS Landscape (Appendix 3, page 86):

Core zone

144. This zone normally coincides entirely with the sanctuary. In practice however, encroached areas inside the sanctuary may not fulfil the criteria of core zone. They need to be declassified or relocation and/or rehabilitation are required. Inside the *Core zone* the following zones are distinguished:

- *Special/unique values zone* for particular protection of specific features,
- *Primitive/wilderness zone* for full preservation of landscapes and ecosystems,
- *Limited development zone* for protection of natural areas used for ecotourism, education and research,
- *Intensive development/services zone* small areas for protected area offices and ecotourism facilities,
- *Rehabilitation zone* for restoring degraded habitats.

Buffer zone

145. The *Buffer zone* is land outside the protected area managed by BFD as Reserved Forest, where human settlement and cultivation is prohibited but where sustainable resource extraction is allowed. Here again encroached areas inside the *Buffer zone* may not fulfil the criteria of *Buffer zone*. They need to be declassified or relocation and/or rehabilitation are required. Buffer zones are managed for sustainable resource use to reduce pressure on protected areas. The following utilization zones can be distinguished within the *Buffer zones*:

- *Traditional and indigenous use zone* for sustainable resource utilization,
- *Rehabilitation zone* for restoring degraded habitats,
- *Limited development zone* for protection of natural areas used for ecotourism, education and research,
- *Intensive development/services zone* for beat/range offices and ecotourism facilities,

Corridor zone

146. This zone is located outside the protected area and it assures connection to support the migration of biological species between the protected areas. It may be located in Reserved Forest, in which case protection can be assured under the Forest Act. If it has to be located

however on private land, agreement needs to be achieved with the owner on its protection. The following utilization zones can be distinguished within the *Corridor zones*:

- Traditional and indigenous use zones where access is controlled during elephant migration,
- Private land/other Government land on elephant corridors which are managed as above.

Impact zone

147. Private land and land owned by other Government agencies than BFD around protected areas, its buffer zones and corridor zones is *called Impact zone*. Part of the resident communities of the *Impact zone* is dependent on the resources from the *Core, Buffer and Corridor zone*. On the one hand, their resource use impacts those areas, and on the other hand their life and goods (including crops) may be impacted by wildlife from these areas. Impact zone is sometimes called Interface zone or (confusingly) Landscape zone. The following utilization zones can be distinguished within the Buffer zones:

- Private use,
- Collective use under Co-Management programmes (e.g. pilots of organic farming, forest plantations, Khowar managed by CMC).

148. A zoning plan and management matrix for Dudpukuria-Dhopachari is presented in Table 13 (page 50) and a map presenting provisional zoning is presented in Appendix 3 (page 86). The proposed zoning plan is meant to be used as a starting point for a consultative process with all stakeholders to establish the boundaries of the zones. Subsequently, zoning boundaries should be determined by GPS in the field and where necessary consolidated concrete markers need to be positioned in the field.

Table 13. Management matrix for protected area management zones in Dudpukuria-Dhopachari Wildlife Sanctuary

DDWS Management zone	**Wildlife Act**	**Utilisation zone** (as defined by WCPA)	**Locations**	**Utilisation**	**Restrictions**	**Measures**
Core zone	Core zone	Special and/or unique values zone	Most streams and steep slopes in the forest, swamps Kamolachari Beat	research	no resource extraction, no other access, no infrastructure, no roads	surveillance; maintaining natural succession and vegetation
Core zone	Core zone	Primitive/ wilderness zone	Crest of hills accessible through trails	research, zero impact ecotourism	no resource extraction, no other access, no infrastructure, no roads	surveillance; maintaining natural succession and vegetation
Core zone	Core zone	Limited development zone	Designated areas near the main roads	ecotourism, research	no resource extraction, no other access, no infrastructure	surveillance; maintaining natural succession; vegetation trails; waste management; surveillance
Core zone	Core zone	Intensive development/services zone	Area around BFD camps and offices	BFD accommodation, management, ecotourism	noise, air and water pollution control	infrastructure maintenance; picnic area management; waste management; surveillance
Rehabilitation zone	Core zone	Rehabilitation zone	Encroached and degraded areas	research	no other access	resettlement; habitat restoration
Buffer zone	Buffer zone	Traditional and indigenous use zones	Reserved Forests and other forest outside the sanctuary	sustainable resource extraction, ecotourism, research	noise, air and water pollution control	surveillance; resource monitoring
Buffer zone	Buffer zone	Rehabilitation zone	Encroached Forest Reserves	research	no other access	resettlement; habitat restoration
Buffer zone	Buffer zone	Limited development zone	Designated areas	sustainable resource extraction, ecotourism, research	noise, air and water pollution control	trails; waste management; surveillance

DDWS Management zone	**Wildlife Act**	**Utilisation zone** (as defined by WCPA)	**Locations**	**Utilisation**	**Restrictions**	**Measures**
Buffer zone	Buffer zone	Intensive development/services zone	Area around BFD camps and offices	BFD accommodation, management, ecotourism	noise, air and water pollution control	infrastructure maintenance; picnic area management; waste management; surveillance
Corridor zone	Corridor zone	Traditional and indigenous use zones	Reserved Forest in elephant corridors	sustainable resource extraction, ecotourism, research	restricted access during elephant migration	waste management; surveillance; resource monitoring
Corridor zone	Corridor zone	n.a.	Private land/other Government land on elephant corridors	sustainable resource extraction, ecotourism, research	restricted access during elephant migration, no settlements, no cultivation	waste management; surveillance; resource monitoring
Impact zone	Private land/other Government land	n.a.	Areas for (joint) socio-economic activities	plantation, cultivation, ecotourism,	n.a.	promotion of organic farming; promotion of tree planting
Impact zone	Private land/other Government land	n.a.	Other areas	any	n.a.	promotion of organic farming; reduction of tobacco farming; promotion of tree planting

7 Management prescriptions and actions (5 year work plan)

7.1 Management of the physical environment

7.1.1 Zoning

149. A zoning plan will be proposed in the plan based on consultation with the managers and other stakeholders (see also section 6.3, page 47). The zoning of the sanctuary needs to be endorsed by the CCF and the CMC.

7.1.2 Boundary demarcation

150. To indicate the different utilization zones in the sanctuary for users and managers it is convenient to demarcate zones inside the sanctuary. There are three approaches which should all be used as far as possible:

(1) written description of boundaries using landscape attributes as reference;

(2) physical demarcation of sanctuary boundaries and management zones of the sanctuary by vegetation clearing, demarcation tree planting, or placing concrete markers - fencing only where villages are bordering the sanctuary;

(3) by registering boundaries with a GPS and storing the data in a GIS system at RIMS; these GPS boundaries can be mapped on different thematic maps.

151. Where possible, rivers, streams, charas and ridges will be taken into consideration during the boundary demarcation. If needed, trenches and mounds will be put in place. Regular annual maintenance programme is necessary for boundary, pillars and signs.

7.1.3 Resolving tenure and encroachment issues

152. Forest fragmentation and encroachment will be reduced by decreasing human occupations inside the forest massif through resettlement. Resettlement will be implemented according to national regulations and international standards (GoB 2011). A Resettlement Action Plan (RAP) needs to be prepared before implementing resettlement, elaborating all required conditions and measures (Appendix 13, page 108).

153. Illegal encroachments may in some occasions require filing of legal cases.

7.2 Management of biological components

7.2.1 Biodiversity conservation

154. Priority species for conservation are elephant, hoolock gibbon, sambar, binturong and white-cheeked partridge, involving the following measures:

- Full protection of swampy read areas (*Special value zone*) in Kamolachari Beat area since this area is used by elephant and probably by Sambar;
- For Elephant conservation the establishment of protected corridors to maintain the connection with Kaptai NP and other protected areas in the region is crucial;
- Intensive surveillance and law enforcement of areas with large Dipterocarp trees to improve habitat for Hoolock gibbon;
- Control hunting where possible; and protect large areas of primary and old secondary forest for the protection of white-cheecked partridge, which is a specific target of hunters.

7.2.2 Maintaining connectivity

155. Conserving connectivity of DDWS with other PAs (Appendix 5, page 88) in southeast Bangladesh is crucial to maintain biodiversity as the sanctuary is too small to support viable populations of the larger wildlife species on its own. The focus of this task reaches beyond the boundaries of the sanctuary and its buffer and impact zones and it relates particularly to land use planning in the region. The responsibility is therefore rather with the DFO and CF.

156. The long term integrity of DDWS ecosystem as a component of the Chittagong Hills and CHT bio-ecological zone can only be assured by managing the connectivity between the protected areas in this area. A plan addressing connectivity in the area is a considerable challenge as it deals with different private and public land owners, and a multitude of stakeholders, requiring a multi-sector approach. An interesting and promising proposal has been proposed as one of the long term actions under Strategy 9[12] of the Bangladesh NBSAP in the form of the development of a Biosphere Reserve in the Chittagong Hills and CHT to consolidate connectivity of its protected areas (GoB 2004). To make a connectivity plan for the area, particularly in the form of a Biosphere Reserve, goes far beyond the mandate and geographical limits of the DDWS management plan, but as according to the NBSAP the process to establish a Biosphere Reserve should be started in the period 2012-2014, it deserves high priority and BFD should search political and financial support for this task.

157. Apart from the integrated approach as brought forward above, BFD officers need to use their power at relevant levels to

[12] Strategy 9: Enhance Protected Area management, recognizing the benefits of collaboration with local communities in their management (co-management).

- prevent road construction in forest areas (PAs, Reserved Forests and corridor areas),
- prevent any development in buffer zones and corridor area,
- limit unsustainable land use such as tobacco cultivation around the sanctuary and in corridor areas.

7.2.3 Forest management

158. Forest management in the *Core zone* will focus on conserving remaining natural forests and bringing back natural vegetation (composition and structure), wherever possible. This will be achieved by providing protection (against illicit removals of forest produce, poaching, encroachment, grazing and fire) and encouraging natural processes for regeneration and rehabilitation of degraded forests. Where necessary, ANR will be applied in the sanctuary for forest rehabilitation as well as removal of invasive species such as *Lantana camara*.

159. Forest management in *Buffer zones* and *Corridor zones* will focus on intensive production of replacement resources, particularly fuel wood, poles and timber, as well as on maintaining stable elephant habitat. However, the participants will, in addition to the protection of plantations, be responsible for providing biodiversity protection in the DDWS areas. These plantations will not be clear felled but instead be managed under selection felling (mainly targeting exotic species) to induce natural regeneration, which offers the option of ultimately including the areas in the Core zone as a mixed forest. The management of FD lands in this sub-zone will focus on sustainable use of the remaining natural patches, bringing existing plantations under co-management practices, raising participatory plantations of indigenous species in vacant areas, preventing conversion of forest into cultivated lands and maintaining biodiversity conservation values. Local stakeholders will be identified and co-management agreements signed for providing livelihood opportunities and protecting habitat.

160. Guidelines for the forestry programme in these zones are:

- Social forestry practices will be applied involving co-management stakeholders,
- Economical and fast growing indigenous species will be mainly used,
- NTFP plantations will be promoted,
- Reintroduction of indigenous species,
- Protection of fruit trees and grasslands will be improved,
- Annually 50 ha of enrichment plantation will be realized.

161. Although the Impact zone will be mainly used for agriculture and habitation, tree planting will be promoted on private land and Government land other Reserved Forest (section 7.3.3, page 57).

7.2.4 Control of livestock

162. Livestock roaming in the sanctuary (a) competes with wildlife, (b) contributes to transferring zoonotic diseases and (c) causes destructing the wildlife habitat. However, livestock provide also important food resources and income to the island population. Therefore livestock needs to be managed in such a way that competition and contact with wildlife as well as forest destruction are minimized, while possibilities for grazing are not limited unnecessary. The following measures are to be applied to reduce impact of livestock:

(1) *Local fencing* at village boundaries to keep livestock inside the village area (barbed wire, electric fencing);

(2) *Taking stray livestock* out of the forest and lock them up in a *Khowar,* where the owners should pay to get them back. A Khowar can be managed by BFD staff or by CMC.

(3) The development of *alternative fodder supply* would reduce pressure on the forest on the condition that it would not lead to increase of the stock. Since land is scarce, the best option is *silage of agricultural by products* such as paddy straw (Caluya 1999).

7.2.5 Release of animals in the sanctuary

163. The introduction of (wild) animals in protected areas and the problem of dealing with confiscated animals require the development of a general national policy for the translocation and release of animals.

164. Translocation causes stress to all wildlife and may lead to death of individual animals due to starvation, inter- and intra-specific competition and predation. The best place to release an animal is the place where it came from as it is familiar to the resources and threats of that area. Animals can only be introduced in an area (a) when there is no immediate risk of interspecific and intraspecific competition, (b) when the area is large enough to support the species, (c) when the habitat in area is suitable for the species, (d) when there is no risk for the transfer of (exotic) diseases to the area, (e) when the species does bring other wildlife species at risk, and (f) when no serious human-wildlife conflicts are to be expected. Exotic animals should never be released in the wild, but either be retained in captivity or euthanized if maintaining in captivity is too expensive or inconvenient. If translocation is justified according to these criteria, appropriate measures have to be taken for the habituation of the animals to the area.

165. Opposite to the risks of the translocation of animals is the wish to (re)introduce animals in areas where they do not occur at the moment of introduction in order to change or restore ecological functions of that area or to expand a meta-population of a threatened species. Since the criteria and mitigating measures for translocation are complex and specific for areas and species, any release of wild animals needs to be consulted with

wildlife experts and a sound translocation plan needs to be prepared. Usually a habituation phase of several months is included in the introduction, where the animal(s) is/are kept in a large enclosure on the site to get used to the place.

7.2.6 Surveillance

166. Surveillance is the most important duty in protected areas to assure biodiversity conservation. Effective surveillance is far more important than habitat interventions. Enhanced surveillance (Appendix 14, page 111) will be achieved by adopting the following Conservation Oriented Patrol standards (Barlow 2014):

- An enforcement plan must be in place for the PA including a monthly patrolling schedule involving shifts of patrol teams;
- Minimum of fifteen days/nights of enforcement patrols per month, covering all accessible areas;
- The minimum number of staff in a patrol team is four;
- Include an officer trained to collect evidence in teams;
- The team should have the powers of arrest[13];
- Enforcement patrols must be supported by an informer network;
- A mobile team should be available (car or motorcycle) to support foot teams in problem and respond to other sudden incidents;
- A communication system must be in place between patrol teams and the ACF and DFO;
- A law enforcement monitoring tool should be in place, which should be at least a monthly reporting system;
- Tactical Maps are available of the PA and surrounding areas in the Park and Range Offices;
- All major access points/routes should be controlled;
- Liaise with police and other relevant agencies in the surveillance strategy.

167. Surveillance is done by BFD staff with assistance from the Community Patrol Groups (CPG). The main duty of CPGs is to protect the forest against criminal activities with support and guidance of forest guards. Separate CPG groups for men and women are formed according to their roles and responsibilities in forest management. Women have duty near their settlements while men patrol in the forest. Sub-group are formed of 5-6 men or women to enable alternating duties.

168. Four CPGs have been formed in Dudpukuria and one in Dhopachari. Two CPG patrol in the Core zone of Dudpukuria and one CPG patrols the Core zone of Dhopachari. In 2014 Tk

[13] Under the current Wildlife Act (2012) wildlife officers do not have the power of arrest. The Acts needs to be ammended urgently.

10 is provided per person for patrolling. This is insufficient to motivate PG members and it should be increased to Tk 100.

169. Patrolling equipment to be purchased to provide to Village Patrol Group (CPG):

- Uniform 2 pc /person
- Shoes 2 pair /person
- Torch 1 pc /person
- Patrol stick 1 /person= Tk 100 / stick
- Binocular 1 /group

7.3 Sustainable resource management interface landscape

7.3.1 Conservation awareness and education

170. Conservation awareness and education programmes will be implemented and supported by the WNCC to the following target groups: schools, resource user associations including village conservation forums, law-enforcers/police, and local authorities (Union). Apart from general nature conservation, these programmes will cover climate change, forest protection, and human impacts in Dudpukuria-Dhopachari WS.

7.3.2 Implementation of co-management

171. IPAC has started to support the development of co-management in Dudpukuria-Dhopachari as developed by under the Nishorgo Support Project (Anon. (c) undated). CREL is continuing support to co-management until 2017. The most important goals to achieve are:

- Financial sustainability and autonomy of the co-management structure,
- Effective linkages between village based groups, two People's Forums, two CMCs and the related government stakeholders (collectively the co-management organisations or CMOs) active in this WS and its adjacent areas,
- Continued motivation commitment of stakeholders,
- Development of benefit sharing mechanism,
- Further development of collaboration among stakeholders,
- Development and establishment of leadership of CMO in landuse planning.

7.3.3 Sustainable funding

172. With NGO/project support (CREL), the two CMCs will develop and coordinate sustainable funding to cover the activities including joint patrols and interventions to address sustainable livelihoods and natural resources in the impact areas. The development

of sustainable funding is a key challenge for the co-management stakeholders. A financially sustainable system can only be achieved when technical and financial support is maintained over a longer period. However, dependence on donor funding is also the main threat to the success of co-management as it undermines the drive for self-sustenance.

173. Possible sources of sustainable funding are for example (a) entry fees of tourists, (b) levies on sale of services to tourists, (c) levies on resource collection in the Buffer zone, (d) by raising funds from third parties (Phillips 2000, WWF 2009), and (e) a complex but significant funding source is the carbon market since Bangladesh has joined the REDD+ partnership (UNREDD 2012). The development of sustainable funding requires technical assistance. A financial mechanism (for example "Landscape Development Fund" or "Conservation and Development Fund") can facilitate the channelling of funds from the sources to prioritized destinations such as conservation, ecotourism development and community development.

174. Inhabitants of villages in the landscape and their associations (including Village Conservation Forums) will be encouraged to develop activities and business that reduce pressure on the sanctuary and generate added value locally. Part of the benefits from eco-tourism is expected to be re-invested back for the development of local communities and DDWS.

7.3.4 Reduction of dependency on forest resources

175. To reduce dependency on forest resources enterprises - Alternative Income Generating Activities (AIGA) will be promoted. The CMO will act as an intermediary channelling technical assistance from Government and Non-Governmental to beneficiaries. The following activities will be developed under this programme:

- Harvesting of plantations established under social forestry program at the end of rotation (10 years) and distribution of sales according to clause-20 of the Social Forestry Rules-2004;
- Strip plantation (20 km) along both sides of the village roads involving local communities;
- Promotion of enterprises that reduce extraction of forest resources and have ready markets:
- Development of a system of eco-guides among local community members;
- Agro-forestry and homestead NTFP production;
- Livestock rearing[14] focussing on species which are not related to environmental degradation, such as broiler, layer, boar, rabbits and ducks;

[14] Livestock rearing and grazing in the sanctuary should be strictly prohibited, cattle, goat and sheep should not be promoted in the impact zone as they accelerate environmental degradation

- High value horticulture such as tomato, potato, papaya, ginger, turmeric, yard long bean, leafy vegetables, chilly, mango, guava, banana, jackfruit, pineapple and lemon;
- village tree nurseries for timber, fruit, vegetable, flower, fuel wood, fodder, medicinal and other NTFPs bearing species;
- Sustainable fisheries management (e.g. establishment of reproduction sanctuaries, seasonal closure, gear limits);
- Fish culture (in small and micro-ponds);;
- Introduction of fuel efficient cooking stoves, biogas, kerosine stoves and compressed rice husk utilization;
- Establishment of fuel wood plantations;
- Bamboo plantation
- Cottage industries and handicrafts including those based on bamboo and cane products;
- Sewing industry (particularly for Tupi women).

7.3.5 Sustainability and resilience to environmental hazard

176. The following adaptive measures will be taken to improve community level resilience to hazards and climate change.

- Tree plantation in the degraded land, river embankment and homestead. Deep rooting trees and creepers will be used for controlling landslide
- Introduction of drought and in low-lying areas closer to the coast saline tolerant tree and crop species;
- Excavation and re-excavation of new and existing ponds for supply of clean drinking water;
- Rainwater harvesting and water conservation in community ponds, community reservoirs and household tanks and motki (earthen jar);
- Installation of deep tube wells for the supply of drinking water.
- Establishment of village based information centre to inform people about environmental disasters and development of awareness programmes;
- Establishment of community based cyclone shelters;
- Creation of shelters for livestock;
- Construction of embankments with appropriate drainage, height and width taking into account cyclone water levels;
- Creation of high bunds around ponds to prevent escape of cultured fish during floods;
- Excavation and re-excavation of water bodies to improve drainage and water carrying capacity;

- Support for rehabilitation of people affected by disasters though the facilitation of contact with various government and non-government organization.

7.3.6 Reduction of wildlife-human conflict

177. Specific measures to reduce wildlife human conflicts will include:

- Assure connectivity by identifying and conserving regular elephant movement corridors and undertake measures to maintain natural vegetation and limit cultivation of crops attractive to elephants;
- Applying electric fences to protect villages and cultivated areas;
- Development and implementation of HEC compensation scheme;
- Training CPGs in HEC management
- Assistance of farmers by BFD and CPG for repelling problem animals.

7.3.7 Capacity building

178. Local level BFD staff, CMO members, resource users groups as well as other local stakeholders are provided with trainings on the following subjects and skills (list not exhaustive):

- Organization building, leadership, book keeping, fund raising, NRM, conflict mediation and communications for newly elected/joined CMO members;
- AIGA, including knowledge and skills (section7.3.3, page 57);
- Sustainability and resilience (section 7.3.5, page 59);
- Responsible nature-based tourism, including among others facility management, marketing, waste management and nature guiding;
- Managing human-elephant conflict including crop protection.

7.4 Responsible tourism development

7.4.1 Roles and responsibilities

179. The role of BFD with regard to tourism is facilitatory and regulatory. The marketing of ecotourism is in the first place a task of the private sector and local private parties which are better placed to deliver the required services in response to the demands. Moreover, BFD should not bear the financial risks related to tourism operations as it does not have the same flexibility as private parties.

180. The role of the CMCs is also to facilitate and enable, while also collecting entry fees, as well as encouraging appropriate enterprise development involving local communities. To maximize the stake of local populations, locally run enterprises and employment of local

people will be a priority and enforced as far as possible and reasonable. The CMCs will play an important role in planning and benefit sharing mechanisms in relation to ecotourism. The CMCs should not become (tourism) business operator itself, as in that case it would not be able to play its role as an independent committee responsible for co-management. So operations should not be taken up by the CMC itself, but may be taken up by members and associations of the community (which may include village conservation forums).

181. The key tasks of the sanctuary management including BFD assisted by the CMCs with regard to ecotourism development are:

(1) Zoning of tourism activities to reduce friction between (a) tourism, (b) other economic activities and (c) biodiversity conservation (section 7.1.1, page 52);

(2) Quality management (staff accommodation and facilities, infrastructure, garbage management);

(3) Information and promotion (with support Wildlife Centre);

(4) Awareness and education (with support Wildlife Centre);

(5) Monitoring and enforcement (e.g. tourist entries, revenues, impacts).

7.4.2 Entry fee collection

182. Two entry points for nature-based tourism will be created at Khurusia Eco-park and Dudpukuria Dakbanglo Beat Office. At these sites entry fees will be collected from visitors by the respective CMC. Entry fees will be shared between BFD and CMC according to the norms of the general benefit sharing mechanism established by BFD.

7.4.3 Facilities and infrastructure development

183. Infrastructure will be as much as possible developed outside the *Core zone*. The proposed visitor facilities and infrastructure to be developed are the following:

- Visitation facilities, such as access roads, parking and picnic areas and toilet facilities at Khurusia Eco-park and Dudpukuria Dakbanglo Beat Office;
- Interpretation facilities, such as displays, stationary and mobile viewing platforms and hospitality facilities;
- Other facilities, such as boat ramps, moorings, huts, cabins and opportunities to stay in traditional accommodation,
- Nature trails (Dudpukuria Dakbanglo 1km, Camp para to Lalutia) will be developed for visitors' movement on foot, traversing key natural and cultural features of interest (e.g. patches of dense forests, cultural remnants, natural charas, religious places, tribal areas, etc.).
- Sign-posts with adequate information will be provided at main foot trail heads.

- Golghor, simple toilets and litter disposal buckets/boxes will be provided at the start of the foot trails in the Buffer zone.
- Two student dormitories (Dudpukuria & Dhopachari) will be built to provide accommodation to students.
- Local entrepreneurs will be encouraged to set up nature camps and cottages for tourists in the impact zone.

184. Observation towers are not very useful in such landscapes. They do not contribute to wildlife viewing or landscape viewing as the undulating landscape does offer beautiful views already without these towers. Moreover, such large and obvious structures dominate disturb the natural character of the scenic landscape. It is more useful to spend these funds on nature trails and eco-friendly wildlife observation hides. Therefore construction of watch towers is not recommended.

7.4.4 Tourism impact reduction

The presence of tourists unavoidably impacts the natural environment of the sanctuary through noise, air and water pollution as well as solid waste. To reduce the impact of solid waste, a solid waste management system will be implemented including:

- placing waste at crucial locations to collect waste;
- collect waste from bins at regular frequency at a central processing place;
- to segregate and treat waste (plastic, paper, metals, organic, chemical) according to a treatment plan;
- Inform visitors about waste management, pollution of ecosystems and the requirement to use bins as well as other behavioural guidelines to keep the sanctuary clean, pleasant and as natural as possible through the circulation of a code of conduct (Appendix 12, page 107).

185. Design of simple waste treatment facilities exist, including incinerators for paper and other combustible materials as well as decomposers for organic materials (eventually producing biogas). Plastics and metals may be brought to recycling companies, and chemicals should also be brought out of the sanctuary to the municipal waste dump and according relevant regulations.

7.4.5 Ecotourism promotion and awareness

186. Publicity and information materials having basic information about the Sanctuary will be provided to visitors by means of fixed signs, brochures, leaflets, printed guides and drama at access points. In the print and electronic media, DDWS will be focused as an eco-tourism site.

187. A Nature Interpretation Centre (Environmental Education Centre) will be established at Dudpukuria where landscape features of WS will be displayed in pictorial forms including topographical and biodiversity patterns. Local exhibits, murals, dioramas, specimen of plants and wildlife, trophies and photographs may be added with proper levelling and description. The centre will be provided with trained staff Additional training on public relations and visitor management will be provided to the Sanctuary staff.

188. Education and awareness activities will also target electronic and print media (e.g. TV, Radio, Videos, newspaper, magazines, and brochures), schools, and other educational institutes, particularly local schools. Sabuja Vahinis (Green Brigades) and Youth Clubs will be formed and trained in nearby schools and maddrasas. Professional publicity and communication personnel will be invited for such tasks.

7.5 Reinforcement of protection administration

7.5.1 Improving mobility

189. Currently no equipment is available to support the mobility of BFD staff at the Range and Beat Offices. The following equipment is required:

- 6 Motor cycles

7.5.2 Office facilities and staff accommodation

190. A Sanctuary office (on RCC platform) is planned to be constructed at the Dudpukuria Beat Office. The site initially selected to build the sanctuary office is in front of the traditionally styled bamboo/wood building of aesthetic value already present here. The office should not be constructed in front of this building as it would disturb the scenery of this spot and the view on this point of attraction. All works required to realize adequate work space for sanctuary staff includes:

- Construction sanctuary office,
- Renovation and maintenance of Range officers' quarters,
- Renovation and maintenance of Beat officers' quarters,
- Construction and maintenance of ACF's quarters.

7.5.3 Equipment

191. The Range and Beat offices have limited equipment for operation. The following requirements have been indentified:

- 2 Digital camera, (One Still Camera and One Video Camera)
- 6 Binoculars,

- 4 GPS,
- 12 Torches,
- 1 Desktop computer with peripherals
- 1 Laptop computer
- 12 Semiautomatic rifles (made in China).

7.5.4 Staff capacity and performance

192. The Range and Beat Offices are currently understaffed. To reach the desired staff number of 26 (Table 14, page 64), 14 new staff need to be posted (Table 15, page 65)

193. Skills and knowledge of staff will be brought up to date for better performance through training on GPS, protected area management, surveillance, nature-based tourism and other subjects determined deemed necessary for adequate performance of their respective jobs and tasks.

Table 14. Staffing requirements at Range and Beat offices

Number of required staff	Khurusia Range office	Dhuhajari range office	Dudpukuria Beat office	Kamlachari Beat office	Dhopachari Beat office	TOTAL
ACF	0	0	0	0	0	0
Forest ranger	1	1	0	0	0	2
Deputy ranger	0	0	0	0	0	0
Forester	1	1	1	1	1	5
Forest guard	1	1	4	4	4	14
Mali	0	0	1	1	1	3
Cook	1	1	0	0	0	2

Table 15. Number of additional staff to be allocated to fulfil requirements

Additional staff requirements	Khurusia Range office	Dhuhajari range office	Dudpukuria Beat Office	Kamlachari Beat Office	Dhopachari Beat Office	TOTAL
ACF	0	0	0	0	0	0
Forest ranger	0	0	0	0	0	0
Deputy ranger	0	0	0	0	0	0
Forester	1	1	0	1	1	4
Forest guard	1	0	3	2	0	6
Mali	0	0	1	1	0	2
Cook	1	1	0	0	0	2

Table 16. Five year activity work plan

Task	Responsible officer or body	Timing	Activities	Requirements	Indicators
1.1 Zoning	DFO	first year	· GPS survey · mapping · dispersion maps to stakeholders	GPS, mapping by RIMS	· Zoning map, description and prescriptions agreed with stakeholders
1.2 Boundary demarcation	DFO, ACF, RO, BO	second year	· GPS survey · planning and placing markers and fences	GPS, mapping by RIMS	· Boundary map, shapefile and markers and buoys established in the field
1.3 Resolving tenure and encroachment issues	DFO	full planning period	· RAP	RAP, funding	· RAP drafted and implemented
2.1 Biodiversity conservation	ACF, BO	Full planning period	· site protection	advice from wildlife experts	· measures implemented · biodiversity survey results
2.2 Connectivity management	CF, DFO	Full planning period	· support development of Biosphere Reserve · prevent non-compatible development in buffer zones and corridor areas	political and financial support	· milestones in process leading to Biosphere Reserve · functional corridors indicated by satellite images and field evidence
2.3 Forest management	DFO, BO	annually	· planting, ANR, harvesting according to prescription and annual work plan	plants, tools, logistics	· areas covered by measures · crown cover from RS ·
2.4 Control of livestock	DFO, BO	annually	· fencing of villages · establishment Khowars · surveillance	effective patrolling	· measures realized · number of livestock held
2.5 Release of animals in the sanctuary	DFO	occasionally	· translocation plan	advice from wildlife expert	· list of animals released
2.6 Surveillance	ACF, RO	daily	· planning · patrolling · monitoring	field equipment	· patrolling reports · number of patrols

Task	Responsible officer or body	Timing	Activities	Requirements	Indicators
3.1 Conservation awareness	WNCC/WC	throughout planning period	· education at schools · awareness workshops · billboards	awareness materials and programmes	· number of awareness events, stakeholder groups covered
3.2 Implementation of co-management	ACF, RO	throughout planning period	· planning · monitoring · benefit sharing system	support CREL	· Functional CMO structures · revenues shared
3.3 Development sustainable funding	DFO, CREL	throughout planning period	· establishment · implementation	consensus on benefit sharing mechanism	· establishment of fund · funds received and disbursed
3.4 Reduction of dependency on forest resources	CMO	throughout planning period	· AIGA and other support as indicated in section 7.3.3 page 57	Funding Commitment of groups/individuals NGO support	· Successful activities · Number of people involved · Revenues generated
3.5 Sustainability and resilience to environmental hazard	CMO	throughout planning period	· Adaptive measures as indicated in section 7.3.5,page 59	Funding Commitment of groups/individuals NGO support	· Successful activities · Number of people involved · Quantification of results
3.6 Reduction of wildlife-human conflict	ACF, RO	throughout planning period	· Wildlife-human conflict management as indicated in section 7.3.6, page 60	Agreement and establishment of compensation system	· Number of incidents · Quantification of crop loss · Compensation paid
3.7 Capacity building	WNCC/WC, NGOs, CREL	throughout planning period, with emphasis on first three years	· Training as listed in section 7.3.7, page 60	Training programmes	· Trainings delivered · Number of participants · Training assessments
4.1 Tourism management	ACF, RO	throughout planning period	· Planning and monitoring	BFD capacity	· Visitor statistics · Evaluation reports
4.2 Entry fee collection	ACF, RO	throughout planning period	· Entry fee collection	Fee collection system Transparent book keeping	· Visitor statistics · Revenues
4.3 Facilities and infrastructure	DFO	first three years	· Infrastructure development as proposed in section 7.4.3, page 61	Eco-friendly designs Environmental assessments	· Calls for tenders · Realized structures

Task	Responsible officer or body	Timing	Activities	Requirements	Indicators
4.4 Tourism impact reduction	RO	throughout planning period	· waste management · code of conduct	Rules, regulations, plans	· Waste facilities realized · Waste collected in forest · Disturbances
4.5 Promotion and awareness	WNCC/WC, NGOs, CREL	throughout planning period	· visitor information · Nature Information Centre establishment · Communication to media and educational institutes	Training Awareness materials	· Number of awareness events · Awareness impact assessments
5.1 Improving mobility	DFO	first year	· procurement	Budget tenders	· Approved budgets · Completed tenders
5.2 Office facilities and staff accommodation	DFO	first two years	· Construction Sanctuary office and ACF quarters · Renovation Range and Beat offices	Eco-friendly designs Environmental assessments	· Calls for tenders · Realized structures
5.3 Equipment	DFO	first year	· procurement as specified in section 7.5.3, page 63	Budget tenders	· Approved budgets · Completed tenders
5.4 Staff capacity and performance	DFO, WNCC/WC	ongoing	· recruitment · training	Training of Trainers, staff recruitment and/or allocation	· Number of staff posted · Trainings completed per staff
			·		

8 Safeguards, monitoring, review and research

8.1 Implementation safeguards

194. Implementation safeguards are mechanisms to deal with environmental and social impacts resulting from management interventions inside and around protected areas. The mechanism includes (1) screening and scoping to identify possible impacts, (2) impact assessment, (3) design and implementation of mitigation and impact monitoring. The Bangladesh environmental legislation as well as regulations of most international donors, including World Bank, ADB and UNDP require environmental and social impact management to be included in project planning and implementation (BFD 2013a, BFD 2013b, GoB 2011).

195. The mechanism is elaborated in an Environmental Management Plan (EMP) which serves as detailed guidance for environmental and social impact management in terms of mitigation measures and monitoring. An Environmental Management Plan (EMP) is a plan of scheduled actions that follows directly from a completed Environmental Assessment of a project and it includes an environmental mitigation plan and environmental monitoring plan.

196. BFD is responsible to carry out screening of interventions to keep record of essential information for proper environmental and social impact management and an Environmental Monitoring Framework (EMF) serves as the guideline for designated staff to monitor the environmental and social safeguards compliance of interventions initiated under their implementation responsibility. Safeguards are as far as possible included in interventions and activities covered in chapters 8 and 9 of the management plan, but as most interventions indicated are to be developed in the future, tasks related to environmental and social impact management need to be included and reviewed in annual operational plans.

8.2 Purpose of monitoring

197. The purpose of monitoring is to assess the effectiveness and efficiency of the activities and the achievement of the management objectives. Monitoring results may be used to adapt the strategies to improve the management performance. The monitoring and evaluation plan provides for the annual review of operational plans, a five year work plan and an overall review period of the management plan of 5 years.

198. Monitoring involves the measurement of agreed indicators indicating changes at various levels: (a) management context (including threats), (b) activity performance, (c) results achievement, (d) outcome and (e) at impact level.

8.3 Biological monitoring

199. Occurrence and abundance of animal species are important indicators for biological monitoring, particularly of birds (Aziz et al. 2004) and mammals, but also other vertebrates or invertebrates may be used as indicator species. Biological monitoring is important to assess the impact of threats and to determine the effectiveness of management measures. Biological monitoring is usually done by carrying out wildlife surveys focussing specific taxonomic groups at regular intervals (Feeroz and Deodatus 2003, Van Lavieren, 1983).

(1) Bird survey

200. Fixed width strip surveys are appropriate to establish abundance and density of birds in forest and cultivated area. In this method the observer(s) slowly walk (ca. 1.5 km/hr) along a trail through the area and count the birds on both sides. The observation-range varies depending on the visibility of the area studied. In DDWS forest an observation range of 20 m is taken on both sides. The initial location of the bird observed is always considered, because it might move away after watching the observer(s). If any bird is sighted beyond the pre-decided observation-range, or if the bird is coming from the back (in order to avoid duplication), the observation is not recorded. The survey should be conducted in early mornings and late afternoons. Each strip transect count is actually the total count of an area of the strip (length of the strip [L] times width of the strip [w] which is equal to twice the observation-range). Population density D is estimated by $D = n/2wL$.

201. Apart from this periodic species observation lists are useful for birds with lower densities and a wider range of movement such as birds of prey.

(2) Mammals and other terrestrial animal survey

202. Transect surveys to determine the abundance of terrestrial animals, particularly mammals, are difficult in dense forest such as DDWS, but variable width transect surveys along forest trails may be used to determine the relative abundance of mammals. The sampling is not independent from the landscape as trails usually follow landscape features and hence the results are biased. In this method the observer(s) slowly and silently walk (ca. 1.5 km/hr) along the trail through the area and count animals from both sides. When an animal or a group of animals are sighted from the trail, the sighting distance (also called "radial distance") should be recorded (D), being the distance from the observer to the animal (S) at the moment of detection. The animal density is determined by dividing the total number of observed animals of one species, divided by the area covered by observation which is calculated by multiplying the distance covered by the observers (length of the trail) multiplied by the average sighting distance multiplied by two (as animals have been sighted on both sides of the transect).

203. Indirect survey methods are more convenient to assess relative abundance of animals which are difficult to observe, due to low densities, dense habitat or hidden way of life. For

this purpose indices of presence (defecations, scent marks, ...) are counted inside circular plots with a radius of 10 m).

(3) Vegetation cover survey

204. Changes of forest cover can be monitored by comparing remote sensing data of different years, or by recording vegetation class boundaries with a GPS. These approaches only show increase and decrease of forest cover, but not changes in vegetation structure and floristic composition. For the latter, structure and floristic composition, more detailed vegetation recording and analysis is required based on vegetation assessment in plots as laid out below.

205. A standardized method is as follows. As square plots are difficult to demarcate in the densely vegetated and accidented landscape of DDWS circular plots are used with a radius of 10 m. In each circular sample plot (radius 10 m), data are collected on the vertical vegetation structure and floristic composition using a relevee sheet. Stratum and species cover is determined by visual assessment. Unidentified species is sampled for identification in the Bangladesh National Herbarium. Soil is classified according to Moore and Chapman (1986). For inundation the following levels are distinguished: permanent, daily, 2-weekly, seasonally and never. A detailed description of the method is given in Feeroz & Deodatus 2003.

206. Vegetation succession monitoring is done by repeating the above procedure at regular intervals (usually one to five years) in fixed sample plots which are marked on the ground.

8.4 Monitoring of environmental indicators and threats

207. Monitoring of environmental threats is important and modern technology is making environmental monitoring easier every day. Crucial variables to measure regularly are rainfall, temperature, forest fire and erosion. Rainfall and temperature are easy to measure by field staff. Erosion can be monitored with RS/GIS analysis by RIMS. And RIMS can also monitor forest fire by using MODIS data (Anon. 2010)[15]. The occurrence of forest fire can be used as an indicator of management effectiveness.

208. Water quality can be measured when pollution is suspected. However, water quality analysis requires an equipped laboratory and a water quality monitoring plan prepared by specialists to determine which indicators are the most appropriate in relation to the potential upstream sources. Water quality measurement in DDWS does not appear relevant at this stage as it is located upstream in the catchment.

[15] http://modis.gsfc.nasa.gov/data/dataprod/nontech/MOD14.php

209. The most important threats to DDWS to be monitored relate to human activities causing habitat degradation and fragmentation as well as direct impact on biodiversity. This information should be collected through surveillance and reporting.

8.5 Measuring, reporting and verifying (MRV) in the frame of REDD+

210. In December 2012 MoEF has approved the REDD+ Readiness Roadmap implying that Bangladesh is now set to prepare itself for REDD financing for sustainable forest management, thus paving the way in the climate financing sector.

211. A cornerstone of any national REDD+ scheme is a reliable, credible system of measuring, reporting and verifying (MRV) changes in forest carbon stocks. MRV relates to both actions on the ground (i.e., that change forest carbon stocks) and REDD+ transactions (i.e., compensation and financial transactions or transfers).

212. Protected Area managers are not responsible for the implementation of MRV, but they may be involved in field data collection. MRV tasks are coordinated and mainly carried out at national level by BFD and partner institutions. Forest Monitoring is done with help of RS/GIS. Forest Inventories are carried through the BFD Management Plan Division, with support from BFRI (UN-REDD 2012).

213. The reporting involves National Communications to the Conference of the Parties, in accordance with UNFCCC criteria every four years.

8.6 Management monitoring and reporting

214. Management motoring is the monitoring of the implementation and results of protection related activities as they described in chapter 8. Management monitoring is an important element of 3-monthly reporting of the site manager (s) (ACF, Range Officer) to the DFO and CF. Indicators for management monitoring are:

- patrolling (when, participating staff, area/distance covered)
- arrests (date, place, offence, conviction)
- confiscations (date, place, item, conviction)
- awareness events, training delivery (when, target group, message/skill)
- revenue collection (when, resource, revenue collected)
- consultations (when, target group, purpose)
- services rendered (e.g. afforestation/reforestation support, wildlife-human conflict management)

8.7 Smart patrolling

215. With technical support from CEGIS, BFD has developed in the Sundarban Reserved Forest a GIS/GPS based system for the systematic collection of patrolling data (Anon. 2013). The system is has been named "MIST" following a similar system developed for Uganda National Parks which has become a model for patrol information collection in many countries.

216. The introduction of this system could be considered for Dudpukuria-Dhopachari WS. Introduction requires however investments for equipment and training. A feasibility study is therefore required (see also section 7.2.6, page 56).

8.8 Management Effectiveness Tracking

217. BFD has decided to introduce the Protected Area Management Tracking Tool (MTT) in Bangladesh.

218. For tracking and increasing the effectiveness of the protected area management a number of tools have been developed to assess management practices. It is clear that the existence of a wide range of situations and needs require different methods of assessment. The World Commission on Protected Areas (WCPA) has therefore developed a 'framework' for this assessment (www.biodiv.org/decisions).The WCPA Framework aims to provide overall guidance in the development of assessment systems and to encourage standards for assessment and reporting (Dudley 2007).

219. According to the WCPA Framework, good protected area management follows a process that has six distinct stages, or elements: it starts with the understanding of the context of existing values and threats, progresses through planning, and allocation of resources (inputs), and as a consequence of management actions (processes), eventually produces products and services (outputs), that result in impacts or outcomes (Dudley 2007).

220. The Management Effectiveness Tracking Tool is one of a series of management effectiveness assessment tools built around the WCPA Framework, which range from the WWF Rapid Assessment and Prioritization Methodology used to identify key protected areas at threat within a protected area system to detailed monitoring systems such as that developed by the Enhancing our Heritage project for UNESCO natural World Heritage sites. Having this range of tools in place will aid the many countries who are signatories to the Convention on Biological Diversity (CBD) in fulfilling their commitments. In particular at the 7th CBD Conference of the Parties in 2004, 188 member countries agreed a Programme of Work on Protected Areas (www.biodiv.org/decisions), one of the most ambitious environmental strategies in history. As part of the programme Nations have committed to develop assessment systems and report on the effectiveness of 30 per cent of their protected areas by 2010 (Dudley et. al. 2005).

8.9 Management plan review

221. The review cycle for the management plan is based on existing practices regarding forest management planning in Bangladesh (Balmforth 1988) and experiences in other countries (Thomas and Middleton 2003). Management of the sanctuary will be organised through an Annual Operational Plan (to be prepared annually), which is based on a 5-year workplan (Part II). The entire management plan (Parts I and II) will be reviewed every ten years.

8.10 Monitoring and review planning

222. A schedule for monitoring and evaluation planning is presented in Table 17, page 75.

8.11 Research

223. Research at DDWS is the task of research institutes such as universities and institutes for fundamental and applied research, including the Bangladesh Forestry Research Institute (BFRI). Relevant research themes for the conservation of the island are:

(1) A study on connectivity of DDWS in relation to other wildlife areas and land use planning

(2) Elephant ecology

(3) Population ecology and viability of Hoolock Gibbon

(4) Biodiversity and ecology of amphibians

(5) Current hunting practices and impact on wildlife

(6) Economic valuation of ecosystem services of DDWS

Table 17. Monitoring and review plan

Task	Responsible officer	Timing	Activities	Requirements	Indicators
1.1 Bird survey	WNCC	annually	field survey		bird abundance
1.1 Survey of terrestrial animals	WNCC	annually	field survey		animal abundance
1.3. Forest cover survey	Beat officer, RIMS	annually	field survey Remote Sensing		% crown cover
2. Management monitoring	Beat officer	3-monthly	logbook keeping reporting		patrolling, arrests, confiscations, awareness events, training delivery, revenue collection, consultations, services rendered
3. Smart patrolling	Beat officer	daily	data collection uploading analysis	Feasibility study before implementation	see MIST framework
4. Management Effectiveness Tracking	DFO	5 year cycle	data collection and recording		see MTT framework
5. Review 5-year work plan	WNCC, DFO	every five years	covering chapters 8 and 9		updated five year work plan
6. Review management plan	WNCC, DFO	every ten years	covering chapters 1 - 7		updated management plan

9 Cost estimates of implementation

225. The total annual costs for staff and other recurrent costs are Tk 3,528,000 (Table 18, page 76). The total costs for works and goods related to activities (investment costs) are Tk 88,160,000 (Table 19, page 76) for the five year work plan period.

226. Various studies are required to determine de actual costs of relocation, ecological corridor development, HEC fencing, and HEC compensation.

Table 18. Recurrent costs

a. Cost item	b. Units	c. Number	d. unit cost (LakhTk)	e. Total cost per year (LakhTk)	f. Covered by projects or FD budgets
ACF	person	0	0.25	0	BFD recurrent budget
Forest ranger	person	2	0.20	4.80	BFD recurrent budget
Deputy ranger	person	0	0.15	0	BFD recurrent budget
Forester	person	5	0.12	7.20	BFD recurrent budget
Forest guard	person	14	0.10	16.80	BFD recurrent budget
Mali	person	3	0.10	3.60	BFD recurrent budget
Cook	person	2	0.12	2.88	BFD recurrent budget
Total per year				35.28	

Table 19. Activity costs

a. Task	b. Activities	c. Works and goods	d. Units, unit cost (Tk)	e. Total cost /5 years (LakhTk)	f. Covered by projects, project name
1.1 Zoning	GPS survey mapping dispersion maps to stakeholders	GPS survey, map printing	500,000	5.00	
1.2 Boundary demarcation	GPS survey planning and placing markers and fences	65 km boundary markers	100,000/km	65.00	
1.3 Resolving tenure and encroachment issues	RAP	Developing RAP relocation costs to be calculated by RAP Conflict resolution	350,000 300,000	3.50 3.00	
2.1 Biodiversity conservation	site protection	Cost covered under other activities, Development of ecological corridor to by addressed by separate project			

a. Task	b. Activities	c. Works and goods	d. Units, unit cost (Tk)	e. Total cost /5 years (LakhTk)	f. Covered by projects, project name
2.2 Connectivity management	Biosphere Reserve development Influencing planning processes	BR development not covered by DDWS management plan	NA		funding to be identified
2.3 Forest management	planting, ANR, harvesting according to prescription and annual work plan	**Core zone:** ANR (40ha/yr) Habitat improvement (20ha/yr) Habitat restoration (20ha/yr) **Buffer zone:** Enrichment plantation (50ha/yr) Forestation (10ha/yr) Elephant corridor NTFP regeneration	 100,000/yr 100,000/yr 40,000/yr 5,000,000/yr 150,000/yr LS LS	 5.00 5.00 2.00 250.00 5.00 5.00	
2.4 Control of livestock	fencing of villages establishment Khowars surveillance	Barbed wire fencing of villages inside DDWS (10km)	600,000/km	60.00	
2.5 Release of animals in the sanctuary	translocation plan	Not included in DDWS budget	-		
2.6 Surveillance	planning patrolling monitoring	Uniform 2 /person Shoes 2 pair /person Torch Patrol stick Binocular one per group Implementation Remuneration CPG Conservation rewards	Tk 1500 x2 x 98 Tk 1000 each x2 x98 Tk 500 x 98 Tk 100 x 98 Tk 20,000 x4 200,000 /yr 400x12x98x/yr LS	2.94 1.96 0.49 0.10 0.80 10.00 23.52 1	
3.1 Conser-vation awareness	education at schools awareness workshops billboards		LS 1,000,000	10	Wildlife Centre, NGOs
3.2 Implemen-tation of co-management	planning monitoring benefit sharing system	CM council (2) meeting CM committee (2) meeting PF (2) meetings VCF (33) meetings CPG (4) meetings FCC (2) meetings	25,500 10,000 10,600 350 500 5000	5.10 12.00 12.72 6.93 1.20 6.00	CREL

a. Task	b. Activities	c. Works and goods	d. Units, unit cost (Tk)	e. Total cost /5 years (LakhTk)	f. Covered by projects, project name
3.3 Development sustainable funding	establishment implementation	Meetings, consultations, drafting of plan, opening account, ...	LS 300,000	3,00	
3.4 Reduction of dependency on forest resources	Livelihood development as indicated in section 7.3.3 page 57 ・ Identification and selection priority productions ・ Stakeholder consultations ・ Skills development ・ Monitoring	・ to be specified	200,000 200,000 500,000 200,000	11.00	
3.5 Sustainability and resilience to environmental hazard	Adaptive measures as indicated in section 7.3.5,page 59 ・ Identification and selection priority measures ・ Stakeholder consultations ・ Skills development ・ Monitoring	・ Social forestry, 20,000 seedlings/yr ・ 5km strip plantation/yr ・ 5 ha homestead plantation /yr ・ Climate resilient cultivation ・ 20 Tube wells ・ ・	300,000 200,000 125,000/ha LS 50,000	15.00 10.00 5.00 10.00 10.00	
3.6 Reduction of wildlife-human conflict	Wildlife-human conflict management as indicated in section 7.3.6, page 60	・ Development of ecological corridor to by addressed by separate project ・ Fencing costs to be determined based on study ・ HEC compensation scheme	600,000 LS 300,000		
3.7 Capacity building	Training as listed in section 7.3.7, page 60	costs			
4.1 Tourism management	Planning and monitoring				
4.2 Entry fee collection	Entry fee collection	PM			

a. Task	b. Activities	c. Works and goods	d. Units, unit cost (Tk)	e. Total cost /5 years (LakhTk)	f. Covered by projects, project name
4.3 Facilities and infrastructure	Infrastructure development as proposed in section 7.4.3, page 61	· Observation tower · 2 Student dormitory · 2 Construction, maintenance picnic site · 3 Nature trails construction and maintenance · 3 location nature camps · 20 Sign boards · 5 Toilets construction, maintenance · 8 Resting facility (golgarh) · 2 Tube well for picnic site and toilets	1,287,853.23 2,000,000 200,000 150,000 70,000 1,000 200,000 70,000 150,000	12.88 40.00 4.00 4.50 2.10 0.20 10.00 5.60 3.00	SRCWP
4.4 Tourism impact reduction	waste management code of conduct	· management · 20 Waste bins · waste collection and incinerator	50,000 5,000 250,000	2.50 1.00 2.50	
4.5 Promotion and awareness	· Visitor information · Nature Information Centre establishment · Communication to media and educational institutes	· Preparing publicity materials · 2 Nature interpretation centre · Audiovisual promotion	LS 1,500,000 500,000	2.00 30.00 5.00	
5.1 Improving mobility	procurement	6 motor cycles	220,000	13.20	
5.2 Office facilities and staff accom-modation	Construction Sanctuary office and ACF quarters Renovation Range and Beat offices	Sanctuary office RCC Platform 1 RO quarter 3 BO quarter 4 FG quarter	2,386,011 2,000,000 1,500,000 1,000,000	23.86 20.00 45.00 40.00	SRCWP (Sanctuary office)

a. Task	b. Activities	c. Works and goods	d. Units, unit cost (Tk)	e. Total cost /5 years (LakhTk)	f. Covered by projects, project name
5.3 Equipment	procurement as specified in section 7.5.3, page 63	· 2 Digital camera, (One Still Camera and One Video Camera) · 6 Binoculars, · 4 GPS, · 12 Torches, · 1 Desktop computer with peripherals · 1 Laptop computer · 12 Semiautomatic rifles (made in China).	20,000 20,000 35,000 2,500 70,000 60,000 50,000	0.40 1.20 1.40 0.30 0.70 0.60 6.00	
5.4 Staff capacity and performance	recruitment training field equipment	week training 1 week pp, 2 groups field equipment 26 staff	300,000 20,000	6.00 5.20	
6.2 Biological monitoring	Surveys	LS/yr	100,000	5.00	
6.3 Environmental monitoring		2 Rain gauge 2 Thermometer	5000 5000	0.20	
6.4 Management monitoring	reporting		PM		
6.5 Smart patrolling	feasibility study		300,000	3.00	
6.6 Management Effectiveness Tracking			PM		
6.7 Management plan review			PM		
6.6 Research and information	research projects carried out by research institutes		LS	20.00	

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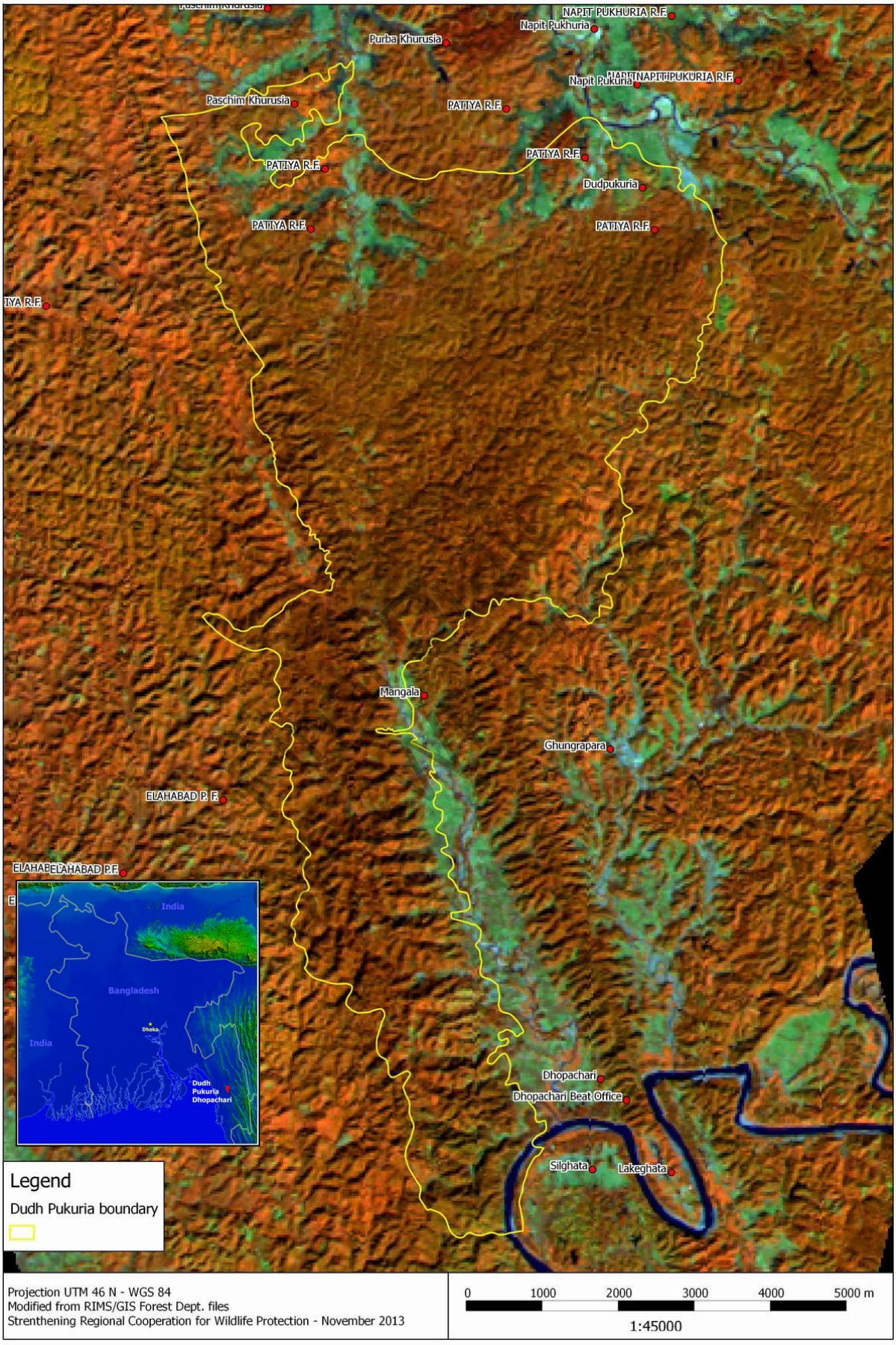
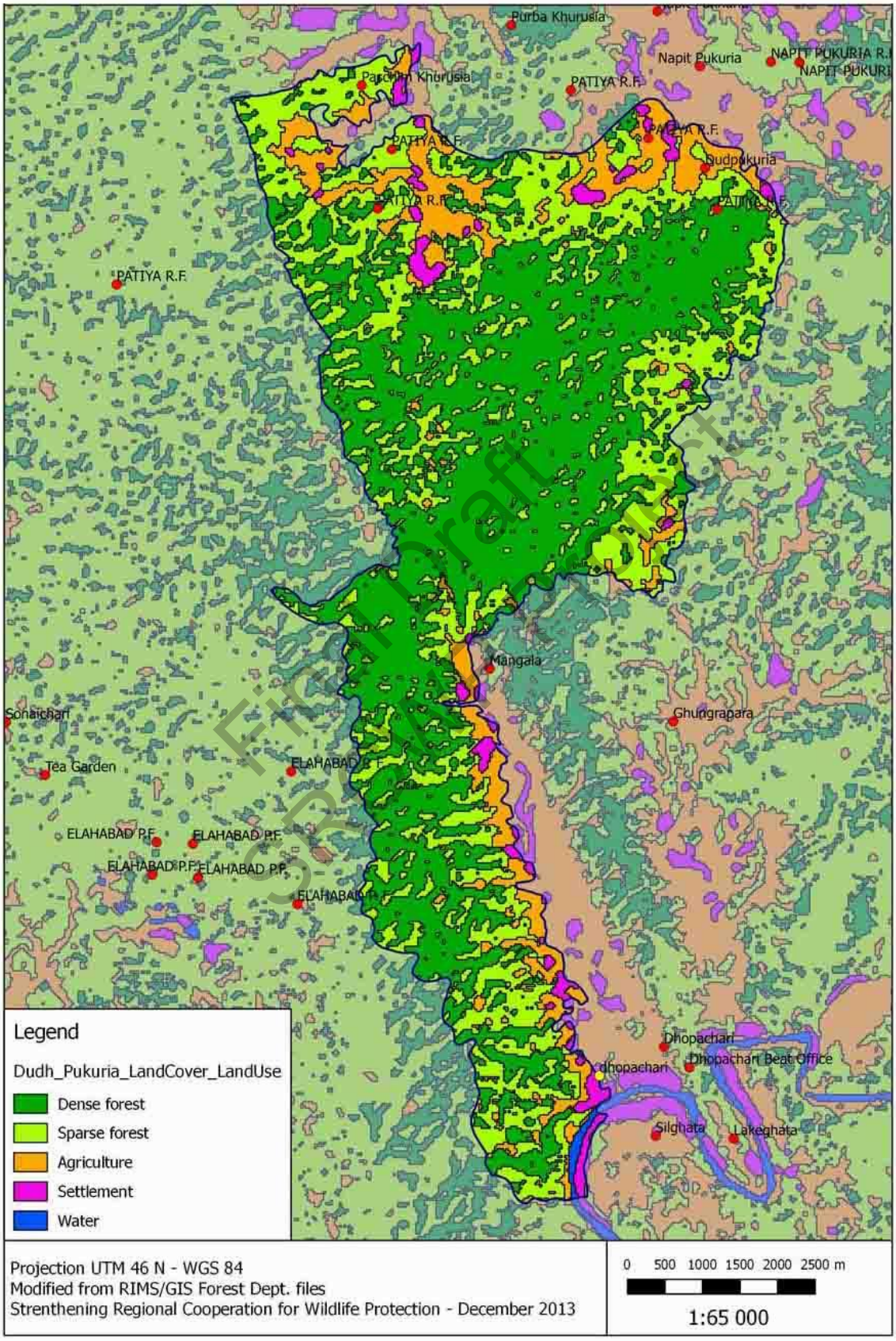
Appendices

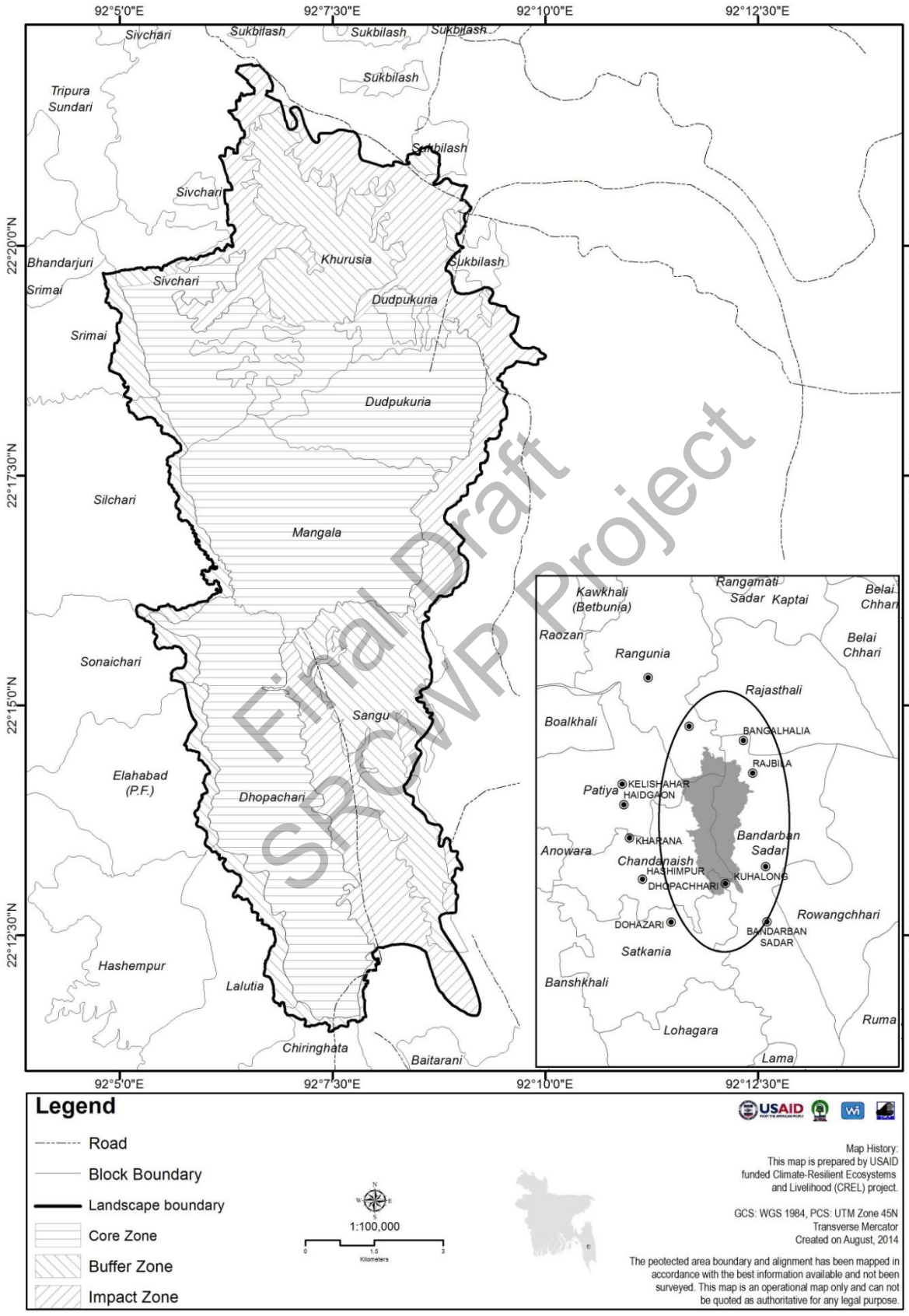
Appendix 1. Satellite map of Dudpukuria-Dhopachari Wildlife Sanctuary



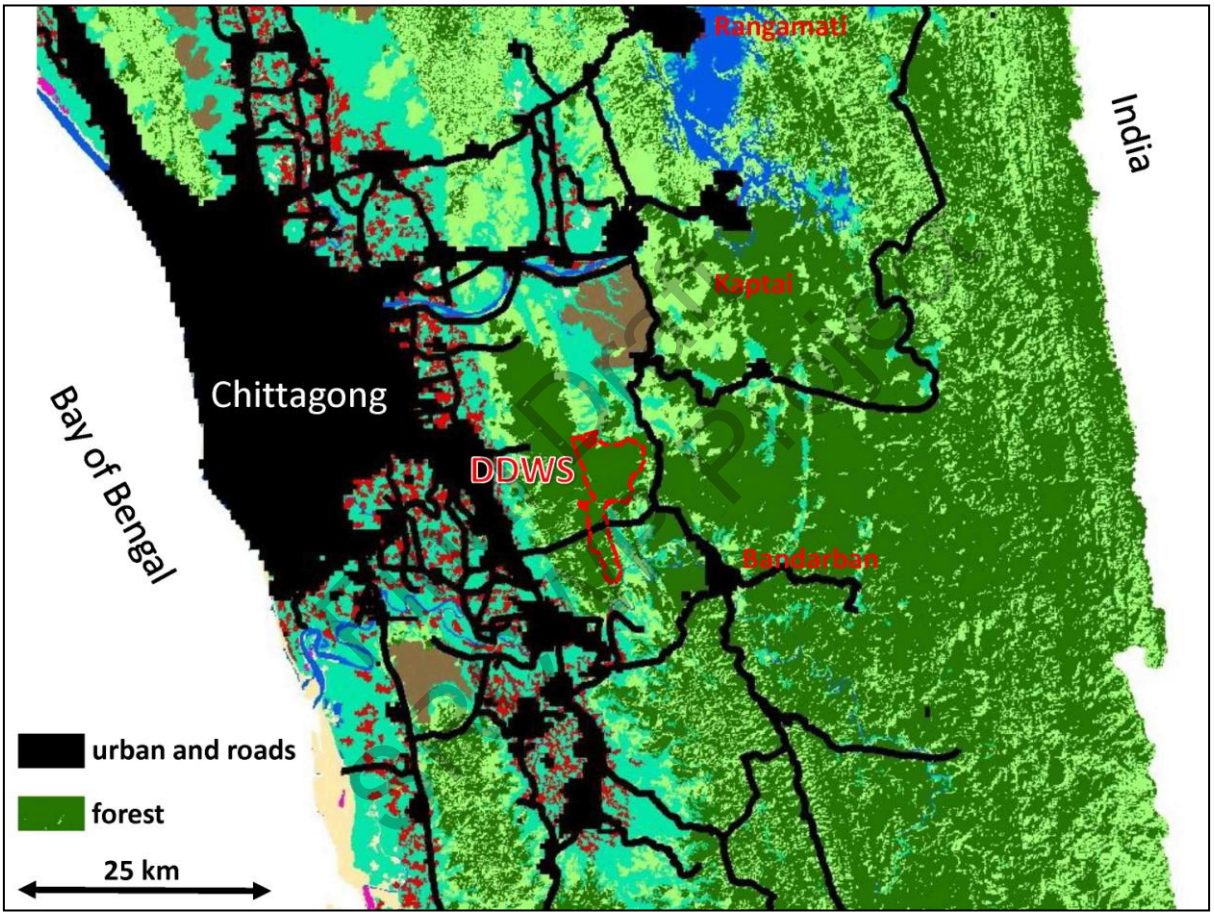
Appendix 2. Landcover map of Dudpukuria-Dhopachari Wildlife Sanctuary



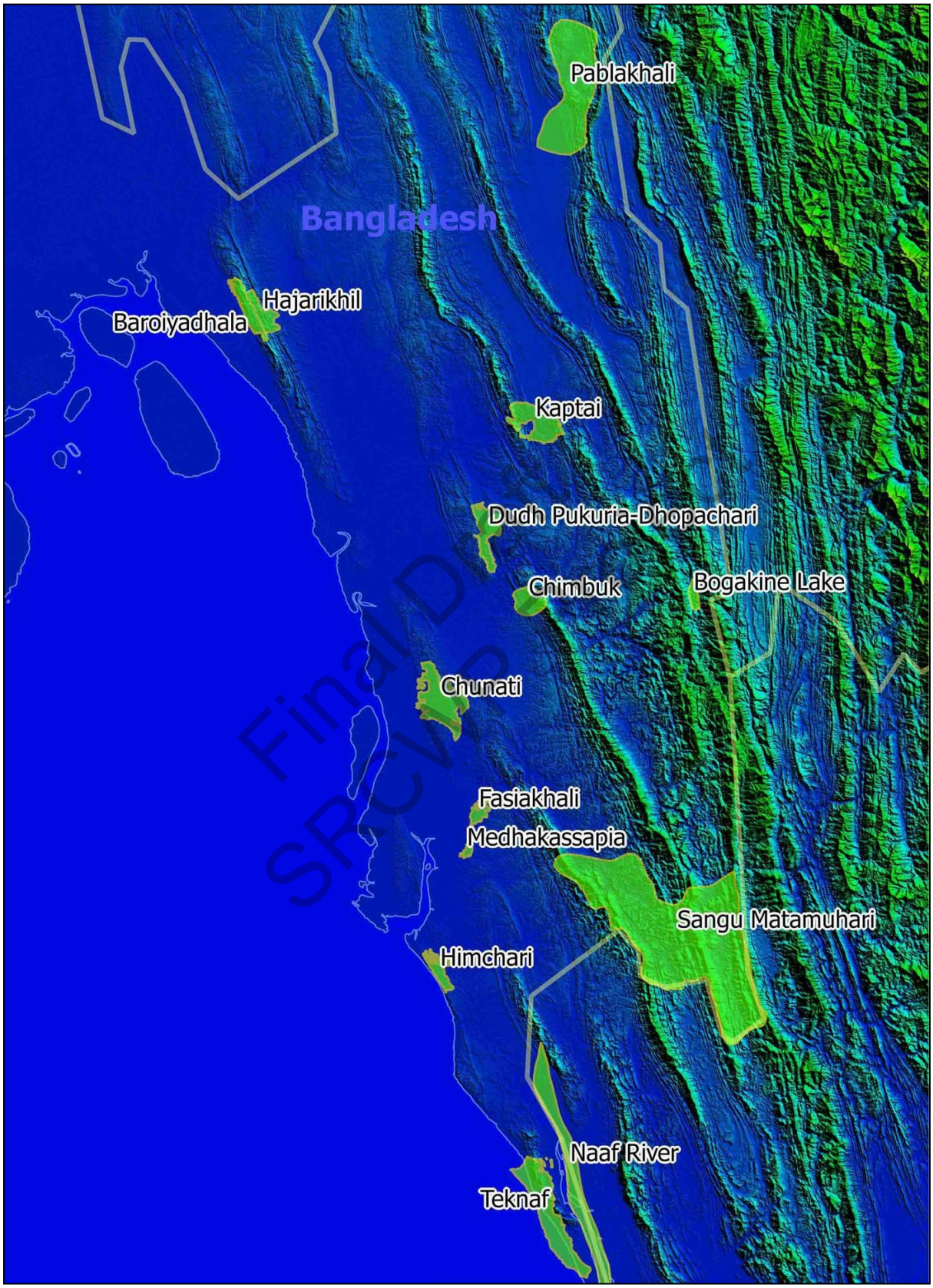
Appendix 3. Zoning in Dudpukuria-Dhopachari Wildlife Sanctuary indicating the main zones: Core Zone, Buffer Zone and Impact Zone



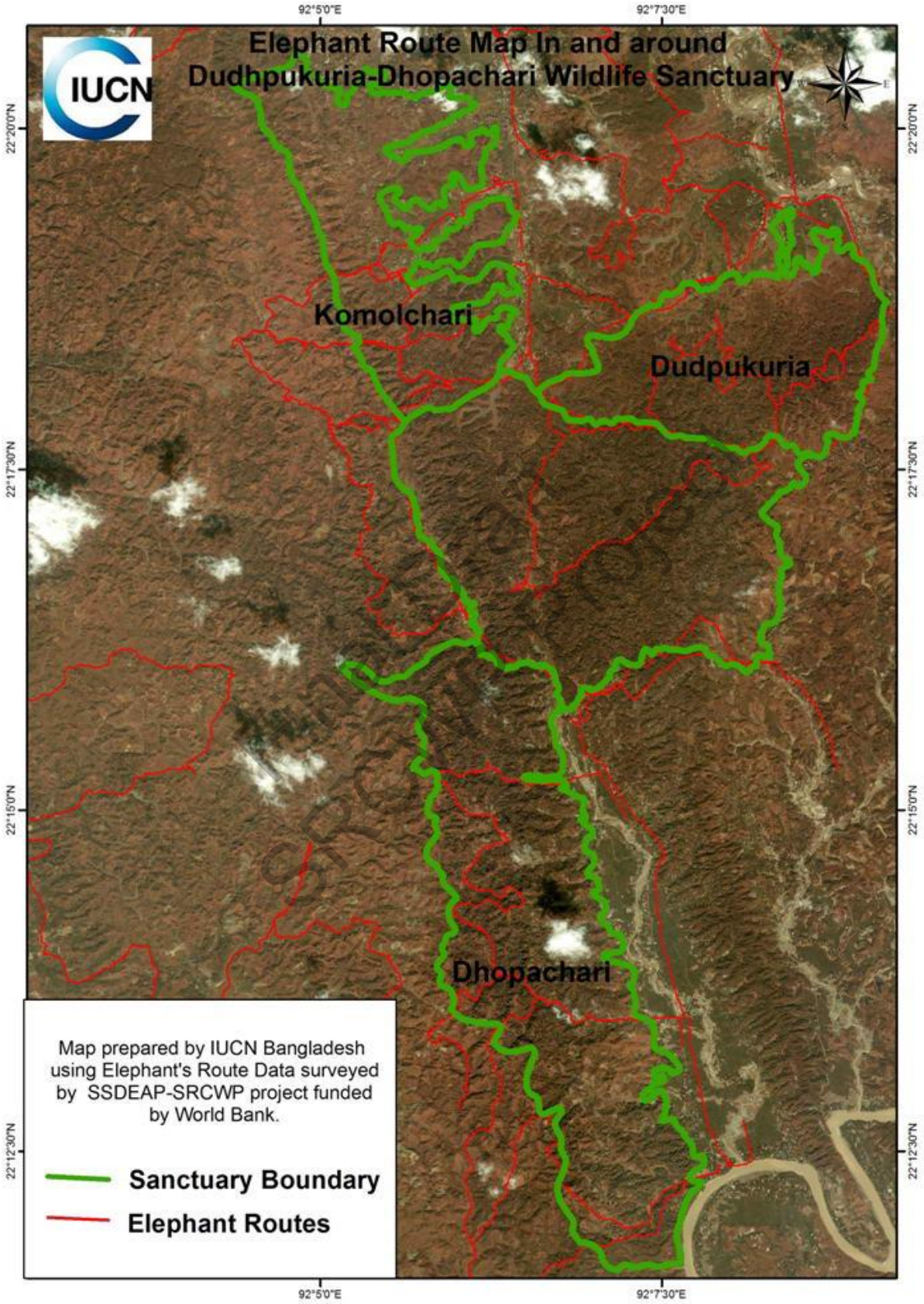
Appendix 4. Connection of Dudpukuria-Dhopachari Wildlife Sanctuary (DDWS) with Chittagong Hill Tract forests



Appendix 5. Position of Dudpukuria-Dhopachari Wildlife Sanctuary in relation to other protected areas in south-east Bangladesh



Appendix 6. Elephant routes in and around Dudpukuria-Dhopachari Wildlife Sanctuary



Appendix 7. Plant species observed during surveys in November 2013 and March 2014 (Huq 1986; Khanam 2006; Khan & Halim 1987).

	Scientific Name	Local Name	Life form	Place of Occurrence		
				Mixed Forest	Cultiva-ted land	Human Settlement
1.	*Dipterocarpus turbinatus*	Kali Garjan	Tree	√		√
2.	*D. gracilis*	Dhali Garjan	Tree	√		
3.	*Artocarpus chaplasha*	Chapalish	Tree			√
4.	*Tectona grandis*	Shegun	Tree	√		
5.	*Syzygium grandis*	Dhaki Jam	Tree	√		
6.	*Syzygium cuminni*	Kalo Jam	tree	√		
7.	*Hopea odorate*	Telshur	Tree	√		
8.	*Erythrina indica*	Mander	Tree			√
9.	*Gmelina arborea*	Gamari	Tree	√		
10.	*Ficus recemosa*	Jag Dumur	Shrub			√
11.	*Shorea robusta*	Sal Tree	Tree	√		
12.	*Calamus viminalis*	Jali Bate	Climber	√		
13.	*Calamus latifolius*	Karak Bate	Climber	√		
14.	*Calamis erectus*	Kadam Bate	Climber	√		
15.	*Mikania cordata*	Assam Lata	Climber	√		
16.	*Calamus guruba*	Sundi Bate	Climber	√		
17.	*Daemonorops jenkinsianus*	Gola Bate	Climber	√		
18.	*Cynodon dactylus*	Durba	Herb		√	
19.	*Derris trifoliata*	Kali Lata	Climber	√		
20.	*Piper longum*	Pipul Lata	Climber	√		
21.	*Bauhinia nervosa*	Kanchan Lata	Climber	√		
22.	*Ichnocarpus fruticens*	Shamlata	Climber	√		
23.	*Cassia nodosa*	Ban sonalu	Tree	√		
24.	*Caesalpina pulcherima*	Rada chura	Shrub	√		√
25.	*Oxalis corniculata*	Amrul	Herb			√
26.	*Smilax roxburghiana*	Kumer Lata	Climber	√		
27.	*Pinus carabiana*	Pine	Tree	√		
28.	*Maesa nagessarium*	Nagasher	Tree	√		
29.	*Stenchlaena palustris*	Dekhi Lata	Fern			√
30.	*Polylthia longifolia*	Debrau	Tree			√
31.	*Scindapus officinalis*	Gojpipul	Climber	√		
32.	*Acacia auriculiformis*	Akashmoni	Tree	√		√
33.	*Millingtonia hortensis*	Akashnim	Tree	√		√
34.	*Melia sempervirans*	Ghora Nim	Tree			√
35.	*Azadirachta indica*	Deshi Nim	Tree			√
36.	*Cassia siamea*	Mingeri	Tree	√		√
37.	*Eucalyptus camaldulensis*	Eucalyptus	Tree	√		√
38.	*Albizia procera*	Korai	Herb	√		√
39.	*Ichnocarpus fruticens*	Sham Lata	Climber	√		

	Scientific Name	**Local Name**	**Life form**	**Place of Occurrence**		
				Mixed Forest	**Cultiva-ted land**	**Human Settlement**
40.	*Cinnamomum obtusifokium*	Ram Tejpata	Tree	√		
41.	*Calotropis procera*	Akanda	Shrub			√
42.	*Hemidesmus indicus*	Anantamul	Climber	√		
43.	*Aquilaria agalloca*	Agar	Tree	√		
44.	*Dillenia indicum*	Chalta	Tree			√
45.	*Butea monosperma*	Pollash	Tree	√		
46.	*Bombax ceiba*	Shemul	Tree			√
47.	*Clerodendrum indicum*	Bamunhati	Shrub	√		
48.	*Antidesma ghaesembilla*	Khudi Jam	Shurb			√
49.	*Bambusa tulda*	Talla Bas	Grass	√		√
50.	*Bambusa valgaris*	Basni bas	Grass	√		√
51.	*Acalypha indica*	Muktajuri	Climber			√
52.	*Argemone mexicana*	Sheal Kata	Herb	√		√
53.	*Holarrhena antidysentrica*	Kurchi	Tree			√
54.	*Vitex negundo*	Nishinda	Shrub	√		
55.	*Swintonia floribunda*	Cevit	Tree	√		
56.	*Saraca indica*	Asoke	Tree	√		
57.	*Amoora rohituka*	Pitraj	Herb		√	√
58.	*Ficus bengalensis*	Bot	Tree			√
59.	*Acacia nilotica*	Babla	Tree	√		
60.	*Randia dometorum*	Mon Kata	Shrub	√		
61.	*Eugenia fruticosa*	Ban Jam	Tree			√
62.	*Ardisia solanacea*	Banjam	Shrub			√
63.	*Duabanga grandiflora*	Bandor Hola	Tree	√		
64.	*Mangifera indica*	Am Gas	Tree			√
65.	*Phoenix dactylifera*	Khajur	Tree			√
66.	*Quercus soicata*	Batna	Tree	√		
67.	*Engelhardtia spicata*	Balash	Tree	√		
68.	*Anona squamosa*	Ata	Tree			√
69.	*Glycomis arborea*	Dat Majon	Shrub			√
70.	*Averrhoea carambola*	Kamranga	Tree			√
71.	*Terminalia arjuna*	Arjun	Tree	√		√
72.	*Hoya parasitica*	Forgacha	Herb	√		
73.	*Ficus religiosa*	Pakur	Tree			√
74.	*Argemone mexicana*	Sheal Kata	Herb			√
75.	*Albizia lebbeck*	Sherish	Tree			√
76.	*Salmalia malabaricum*	Shemul	Tree			√
77.	*Albizia odoratissima*	Kalo korai	Tree			√
78.	*Albizia procera*	Shield Korai	Tree			√
79.	*Terminalia catappa*	Kat Badam	Tree	√		
80.	*Moringa olifera*	Sajna	Tree			√

	Scientific Name	**Local Name**	**Life form**	**Place of Occurrence**		
				Mixed Forest	**Cultiva-ted land**	**Human Settlement**
81.	*Flueggea virosa*	Shitka	Shrub			√
82.	*Phylunthus reticulatus*	Kalo Sitka	Shrub			√
83.	*Alastonia scholaris*	Satim	Tree			√
84.	*Lagerstroemia speciosa*	Jarul	Tree	√		√
85.	*Swietenia macrophylla*	Bara Mehigini	Tree	√		
86.	*Samanea saman*	Raintree Koroi	Tree			√
87.	*Terminalia arjuna*	Arjun	Tree	√		
88.	*Saraca indica*	Ashok	Tree			√
89.	*Swietenia mahagoni*	Mahagani	Tree	√		√
90.	*Calotropis giagantea*	Akanda	Shrub			√
91.	*Spondius pinnata*	Amra	Tree	√		
92.	*Emblica officinalis*	Amloki	Tree	√		
93.	*Terminalia chebula*	Hartoki	Tree	√		
94.	*Terminalia bellerica*	Boira	Tree	√		
95.	*Zizyphus jujuba*	Ban Borai	Shrub	√		
96.	*Zizyphus mauritiana*	Baroi	Tree	√		
97.	*Aegle marmelos*	Bel Gas	Tree			√
98.	*Andrgraphis paniculata*	Kalomegh	Herb		√	
99.	*Asparagus racemosus*	Shatamuli	Climber	√		
100.	*Coccinia cordifolia*	Telakucha Lata	Climber	√		√
101.	*Citrus grandis*	Jambura	Tree			√
102.	*Punica grantum*	Dhalim	Shrub			√
103.	*Ipomoea fistula*	Dolkalmi	Herb		√	√
104.	*Delbergia sissoo*	Shishu	Tree	√		√
105.	*Ocimun americanum*	Ban tulsi	Herb		√	√
106.	*Ficus racemosa*	Bara Dumor	Shrub			√
107.	*Aphanamixis polystachya*	Royna	Tree			√
108.	*Erythrina variegata*	Mander	Tree			√
109.	*Streblus aspera*	Sheora	Tree			√
110.	*Artocarpus lachucha*	Dehua	Tree			√
111.	*Ficus heterophylla*	Bala Dumur	Shrub	√		√
112.	*Mimusops elengi*	Bakul	Tree			√
113.	*Cassia fistula*	Badarlati	Tree			√
114.	*Smilax zeylanica*	Kumaria Lata	Climber	√		
115.	*Ficus hispida*	Dumor	Tree	√		√
116.	*Mimusops hexandra*	Bakul	Tree			√
117.	*Tamarindus indica*	Tetul	Tree			√
118.	*Adhatoda vasica*	Bashak	Shrub		√	√
119.	*Justicia gandarosa*	Basok Pata	Shrub			√
120.	*Ficus bengalensis*	Bhat	Shrub	√		√
121.	*Albizzia richardiana*	Belati Koroi	Tree	√		√

	Scientific Name	**Local Name**	**Life form**	**Place of Occurrence**		
				Mixed Forest	**Cultiva-ted land**	**Human Settlement**
122.	*Hymenodictyon excelsum*	Bhui Kadam	Tree			√
123.	*Musa sapientum*	Kola Gas	Shrub			√
124.	*Borassus flabellifer*	Tal	Tree			√
125.	*Cocos nucifera*	Narical	Tree			√
126.	*Amaranthus gangeticus*	Kachu	Herbs		√	
127.	*Carica papaya*	Papya	Shrub		√	
128.	*Artocarpus heterophyllus*	Kathal	Tree			√
129.	*Litchi cinensis*	Lechi	Tree			√
130.	*Psidium guajava*	Payera	Tree			√
131.	*Albizia lucidia*	Sheild Korei	Tree		√	√
132.	*Albizia lebbeck*	Sheristy Koroi	Tree			√
133.	*Syzygium cumini*	Jam	Tree			√
134.	*Anthrocephalus chinensis*	Kadam	Tree			√
135.	*Bombax ceiba*	Shemul Tula	Tree			√
136.	*Adhatoda vasica*	Bashak	Herb			√
137.	*Andrographis paniculata*	Kalomak	Herb		√	√
138.	*Centella asiatica*	Thankuni	Herb		√	
139.	*Dutura metel*	Dutura	Herb	√	√	
140.	*Ocimum sanctum*	Tulshi	Herb		√	
141.	*Cassia alata*	Dadmortan	Shrub			√
142.	*Hibiscus rosa-sinensis*	Jaba	Shrub			√
143.	*Ipomoea aquatica*	Kalmi	Creeper			√
144.	*Diospyros peregrina*	Gab Gas	Tree			√
145.	*Vanda roxburghii*	Rashna	Epiphyte	√		√

Appendix 8. Vertebrate wildlife species observed during surveys in November 2013 and March 2014.

Mammalian species					Land cover class of occurrence				
Scientific Name	**English Name**	**Local Name**	November/Dec 2013	March 2014	Dense forest	Sparsely forests	Agriculture	Settlement	Water
Callosciurus pygerythrus	Irrawaddy Squirrel	Badami Kathbirali	√	√	√	√	-	-	-
Ratufa bibicolor	Black Giant Squirrel	Bara kalo Katbirali	√	√	√	-	√	-	-
Suncus murinus	Asian House Shrew	Chika	-	√	-	-	-	√	-
Bandicoto bengalensis	Lesser Bandicoot-Rat	Dhari /Baro Idur	-	√	-	√	√	√	-
Sus scrofa	Wild Boar	Ban Shukor	√	√	√				-
Herpestes auropunctatus	Small Indian Mongoose	Choto Benji, Nakul	-	√	-	√	√	√	-
Canis aureus	Golden Jackal	Shial, Shial Pandit	-	√	√	-	-	-	-
Pteropus giganteus	Indian Flying Fox	Baro Badur	√	√	√	-		√	-
Pipistrellus coromandra	Indian Pipistrelle	Chamchika	√	√	-	√	-	√	-

Amphibian species					Land cover class of occurrence				
Scientific Name	**English Name**	**Local Name**	November/Dec 2013	March 2014	Dense forest	Sparse forest	Agriculture	Settlement	Water
Duttaphrynus melanostictus	Common Toad	Kuno Bang	√	√	-	√	-	√	-
Euphlyctis cyanophlyctis	Skipper Frog	Mali Bang	-	√	√	-	√	-	√
Polypedates maculaus	Indian Tree Frog	Gecho Bang	-	√	√	-		√	-
Hoplobactrachus tigerinus	Bull Frog	Sona Bang	-	√	√	-	√	√	√
Fejervaria limnocharia	Cricket frog	Jiji Bang	-	√	√	-	√	√	√
Rhacophorus maximus	Common Tree Frog	Bara Gecho-bang	-	√	√	-	-	-	-

Reptilian species					**Land cover class of occurrence**				
Scientific Name	**English Name**	**Local Name**	November/Dec 2013	March 2014	Dense forest	Sparsely forests	Agriculture	Settlement	Water
Calotes versicolor	Common Garden Lizard	Raktachosa	√	√	√	√	√	√	-
Hemidactylus frenatus	Common House Lizard	Haroil Tiktiki	-	√	-	-	-	√	-
H. flaviviridis	Yellow-bellied House Gecko	Goda Tiktiki	√	√	-	-	-	√	-
H. brookii	House Lizard	Tiktiki		√	√	√		√	-
Gekko gecko	Tokay Gecko	Tokkhak	√	√	√	-		√	-
Mabuya carinata	Keeled Grass Skink	Anzoni	-	√	-	√	√	√	-
M. dissimilis	Stripped Grass Skink	Anzoni	-	√	-	-		√	-
Varanus bengalensis	Bengal Monitor	Kalo Gui Shap	√	√	√	-	-	√	-
Xenochrophis piscator	Checkered Keelback water snake	Dhora Shap	-	√	√	-	-	-	√
Ptyas mucosus	Oriental rat snake	Darash Shap	√	√	-	√	-	√	-
Naja naja	Indian cobra (Ecdysis)	Ghokra shap	-	√	√	√	-	√	-

Aves					**Land cover class of occurrence**				
Species Name	**English Name**	**Local Name**	November/Dec 2013	March 2014	Dense forest	Sparse forest	Agriculture/Paddy	Settlement	Water
Gallus gallus	Red Jungle fowl	Bon Murghi	√	√	√				
Spilornis cheela	Crested Serpent Eagle			√	√				√
Accipiter badius	Shikra	Shikra		√	√				√
Falco severus	Oriental Hobby		√	√	√	√			
Spilopelia chinensis	Spotted Dove	Tila Ghugu		√		√	√	√	
Chalcophaps indica	Common Emerald Dove	Sobuj Ghugu	√	√	√				
Treron pompadora	Pompadour Green Pigeon	Choto Harial	√	√		√	√	√	
Treron phoenicoptera	Yellow-footed Green Pigeon	Horial		√	√	√			
Treron affinis	Grey-fronted Green Pigeon		√	√	√	√			
Centropus bengalensis	Lesser Coucal	Choto Kanakukka	√	√		√			
Phaenicophaeus tristis	Green-billed Malkoha	Dophajongol	√	√		√			
Cuculus canorus	Common Cuckoo	-		√	√	√	√	√	√
Cuculus poliocephalus	Lesser Cuckoo	-	√	√	√	√	√	√	

Aves					**Land cover class of occurrence**				
Species Name	**English Name**	**Local Name**	November/Dec 2013	March 2014	Dense forest	Sparse forest	Agriculture/Paddy	Settlement	Water
Alcedo atthis	Common Kingfisher	Tit/Talghaira Machranga	√	√	√	√	√	√	
Halcyon smyrnensis	White breasted kingfisher			√			√		√
Psittacula alexandri	Red-breasted Parakeet	Lal bok tia	√	√	√	√			
Picus viridanus	Streak breasted wood pecker		√	√	√	√			
Coracias benghalensis	Indian Roller	Nilkanto	√	√			√	√	
Anthracoceros albirostris	Oriental Pied Hornbill	Kau/Reshulla Dhanesh	√	√		√	√	√	
Cypsiurus balasiensis	Asian palm swift	Talchorai	√	√		√	√	√	
Merops orientalis	Green Bee-eater	Suichora	√	√		√	√	√	
Merops leschenaulti	Chestnut-headed Bee-eater			√			√	√	
Megalaima haemacephala	Coppersmith Barbet	Bosontobouri	√	√	√	√			
Megalaima asiatica	Blue throated barbet	Dhonia Basantabouri	√	√	√		√	√	
Megalaima lineata	Lineated barbet	Bosonto bawri	√	√	√	√	√	√	
Corvus macrorhynchos	Jungle crow	Darkak	√	√	√	√	√	√	
Dicrurus aeneus	Bronzed Drongo	Bronze Fingey	√	√	√	√	√	√	
Dicrurus hottentottus	Hairy crested drongo	Keshaj, Dukhmel		√		√	√		
Dicrurus paradiseus	Greater racket-tailed Drongo	Bhimraj	√	√	√	√			
Dicrurus macrocercus	Black Drongo	Kala Fingey	√	√		√	√	√	
Acridotheres fuscus	Jungle myna	Jhuti Sahlik	√	√	√	√	√	√	√
Sturnus contra	Pied starling	Pakra Shalik, gubra Shalik	√	√	√	√	√	√	√
Acridotheres tristis	Common myna	Bhat Shalik	√	√	√	√	√	√	√
Copsychus malabaricus	White-rumped Shama		√	√	√		√		
Turdoides striatus	Jungle Babbler	Satvaila	√	√	√	√	√	√	
Pellorneum ruficeps	Puff-throated Babbler		√	√	√			√	
Tephrodornis pondicerianus	Common wood shrike	Choto Dukka	√	√		√			
Tephrodornis gularis	Large wood shrike	Boro Dukka	√	√			√	√	
Aegithina tiphia	Common Irora	Fotikjal	√	√	√				
Oriolus xanthornus	Black-headed Oriole	Sadamachranga	√			√		√	
Turdus ruficollis	Rufous throated thrush		√	√	√	√	√	√	
Garrulax ruficollis	Rufous-necked Laughingthrush	-	√	√		√	√	√	
Garrulax albogularis	White-throated Laughingthrush		√	√	√	√			

Aves					**Land cover class of occurrence**				
Species Name	**English Name**	**Local Name**	November/Dec 2013	March 2014	Dense forest	Sparse forest	Agriculture/Paddy	Settlement	Water
Rhipidura albicollis	White-throated Fantail			√	√	√	√	√	
Orthotomus sutorius	Common Tailor Bird	Pati Tuntuni		√		√			
Dicaeum erythrorhynchos	Pale-billed Flowerpecker	Fuljhuri	√	√		√		√	
Ficedula sapphira	Sapphire flycatcher		√	√		√			
Pericrocotus flammeus	scarlet minivet	Altapori/Lal satsahli		√		√	√	√	
Pericrocotus cinnamomeus	small minivet	Teni Satsaheli	√	√		√		√	
Dicaeum cruentatum	Scarlet-backed Flower pecker			√					
Hypothymis azurea	Black-naped Monarch			√		√	√		
Pycnonotus cafer	Red-vented Bulbul	Bulbuli	√	√	√	√		√	
Pycnonotus jocosus	Red-whiskered Bulbul	Sipahi Bulbuli	√	√	√	√			
Pycnonotus melanicterus	Black-crested Bulbul	Fifrodu, Robolong	√	√		√	√	√	
Malacocincla abbotti	Abbott's Babbler		√	√	√		√		√
Leptocoma zeylonica	Purple-rumped Sunbird	Beguni komor Moutushi		√		√	√	√	

Appendix 9. Conservation status of vertebrate species in Dudpukuria-Dhopachari WS (Anon. 2000. Deniel, 1983, Khan 2010)

Source: Anon. 2000. Deniel, 1983, Khan 2010

Local status: VC= Very Common, C= Common, FC = Fairly common, F= Few, UC= Uncommon, O= Occasional, R = Resident, M= Migratory

Global status: NO = Not threatened, VU= Vulnerable, NT= Near Threatened, CR= Critically Endangered, DD=Data deficient, LC= Least Concern

Amphibian species name	English Name	Local Name	Relative Abundance	Local status	Global status
Duttaphrynus melanostictus	Common Toad	Kuno Bang	C	NO	LC
Euphlyctis cyanophlyctis	Skipper Frog	Mali Bang	VC	NO	*LC*
Hoplobactrachus tigerinus	Bull Frog	Sona Bang	C	NO	-
Polypedates maculaus	Indian Tree Frog	Gecho Bang	FC	NO	-
Fejervaria limnocharia	Cricket frog	Jiji Bang	F	NO	-
Rhacophorus maximus	Common Tree Frog	Bara Gechobang	F	NO	LC

Reptilian species name	English Name	Local Name	Relative Abundance	Local status	Global status
Calotes versicolor	Common Garden Lizard	Raktachosa	C	NO	-
Hemidactylus frenatus	Common House Lizard	Haroil Tiktiki	FC	NO	LC
Hemidactylus flaviviridis	Yellow-bellied House Gecko	Goda Tiktiki	FC	NO	-
Hemidactylus brookii	House Lizard	Tiktiki	C	NO	-
Gekko gecko	Tokay Gecko	Tokkhak	FC	NO	-
Mabuya carinata	Keeled Grass Skink	Anzoni	FC	NO	LC
Mabuya dissimilis	Stripped Grass Skink	Anzoni	FC	NO	-
Varanus bengalensis	Bengal Monitor	Kalo Gui Shap	FC	VU	-
Xenochrophis piscator	Checkered Keelback water snake	Dhora Shap	C	NO	-
Ptyas mucosus	Oriental rat snake	Darash Shap	FC	NO	-
Naja naja	Indian cobra (Ecdysis)	Ghokra shap	F	NO	-

Mammalian species name	English Name	Local Name	Relative Abundance	Local status	Global status
Callosciurus pygerythrus	Irrawaddy Squirrel	Badami Kathbirali	C	NO	LC
Ratufa bibicolor	Black Giant Squirrel	Bara kalo Katbirali	C	NO	-
Suncus murinus	Asian House Shrew	Chika	C	NO	LC
Bandicoto bengalensis	Lesser Bandicoot-Rat	Dhari /Baro Idur	FC	NO	-
Sus scrofa	Wild Boar	Bab Shukor	C	VU	LC
Herpestes auropunctatus	Small Indian Mongoose	Choto Benji, Nakul	FC	NO	-
Canis aureus	Golden Jackal	Shial	C	NO	LC
Pteropus giganteus	Indian Flying Fox	Baro Badur	FC	NO	LC
Pipistrellus coromandra	Indian Pipistrelle	Chamchika	C	NO	LC

Avian species Name	English Name	Local Name	Relative abundance	Local status	Global status
Accipiter badius	Shikra	Shikra	O	NO	LC
Spilornis cheela	Crested Serpent Eagle	-	F	NO	LC
Falco severus	Oriental Hobby	-	F	DD	LC
Gallus gallus	Red Jungle fowl	Bon Murghi	F	NO	LC
Treron phoenicoptera	Yellow-footed Green Pigeon	Horial	F	NO	LC
Treron affinis	Grey-fronted Green Pigeon	-	F	NO	LC
Spilopelia chinensis	Spotted Dove	Tila Ghugu	C	NO	LC
Chalcophaps indica	Common Emerald Dove	Sobuj Ghugu	F	NO	LC
Treron pompadora	Green Pigeon	Choto Harial	FC	NO	LC
Columba punicea	Pale-capped Pigeon	-	O	NO	VU
Anthracoceros albirostris	Oriental Pied Hornbill	Kau/Reshulla Dhanesh	O	NO	LC
Megalaima asiatica	Blue throated barbet	Dhonia Basantabouri	FC	NO	-
Megalaima lineata	Lineated barbet	Bosonto bawri	FC	NO	LC
Megalaima haemacephala	Coppersmith Barbet	Bosontobouri	FC	NO	LC
Centropus bengalensis	Lesser Coucal	Choto Kanakukka	F	NO	LC
Phaenicophaeus tristis	Green-billed Malkoha	Dophajongol	FC	NO	LC
Coccycua minuta	Little Cuckoo	Chotokokil	F	NO	LC
Cuculus canorus	Common Cuckoo	-	M F	NO	LC
Cuculus poliocephalus	Lesser Cuckoo	-	M C	NO	LC
Alcedo atthis	Common Kingfisher	Tit/Talghaira Machranga	FC	NO	LC
Halcyon smyrnensis	White breasted kingfisher	-	F	NO	LC
Picus canus	Blackednaped Green Woodpecker	Sobuz Kaththokra	FC	NO	LC
Psittacula alexandri	Red-breasted Parakeet	Lal bok tia	FC	NO	LC
Coracias benghalensis	Indian Roller	Nilkanto	F	NO	LC
Apus apus	Common Swift	-	C	NO	LC

Avian species Name	English Name	Local Name	Relative abundance	Local status	Global status
Merops leschenaulti	Chestnut-headed Bee-eater	-	FC	NO	LC
Merops orientalis	Green Bee-eater	Suichora	FC	NO	LC
Corvus macrorhynchos	Jungle crow	Darkak	F	NO	LC
Acridotheres fuscus	Jungle myna	Jhuti Sahlik	C	NO	LC
Sturnus contra	Pied starling	Gubra Shalik	C	NO	LC
Acridotheres tristis	Common myna	Bhat Shalik	C	NO	LC
Pycnonotus cafer	Red-vented Bulbul	Bulbuli	F	NO	LC
Pycnonotus jocosus	Red-whiskered Bulbul	Sipahi Bulbuli	C	NO	LC
Pycnonotus melanicterus	Black-crested Bulbul	Fifrodu, Robolong	F	NO	LC
Pellorneum ruficeps	Puff-throated Babbler	-	F	NO	LC
Malacocincla abbotti	Abbott's Babbler	-	FC	NO	LC
Tephrodornis gularis	Large wood shrike	Boro Dukka	F	NO	LC
Tephrodornis pondicerianus	Common wood shrike	Choto Dukka	F	NO	LC
Oriolus xanthornus	Black-headed Oriole	Sadamachranga	FC	NO	LC
Dicrurus macrocercus	Black Drongo	Kala Fingey	VC	NO	LC
Dicrurus paradiseus	Greater racket-tailed Drongo	Bhimraj	F	NO	LC
Dicrurus hottentottus	Hairy crested drongo	Keshaj, Dukhmel	FC	NO	LC
Dicrurus aeneus	Bronzed Drongo	Bronze Fingey	F	NO	LC
Myioparus plumbeus	Fantailed flycatcher	-	FC	NO	LC
Orthotomus sutorius	Common Tailor Bird	Pati Tuntuni	C	NO	LC
Dicaeum erythrorhynchos	Pale-billed Flowerpecker	Fuljhuri	F	NO	LC
Ficedula nigrorufa	Black and orange flycatcher	-	F	NO	LC
Pericrocotus flammeus	Scarlet minivet	Altapori/Lal satsahli	F	NO	LC
Pericrocotus cinnamomeus	Small minivet	Teni Satsaheli	FC	NO	LC
Dicaeum cruentatum	Scarlet-backed Flower pecker		F	NO	LC
Garrulax ruficollis	Rufous-necked Laughing thrush	-	FC	NO	LC
Garrulax albogularis	White-throated Laughing thrush	-	FC	NO	LC
Turdus ruficollis	Rufous throated thrush	-	F	NO	LC
Copsychus malabaricus	White-rumped Shama	-	O	NO	LC
Hypothymis azurea	Black-naped Monarch	-	F	NO	LC
Leptocoma zeylonica	Purple-rumped Sunbird	Beguni komor Moutushi	F	NO	LC
	Black and orange flycatcher	-	F	NO	LC
Saxicoloides fulicatus	Robin	-	FC	NO	LC
Turdoides striata	Jungle Babbler	Satvaila	C	NO	LC
Aegithina tiphia	Common Iora	Fotikjal	FC	NO	LC

Appendix 10. Some pesticides known to be used inside and around protected areas in Bangladesh and their level of toxicity

- *Carbofuran*, one of the most toxic carbamate pesticides, is marketed under the trade names Furadan. It is particularly toxic to birds as birds often eat numerous grains of the pesticide, mistaking them for seeds dying shortly thereafter. It has been illegally used to intentionally poison wildlife.
- *Diazinon* (Basudin) is considered to be of relatively high toxicity for vertebrates.
- *Phosphamidon* (Dimecron) is very highly toxic to mammals and is listed as WHO Hazard Class Ia
- *Malathion* (Cythion, Fyfanon) is of low toxicity, but absorption or ingestion by humans readily results in its metabolism to malaoxon, which is substantially more toxic. Malathion is toxic to birds, fish, aquatic vertebrates, aquatic life stages of amphibians and highly toxic to bees.
- *Fenitrothion* (Sumithon) can over-stimulate the nervous system causing nausea, dizziness, confusion; at very high exposures (accidents or major spills) respiratory paralysis and death. Some hazard to birds, fish, and beneficial insects. Hazardous to honey bees.
- "*Karate*" is a commercial name of Cyhalothrin which is an organic pesticide. It is a pyrethroid. It has low water solubility and is non-volatile. Lambda cyhalothrin is moderately toxic in the technical form, but may be highly toxic via some routes in formulation, e.g. as Karate(http://pmep.cce.cornell.edu/).
- *Folidol* (Methyl Parathion) is one of the most toxic organophosphate pesticides which can over-stimulate the nervous system causing nausea, dizziness, confusion, and at high exposures, respiratory paralysis and death (www.epa.gov). It poses a high risk to birds and aquatic invertebrates. It is very highly toxic to honey bees. The World Health Organization proposes a global ban on this pesticide.
- "*Predator*" (Chlorpyrifos) is an insecticide moderately toxic to humans, and exposure has been linked to neurological effects, persistent developmental disorders, and autoimmune disorders. Among freshwater aquatic organisms, crustaceans and insects appear to be more sensitive to acute exposure than are fish or the aquatic life stages of amphibians, although little data may exist for amphibians. Because of its combined high toxicity to bees and prevalence in pollen and honey, bees are considered to have higher risk from chlorpyrifos exposure via their diet than from many other pesticides
- *Endosulfan*, Endosulfan has been used in agriculture to control insect pests including whiteflies, aphids, leafhoppers, Colorado potato beetles and cabbage worms. Due to its mode of action, it is useful in resistance management; however, as it is not specific, it can negatively impact populations of beneficial insects. It is, however, considered to be moderately toxic to honey bees

- *Pirimiphos-methyl* can cause cholinesterase inhibition in humans; that is, it can over-stimulate the nervous system causing nausea, dizziness, confusion, and at very high exposures (e.g., accidents or major spills), respiratory paralysis and death. Pirimphos-methyl is highly toxic to birds and fish

Appendix 11. Composition, roles and responsibilities of the Co-Management bodies

(a) Co-Management Committee (CMC)

Structure and procedures

- The Divisional Forest Officer (DFO) and Upazila Nirbahi Officer (UNO) are the advisor of the committee and the respective Range Officer (RO) will serve as the Member-Secretary of the CMC.
- The members of the respective categories\groups will elect members for the CMC according to the quota mentioned in government order.
- All members will be elected for 2-year tenure except the nominated (ex-officio) members and no person can be a member for more than 2 consecutive terms.
- The members of the CMC will elect one Chairperson, one Vice-Chairperson one Treasurer among themselves.
- The bank account of the committee will be operated under the joint signature of the Member-Secretary and the Treasurer.
- The DFO, The Chairperson, Vice-Chairperson, Treasurer and Member-Secretary of the CMC will meet at least once in every three months to review the progress.
- The CMC will have its own office as far as possible near to the forest office. There will be a full time accountant cum administrative officer. The said officer will maintain financial and other records of the committee.
- The maximum number of members of the committee will be 29.
- The members of the committee will meet at least once in a month. The quorum of the meeting will be attendance of 50% members of the committee.

The roles and responsibilities of Co Management Committee

- monitor the activities of VCF, PF and CPG
- facilitate voluntary work in forest conservation and management,
- facilitate effective management of natural resources,
- ensure effective participation of all the stakeholders in forest management,
- help in the implementation of adopted development activities,
- ensure effect distribution among the stakeholders acquired from PA.

(b) Co Management Council

Aim

- The co-management council is formed to support the management of DDWS with the full support and active participation of the stakeholders of the Protected Areas and the landscape.

Composition

- Stakeholder groups select their representatives for the Co-management Council: Civil Society (Maximum 5 persons); Local Administration (Maximum 3 persons); Forest Department (Maximum 8 persons); Local Government (Maximum 5 persons); Community (Maximum 39 persons); Representatives from other Government (Maximum 5 persons)

Roles and procedures

- Local Parliament Member, Upazila Parishad Chairman and Divisional Forest Officer are the Advisor of the council
- Upazila Nirbahi Officer (UNO) and the respective Range Officer will serve as the Chairman and Member secretary of the Co-management council
- The Co-management Council will have maximum 65 members. Out of these, minimum number of women will be 15
- The members of the Co-management council will be elected for 4 years and after four year the council will be dissolve and the new council will be formed through election at Annual General, however, the representatives from government institutions will remain as ex-officio members of the council
- The Co-management Council can be dissolved:
- According to Government Order the duration of the council is 4 years and after that a new council would be formed through election
- A council could be dissolved if two third members vote against the council and write a petition to advisors; Advisors can be decided to hold a election for a new council
- However the Government Officials will continue their membership as ex-officio.

(c) Peoples Forum (PF)

Composition

- The peoples Forum will be formed by election of representative from villages and local communities within the Protected Area landscape. All key stakeholders should be represented, particularly women, the youth, lower income households, and important resource users groups.

- The Village Conservation Forum (VCF) will select two representatives for the People's Forum (PF).
- The members of the Peoples Forum will elect the executive committee through ballot.
- The committee will have a president, Vice President, Secretary, joint Secretary, Treasurer, Members (33% of the members should be women).
- The members of the committee will be changed every two years.

Roles and responsibilities

- Meeting at least twice in a year
- Represents local users of natural resources and ensure that local livelihood issues are taken into account in the preparation and implementation of Protected Area Co-Management plans.
- Recommend and support initiatives for protecting the natural's resources of the protected Area and conserving biodiversity and assist the Forest Department and Co-management institutions in implementing tree plantation, reforestation, habitat restoration, nature-based tourism activities and other management activities of the protected area.
- Assist to prepare Protected Area Co-management plans and Annul work plans for landscape area conservation and development in and around the Protected Area.

(d) Village Conservation Forum (VCF)

Role

- The Village Conservation Forum is an inclusive platform of the Co-Management process where the poor villagers or resources except specific categories like local government member, civil society member and owner of the resources user institutions that ensures direct participatory democracy. Village Conservation Forum (VCF) can be effective to discuss the issues like (a) the right of the community to conserve natural forests, (b) possible actions to protect illicit felling, (c) social security, gender justices, health and hygiene, (d) options for alternative income generation activities, and (e) infrastructures development.

Forming VCF

- Organize village meeting to describe the objective of the census.
- Household census to be conducted for identifying the position and condition of the village people.
- At the time of census, clearly describe the power and responsibilities of the VCF, PF and CMC.
- 50% of the committee members should be women.

- Elect Peoples Forum from the VCF.

Responsibilities

- For local governance to be effective, activating VCF is a challenge. It needs to motivate and mobilize the member of the VCF for participating in regular and meaningful meeting.
- VCF will seat together to select Community Patrolling Group (CPG) Members, People's Forum (PF) members from their own village. They are also responsible to exclude, change or reselect the CPG members according to the decisions of Co Management Committee and People's Forum.
- VCF can monitor and discuss the implementation of the development projects and suggest PF and CMC to improve the quality of work and they are also responsible to assist PF and CMC for selecting participants of social forestry program of the Forest Department (FD).
- To select labour for cleaning or any sorts of activities inside the forest. VCF will assist PF, CMC and FD.
- VCF are responsible to give comments and recommendations of CMC activities through PF, if they are not satisfied by the answer of the CMC they can raise the question in front of Divisional Forest Officer (DFO).
- VCF is mandated to meet at least four times in a year; may meet more according to the necessity of community.

(e) Community Patrol Group (CPG)

- Community Patrol Groups are formed from the VCF members by the CMC. These groups regularly patrol for the protection and conservation in the protected areas and also buffer zone along with the FD personnel. There are five CPGs in DDWS of which four groups in Dudpukuria range and one group in Dhopachari range. From Each CPG group 4 member participate for patrolling. Each member participates four days in a month. For each working day each CPG member gets Tk 10 only.

Appendix 12. Rules of Conduct for tourism in the Dudpukuria-Dhopachari WS

The following elements of a code of conduct for the Dudpukuria-Dhopachari WS are based on the existing code of ethics for the Sundarban Reserved Forest (Chaves 2002). It is recommended that these guidelines become established legally and enforced, that each entry pass be considered as a contract between visitors and the Forest Department. Guidelines must be clearly posted in Bangla and English at all Forest Department stations and tourist areas, and be printed on the back side of entry passes.

Recommended Code of Conduct for Visitors:

- Be respectful of wildlife and other visitors - keep noise to a minimum. Audio systems and fireworks are prohibited in the Dudpukuria-Dhopachari WS.
- Leave the night to the animals - keep night lighting to a minimum.
- Be alert and mindful for your own safety and that of others.
- Dress in dark clothes or garments that blend with the flora.
- Respect signs and remain in areas of public access only.
- Take only pictures, leave only footprints. Pack out all trash or dispose of trash in designated receptacles. Do not extract or collect plants and animals from the Dudpukuria-Dhopachari WS.
- Keep animals wild - do not feed wild animals.
- No cooking or open fires in the Dudpukuria-Dhopachari WS.

Recommended Code of Conduct for Tour Operators (additional to the Visitors' Code of Conduct):

- All tour operators visiting the Dudpukuria-Dhopachari WS must be licensed by the Forest Department.
- Overnight mooring will only be allowed in designated areas.
- Tours must be conducted on designated circuits only.
- Tour operators will apply appropriate safety standards in their operations - boats not to exceed maximum carrying capacities; all boats must be equipped with sufficient life vests (one per passenger), a first aid kit, and a two-way radio.
- Tour operators must educate all participants on the DDWS code of conduct prior to tour initiation.
- No dumping of waste or sewage in Dudpukuria-Dhopachari WS.

Appendix 13. Outline of Relocation/Resettlement Action Plan (RAP)

228. As per the provisions of Bangladesh Acquisition and Requisition of Immovable Property Ordinance, 1982, squatters/encroachers affected by acquisition of land will not be entitled to compensation for land. Affected vulnerable squatters will, however, be provided with relocation assistance.

229. For providing assistance a Relocation Action Plan (RAP) needs to be prepared. The plan is based on up-to-date and reliable information about (a) the proposed resettlement and its impacts on the displaced persons and other adversely affected groups, and (b) the legal issues involved in resettlement. The relocation plan covers the elements below, as relevant. When any element is not relevant to project circumstances, it should be noted in the resettlement plan.

(1) Socioeconomic studies

230. The findings of socioeconomic studies to be conducted in the early stages of project preparation and with the involvement of potentially displaced people, including

(a) standard characteristics of displaced households, including a description of production systems, labour, and household organization; and baseline information on livelihoods (including, as relevant, production levels and income derived from both formal and informal economic activities) and standards of living (including health status) of the displaced population;

(b) the magnitude of the expected loss--total or partial--of assets, and the extent of displacement, physical or economic;

(c) information on vulnerable groups or persons as provided for in OP 4.12, para. 8, for whom special provisions may have to be made; and

(d) provisions to update information on the displaced people's livelihoods and standards of living at regular intervals so that the latest information is available at the time of their displacement.

(2) Relocation of displaced squatters

231. Affected households will be provided with viable options for relocation to choose from, such as (a) self-relocation; (b) special package for transfer to the place of origin; and (c) relocation to a suitable resettlement site on other public lands in the vicinity. Where attempts to find suitable relocation sites are not successful or the locations of identified sites are not acceptable to the PAPs, other options will be considered.

(3) Entitlements

All affected squatters will be entitled to:

- Compensation in cash for affected structure

- Transfer/Shifting allowance
- Transition allowance for three months

232. Compensation amounts will be based on the principle of replacement value. The exact value of compensation and replacement cost will be different for each activity and will be based on an economic and social survey of the area of the activity and of affected persons. The methodology to be used in valuing losses to determine their replacement cost; and a description of the proposed types and levels of compensation under local law and such supplementary measures as are necessary to achieve replacement cost.

(4) Institutional Framework

233. The findings of an analysis of the institutions supporting and implementing resettlement, covering:

(a) the identification of agencies responsible for resettlement activities and NGOs that may have a role in project implementation;

(b) an assessment of the institutional capacity of such agencies and NGOs; and

(c) any steps that are proposed to enhance the institutional capacity of agencies and NGOs responsible for resettlement implementation.

(5) Site Selection, Site Preparation, and Relocation

234. Alternative relocation sites considered and explanation of those selected, covering

(a) institutional and technical arrangements for identifying and preparing relocation sites for which a combination of productive potential, locational advantages, and other factors is at least comparable to the advantages of the old sites, with an estimate of the time needed to acquire and transfer land and ancillary resources;

(b) any measures necessary to prevent land speculation or influx of ineligible persons at the selected sites;

(c) procedures for physical relocation under the project, including timetables for site preparation and transfer; and

(d) legal arrangements for regularizing tenure and transferring titles to resettlers.

(6) Grievance procedures

235. Affordable and accessible procedures for third-party settlement of disputes arising from resettlement; such grievance mechanisms should take into account the availability of judicial recourse and community and traditional dispute settlement mechanisms.

(7) Implementation schedule.

236. An implementation schedule covering all RAP activities from preparation through implementation, including target dates for the achievement of expected benefits to resettlers and hosts and terminating the various forms of assistance. The schedule should indicate how the resettlement activities are linked to the implementation of the overall project.

(8) Costs Estimate

237. A tentative budget estimate in Taka (Tk) to relocate an estimated 150 families is as follows:

Compensation in cash for affected structures	150,000/family	30,000,000
Transfer/Shifting allowance	20,000/family	3,000,000
Transition allowance for three months	25,000/familyX3months	11,250,000
Total		44,250,000

(9) Monitoring and evaluation

238. A section is included on arrangements for monitoring of RAP activities by the implementing agency, supplemented by

- independent monitors as considered appropriate, to ensure complete and objective information;
- performance monitoring indicators to measure inputs, outputs, and outcomes for resettlement activities;
- involvement of the displaced persons in the monitoring process;
- evaluation of the impact of relocation for a reasonable period after all relocation and related development activities have been completed.

Appendix 14. Conservation Oriented Patrol standards (COPs)[16]

1. An enforcement plan must be in place for the PA – The enforcement plan will be based on the enforcement strategy and will provide the guidelines for patrol activities and planning. It should contain:

a) Situation: containing a list of Threats to the Protected Area, maps, aerial photos, etc.

b) Mission (Objectives): E.g. Maintain an effective compliance and enforcement capacity to mitigate the impacts of users, visitors and illegal activities.

c) Execution (Methodology): E.g. i) Maintaining regular reserve patrols particularly along the boundaries, ii) Ensuring the effective deployment of the enforcement and compliance members towards controlling illegal activities, enforcing legislation and regulations, iii) Mapping areas where illegal activities occur and maintaining an inventory of incidents

d) Administration and logistics: Include i) essential provisions for transportation, clothing, and equipment ii) a safety and risk assessment, iii) training requirements.

2. Minimum of fifteen days/nights of enforcement ranger patrols per month – The patrol schedule and adequate staff numbers may allow for 100% coverage over the month, but at the minimum, a random 50% coverage using available staff is required. This is to include night patrols.

3. Coverage of accessible areas of the PA – patrols that cover at least 75% of all readily accessible areas of the PA per month. If the area is accessible to the public, it must be patrolled by the rangers. At least 75% of all accessible areas covered per month.

4. Minimum of four team members – If patrolling by vehicle, this may be reduced to three members. In addition to normal enforcement patrol requirements and efficiency (contact & cover officers) this is also an officer safety issue. If a ranger is injured then two of the rangers can carry him out, while one is available for point, or one ranger can stay with the injured ranger while the other two go for assistance. If the rangers are travelling by vehicle or boat, then the difficulty with the transport of apprehended persons or injured individuals changes, therefore three rangers will be adequate

5. Include an officer trained to collect evidence – At least one of the enforcement patrol team must be trained in wildlife crime scene investigations (WCSI) and informant handling and interrogation techniques. The minimum standards expected are the successful completion of the following modules, ASEAN Standards for PA Staff (2003) ENF 2.3 Correctly secure, manage and process a crime scene, ENF 3.4 Follow correct procedure for dealing with violations, seized or confiscated evidence, ENF 3.7 Develop and manage informant networks

6. Powers of arrest – Enforcement patrol rangers must have powers of arrest. This includes the powers of detention necessary until the suspect has been handed over to the police, or powers of arrest to process for court, within the agency. These powers are necessary to effectively deal with poaching and other incidents or threats the rangers may face.

7. Enforcement patrols must be supported by an informer network – As in many areas of law enforcement, confidential informers (CIs) are a crucial part of the system. Most protected areas (PAs) are too large to be adequately patrolled. Therefore using informants and targeting known hotspots or suspected individuals, will make the patrols more effective (UNODC claim that 86% of border seizures result from informers).

[16] reference: Barlow 2014

8. Mobile team – consisting of PA staff effectively deployed to respond to "hot spots" and other illegal activities not covered by regular patrols. This mobile team is internally staffed, allowing for standardized training, protocols, equipment, control and immediate response if needed

9. Some guards should be permanently based on site – These rangers may either be in an outpost, a ranger station or a guard house at the PA entrance or other available site.

The public must:

a) In an emergency or circumstances requiring assistance, be able to contact rangers at a known location, and

b) be aware that there exists a ranger presence in the area to show "ownership" of the PA – that Government is paying attention to its PAs

10. **A communication system must be in place between patrol teams and Headquarters (HQs)** – The type of communication system will only be as sophisticated as budgets and terrain allow, however rangers must be able to get emergency assistance by some method.

11. **A law enforcement monitoring tool should be in place** – Some types such as MIST, SMART (currently being introduced) or written patrol reports, are already in use. We often cannot dictate which system is in use but we must be able to keep track of results, plan for future activities, show improvements.

12. **Tactical Maps are available of the PA and surrounding areas. (**Actual maps not something contained electronically) These should be of the Topographic type Scale 1:50,000 and 1:25,000. "GIS" produced maps often do not include areas outside the PA. The PA is not an "island". It is essential that the maps include all the surrounding areas, and are suitable for posting on a wall

13. **All major access points/routes should be controlled** – There should be a "gate house" at the entrance to the PA, or on the road traversing the PA, to welcome visitors, monitor traffic access and egress, and search suspicious vehicles if necessary. This forms part of the visible deterrent approach.

14. **Include multiple agencies** – Different Government legislation and regulations apply. In some PAs the enforcement rangers will be trained, authorized and capable of properly carrying out all their duties. In this case the PA would be exempt from this requirement.

Appendix 15. List of institutes with their training and capacity building programs

Name of NGO/CBOs	Area	Capacity building program
Integrated Development Foundation (IDF)	Dhopachari, Dudpukuria,	Solar power, micro credit
Brac	Dhopachari, Dudpukuria	Health; WASH-program, micro-credit, primary education & primary health.
Mamata	Dhopachari	Malaria control program & wash
Grameen Bank	Dhopachari, Dudpukuria	Micro credit
Sonali Bohomukhi Somobay Somity ltd.	Dhopachari	Micro credit
CCDR	Dudpukuria	Micro credit, solar, savings, deposit
U N D P	Dudpukuria	Food security; health & nutrient, primary education, health care child & mother
Asha	Dudpukuria	Micro credit
Podakhep	Dudpukuria	Micro credit, solar power

Appendix 16. Climate change adaptation interventions in Dudpukuria Beat, Kamalachari Beat and Shukbilash Beat

Dudpukuria Beat								
Village Name	**Canal excavation**	**Roadside plantation**	**Pond excavation**	**Deep Tube well Installation**	**Cyclone Shelter**	**Agro forestry**	**Community Clinic**	**Road Maintenance**
Borochan-khola	Priority 2 1 km (Dudpukuria Dakbanglo to Khaiya para rubber plantation	Priority 1 4 km (Dudpukuria-Chandraghona-Bandarban Road)		Priority 3 two deep tube wells	Priority 4 Nos-1	Priority 5 1200 saplings (beneficiaries-6) 0.3hectres in the hill	Priority 6 Nos-1	
Dakbanglo Muslim para	Priority 2 Same as Borochankhola			Priority 1 5 Deep tube well	Priority 3 Nos-1		Priority 3 Nos-1	
Khaiyapara North	Priority 2 0.5 km (Dudpukuria Khaiya chara khal)			Priority 1 5 shallow tube wells 5 deep tube wells	Priority 5 Nos-1	Priority 4 700 Saplings (beneficiaries-4) 0.2 hectors in the hill	Priority 3 Nos-1	
Khaiyapara South	Priority 3 Same as Khaiyapara North			Priority 1 Deep Tubewell-10 Shallow Tube well-5	Priority 3 Nos-1	Priority 4 800 saplings (beneficiaries-4) 0.2 hectors in hill	Priority 5 Nos-1	Priority 2 3 km
Dudpukuria 1	Priority 2 0.5 km (Dudpukuria Khaiya chara khal)			Priority 1 5 shallow tube wells 5 deep tube wells	Priority 7 Nos-1	Priority 5 1200 saplings (beneficiaries-6) 0.3hectres in the hill	Priority 3 Nos-1	Priority 4 1.5 km
Dudpukuria 2	Priority 2 Shilak canal excavation and guide wall on both side to protect roads and houses	Priority 7 Plantation on both side of Shilak khal (2km)	Priority 4 1 CMC owned pond to preserve rain water	Priority 1 5 Deep tube well	Priority 6 Nos-1	Priority 5 500saplings (benificiaries-5) 0.2 hectares	Priority 3 Nos-1	
Kibuk Para				Priority 1 Deep	Priority 2		Priority 4	Priority 3

Dudpukuria Beat								
Village Name	**Canal excavation**	**Roadside plantation**	**Pond excavation**	**Deep Tube well Installation**	**Cyclone Shelter**	**Agro forestry**	**Community Clinic**	**Road Maintenance**
				Tubewell-10	Nos-1		Nos-1	1.5
Intervention Objectives	Need to summarize expected purpose / change that excavation will result in as this is their main priority			Ownership for community water supply not identified, proposed numbers need verifying against populations of each	Only Kibukpara is prone to cyclones. It was hit by tidal surge in 1991. Other villages experience thunderstorm and flash floods from streams during monsoon. Presumably re-excavation will reduce housing damage and need for shelters	These are not landscape plans. Not to include in landscape plan, but issue of degraded hill land to be discussed in site level mgt planning process	Poor local health care in remote villages. Appropriate solution to be sought and raised by CMC/PF with UPs and relevant agencies. Possibly this could be met by nurses and doctors who operate mobile clinics making use of public or other buildings including those used by CMC.	

Kamalachari beat							
	Village Name	**Kamalachari**	**Kalichari**	**Khurusia**	**Garaderder**	**Intervention Objectives**	**Scope:**
Water Supply	Bamboo Plantation along Canal Bank	Priority 8 *1 km Kamalachori canal	Priority 6 *1 km Kalichari canal			To protect road/embankment	NRM landscape plan
	Pond Excavation (For Irrigation)	Priority 3 No. 20	Priority 3 No. 10	Priority 2 No. 10		To arrange alternative water source during drought	If public ponds (non private) community resilience
	Tube well Installation (For drinking water)	Priority 2 No.20	Priority 1 No.10	Priority 1 No.20	Priority 1 No.20	To arrange alternative and safe drinking water sources during drought and disaster	Local government and DPHE

Kamalachari beat							
	Village Name	**Kamalachari**	**Kalichari**	**Khurusia**	**Garaderder**	**Intervention Objectives**	**Scope:**
	Deep tube well Installation (For Irrigation)	Priority 1 No. 5	Priority 2 No.4	Priority 3 No.2	Priority 2 No. 1	To arrange alternative water source during drought	If public wells (non-private) community resilience. BUT note same villages as ponds
	Canal Re-Excavation	Priority 13 3 km Kamalachari Chara	Priority 7 3 km Kalichari Chara	Priority 9 2 KM Khurusia Chara	Priority 3 2 KM Garaderder Chara	To save homestead from landslide caused by river	Depends on BWDB/LGED and absence of -ve impacts
Public infrastructure (transport, health)	Bridge/Culvert Construction	Priority 14 No.3	Priority 4 No.3	Priority 4 No. 4	Priority 4 No.2	To facilitate drainage of excessive water during excessive rainfall	Roads and Highways or LGED
	Road Construction/ Carpeting	Priority 6 3 KM, (Carpeting)	Priority 5 2 KM (Carpeting)	Priority 5 3 KM, (Carpeting)	Priority 8 0.5 KM, (Carpeting)	To address flood	
	Shelter Centre	Priority 7 No.1	Priority 8 No.1	Priority 7 No.1	Priority 5 No.1	To save people during disaster	Relief and rehabilitations Department
Private adaptation	Community Clinic	Priority 9 No.1	Priority 9 No.1	Priority 8 No.1	Priority 6 No.1	To treat themselves diseases arises from excessive cold and heat wave	Heath Department
	Storm/ cyclone tolerant houses	Priority 12, *40 (Brick house) *50 mud house	Priority 10 *35 (Brick house) *35 mud house	Priority 6 *50 (Brick house) *50 mud house	Priority 7 *15 (Brick house) *20 mud house	To address Cyclone	Individual household investment
	Crops (early)	Priority 4, * 40 families (Early variety crops, like cucumber, Chilli)				To save crop from water logging arises from erratic rainfall	Individual household investment
	Bamboo ceiling in roof	Priority 10 No. 40	Priority 13 No. 35	Priority 11 No. 40	Priority 9 No. 15	To save from heat wave	Individual household investment
	Crops (alternatives)	Priority 5 * 50 families (Cold resilient potato, maize cultivation) *30 families (temperature resilient rice, ladies finger and bitter gourd cultivation)	Priority 11 * 20 families (Cold resilient potato, maize cultivation) *20 families temperature resilient rice, ladies finger and bitter gourd cultivation	Priority 10 * 30 families (Cold resilient potato, maize cultivation) *25 families (temperature resilient rice, ladies finger and bitter gourd cultivation)	Priority 11 *15 families (Cold resilient potato, maize cultivation) *30 families (temperature resilient rice, ladies finger and bitter gourd cultivation)	To save crop in severe heat/ cold	Extension
	Homestead Plantation	Priority 11 * 30 Families	Priority 12, * 40 Families	Priority 12 * 60 Families	Priority 10 * 30 Families	To address heat wave	Individual household investment

Shukbilash Beat												
	Water Supply					Public infrastructure (transport, health)			Private adaptation			
Village name	**Social & Agro-forestry**	**Pond Excavation**	**Deep tube well Installation**	**Canal Excavation**	**Embankment Construction**	**Bridge/Culvert Construc-tion**	**Road Construction/ Carpeting**	**Community Clinic**	**Make house permanent**	**Bamboo ceiling in roof**	**Cold/temp-erature re-silient Crop cultivation**	**Homestead Plantation**
	Priority & Brief outline	Priority & Brief outline	Priority & Brief outline	Priority & Brief outline	Priority & Brief outline	Priority & Brief outline	Priority & Brief outline	Priority & Brief outline	Priority & Brief outline	Priority & Brief outline	Priority & Brief outline	Priority & Brief outline
Falaharia Muslim Para	Priority 3 50 ha. With spp like Jam, Horitoki, bohera etc	Priority 2 No. 3	Priority 1 2 no.	Priority 8 2 Km	Priority 10 Falaharia-Caragikhola: 2 km		Priority 6 Cons: 1 Kim, Carpet: 1.5 km	Priority 7 1 No.	Priority 9 No. 50	Priority 11 No. 50	Priority 4 Cold resilient potato, maize cultivation	Priority 5 50 seedlings
Falaharia Barua Para		Priority 2 No. 3	Priority 1 2 no.				Priority 5 Cons: 1 km, Carpet: 1.5 km	Priority 6 1 No.	Priority 8 No. 50	Priority 7 No. 40	Priority 3 Cold resilient potato, maize cultivation	Priority 4 50 seedlings
Sukhbilash	Priority 3 Alley croping: 1000 Seedlings	Priority 2 No. 2	Priority 1 No. 2	Priority 7 3 Km			Priority 5 Cons: 1 km, Carpet: 1.5 km	Priority 6 1 Nos	Priority 10 No. 25	Priority 9 No. 20	Priority 4 Cold resilient potato, maize cultivation	Priority 8 25 seedlings
Jilani Para	Priority 6 Alley cropping: 500 Seedlings	Priority 2 No. 1	Priority 1 No. 2				Priority 3 1.5 km	Priority 4 1 Nos		Priority 8 No. 30	Priority 5 Cold resilient potato, maize cultivation	Priority 7 30 seedlings

Shukbilash Beat												
	Water Supply					Public infrastructure (transport, health)			Private adaptation			
Village name	**Social & Agro-forestry**	**Pond Excavation**	**Deep tube well Installation**	**Canal Excavation**	**Embankment Construction**	**Bridge/Culvert Construc-tion**	**Road Construction/ Carpeting**	**Community Clinic**	**Make house permanent**	**Bamboo ceiling in roof**	**Cold/temp-erature re-silient Crop cultivation**	**Homestead Plantation**
Uttar Napit Pukuria	Priority 3 Alley cropping: 1000 Seedlings			Priority 2 1 Km				Priority 1 1 Nos		Priority 5 No. 20		Priority 1 30 seedlings
Caragi Khola	Priority 3 Alley cropping: 500 Seedlings				Priority 5 Falaharia-Caragikhola: 2 km			Priority 4 1 Nos		Priority 4 No. 25		Priority 2 30 seedlings
Rabindrapara	Priority 3 Alley cropping: 1000 Seedlings	Priority 2 No. 1	Priority 1 No. 2					Priority 4 1 Nos				Priority 5 30 Seedlings
Madham Napit Pukuria	Priority 6 Alley cropping: 2500 seedlings	Priority 2 No. 3	Priority 1 No. 3	Priority 5 1 km			Priority 3 Cons: 1 km, Carpet: 1 km	Priority 10 1 Nos	Priority 9 No. 25	Priority 8 No. 40	Priority 4 Cold resilient Crop	Priority 7 60 seedlings
Dhakkin Napit Pukuria		Priority 2 No. 3	Priority 1 No. 3	Priority 6 1 km		Priority 8 1 Nos	Priority 3 Cons: 2 km, Carpet: 2 km	Priority 5 1 Nos	Priority 10 No. 40	Priority 9 No. 35	Priority 7 Drought resistant Crop	
Intervention Objectives	To address heat wave	To arrange alternative water	To arrange alternative water	To facilitate drainage of excessive	To save homestead from	To facilitate drainage of	To address flood	To treat themselves diseases	To address Cyclone	To save from heat wave	To save crop in severe heat/ cold	To address heat wave

Shukbilash Beat												
	Water Supply					Public infrastructure (transport, health)			Private adaptation			
Village name	**Social & Agro-forestry**	**Pond Excavation**	**Deep tube well Installation**	**Canal Excavation**	**Embankment Construction**	**Bridge/Culvert Construc-tion**	**Road Construction/ Carpeting**	**Community Clinic**	**Make house permanent**	**Bamboo ceiling in roof**	**Cold/temp-erature re-silient Crop cultivation**	**Homestead Plantation**
		source during drought	source during drought	water during excessive rainfall	landslide caused by river	excessive water during excessive rainfall		arises from excessive cold and heat wave				
Scope:	NRM landscape plan	If public ponds (non private) community resilience	If public wells (non private) community resilience. BUT note same villages as ponds	As not aimed at habitat or direct NRM e.g. fisheries, depends on BWDB/LGED and absence of -ve impacts	Depends on BWDB/LGED and absence of -impacts	Roads and Highways or LGED	Roads and Highways or LGED	Health	Individual household investment	Individual household investment	Extension	Individual household investment