Integrated River Basin Management for Kholongchhu Sub-Basin

Trashi Yangtse

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Ministry of Agriculture and Forests
Royal Government of Bhutan

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ROYAL GOVERNMENT OF BHUTAN
Ministry of Agriculture & Forests
Tashichhodzong, Thimphu : Bhutan

MINISTER'S MESSAGE

Bhutan consists of a mosaic of watersheds that produce a regular supply of high quality water. The flow of 109,000 cumecs per capita per year is the highest in the region. In spite of this, there are reports of water shortages in some parts of the country. However, prior to 30-40 years ago, there were few reports of water shortages or water sources drying. This could be due to lower population and less water usage by communities at that time. As the country has undergone rapid development, the use of water has greatly increased and this trend is likely to continue in the future. Thanks to our visionary leaders, a series of Policies, Acts, Regulations and Rules have been put in place that aim to provide maximum protection of our environment while ensuring that the country will have adequate supplies of high quality water for both national and local development in the future.

In addition to water for drinking and irrigation, Bhutan has embarked on an ambitious programme to develop its hydropower resources to substantially increase revenue from hydropower generation. This is dependent on a sustainable supply of high quality water. Hence, efficient and effective management of the country's watersheds is critical to this national endeavour.

Despite substantial efforts to protect or restore the nation's watersheds, the health and quality of many watersheds continues to decline. Climate change and human activities have both caused detrimental effects resulting in a reduction in the provision of watershed goods and services. For example, physical alteration of the landscape, such as the removal of riparian vegetation, can have adverse effects on the quality and quantity of water.

The provision of watershed goods and services is a complex issue that cannot be dealt with by a single agency. We need to adopt an integrated management

approach that involves multiple agencies, and that particularly involves local stakeholders.

The Watershed Management Division (WMD) has delineated 186 watersheds within the five major and two minor river basins across the country and is systematically assessing them for status and condition. The Water Policy (2011) and the Water Regulation (2014) mandate the development of a River Basin Management Plan (RBMP) for each river basin. The WMD, with financial and technical support from the WWF Bhutan office, undertook to develop a RBMP for the Kholongchhu sub-basin as a pilot exercise. Lessons learned from this pilot exercise will provide guidance in developing future river basin management plans.

I am pleased that the WMD under the Department of Forest and Park Services has piloted the preparation of this RBMP for Bhutan. I would like to recommend that all the relevant agencies within the Ministry of Agriculture and Forests, and beyond, support implementation of the activities outlined in the plan, so that it will achieve its goal and objectives. Let me take this opportunity to particularly urge Kholongchhu Hydro Electricity Limited to support those activities related directly to restoration of degraded lands and sustainable land management in collaboration with the Trashi Yangtse Dzongkhag administration and other relevant agencies within the sub-basin. I am confident that this integrated and holistic plan will enhance the provision of watershed goods and services to benefit the people in the Kholongchhu sub-basin as well as downstream users into the future. Finally, I would like to express my appreciation to Watershed Management Division, the planning team and other stakeholders who were involved in developing this plan and I look forward to its successful implementation.

Yeshey Dorji
MINISTER

FOREWORD

The conservation, use and sustainable management of watersheds have been given high priorities for the country to meet the demand of the growing population and economic development.

Watershed management plan is an integrated approach in managing the land and its ecosystem resources through participatory processes where communities are involved in identifying the issues and problems. Through sustainable land management practices, carbon sequestration, conservation of biodiversity and landscape beauty are enhanced besides minimizing surface runoff and soil erosion. In addition, hydropower development is an acknowledged national priority. Therefore, watershed management plans are prepared to identify and address the degrading influences and attempt (to the greatest extent possible) to return the watersheds to a "normal" or "pristine" condition (FNC Rules 2017).

With the financial support from the WWF, Bhutan, an integrated river basin management plan (RBMP) for the Kholongchhu sub-basin was developed.

This sub-basin management plan identifies activities that each key stakeholder group will need to implement to contribute to the sustainable management of the sub-basin and ensure a supply of quality water to downstream communities including the hydropower. In developing the integrated plan, WMD focuses seriously in the stakeholder consultation at all levels from grassroots to Geog, Dzongkhag and National level. This was followed by field verification to validate perceptions of stakeholder groups. Further, the plan was extensively revised and improved during two write-shops by subject matter specialists and then supplemented by input from WMD staff.

In addition, two field reports were prepared and circulated to relevant stakeholders: (i) Result of Stakeholder consultations and Recommendations for IRBMP Plans, and (ii) River training in Bumdeling and degradation in the Buyangchhu Catchment in 2014.

I am grateful to the planning team of Watershed Management Division and WWF Bhutan for the financial support in developing the first River Basin Management Plan in the country. Finally, I would like to request all relevant agencies to fully support in the implementation of this plan.

Phuento Tshering
Director

ACKNOWLEDGEMENTS

This River Basin Management Plan (RBMP) for the Kholongchhu sub-basin is the outcome of a collaborative process that involved many stakeholders who contributed technical, administrative and logistic support over a long period of time. The process began by involving local leaders of Bumdeling, Yangtse, Tongmizhangsa and Khamdang geogs, RNR extension officers, dzongkhag administration, communities and other agencies working within the sub-basin. The outcome of the geog and dzongkhag level consultations was further discussed at the national level in Thimphu involving relevant ministries and other agencies. The stakeholder consultations also gave attention to the goals, objectives and structure of the Management Plan.

The initial draft of the RBMP was prepared by a consultant and was revised in two write shops attended by colleagues from WMD and subject matter specialists. It was further peer reviewed and edited by Dr. Don Gilmour, a senior Australian Volunteer attached to the Watershed Management Division.

The project was financially and technically supported by the Bhutan WWF office and this is gratefully acknowledged. Relevant financial agencies are also thanked for the timely release of funds which greatly assisted the planning team to carry out program activities in a timely manner.

Thanks are also due to Dr. Pema Gyamtsho, the former Agriculture Minister, Dasho Chencho Norbu, NEC Secretary and Mr. Karma Tshering, Director, Department of Hydro-met Services for their valuable suggestions and policy guidance.

The WMD would also like to thank all the agencies and individuals involved throughout the entire process of developing this River Basin Management Plan for the Kholongchu sub-basin, and in particular the MoAF and the DoPFS for their continuous support and guidance.

EXECUTIVE SUMMARY

The Manas River Basin comprises of four sub-basins (Mangdechhu, Chamkharchhu, Kurichhu and Drangmechhu) in the Central and Eastern parts of the country and Kholongchhuis a part of the Drangmechhu sub-basin. The Kholongchhu sub-basin has an area of 1,17,739 Ha which includes four geogs (Bumdeling, Yangtse, Khamdang and Tongmizhangsa). The main tributaries of the Kholongchhu are Langmalachhu, Womenangchhu and Dongdechhu. Kholongchhu joins the Gongrichhu and forms the Drangmechhu at Doksum. The sub-basin has a minimum elevation of 811m at Doksum and a maximum of 5460 m in the far north. The average rainfall is 850 mm at Doksum but rainfall reaches more than 3000 mm in the northern border areas. The sub-basin has a wide diversity of flora and fauna, including several endemic plant species and some endangered wildlife species which requires special attention for protection and conservation.

A sub-basin management plan for Kholongchhu is developed because of its long history of flash floods, debris flows and landslides that have caused the losses of agricultural lands, infrastructures and even threatened the lives of people and livestock. Several engineering mitigation measures were initiated by the government and various donor agencies in the past. The other reasons that led to the development of this management plan were (i) the construction of a 600 MW hydro-electric power plant and (ii) a desire to focus attention on the Bumdeling Ramsar site to preserve its integrity and minimise habitat loss and degradation. Collectively, these reasons provided an opportunity for both WWF and the WMD to think more deeply about what can be achieved through sub-basin planning.

Various stakeholder consultation meetings and workshops were conducted at local, dzongkhag and national levels followed by field evaluations and verification

throughout the preparation of this plan. The activities identified in this plan were based on the issues identified and prioritized during the consultations and field validation visits.

The core element of the management plan is the Logical Framework Analysis (LFA) matrix where activities and agencies responsible for their implementation are identified. The activities are designed to mitigate or remove the degrading influences and improve the condition of the sub-basin. The plan clearly specifies that the Dzongkhag Administration, in particularly the Dzongkhag Water Management Committee, is lead agency in coordinating and implementing the plan with technical assistance from relevant Departments and Ministries. The duration of the management plan is five years and will be revised if necessary. The verifiable indicators given in the Logical Framework Analysis Matrix will assist in the monitoring and evaluation tasks.

The Kholongchhu sub-basin management plan is not a single stand alone plan, but is the totality of the activities identified as being necessary to mitigate or remove degrading influences. These activities are to be incorporated into area based planning frameworks of Dzongkhag, geog, FMU, CFMG and Park's annual and Five Year Plan. This Kholongchu sub-basin management plan has been endorsed by the Technical Advisory Committee (TAC) of the Department of Forests and Park Services.

Disclaimer:

Although this Management Plan is titled an "Integrated River Basin Management Plan" it is not intended to be a River Basin Management Plan in the context of the Water Act (2011) and the Water Regulations of Bhutan (2014). River Basin Management Plans aim to enhance water resources and water security in river basins through improved planning and coordination (NEC 2016). Kholongchhu is a sub-basin of the Drangmechhu of the Manas River Basin and is contained within one dzongkhag. As such, the activities and outputs identified in this Management Plan were mostly aimed at addressing the detailed management needs of the Kholongchhu sub-basin to improve watershed conditions. Therefore, WMD would like to see this plan considered as a watershed management plan (in the context of the Water Act 2011 and the draft FNC Rules 2016) rather than a River Basin Management Plan *per se*. The focus of watershed management plans is on identifying degrading influences and developing interventions aimed at removing or mitigating them.

Acronyms and abbreviations

BTFEC	**– Bhutan Trust Fund for Environmental Conservation**
BWS	**–Bumdeling Wildlife Sanctuary**
CFO	**- Chief Forest Officer**
DAMC	**– Department of Agriculture & Marketing Cooperation**
DAO	**– Dzongkhag Agricultur Officer**
DWMC	**- Dzongkhag Water Management Committee**
DE	**– Dzongkhag Engineer**
DES	**– Department of Engineering Services (MoWHS)**
DFO	**- Divisional Forest Officer**
DGM	**- Department of Geology and Mines**
DHO	**– Dzongkhag Health Officer**
DLO	**– Dzongkhag Livestock Officer**
DoA	**– Department of Agriculture**
DoE	**- Department of Energy**
DoFPS	**- Department of Forest and Park Services**
DWMC	**- Dzongkhag Water Management Committee**
DzFO	**– Dzongkhag Forest Officer**
EIA	**- Environmental Impact Assessment**
EMC	**– Environmental Management Cell (KHEL)**
EMP	**– Environmental Management Plan (KHEL)**
FMU	**– Forest Management Unit**
FNC	**– Forest and Nature Conservation**
FYP	**– Five Year Plan**
GNHC	**- Gross National Happiness Commission**
Ha	**– Hectare**
HEL/P	**– Hydro-Electric Limited / Project**
HH	**- household**
HWC	**– Human Wildlife Conflict**
IRBMP	**- Integrated River Basin Management Plan (also for sub-Basins)**
KC	**– Kholongchhu**
KHEP/KHEL	**– Kholong Chhu Hydro-Electric Project/Limited KV**
LDOF	**– Landslide & Dammed Outburst Flood**
MBT	**– Main Boundary Thrust**
MCF	**- Main Central Thrust**
MEF	**– Minimum Environmental Flow**
MoAF	**– Ministry of Agriculture and Forestry**
MoEA	**– Ministry of Economic Affaire**
MoHCA	**– Ministry of Home & Culture Affaire**
MoWHS	**- Ministry of Works and Human Settlement**
NIWRP	**- National Integrated Water Resources Management Plan**
Nu	**- Ngultrum, the Bhutan currency, 1 Nu = 1 Indian Rupee**
PAF	**– Project Affected Families (KHEL)**
PES	**– Payment for Eco-Services**
RBC	**– River (sub-) Basin Committee**
RGoB	**– Royal Government of Bhutan**
RNR	**- Renewable Natural Resources**
RSPN	**- Royal Society for Protection of Nature**
TY	**– Trashi Yangtse**
WA	**– Water Act (2011)**
WMD	**- Watershed Management Division**
WP	**– Water Policy (2003)**
WR	**– Water Regulations of Bhutan (2014)**
WRM	**– Water Resources Management**
WUA	**- Water Users Association**

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1. Introduction

The Integrated River Basin Management Plan (IRBMP) was prepared for the Kholongchhu sub-basin of the Manas River Basin (Figure 1). The Manas River Basin comprises four sub-basins (Mangdechhu, Chamkharchhu, Kurichhu and Drangmechhu) in the Central and Eastern parts of the country. The Kholongchhu watershed constitutes part of the Drangmechhu sub-basin. For the purpose of this management plan, Kholongchhu is considered to be a sub-basin in its own right (Figure 1).

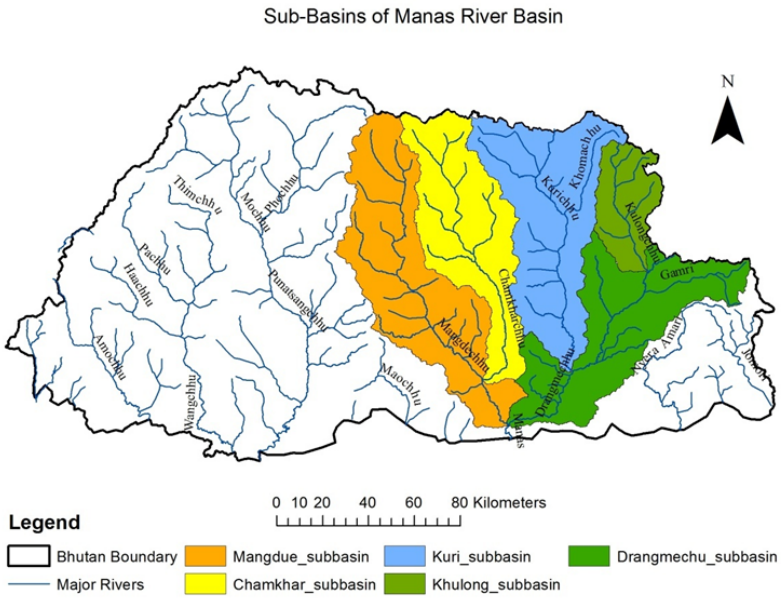

Figure 1. Map of Manas River Basin showing Kholongchhu sub-basin as part of larger basin

1.1 Rationale for selecting Kholongchhu sub-basin for integrated river basin planning

A summary of the policy settings for watershed management in Bhutan is given in Annex 1. According to the Water Act of Bhutan 2011 and the Water Regulation of Bhutan 2014, the National Environment Commission (NEC), with the assistance of relevant River Basin Committees (RBCs), has the mandate to prepare River Basin Management Plans (RBMPs) for each river basin in the country. However, RBCs have not been established in most river basins, and capacity to carry out river basin planning is limited at all levels. The Watershed Management Division (WMD) of the Department of Forests and Park Services

(DoFPS) has a mandate under the Water Act and the Water Regulations to develop and implement watershed and wetland management plans.

In accordance with the FNC Rules (2016) a watershed management plan is required to be developed if a watershed is classified as "critical" following the application of the watershed classification guidelines in WMD (2010) or as "degraded" or "critical" following the application of the revised guidelines in WMD (2016). The purpose of such watershed management plans is to address the degrading influences and attempt (to the greatest extent possible) to return the watersheds to a "normal" or "pristine" condition (FNC Rules 2016).

The Kholongchhu sub-basin was not identified as being a "degraded" or "critical" watershed. However, other factors led to a decision to prepare an Integrated River Basin Management Plan (IRBMP) for the sub-basin. There were two major factors behind this decision: (i) a long history of floods, flash floods and debris flows causing damage to agricultural land and infrastructure in Bumdeling geog, and (ii) work has commenced to construct a hydro-electric dam and a power generating station (to generate 600 MW) on the Kholongchhu in Khamdang and Tongmizhangsa geogs. Subsequently, WWF provided funds to support the development of a comprehensive and holistic river basin management plan for the Kholongchhu sub-basin. In addition, the Ramsar site in Bumdeling geog was considered to require focused attention in order to retain its integrity and prevent habitat loss and degradation. It was decided to incorporate activities from the Ramsar plan into the Kholongchhu sub-basin plan to the extent that they contribute to the objectives of the sub-basin plan.

There is a lack of clarity about the distinction between River Basin Management Plans (which are part of the mandate of the NEC) and watershed management plans (which are part of the mandate of the WMD under the DoFPS). The development of this management plan was seen as an opportunity to pilot the development of River Basin Management Planning and use this as a learning exercise to guide future river basin and watershed management planning.

2. Kholongchhu Sub-Basin

2.1 Geographic and administrative description

The Kholongchhu sub-basin comprises an area of 1,17,739 ha and includes four geogs (Bumdeling, Yangtse, Khamdang and Tongmizhangsa) within its boundary. It starts from the northern border of the country with Bumdeling geog and flows down to Doksum, where it joins the Gongrichhu to form the Drangmechhu. In the north, the sub-basin borders the Tibetan Autonomous Province of China; in the east the Tawang area of Arunachal Pradesh, India; in the south-east the Toedtsho catchment and Geog; in the-west the Kurichhu basin in Lhuentse and the Sherichhu sub-basin in Mongar (Figure2). In the south-west the border follows the ridge from Thrumbrang ridge to the confluence at Doksum.

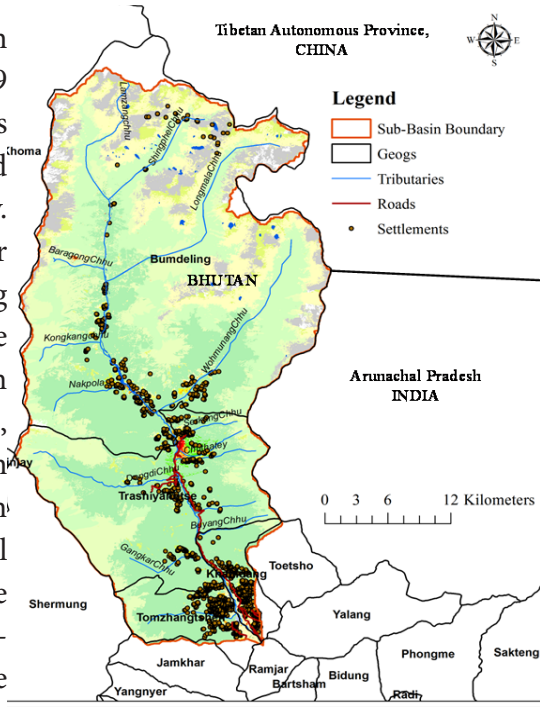

Figure 2. Administrative boundaries and settlements

Annex 2 shows additional information on the location of gonpas, roads, sub-watershed boundaries and villages.

2.2 Land management arrangements and area-based management plans

More than half (85,125 ha) of the sub-basin is managed by the Bumdeling Wildlife Sanctuary for which a Conservation Management Plan was approved in 2013. Several community forests have been established, all of which operate under Community Forest Management Plans. A Forest Management Unit under the control of the DFO is operational in the south of the sub-basin, and operates under a CFU management plan. A management plan is in preparation for the Bumdeling Ramsar site in Bumdeling geog. Figure 3 shows the boundaries of these various land management units within the Kholongchhu sub-basin.

2.3 Bio-physical features

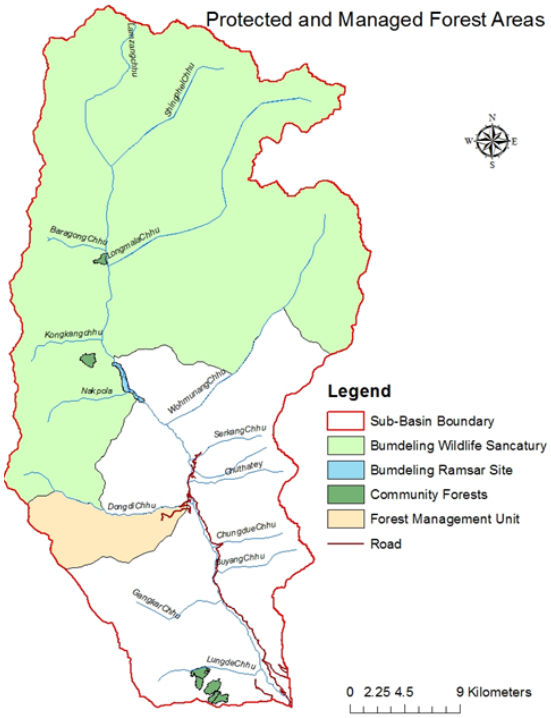

Figure 3. Parts of the Kholongchhu sub-basin covered by area-based management plans (CFs, wetland etc)

2.3.1 Geomorphology

The Kholongchhu sub-basin is characterized by steep slopes with limited river valley flat lands (Figure 4). The minimum elevation is 811 m.a.s.l. at Doksum and the maximum of 5460 m.a.s.l. is in the far north. In the north, there are snow covered mountains and relatively flat plateaus formed by glacial erosion and dotted with several glacial lakes. Scree slopes and rock outcrops including cliffs are also common in this area.

Debris flows and landslides are common natural hazards and play an on-going and major role in landscape forming processes along the Kholongchhu. The frequent debris flows tend to occur in the tributaries of the Kholongchhu that have deeply eroded valleys (see Figure 15 for a debris flow risk map). Erosion processes such as soil creep, rill and gully erosion and landslides continuously deposit eroded materials in the valleys. Rivers wash the debris further downstream, eventually draining it into the Drangmechhu. Debris ar deposited along the Bumdeling reach due to its relatively low gradient, thus increasing the amount of bed load in the streams in this area.

The survey conducted in 2014 on debris flows along the Kholongchhu sub-basin during the planning process, indicated an increased occurrence of debris flows since 2011(Van der poel and WMD 2014b). Extensive damage was observed along the Kholongchhu and its tributaries (between Ngalimang and Lao - the confluence of the Langzamchhu and the Shingphelchhu), including loss of trees and other riverine vegetation.

2.3.2 Geology

The main rock types in the Kholongchhu sub-basin are granites, granitic gneisses and biotite gneiss of the Sumar formation, constituting a part of the Thimphu formation. The Sumar formation is described as a two-mica granite gneiss dominated assemblage with medium to high grade schist often containing granite. The KHEP DPR report (2012) mentions minor thrust zones east of Trashi Yangtse (old Dzong and NE of Trashi Yangtse town). The main thrust zones, linked to larger earthquakes, are the Main Central Thrust (MCT) at 25 km SE of Trashi Yangtse and the Main Boundary Thrust (MBT) at 55 km south of Doksum.

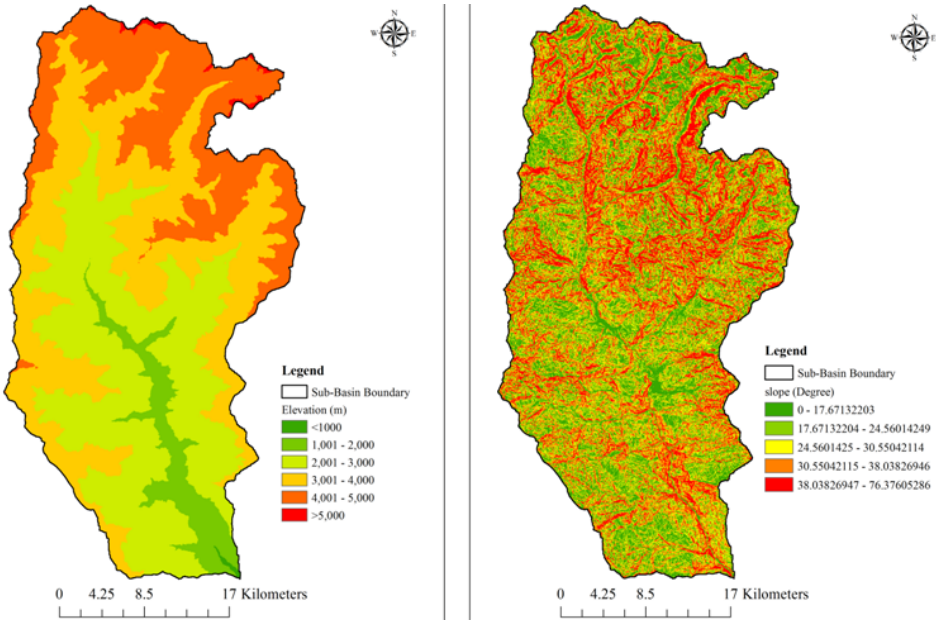

Figure 4. Terrain conditions; left: elevation range (m) and right: slope (degrees)

2.3.3 Climate

The climate in the Kholongchhu sub-basin ranges from sub-tropical at the confluence with the Drangmechhu at Doksum to alpine in the north. The temperature and rainfall profile in Trashi Yangtse town and monthly average temperatures in the central part of the sub-basin vary from 20°C in summer to 10°C in winter (Figure 5).

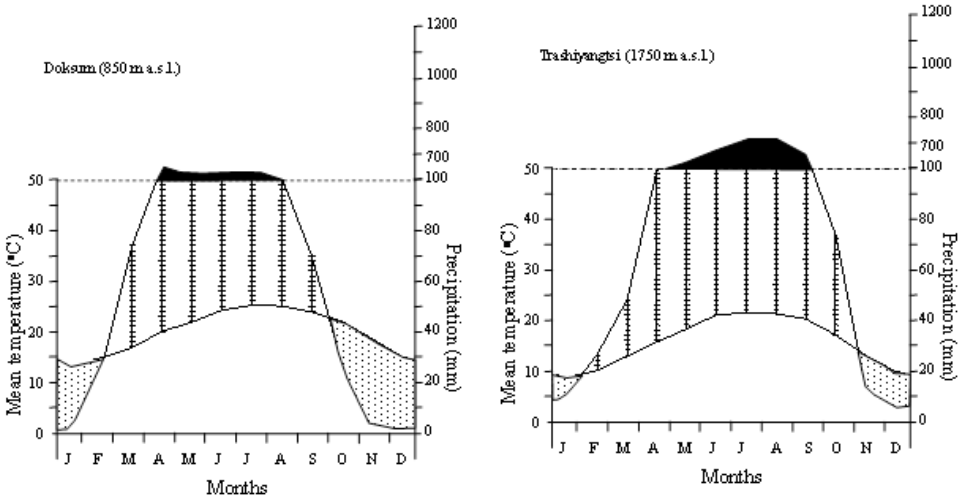

Figure 5. Walter climate diagram for Doksum (830 m a.s.l.) and Trashiyangtsi (1750 m a.s.l.). Data period: Trashiyangtsi (1985-2009) and Doksum (2000-2003, 2005, 2006)

Doksum (830 m.a.s.l) in the lower Kholongchhu sub-basin receives an annual rainfall of about850 mm resulting in relativelydry conditions with the vegetation mainly dominated by zeric elements (Pinusroxburghii andZyzyphus sp.). Trashi Yangtse (1750 m.a.s.l) receives an average of 1100 mm which marks a transition to humid broadleaved forest. Most of the rainfall occurs during the monsoon months of June to September.

The annual maximum daily rainfall at TashiYangtse increased by 10mm over 28 years, mainly influenced by extreme rainfall events in 2005 and 2008. Rainfallwas interpolated based on records from available metrological stations (shown in Figure 6) and indicates a much higher rainfall in the north than the south, possibly rising to 3000 mm or more.According to local perceptions and observations, winter snowfall has decreased in recent years. The locals also reported more erratic rainfall and hotter summers than in the past(van der Poel and WMD 2014a).

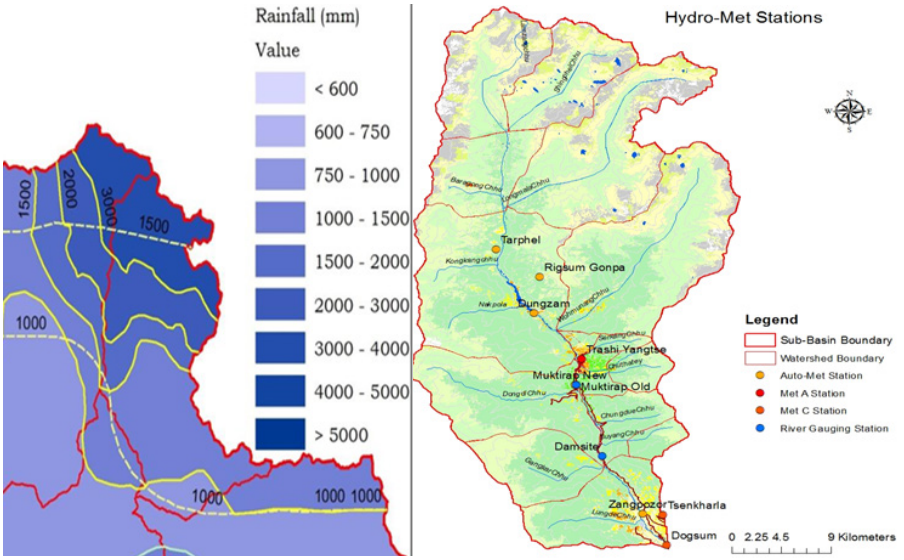

Figure 6. Interpolated rainfall distribution (left) and hydro-met stations (right)

2.3.4 Hydrology

The Kholongchhu originates in the high mountains about 5700 m.a.s.l., along the northern border of Trashi Yangtse. Several glaciers and numerous glacial lakes occur in these higher areas. KHEL (2012) reported more than 40 glacial lakes in the Kholongchhu sub-basin. The river commences at Lau (at the confluence of the Shingphelchhu and the Langzamchhu). The main tributaries of the Kholongchhu are the Langmalachhu, Womenangchhu and Dongdechhu. At Doksum, it joins the Gongrichhu and forms the Drangmechhu. The Bumdeling flood plain area in the middle reaches of the Kholongchhu is the largest wetland in the sub-basin and was declared a Ramsar site - a wetland of international importance in 2012. Table 1 and Figure 7 give relevant hydrological data for the sub-basin.

Factor	Trashi Yangtse stations	KHEL Dam site	Remarks (snow and ice for whole Kholongchhu sub-basin)
Area (km2)	865 / 905	1044	Kholongchhu: 1500km2
Snow and ice %	(13%)	1.5%	From Land Use map (2010) for Dzongkhag , adjusted to 1-2 %
Max. observed discharge (cumecs)	803	929	Daily values for Trashi Yangtse
Average discharge (cumecs)	67		Daily values for Trashi Yangtse

Min. observed discharge (cumecs)	9.25	10.3	Daily values for Trashi Yangtse
Probable maximum flood (cumecs)		8750	
Average annual yield (million m3)	2035	1621	Should be higher at Dam site, unless TY measurements wrong
Total annual run-off (mm)	2300	1581 (DPR); 2050	Based on TY and Muktirap stations, calculated run-off at the dam site is 2060mm. Measured run-off at Dam site over 5 years is 2050mm.

Table 1. Hydrological information for Kholongchhu sub-basin and KHEL watershed (DPR, 2012)

The average 10-day run-off for seven river gauging stations indicated that the Kholongchhu (at Trashi Yangtse station (1987-1998) and Muktirap station (2001-2011) and the Khomachhu (at Lhuntse station) had higher discharges than other rivers in the Bhutan Himalayas (Figure 7). The figure shows the differences in flow between the dry and rainy seasons, with two-thirds of the annual discharge occurring during the monsoon period of June to September.

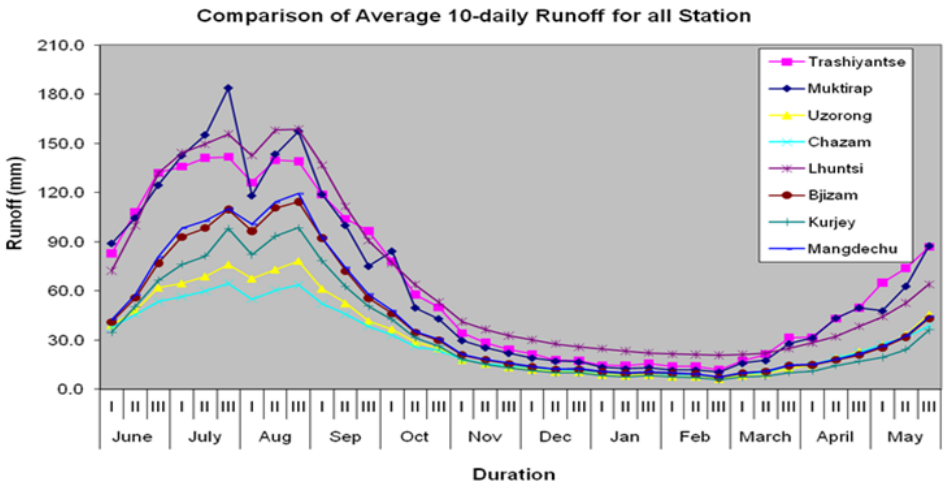

Figure 7. Average 10-day run-off for river gauging stations in Bhutan (KHEL 2012)

There are two incomplete data sets of long term annual runoff for Kholongchhu from 1987 to 2012. One set shows a slight decrease over time and one set shows a slight increase over time (Figure 8). It is not clear which of these data sets is the most reliable and whether the trends are part of normal variation, or are reflective of longer term changes associated with climate change.

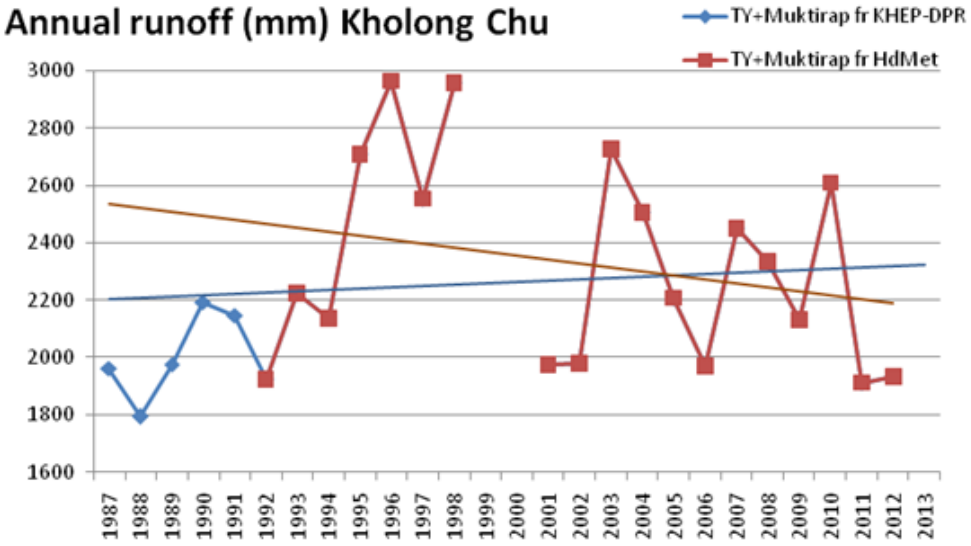

Figure 8. Annual runoff (mm) of Kholongchhu

2.3.5 Biodiversity

Detailed studies of biodiversity in the watershed have not been carried out, but information from different sources indicates that the sub-basin has a rich diversity of both flora and fauna. The wide range of environmental conditions, including elevation, high rainfall, mosaic of vegetation types and land use practices has created a wide range of habitats, supporting a rich biodiversity (Figures 9, 10 and 11). There are several endemic plant species, including *Bhutanthera albovirens, B. himalayana, Corallodiscus cooperi, C. oxalidifolia, Isodon atroruber, Pedicularis melalimne, P. jigmediana, Pomatocalpa bhutanicum, Rhododendron bhutanense, R. kesangiae, Saxifraga harry-smithii, Scrophularia subsessilis, Strobilanthes jennyae, Swertia crossoloma and S. grandiflora*. In addition, several endangered wildlife species, including the snow leopard and tiger, have been reported from different forest types within the sub-basin. The national butterfly of Bhutan, the Mystical Bhutan Glory (*Bhutanitis ludlowi*) was rediscovered after 75 years (BWS, 2013) and it is seen on wing during the month of August. A list of endangered and threatened species of the Kholongchhu sub-basin is given in Annex 3 (taken from the BWS Management Plan 2013).

Figure 9. Vulnerable species: Black-necked Crane, Mystical Bhutan Glory and tiny tree frog

Figure 10. Endemic and new plant species: (left) Corallodiscus bhutanicus and (right) Roscoamegalantha

Figure 11. Flowering plants on the way to Rigsum Goemba

2.4 Socio-economic factors

2.4.1 Land use

The sub-basin has about 70% forest cover, with conifer and broadleaved forest covering about 50% each. The conifer forest is dominated by Fir (80%), while 20% is mixed conifer. The broad-leaved forest includes small areas of subalpine birch, maple and temperate oak forest at higher elevations. Small areas of agricultural land, covering less than 2% are found in the valleys and on the gentler slopes below 2500 m.a.s.l. The most extensive agricultural areas are in Khamdang and Tongmizhangsa (Figure 12 and Table 3).

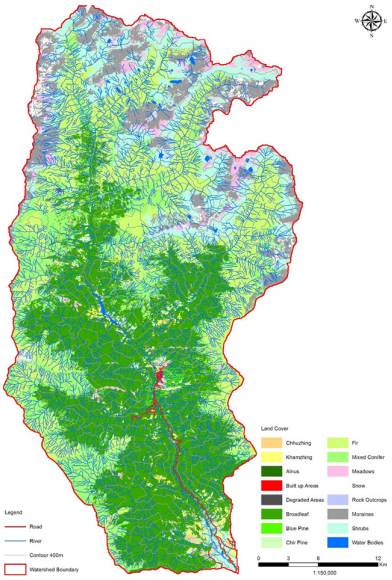

Figure 12. Vegetation cover map of Kholongchhu sub-basin

Table 3. Vegetation coverage and landuse in the four geogs in Kholongchhu sub-basin

Land cover class	Bumdeling (ha)	Yangtse (ha)	Khamdang (ha)	Tongmizhangsa (ha)	Total KC sub-basin	
					(ha)	%
Forest	514.8	259.0	27.6	50.7	852.1	69.0
Shrubs	149.7	4.0	11.5	9.7	174.9	14.2
Meadows	15.2	2.8	0.17	0.19	18.36	6*
Snow & ice	164.6				164.6	2*
Agriculture	3.98	5.19	5.93	3.50	18.6	1.5
Water	4.33	0.35	0.52	0.51	5.71	0.5
Degraded & bare (rocks and scree)	0.85		0.07	0.30	1.22	7*
Total area (km2)	853.46	271.34	45.79	64.9	1235.49	`
%	69.1	22.0	3.7	5.3		100

** Figures adjusted from original RNR data Based on RNR (2012) with adjusted percentages of snow and ice, meadows and degraded and bare land*

2.4.2 Agriculture and livestock

Agricultural activities occur mainly below 2500 m.a.s.l. with dry land farming the dominant form (maize, potatoes and millet). The main cash crops are potatoes and chillies. However, mixed farming systems are also practiced in the lower valleys, characterized by wetland rice farming and other cash crops.

The survey of cattle population indicated that overall livestock numbers have been decreasing in recent years (Figure 13). Cattle numbers have decreased by 25-30% in the last 20 years (Group interview and livestock census 2014). However, the numbers of improved cattle breeds have increased over the same time period (from 500 to 1500), while the number of local breeds have decreased (from 8500 to 5000). Thus, on average, 3.5 local cattle have been replaced by one improved breed, most of which are stall fed. This trend from open range grazing to stall feeding has reduced the grazing pressure on open pastures. It was noted that the high altitude pastures above Khamdang are now largely abandoned. This reduction in grazing may result in a reduction of biodiversity, because some aggressive grass species are dominating other species. In addition, the expansion of the road network has resulted in a decline in horse numbers (it was estimated that horse numbers may have declined from about 1000 to 500).

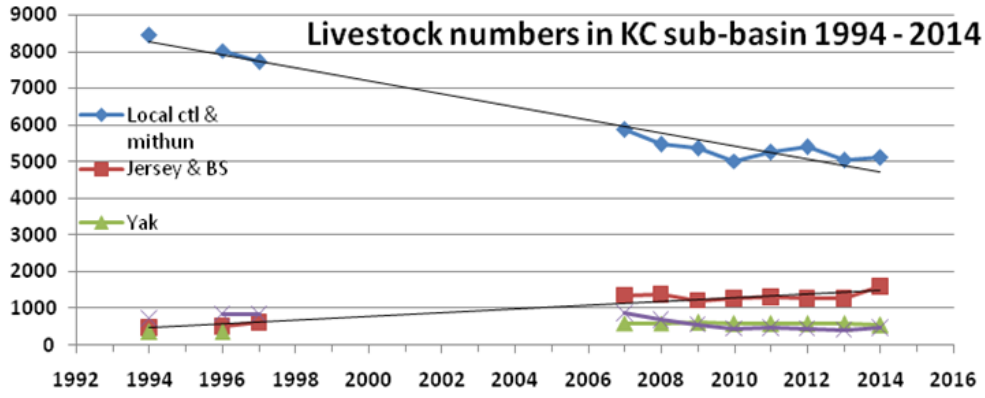

Figure 13. Trend in Livestock numbers in Kholongchhu sub-basin

In the alpine areas of Trashi Yangtse, a small number of yak herding families herd some 600 yaks in summer. In winter they migrate to lower elevation overlapping with winter grazing areas of villages causing increase in grazing pressure.

2.4.3 Population and households

The Kholongchhu sub-basin comprises four geogs of the Trashi Yangtse Dzongkhag, Bumdeling in the north, covering more than half the area of the sub-basin, Yangtse in the centre and Khamdang and Tongmizhangsa in the lower part of the sub-basin.

Khamdang has the highest population density but has the lowest area of agricultural land per household (Table 4). The number of people per household appears high in Tongmizhangsa and has the lowest mean annual income. In Bumdeling, some households in the upper reaches are involved in the collection and sale of *Ophiocordyceps sinensis*.

Based on the survey conducted during the course of this plan preparation (WMD 2014) rural-urban migration was reported to be a major issue throughout the sub-basin. Low income from agricultural activities, crop damage by wildlife, job opportunities elsewhere and increase in literacy rate were some of the reasons given for out-migration.

Table 4. Socio-economic information on Kholongchhu sub-basin

Factor	Bumdeling	Yangtse	Kham-dang	Tong-mizhangsa	Remarks
Area (km2)	851	268	44.5	84	
HHs	389	510	671	372	
Population	3581	4128	5059	3611	Source: estimates by Geog admin.
Population density (person/ km2)	4	15	114	43	
Persons/HH	9.2	8.1	7.5	9.7	calculated
Agriculture (ha)	398	519	593	350	Source: RNR-2012
Acres of land/ HH	2.6	2.6	2.2	2.4	calculated
Main crops	Rice, millet, potatoes, maize, chillies	Rice, maize, potatoes, chillies	Maize, rice, chillies, potatoes	Rice, maize, chillies, mandarins	Source: RNR-2012
% HHs with electricity	100%	98%	100%	99%	
% HHs with clean drinking water	100%	100%	100%	99%	SYB,'14: 96.4% has water supply, 85.6% functional pipe water

% HHs with toilets/latrines	84%	99%	100%	100%	
Mean annual income (Nu)	72,000	70,200	61,400	44,500	TY Dzongkhag: 83,700
Poverty % of HHs	13.2 – 20.9	13.2 – 20.9	12.1 – 13.1	12.1 – 13.1	Source: review mid-term FYP10. Web: 11.6 % for TY in 2012
No. lhakhangs	20	26	27	16	

(Source: 11th FYP (2013) and Statistical Yearbook of Bhutan (2014)

2.4.4 Infrastructure

Numerous institutions are present within the sub-basin including the Vocational Training Institute, Bumdeling Wildlife Sanctuary, Regional Seed Centre, RNR centers, health institutions (hospital, Basic Health Units and outreach clinics), community schools, primary schools, and middle secondary schools. A network of farm roads connects all villages within the sub-basin.

The offices of these institutions are located mainly in their respective geogs, while the Regional Seed Centre, the Vocational Training Institute and high school are located in Yangtse geog. The Bhutan Power Corporation, Bank of Bhutan, Royal Bhutan Army, Dratshang, and Bhutan Telecom are also present within the sub-basin. All of these institutions depend on resources from the sub-basin, particularly water. KHEL will be constructing houses, roads, bridges, offices and residents in the lower part of the sub-basin. The planned KHEL dam will be located downstream of the sub-basin.

3. Issues Impacting on Watershed Services

During the course of data collection for the preparation of this plan, three consultative meetings were held with stakeholders at geog, Dzongkhag and national levels. These meetings were used to identify the key issues in the watershed that were impacting on the delivery of watershed services (or have the potential to cause major impacts). The information from the stakeholder consultations was supplemented and cross checked by focused field visits by staff of the Watershed Management Division, input from technical staff of Tashi Yangtse Dzongkhag and scrutiny of relevant literature. The key issues are discussed below and form the basis of designing interventions in the watershed management plan. Photographs in Annex 4 illustrate some of these issues.

3.1 Natural phenomena

3.1.1 Landslides and debris flows

The Bhutan seismic hazard risk map indicates that the Kholongchhu sub-basin is in the very high risk category for seismic activity (Figure 14).

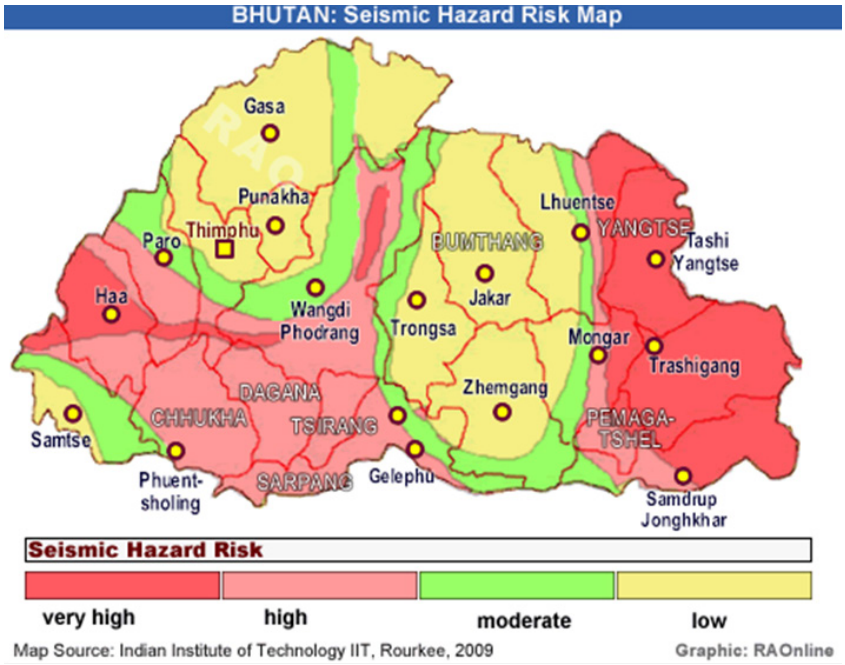

Figure 14. Seismic hazard risk map

In addition, most of the areas in the head waters of the sub-basin have very steep slopes and steep stream gradients.

As a result of combination of many factors, landslides, debris flows and other types of mass movement are common occurrences. These events are exacerbated by land use practices and infrastructure development (such as poorly planned and constructed farm roads, irrigation channels and power transmission lines). These events are most frequent in the headwater areas falling within Bumdeling geog. This area tends to experience much higher rainfall totals than other areas in the sub-basin. The tributaries of the Kholongchhu, particularly the Nagpolachhu, have also experienced erosion of cultivable agricultural lands and destruction of infrastructure including bridges, farm roads and irrigation channels (Van der Poel and WMD 2014a).

The northern part of Tashi Yangtse tend to be more prone to landslides and debris flows than the southern areas, predominantly in the east-flowing valleys between Dungzam and Lao (at the confluence of the Langzamchhu and Shingphelchhu) (Figure15). While most landslides are natural phenomena, there could be some human influence. The landslide in the Baragang area in 2002 was clearly a natural event caused due to heavy rainfall, steep stream gradients and the presence of unconsolidated deeply weathered sandy soils with some thin clay layers, combined with a static load of a dense stand of trees (Dorji 2004). In this instance there were no visible signs of human influence. However, influence of human activities in the sub-basin area cannot be ignored as there was some indications that poorly planned and constructed farm roads and the removal of protective vegetation may have increased the occurrence of landslides.

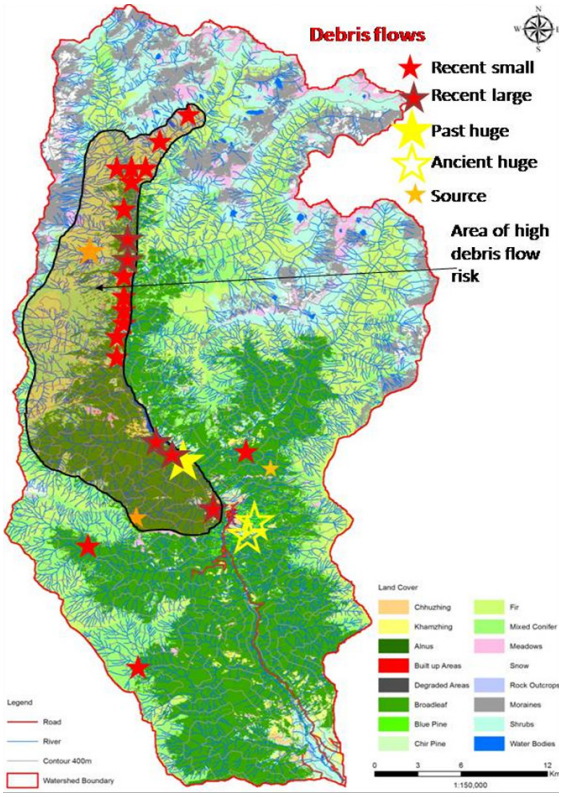

Figure 15. Past occurrence of debris flows in Kholongchhu sub-basin.

In most cases, the occurrence of debris flows is directly proportional to the intensity of precipitation and the steepness of the terrain. There are no hydro meteorological stations in the upper areas of the sub-basin, but rainfall records from the downstream areas of Trashi Yangtse and Tsenkharla were considered. The data from these two stations over a 25 year period indicated maximum daily rainfall totals of 82 and 80 mm respectively. Local people report that rainfall in the northern areas of Trashi Yangtse is very high, possibly three times higher than in Trashi Yangtse town. These northern areas are where debris flows are frequent occurrences.

3.1.2 Glacial Lake Outburst Floods (GLOFs)

Several studies have been conducted to assess the risk of glacial lake outburst floods (GLOFs) in Bhutan. A collaborative study carried out by ICIMOD and DGM in 2001 identified 2674 glacial lakes in Bhutan of which 24 were assessed to be potentially dangerous for GLOFs (Mool et al.2001). However, the report indicated a low level of risk in the Kholongchhu sub-basin. A separate report by KHEL (2012) also concluded that hazardous GLOFs are highly unlikely to occur in the Kholongchhu sub-basin.

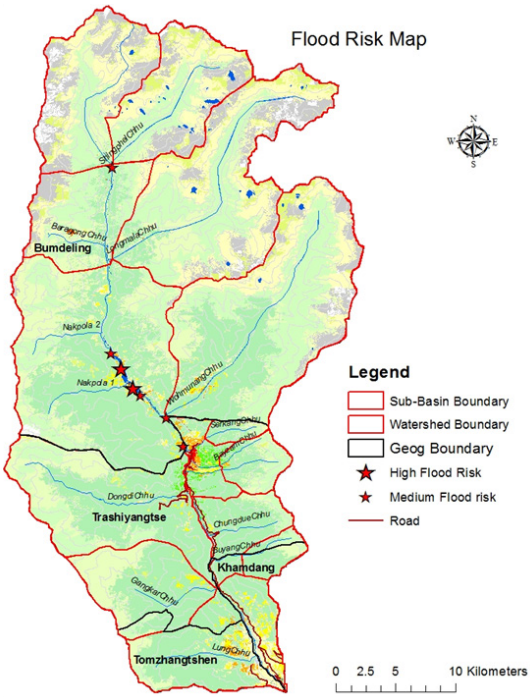

Figure 16. Flood risk map of the Kholongchhu sub-basin

3.1.3 Floods and flash floods

As noted previously, the northern parts of the Kholongchhu sub-basin are reported to experience very high rainfall, with the result that high river flows and major flooding are common occurrences during the monsoon (UNDMT 2005). In the last two decades flash floods and debris flows have claimed several lives and caused loss of livestock. The floods also destroyed several bridges, gabion walls, a river gauging station and eroded about 180 acres of paddy fields, depriving some households of their source of income. A flash flood in 2004 took toll on both life and infrastructure along the course of the

river. It was primarily a natural event caused by high rainfall, but was exacerbated by landslides and debris flows that blocked the main river, causing temporary ponds and lakes to develop, and when the blockages burst, the resulting flash flood increased river levels and consequent damage. These Landslide and Dammed Outburst Floods (LDOF) are frequent and destructive events (Van der Poel and Tshering 2002). The occurrence of such events can increase if an earthquake coincides with heavy rainfall in the area, as earthquakes often trigger landslides. Figure 16 shows a flood risk map of the Kholongchhu sub-basin.

The flood plain of Bumdeling had been particularly affected by flash floods and consequent erosion (Figure 17) and there are strong possibilities of repeat events in the future. This could cause substantial damage to prime agricultural land in Nelepang chewog. Flood damage between Lao and Zhapang mainly concerns the riverine vegetation and the trail that runs along the river. The Chorten Kora area also has a small risk of damage from flash floods.

Figure 17. Erosion and landslides: Effected paddy field at Bumdeling (left) and the Baragang land slip in 2002 (right)

A resident looks at the debris that the swollen river brought downstream

Figure 18. Sand layer deposited on paddy fields in Ramsar site in Bumdeling

3.2. Land-use issues

Table 5 is a prioritised list of the land use and livelihood problems/issues identified by local stakeholders in the sub-basin. The presence of fallow lands throughout the sub-basin, and the consequent loss in agricultural productivity, is one of the key issues identified during the consultations (both at local and national levels). This was directly linked to human-wildlife conflict leading to out-migration and land abandonment, although broader socio-economic issues could be contributory. Human-wildlife conflict was ranked as the most important issue within the sub-basin. Consultations with the local people indicated that the increase in fallow lands, and their subsequent colonisation by shrubby vegetation, has improved the habitat for wild animals. Wild boar and Assamese macaques are the major animals causing crop depredation closely followed by sambar deer and porcupine.

The flood events from 1989 to 2005, and consequent changes in the river morphology, have damaged paddy fields in the floodplains of Bumdeling geog. A total area of 180 acres of paddy field has been damaged and almost 1 m depth of sand has been deposited. Apart from the direct impact on the livelihood of the local communities, it has also reduced the feeding ground of the vulnerable black-necked cranes. The Bumdeling paddy fields were one of the main feeding areas of the cranes and are very close to their roosting area. The local community has tried to reclaim the paddy fields but without success. The Bumdeling community believes that the recent floods are a result of them having discontinued the age old traditional ceremony to appease the mountain deities.

In their winter grazing areas between Lao and Tarphel, yak herders are in the habit of cutting trees right at the bank of the river and this may lead to an increase in the incidence of shallow landslides.

Table 5. Main land use and livelihood issues / problems according to local stakeholders in the Kholongchhu sub-basin

Rank	Problem	Score[1]	Geogs*
Main problems			
1	Crop damage by wildlife	50.5	T-Y-B-K
2	Insufficient drinking water (sources/lake drying, pipe bursting)	36.5	K-Y-T
3	Loss of irrigation water, no/poor channel	17	Y-K-T
4	River floods, loss of agricultural land	15	B
5	Urban migration	14	K-B-T
6	Pests and diseases for crops	14	T-K-B
7	No market for agric. products (vegetables)	12	B-T
8	Poor water quality (summer)→ diarrhoea		K-Y, BHU, Hosp
9	Bad farm road construction		Y-B
10	Waste		Y-B
11	Overgrazing		B, BWS
Minor problems			
	Livestock depredation		B-K-T
	Insufficient fodder/unprotected improved pasture		K-Y
	Pressure on Gov Res Forest (due to young CF's)		T
	Lack of timber		K
	Insufficient development activities (budget)		T
	Insufficient burrs (for dapa) in forest		Y
	Town extension (taxes)		Y
	Insufficient health staff		T-B
	Group formation difficult		B
Problems indicated by other stakeholders			
	Poaching		all?, BWS
	Lack of sand and rock quarries		Y-K-T, KHEP

** B=Bumdeling Y=Yangtse, K=Khamdang, T=Tomizhangsa*

[1]Score indicates the relative importance of each issue as assessed by key stakeholders at geog level (geog administration and RNR extension staff). The scores were weighted so that the ratings by the geog administration carried twice the weight of ratings by RNR extension staff.

3.3 Infrastructure issues

3.3.1 Roads

Many new farm roads in the sub-basin have been poorly constructed and maintained. They lack proper alignment according to gradient of the slope, and cross drainage is generally lacking (Figure 19). In general, runoff and erosion control measures are absent. Undercutting steep slopes during road construction has led to an increase in landslips and the depositing of eroded materials into stream beds. This inevitably leads to an increase in sediments loads in streams and rivers.

Figure 19. Poor road drainage on a farm roads

3.3.2 Irrigation

Paddy cultivation is common throughout all four of the geogs in the sub-basin. In several places the irrigation channels are of earth construction and are prone to water seepage as a result of which erosion and gully formation are common. Earthen channels are prone to leakage along their length and this water loss contributes to a reduction in the amount of water available for irrigation. In Khamdang geog, an irrigation channel was constructed using concrete. However, the drinking water pipe was positioned above the channel and burst in 2004 as a result of which the irrigation channel was washed away. This forced people to shift from paddy to maize cultivation. The issue also forced some people to look for alternative livelihood options leaving their lands fallow.

3.3.3 Drinking water

The drinking water supply in all geogs in the sub-basin is tapped from small streams with distances from source to delivery point ranging from 1 to 10 km (Figure 20). The water communities reported that there are issues related to both water quality and quantity especially during the monsoon. This was attributed to poor water tapping infrastructure. One such example was in Khamdang geog, where low pressure PVC pipes were used which developed leaks and which had triggered rill and gully erosion. The consultation with communities suggested that poor water infrastructure was the major factor causing insufficient supply of water for the people in the sub-basin.

In Trashi Yangtse town, domestic water is provided via a filtration tank, but the system is very old and often breaks down leading to the delivery of untreated water to residents. The other three geogs in the sub-basin do not have water treatment plants so the water delivered to residents is untreated. Gastro-intestinal diseases are reported by medical staff at the hospital to be common, particularly during the monsoon season.

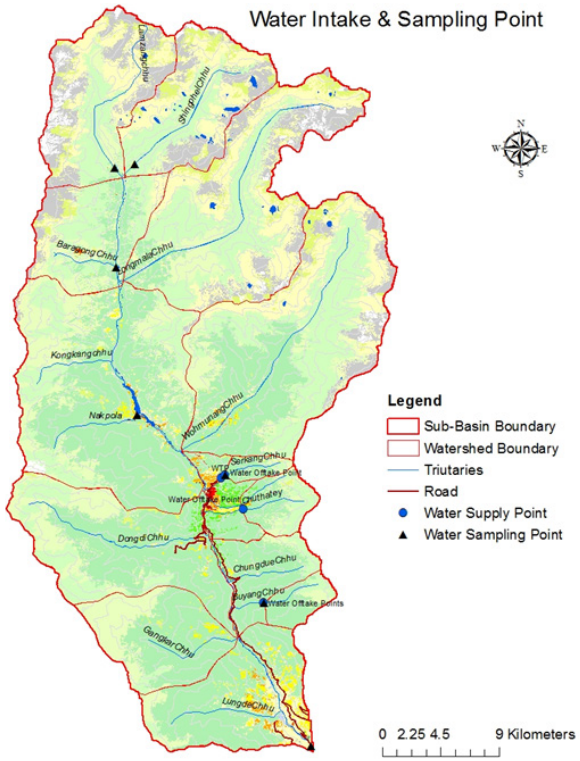

Figure 20. Drinking water intake and water sampling point

3.3.4 KHEL activities

KHEL commenced construction during 2015 and activities will continue for several years. The dam site is in Yangtse geog but construction activities will also directly affect Khamdang and Tomizhangsa geogs. There is likely to be major disruption of watershed functions locally during the period of construction.

It is expected that a workforce of 5000 to 7000 will be engaged for the project and the influx of such a large number of people will place additional pressure on the natural resource base. They will also provide a market for local agricultural produce and job opportunities for local people.

3.4 Biodiversity conservation

Figure 21 Alnus regenerating in the flood plain area of Bumdeling Ramsar site

3.4.1 Ramsar site

The change in river morphology in Bumdeling geog, mentioned in Section 3.2, has not only destroyed a substantial area of paddy fields (with a consequent reduction in the feeding area available for black necked cranes) but has also reduced the crane's roosting area. The park management has diverted the river to provide an island for the cranes to roost, away from predators especially from leopards. The roosting area is as important as the feeding area for a viable population of black-necked cranes in the site. Grass and *Alnus* regeneration has developed on some parts of the 180 acres of sand-covered previous paddy land, and this provides an ideal location for people to come for picnics (Figure 21). The picknickers not only disturb the cranes but also litter the site with garbage.

3.5 Summary of key issues impacting on watershed services

Table 6 gives a summary of the key issues that do, or have the potential to, impact adversely on the provision of watershed goods and services, along with their geographic occurrence, across the sub-basin. An indication is also given of the likelihood of management interventions to address the issues.

Table 6. Summary of issues relevant to watershed management in the KC sub-basin and their geographic distribution within the sub-basin

Issue	Geographic occurrence	Likelihood of management intervention to address issue
Natural phenomena		
Landslides and debris flows	Mainly in Bumdeling geog	Limited options to prevent, but awareness raising could help prepare residents. Expert study warranted.
Glacial lake outburst floods	None in recent history	None needed
Floods and flash floods	Mainly in Bumdeling geog	Limited options to prevent floods, but awareness raising could help prepare residents. Expert study on river morphology and river training works warranted, building on consultant's report of May 2014.
Loss of agricultural land due to flooding	Mainly in Bumdeling geog	Limited options are available to reclaim lost agricultural land. A socio-economic study on the impacts of the loss of agricultural land on the affected farmers could be of value. In addition, it could be of value to explore alternative livelihood options for the affected farmers.
Land use issues (major issues only)		
Crop damage by wildlife	All four geogs	Interventions limited to provision of electric fencing, which is only effective for wild boar.
Insufficient drinking water (sources/lake drying, pipe bursting)	Mainly Khamdang geog	Improvements to drinking water infrastructure feasible. Limited options to address lake drying. Could conduct feasibility study on reviving the lake to restore downstream springs.
Loss of irrigation water, no/poor channel	All four geogs	Improvements to irrigation channels feasible, but costly.
River floods, loss of agricultural land	Mainly Bumdeling geog in the Ramsar area.	Options exist to construct gabion walls to protect high value agricultural land (see consultant's report of May 2014).
Urban migration	All four geogs	Limited options to address because of macro-economic drivers.
Pests and diseases for crops	All four geogs	Agricultural extension officers can advise and support.

No market for agric. products (vegetables)	All four geogs	Agricultural extension officers can advise and support. Possibilities exist to link to KHEL and other institutions to provide agric. products. Formation of farmers groups could assist marketing.
Poor water quality (summer)→ diarrhoea	All four geogs.	Improvements to drinking water infrastructure feasible.
Bad farm road construction	Mainly Bumdeling, but some parts of Yangtse and Tomizhangsa geogs.	Options exist to improve planning, construction and maintenance of farm roads, particularly to improve road alignment and drainage.
Solid waste management	All four geogs.	Waste management booklet prepared. Advocacy needed.
Overgrazing	Only Bumdeling.	Study completed, and concluded that overgrazing not a major problem for watershed values. Possibilities exist to improve pasture species in yak grazing areas.
Infrastructure issues		
Roads	Addressed under land use issues	Addressed under land use issues
Irrigation	Addressed under land use issues	Addressed under land use issues
Drinking water	Addressed under land use issues	Addressed under land use issues
Biodiversity issues		
Loss of habitat for vulnerable black neck crane	Bumdeling Ramsar site	The park management can help advocate on the importance of habitat conservation and waste management. Additionally proper signage and designating areas for recreation would be effective. It is also important to map the feeding and the roosting areas of the vulnerable black necked cranes, to develop appropriate strategies for habitat conservation.
Other biodiversity conservation issues		
Habitat damage for iconic species (tiger, snow leopard)	Throughout the sub-basin, but mainly in the northern regions.	Addressed in the BWS Management Plan

4. Policy Framework and Process for Watershed Management Planning

4.1 Policy framework

Protection and management of natural resources, water resources, river basins and watersheds is crucial for long term sustenance of natural resources, as enshrined in Article 5.1 of the Constitution of the Kingdom of Bhutan. The Water Policy (WP 2003), Water Act (WA 2011) and Water Regulation (WR 2014) largely set the framework for IRBM planning.

Forest Policy (2011) Forest and Nature Conservation Act (1995) Land Act (2007) Waste Management Act (2009) are among the most important policies and regulatory documents that influence the preparation of integrated watershed management plans in the country.

The pilot IRBMP of the Kholongchhu sub-basin follows the existing rules and guidelines as far as possible. Where contradictions are encountered, the most logical or practical options were selected. A review of the policy situation was presented in the stakeholder consultation meetings and the contents of the plan largely follow the recommendations of those meetings, within the overall framework of the Water Regulation (2014).

4.2 Planning Process

Planning for the KC Integrated River Basin Management was carried out in conformity with relevant national policies, acts and regulations. It is intended that the activities identified as being necessary to achieve the goals and objectives of the river basin plan will be reflected in the operational plans of the Dzongkhag, geogs and other agencies operating in the river basin.

For the preparation of the IRBMP, a Kholongchhu River Basin Committee (RBC) was formed, with members from the local government, water users and the KHEL project. Members include the Dasho Dzongda as chairman, the Environment Officer as member secretary, DAO, DLO, DHO, DE, DzFO, DFO of the Territorial Division, Park Manager of the BWS, four Gups and one yak herder. Most of these members are engaged in Dzongkhag and geog level annual and 5-year planning. As per the Water Act and Regulation, the RBC should prepare the IRBMP. However, the members of the RBC lacked the technical capacity to prepare a detailed plan and recommended the relevant agency (the

WMD) to prepare the plan. In 2014, stakeholder meetings in Trashi Yangtse and Thimphu agreed on chapters and contents of the IRBMP. Several meetings and discussions were held to identify the issues and problems and discuss solutions (Figure 22).

4.2.1 Consultation meetings at the geog level

The planning process started with consultative meetings in all four geogs in the sub-basin. These were attended by all relevant stakeholders and community representatives. During the meetings, issues that impacted on the delivery of watershed goods and services were identified, using participatory methods, and prioritized.

4.2.2 Consultation meetings at Dzongkhag level

Meetings were also held with the Dzongkhag administration and other relevant stakeholders including geog representatives. The first Dzongkhag level meeting was held to sensitize stakeholders on the proposal to develop an IRBMP. The meeting discussed the issues and problems in the Kholongchhu sub-basin and jointly agreed on the need to address the issues through preparation of a sub-basin plan. Subsequent consultation meetings at the Dzongkhag level also endorsed the draft plan.

4.2.3 Consultation meetings at national level

Two consultation meetings were conducted at the national level, in 2014 and 2015. The findings from the Dzongkhag and geog level meetings were presented to seek suggestions and critical views from relevant national level stakeholders. Another round of national level stakeholder meetings was conducted in 2015 to discuss the draft structure of the plan with particular focus on the goals, objectives and content of the plan (Figure 22).

Figure 22. Consultation meetings: (A) National (B) Dzongkhag and (C) Geog level

4.2.4 Field verification

Figure 23. Field visit in Buyang watershed

The consultation meetings at geog level were followed by field visits and detailed assessment of the sub-basin to identify and validate the major issues. They included investigations of debris flows, landslides, flooding and grazing impact in the upper watershed (Field report 2014). A detailed study was also carried out on Buyang watershed as it is the main source of water for KHEL and the new township (Field report 2014) (Figure 23). The information in these reports has been incorporated into the IRBMP.

5. The Plan

5.1 Goal and objectives

The goal for managing the Kholongchhu sub-basin was arrived at in consultation with key stakeholders and aims to reflect the vision statement of the Bhutan Water Policy (WP, 2003) and related documents.

The overall goal for managing the Kholongchhu sub-basin is:

The Kholongchhu sub-basin actively managed to supply quality water, and other watershed goods and services to contribute to sustainable land management and sustainable rural livelihoods that are resilient to natural and anthropogenic shocks, including climate change.

The objectives set to attain the goal are:

1. Ensure a reliable supply of good quality water for household use.

2. Ensure the provision, as far as possible,[1] of a reliable supply of quality water to KC stakeholders for non-domestic use (in particular, irrigation and hydro power).

3. Sustainably manage other natural resources and development initiatives to improve rural livelihoods while protecting the environment and the social and cultural heritage of the basin.

4. Assess risks and make needed preparations to minimize the impact of natural disasters (such as debris flows, floods and earthquakes) and anthropogenic changes including climate change.

The issues that were identified during the planning process were used as the basis for designing interventions. These interventions are activities aimed at explicitly addressing the issues that impact adversely on the provision of watershed goods and services. Collectively, they should contribute to the attainment of the objectives and the long term goal. During various consultations and prioritising of issues within the sub-basin, Bumdeling geog was identified as the area facing most of the issues that impact on the delivery of watershed goods and services. The Bumdeling Ramsar site (declared in 2012) is also facing threatening influences in the habitat of the endangered black neck crane. Under the Ramsar Convention, the development of a management plan is required to manage the wetlands wisely. It was decided to integrate those outcomes and activities in the Ramsar plan, which will not be included in the Bumdeling Wildlife Sanctuary Management Plan, into the Kholongchhu IRBMP.

5.2 Outcomes and activities to achieve the goal and objectives

The outcomes and activities needed to achieve the objectives and move towards the goal are shown in Table 7 along with an indicative budget, the local level area-based plan where the activities occur and the person/official responsible for ensuring implementation takes place

Table 7. Kholongchhu IRBMP: Table of outcomes, activities and budget

Outcomes	Activities	Verifiable indicators	Responsible person for implementation	Local area based plan	Budget (M Nu)
Objective 1. Ensure a reliable supply of good quality water to KC stakeholders for household use.					
1.1 Water treatment plants to produce high quality drinking water in 4 geogs.	1.1.1 Repair 2 existing water tanks (Khamdang and Yangtse)	2 repaired water tank	Gup Khamdang and Yangtse geogs	Khamdang and Yangtse annual plan	0.04 0.04
	1.1.2 Build 2 new water reservoir tanks (Bumdeling and Tongmizhangsa	2 new water reservoir tanks	Gup Bumdeling and Tongmizhangsa geogs	Bumdeling and Tongmizhangsa annual plan	0.15 0.06
	1.1.3 Build 4 water treatment plants (one in each geog)	4 new water treatment plants	Gups of 4 geogs	Geog annual plan	0.24 0.03 0.09 0.49
1.2 Efficient and effective drinking water distribution system in place.	1.2.1 Replace damaged drinking water pipelines in Khamdang geog. (Durdur to Tshenkhala--10 km)	10 km of repaired drinking water pipe lines	Gup Khamdang	Geog annual plan	21.84
	1.2.2 Facilitate coordination between water users to combine budgets for Activity 1.2.3.	Report on results of coordination meeting	Dz admin	Dzongkhag and Geog annual plan	0
	1.2.3 Replace multiple low quality drinking water pipes with one high quality and high capacity pipe from water source to reservoir tank (14 km).	A 14 km long high quality drinking water pipe from water source to reservoir	Gup Khamdang and Dz engineer	Khamdang geog annual plan	0.44
	1.3.1 Monitor watershed condition	Monitoring reports in office of DFO, CFMG, BWS	DFO, CFMG and BWS	5-year and annual plans of FMU; GF outside FMU; CFMG and BWS	
	1.3.2 Ensure that buffer zone regulations are included in FMU management plans and adhered to.	FMU plans and field verification reports in DFO office	DFO	FMU management plan	

Objective 2. Ensure the provision, as far as possible, of a reliable supply of high quality water to KC stakeholders for non-domestic use (in particular, irrigation and hydro power).					
2.1 Stable irrigation channels with minimum transmission water losses in all 4 geogs.	2.1.1 Carry out maintenance of existing concrete irrigation channels: Maintenance of 15 km concrete channel from Buyang to lower Khamdang.	15 km of repaired concrete irrigation channel	Gup Khamdang geog and Dz engineer	Geog annual plan	15.19
	2.1.2 Construct 20 km of concrete irrigation channels: a) 11 km in Yangtse geog b) 2 km in Khamdang geog c) 7 km in Barchhu and Gongchhu chewogs	20 km of new irrigation channels	Yangtse, Khamdang and Tongmiizhangsa Gups and Dz engineer	Yangtse, Khamdang and Tongmizhangsa annual plans	11.14 2.03 7.09
	2.1.3 Facilitate the establishment of a Water Users Association in Khamdang geog to agree on water distribution.	Report of facilitation meeting; Water Users Association; meeting minute book	Dz agr extension officer, BHU and Khamdang geog admin	Khamdang geog annual plan	0
2.2 Watershed managed to minimise degrading influences.	2.2.1 Carry out drainage works on 101.5 km of existing farm roads: a) 28 km in Tongmizhangsa geog b) 15 km in Khamdang geog c) 33.5 km in Bumdeling geog d) 25 km in Yangtse geog	Drainage works on 101.5 km of existing farm roads	Dz engineer Gups of all 4 geogs	All 4 geog annual plans	2.19 1.17 2.78 1.96
	2.2.2 Ensure that new farm roads are planned and constructed with adequate attention to drainage.	Plans for new farm roads include adequate drainage provisions; New farm roads with adequate drainage; Monitoring reports of Dz engineer	Dz engineer and Gups of all 4 geogs	All 4 geog annual plans	0
	2.2.2 Ensure that new farm roads are planned and constructed with adequate attention to drainage.	Reports by Dz officials which assess potential watershed degradation associated with development activities	Dz administration and Geog	Dz 5 year and annual plans	
2.3 Alternate water sources identified for Khamdang geog.	2.3.1 Carry out a survey of alternate water sources for Khamdang geog (with emphasis on water quantity during low flow periods) and assess whether there is sufficient water for both Khamdang and Tatso geogs.	Survey report	Dz engineer and/ or WMD (or water resources engineer or consultant)	Dz, geog and WMD annual plans	

Objective 3. Sustainably manage other resources and developments to improve livelihoods while protecting the environment.					
3.1 Wildlife depredations of agricultural crops reduced.	3.1.1 Study water sources drying or fenced 3.1.2 Plantation of native fruits trees in the buffer areas 3.1.3 Establish native sp. nursery Provide electric fencing for high value agricultural lands.	report Area covered No of nursery Electric fencing	DFO Trashigong -do- -do- DoFPS (WCD)	All 4 geog annual plans	0.1 0.2 0.3 Dzongkhag Agriculture Sector
	3.1.2 Raise awareness of the existence of crop insurance scheme.	Residents of all 4 geogs aware of existence of crop insurance scheme	Gups of all 4 geogs	All 4 geog annual plans	
	3.1.3 Raise awareness about the human-wildlife endowment fund (for areas within the boundaries of BWC)	Residents of Bumdeling geog aware of the existence of human-wildlife endowment fund	WCD, DoFPS	WCD annual plan	
	3.1.4 Coordinate with agencies with expertise in human-wildlife conflict (particularly WCD, WMD and NPPC) to obtain advice to minimise wildlife crop depredations.	Report of coordination meetings	NPPC	NPPC annual plan	
3.2 Additional markets for agricultural products (particularly vegetables) identified and developed.	3.2.1 Identify crops suitable for marketing and identify potential markets, particularly existing institutions such as schools, hospitals, training institutes, etc.	List of suitable crops	Dz agricultural officer and geog agr extension officers	Dz 5 yr plans and all 4 geog annual plans	No separate budget
	3.2.2 Form farmers' groups to coordinate collection and distribution of crops to markets.	Farmers' groups	Dz agricultural officer and geog agr extension officers	Dz 5 yr plans and all 4 geog annual plans	No separate budget
	3.2.3 Explore post-harvest technology options to extend market period by low cost processing (such as storing, drying, etc.)	Report by Dz agricultural officer of post-harvest technology options	Dz agricultural officer and geog agr extension officers	Dz 5 yr plans and all 4 geog annual plans	No separate budget
	3.2.4 Link local farmers' groups to KHEL to expand the short-medium term market for local agricultural produce.	Farmers' groups in regular dialogue with KHEL	Dz agricultural officer and geog agr extension officers	Dz 5 yr plans and all 4 geog annual plans	No separate budget
3.3 Crop pests and diseases controlled.	3.3.1 Farmers request Dz agricultural officers and geog agricultural extension officers for assistance.	Record of Dz agricultural officer of farmers' request	Dz agricultural officer and geog agr extension officers	Dz 5 yr plans and all 4 geog annual plans	No separate budget

3.4 Grazing lands not degraded.	3.4.1 Continue support to improve quality of cattle (through AI and supply of improved bulls) to reduce animal numbers.	Record of DoL and Dz livestock officers of support provided	DoL; Dz and geog livestock officers	Dz 5 yr plans and all 4 geog annual plans	No separate budget
	3.4.2 Support pasture development to encourage stall feeding: a) provide improved pasture seeds b) provide barbed wire to control grazing c) lease barren government land to graziers for pasture development	Record of DoL and Dz livestock officers of support provided	DoL; Dz and geog livestock officers	Dz 5 yr plans and all 4 geog annual plans	No separate budget
3.5 Solid waste management system in place.	3.5 1 Continue awareness campaign (particularly mass media): a) emphasise clean tidy environment b) separate waste into degradable and non-degradable components	Record of awareness campaign (Dz admin)	Dz admin	Dz 5 yr plan	Dz. annual budget
	3.5.2 Carry out regular Dz "clean-up" days.	Record of Dz "clean-up" days (Dz admin)	Dz admin	Dz 5 year plan	
	3.5.3 Enforce national regulations on waste disposal	Record of fines / admonitions, etc. (Dz admin)	Dz admin	Dz 5 year plan	
3.6 Alternative livelihoods options explored for farmers affected by loss of agricultural land from flooding in Bumdeling geog	3.6.1 Carry out a socio-economic impact of the loss of agricultural lands on affected farmers	Report	BWS	BWS Management Plan	1.0
	3.6.2 Explore alternative livelihood options for farmers in Bumdeling geog who have lost agricultural land.	Report	BWS	BWS Management Plan	0.5

	3.7.1 Map the feeding and roosting area of black neck crane and demarcate core zone	Report	BWS	BWS management plan	0.1
	3.7.2 Designate camping and picnicking areas	Assessment report; Signage	BWS	BWS management plan	0.05
3.7 Ramsar site at Bumdeling managed to minimise threats to black neck crane and its habitat.	3.7.3 Establish patrolling system	Operating patrolling team; Reports	BWS (in collaboration with Wetlands Conservation Support Group, WCSG, and Bumdeling geog)	BWS management plan	0.05
	3.7.4 Establish a BNC information centre and a watch tower	Project completion report; information centre established; watch tower established	BWS (in collaboration with WCSG and Bumdeling geog)	BWS management plan	7.0
	3.7.5 Carry out advocacy programme on biodiversity conservation	Documentary produced; report showing number of organisations and people reached; establishment of a library in the information centre	BWS (in collaboration with WMD, WCD, ICS, UWICE and WCGS)	BWS management plan	3.0
Objective 4. Assess risks and make needed preparations to minimise the impact of natural disasters (such as debris flows, floods and earthquakes) and anthropogenic changes such as climate change					
4.1 Impact of natural disasters (particularly floods, flash floods, earthquakes and debris flows) minimised. [Mainly affects Ramsar site and adjacent areas in Bumdeling geog]	4.1.1 Carry out risk assessment of natural disasters (using expert analysis)	Risk assessment report	Expert contracted by DDM	DDM annual plan	
	4.1.2 Support public awareness campaign of risks of natural disasters	Dept of Disaster Management records of public awareness campaign	Dept of Disaster Management	Dept of Disaster Management 5 yr plan	Subject to Dept of Disaster Management budget
	4.1.3 Support development of early warning system of natural disasters	Early warning system (Dept of Hydro met Services)	Dept of Hydro met Services	Dept of Hydro met Services 5 yr plan	Subject to Dept of Hydro met Services budget

4.2 Mitigation and adaptation strategies in place to increase resilience of communities to withstand shocks and minimise adverse effects of climate change.	4.2.1 Provide support to local institutions (CFMGs farmers' groups, Tashi Yangtse RBC, etc.) to build their capacity to develop strong social and cultural systems to manage their affairs effectively and efficiently. 4.2.2. Awareness on forest fire management 4.2.3 Supply of fire fighting equipments 4.2.4. Training on forest fire management 4.2.5. Restoration	Record of capacity building activities carried out to local institutions	Dz admin DFO Trashigong	Dz 5 yr plan DFO annual plan	0.3 0.4 0.15 0.5
4.3 Reduce risk from floods and loss of arable land and BNC habitat in Bumdeling Ramsar site	4.3.1 Carry out a study of river morphology to assess likely impacts of river training works	Report	BWS (in collaboration with WMD)	BWS Management Plan	1.0
	4.3.2 Carry out a socio-economic impact study of the loss of agricultural lands on affected farmers	Report	BWS	BWS Management Plan	1.0
	4.3.3 Explore alternative livelihood options for farmers in Bumdeling geog who have lost agricultural land.	Report	BWS	BWS Management Plan	0.5
	4.3.4 Revive traditional ceremonies to appease mountain deities	Documentary	MoAF-Information and Communication Services (ICS) (in collaboration with BWS, Bumdeling geog and WMD)	Bumdeling geog 5 yr plan	0.3
Total Budget Nu. 83.42 M					

6. Implementation Strategies

The IRBMP shall come into effect in 2017 and operate until 2022, i.e. for a plan period of five years.

Activities are spread over eight separate area-based management plans, although the majority are included in geog and Dzongkhag annual and 5-year plans. Hence, Dzongkhag and geog administrations are the main implementation agents for the proposed IRBMP activities as part of their annual and five-year plans and programs. For the effective implementation of the plan, RBC or also called as DWMC was established in 2014. The committee is chaired by Dasho Dzongda and the environment officer being the secretary of the committee will play an lead role to coordinate and implement the plan. However, the DFO, CFMGs and BWS also have direct implementation roles as shown in the table of outcomes and activities in Table 7.

The role of the River Basin Committee (RBC) in the medium to long term (as envisioned in the Water Act 2011 and the Water Regulation 2014) is to assist the Secretariat of the NEC to prepare the River Basin Management Plan and oversee its implementation. However, in this case the plan was prepared in a participatory manner by the WMD of the DoFPS. The functions of the Committee also include oversight and coordination of activities, and should include coordination with KHEL. However, at the present time there is a lack of clarity about the role of the RBC, as there are no clear terms of reference to guide its functioning. In addition, there is a question of the capacity of the RBC to carry out its function.

Budget for implementation can come from a variety of sources. Most of the budget should be proposed in the annual sectoral Dzongkhag and geog plans and budgets. In addition to regular budgets, the government also provides a separate budget for geog development funds under the control of the gup and this could be accessed for special activities identified in the IRBMP. An alternative source of funding for the activities could be sourced from the KHEL-EMP, BTFEC and other potential donors. The Flood Management Division (FMD) under MoWHS has a large financial resource for addressing the flooding problems in the Bumdeling flood plain area, which can be used to implement selected IRBMP activities. The RBC should collaborate with the WMD for planning and implementing bio-engineering works for flood mitigation and river taming works.

KHEL is required to prepare an Environmental Management Plan (EMP) that will identify remedial activities specific to their own work areas, such as the management of sites disturbed during construction. Their plan, to be implemented in collaboration with the local authorities, can also include activities of general public benefit throughout the sub-basin. Annex 5 shows details of an indicative EMP obtained from KHEL. It would be desirable for local authorities (supported by the WMD) to coordinate with KHEL to have priority activities identified in the IRBMP incorporated into, and funded through, the KHEL-EMP.

Technical support for implementation can be provided by the relevant agencies particularly for implementation of interventions such as flood and debris flow risk assessment and mitigation.

7. Monitoring and Evaluation

The activities identified in this management plan as being necessary to achieve the goal and objectives of the plan are designed to be integrated into the area based management plans of a variety of agencies and organisations, particularly the geog and Dzongkhag annual and 5-year plans. These organisations will be responsible for monitoring and implementation of the activities and submit the copy of the progress report to WMD. The verifiable indicators given in the Logical Framework Matrix in Table 7 will assist in the monitoring task.

Evaluation of the impact of the management plan and the extent to which it has achieved its objectives and contributed to attaining the goal should be carried out by the WMD on annual basis (in accordance with the draft FNC Rules 2016).

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9. Annexes

Annex 1. Watershed management in Bhutan

BACKGROUND

Bhutan is a mountainous country located in the Eastern Himalayas, with rugged topography and a wide variety of ecological conditions. Most of the rivers originate in the Himalayas and flow south to the Brahmaputra River in India. Geographically, Bhutan is divided into five major and two minor river basins (Figure 1 and Table 1). Human activities take place in all of these basins, each of which is made up of a number of sub-watersheds. Sustainable management of the natural resources in these watersheds is critical to the well-being of the inhabitants and also of downstream water users.

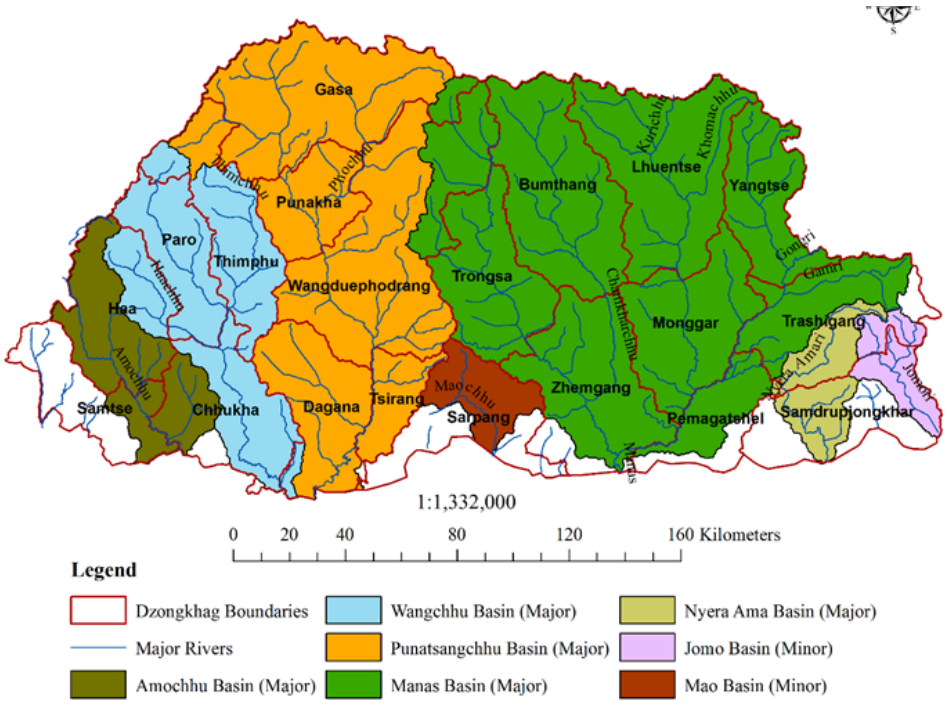

Figure 1. Major and minor river basins in Bhutan

Table 1. River basins and their tributaries in Bhutan

Sl. No	River Basins	Area (ha)	Basin category	Tributaries
1	Wangchhu	4,60,176	Major	Haachhu, Pachhu, Thimchhu
2	Punatsangchhu	9,73,270	Major	Mochhu, Phochhu, Dangchhu, Dagachhu
3	Manas	15,95,521	Major	Mangdechhu, Chamkharchhu, Kurichhu, Drangmechhu, Kholongchhu
4	Amochhu	2,21,156	Major	
5	Nyera-Amachhu	1,13,970	Major	
6	Maochhu	85,783	Minor	Kharchhu, Gongchhu, Gulechhu, Ruthal-gongchhu
7	Jomochhu	75,247	Minor	

POLICY SETTINGS

The importance of sustainable management of the country's watersheds has been accorded the highest priority in the country's regulatory framework including:

- Article 5 of the Constitution of the Kingdom of Bhutan, 2008
- Fundamental vision document, Bhutan 2020
- National Forest Policy 2011
- Forest and Nature Conservation Act 1995
- Land Act 2007
- Bhutan Water Vision 2025
- Bhutan Water Policy 2008
- Water Act of Bhutan 2011
- Water Regulation of Bhutan 2014

The clear intent of the policy settings is that effective watershed management should aim to maintain and improve watershed conditions and, where possible, contribute to sustainable livelihoods.

INSTITUTIONAL AND PRACTICAL RESPONSE TO POLICY SETTINGS

Under the provisions of The Water Act of Bhutan 2011 and The Water Regulation of Bhutan 2014, the Secretariat of the National Environment Commission (NEC) has the mandate to form River Basin Committees (RBCs) and, with the assistance of the RBCs, to prepare River Basin Management Plans for each river basin in the country. The Ministry of Agriculture and Forestry (MoAF) has the mandate under these two legal instruments to develop and implement watershed and wetland management plans.

In order to operationalise watershed management interventions, both the 10th Five Year Plan (2008-2013) and the national vision document (Bhutan 2020) indicate that master plans should be developed for all river basins in the country. In 2009, the Government established the Watershed Management Division (WMD) under the Department of Forests and Park Services (DoFPs). The WMD was designated as the national focal agency to operationalise a watershed management program.

A "Roadmap" to guide the implementation of strategies aimed at improving the management of the country's watersheds was developed in 2009 and adopted by the WMD (WMD 2011). This included a strategy to focus watershed management planning initially on those watersheds requiring urgent management interventions. A document "Guideline for Classification of Watersheds" was prepared in 2010 (and revised in 2016) to provide guidance on the classification of watersheds according to the level of degradation (WMD 2010 and WMD 2016). Watersheds are classified as pristine, normal, degraded or critical, and those classified as degraded or critical are scheduled for the development of management plans. This approach is codified in the Forest and Nature Conservation Rules (FNC Rules 2016), where the role of the DoFPS in watershed management is defined as to:

- 15.1 (a) Assess watersheds in river basins and classify them into Critical, Degraded, Normal and Pristine
- 15.2 Prepare management plans for degraded/critical watersheds. Such plans should have the primary focus of returning degraded or critical watersheds to normal or pristine condition (to the extent possible) by addressing the degrading influences.
- 15.1 (b) Consult with local communities and other stakeholders as part of the assessment process and in preparing management plans.

- 15.5 (c) Carry out Monitoring and Evaluation, to assess the extent to which degrading influences have been mitigated, as per the prescription in the Management Plan.

A clear thread on the process needed to carry out watershed management planning has emerged, with the key aspects being:

- Carry out assessments to identify degraded/critical watersheds (in the process, identify degrading influences).
- Carry out community (and other) consultations to gather additional information on issues/problems associated with watershed degradation.
- Prepare management plans to address (remove or mitigate) degrading influences.
- Carry out monitoring and evaluation to assess the extent to which degraded/critical watersheds are being returned to normal or pristine condition.

Watersheds across the country were delineated using a minimum threshold area of 5000 ha. This resulted in 186 individual watersheds being identified with each being assigned a unique identity number (Figure 2). Their condition is being systematically assessed and those assessed as degraded or critical are targeted for the development of individual (or grouped) management plans.

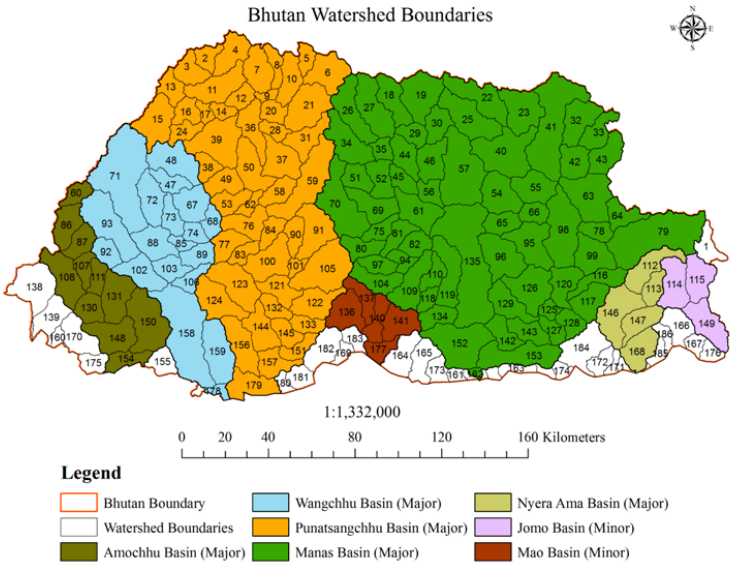

Figure 2. Watersheds in Bhutan identified for assessment of condition

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Annex 2. Location of gonpas, sub-watershed boundaries, roads and village

Annex 3. Threatened / protected species in the Kholongchhu sub-basin (based on BWS-MP, 2013)

Species		IUCN status			FNC	Remarks
Scientific name	Common name	EN	VU	NT	LP	
MAMMALS						
Uncia uncia	Snow leopard	✓			✓	
Panthera tigris	Tiger	✓			✓	
Moschus chrysogaster	Himalayan musk deer	✓			✓	
Cuon alpinus	Asiatic wild dog (dhole)	✓				Not uncommon
Ailurus fulgens	Red panda		✓		✓	
Trachypithecus pileatus	Capped langur		✓			
Ursus thibetanus	Himalayan black bear		✓		✓	
Pardofelis marmorata	Marbled cat		✓			
Neofelis nebulosa	Clouded leopard		✓		✓	
Rusa unicolor	Sambar		✓			common
Macaca assamensis	Assamese macaque			✓		common
Capricornis sumatraensis	Serow			✓	✓	Not uncommon
Panthera pardus	Common leopard				✓	Not uncommon
Felis bengalensis	Leopard cat				✓	
BIRDS						
Grus nigricollis	Black-necked crane		✓		✓	
Arborophila mandelli	Chestnut-breasted partridge		✓			Restricted range sp.
Gallinago nemoricola	Wood snipe		✓			
Harpactes wardi	Ward's trogon			✓		Restricted range sp.
Indicator xanthonotus	Yellow-rumped honeyguide			✓		
Aythya nyroca	Ferruginous pochard			✓		
Lophophorus impejanus	Himalayan monal (Monal pheasant)				✓	
Corvus corax	Raven				✓	Bhutan's national bird
OTHERS						
Bhutanitis ludlowi	Ludlow's Bhutan glory		✓			National butterfly
Taxus baccata	East Himalayan yew	✓			✓	*Taxus baccata* in FNC-rules 2006
Meconopsis grandis	Blue poppy				✓	
Panax pseudo-ginseng	Ginseng				✓	
Ophiocordyceps sinensis	Chinese caterpillar				✓	Periodic collection permitted

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Annex 4. Glimpses of issues effecting Kholongchhu sub-basin

Yak herder settlements at the head of the Kholongchhu sub-basin (Lao, left and Shingphel, right)

Landslides and debris flows in the upstream areas of the Kholongchhu sub-basin

Loss of agricultural land in the Bumdeling flood plain has resulted in a decrease in feeding area of the black neck crane

Drinking water problems in Khamdang and poor/old water reservoir tank in Yangtse

Poor quality farm roads, particularly with inadequate drainage, have led to an increase in erosion and subsequent stream sedimentation

Annex 5. KHEL's proposed budget

(The items for which the Dzongkhag, geogs and local population could be involved in decision making are highlighted in green)

Activity (+ EMP reference chapter)	Budget in million Nu	Remarks
2. Stabilization of muck disposal sites	***83.77***	
a. Engineering measures	57.00	
b. Biological measures	17.00	
c. Fencing	6.50	
d. Biological fertilizer procurement	2.00	
e. 4 watch/ward for 3 years	1.27	
3. Land Environment Management Plan	***14.77***	
a. Restoration of quarry sites, land-slide, soil erosion and sedimentation mitigation	11.27	Partly KHEL (e.g. quarries), partly involves others
b. Land reclamation, landscaping, beautification, incl. 2 viewpoints	3.50	Can be linked to tourism development
4. Noise, air and water pollution control and waste management	***44.88***	
a. Noise pollution control	3.0	
b. Sprinkling water on roads (3 tankers)	3.5	Dust reduction
c. 5 sweepers for dust reduction for 5.5 years	2.49	
d. 4 traffic managers for 5.5 yrs	4.15	
e. 250 community toilets	8.75	
f. 10 septic tanks	4.00	
g. Settling tanks	5.00	
h. 2 covered waste collection trucks	2.5	These measures should be integrated with the Doksum waste management and should involve DWMC, & pay attention to awareness rais-ing, segregation & recycling
i. 5 waste management employees 5.5 years	2.49	
j. Waste collection carts, community dust bins, brooms, etc	4.00	
k. Construction, management of landfill site	5.00	
5. Forest and biodiversity conservation	***50.00***	

a. Fuel and energy conservation to reduce use of fuel wood	5.00	
b. Compensatory afforestation 298 ha in consultation with DoFPS, incl. life cuttings, green belt development	19.90	
c. 2 rangers + 8 guards for 5.5 years and equipment and vehicle for anti-poaching	10.10	
d. Fish nursery and stocking	15.00	Based on wrong species list! >50% of the EIA fish species not found in the Kholong Chu
6. Catchment area treatment	***79.86***	
a. Plantation	40.00	Not clear how this differs from 3b
b. Social forestry	2.00	
c. Fuel wood and fodder grass near villages	1.00	
d. Tree nursery, maintenance, 5 staff for 3 yrs	3.50	
e. Engineering: step drains	10.00	
f. Engineering: check dams	2.00	
g. Admin (Gov) & contingency for plantations	9.36	4a-4d.
h. Eco-tourism	2.00	
i. Animal husbandry & horticulture	5.00	
j. Measures in BWS	5.00	
7. Dam break mitigation, incl warning system	***25.00***	***Incl . disaster management plan***
8. Public health measures (health posts, staff)	***45.00***	
9. Resettlement and rehabilitation	***71.06***	
a. Compensation of Project Affected Families	20.56	
b. Road development	20.00	Connectivity and road improvement. All to improve the quality of life in the area for the entire population in project area
c. Medical facilities	12.50	
d. Educational facilities (infrastructure and PAF scholarships, etc)	12.50	
e. Protection of neys and monasteries	5.00	
10. Monitoring of environmental indicators	***8.00***	
11a. Environmental Management Cell: 5 staff		***To implement EMP measures, incl. awareness raising***
11b. EMP Monitoring Committee (EMC & TY Dz)		To monitor EMP implement