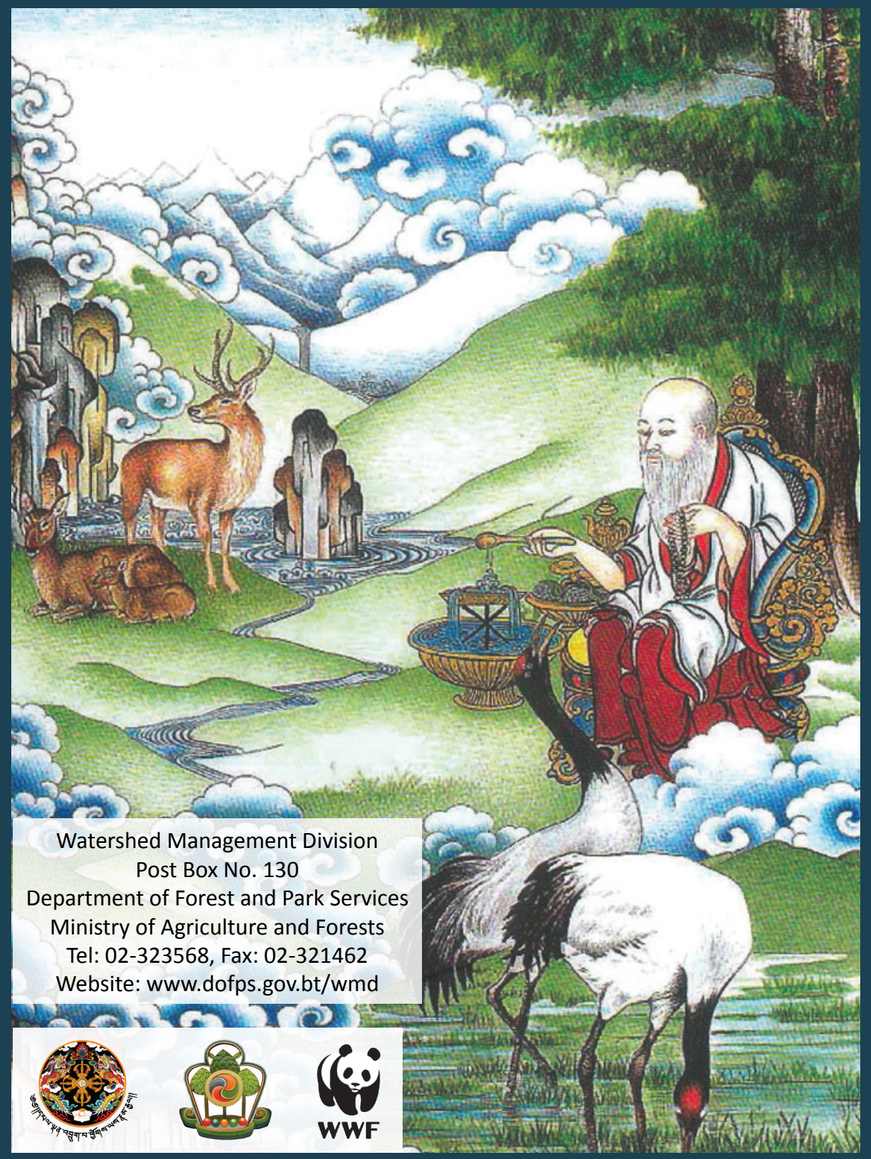

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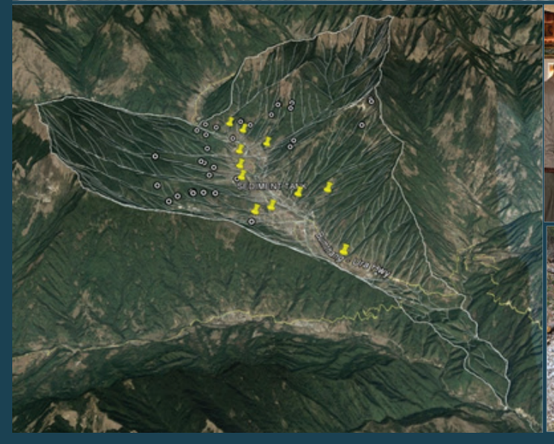
WATERSHED MANAGEMENT PLAN

Lower Chhoekhor, Bumthang Dzongkhag
Chamkharchhu sub-basin

(July 2018 - June 2023)



JUNE 2017

Watershed Management Division
Department of Forest and Park Services
Ministry of Agriculture and Forests

Watershed Management Plan for Lower Chhoekhor, Bumthang
Chamkharchhu sub-basin
2017

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

བློན་པོ།
MINISTER

MESSAGE

Sustainable management and rehabilitation of degraded watersheds have been integral parts of the policy framework in Bhutan for many years. Watershed management themes appear in most of the policy and legal documents concerned with the management of renewable natural resources. The Article 5 of the Constitution of the Kingdom of Bhutan, 2008 explicitly states that the Parliament may, by law, declare any part of the country to be critical watershed, indicating the importance of watershed management in the country. The significance of managing watersheds is also highlighted in various policy documents such as Bhutan Water Policy 2007, Forest and Nature Conservation Rules and Regulations of Bhutan 2017, Bhutan 2020 Vision and many others. The Water Act 2011 and Water Regulation 2014 mandates Ministry of Agriculture and Forests (MoAF), Department of Forests and Park Services (DoFPS) to develop and implement watershed management plans in the country.

Mountains are the source of fresh water for the huge number of world's population. Bhutan consists of mosaics of watersheds which plays an important role in ensuring food, water and energy security in the country. Watersheds are critical for hydropower generation, which is considered one of the backbone of economy in the country. The glaciers and fresh water lakes form major natural reservoir and fresh water sources of Bhutan. The rich forest cover of the country facilitates the recharge of the ground water which ensures sustainability and discharge of fresh water sources in the form of springs and streams. The availability of the water sources will affect the livelihoods of the communities and their capacity to adapt to the impacts of climate change. Any negative impacts due to bad management of land and forests in the watersheds could pose threat to livelihoods of the downstream communities.

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Tashichhodzong, Thimphu: Bhutan

བློན་པོ།
MINISTER

Recently, the management of watersheds has also become critical with increasing reports of emerging issues such as drying of water sources and subsequent water shortages being reported in the country. In view of growing importance, one of the program under the 12th Five Year Plan is on integrated watershed management which underscores the significance of watershed management in the upcoming five year plan.

I am pleased to learn that Watershed Management Division (WMD) is carrying out assessment of watersheds and developing management plans for degraded watersheds in the country. WMD has developed Watershed Management Plan for Lower Choekhor, Bumthang. While I applaud WMD for coming up with such plans, I would also like to urge other relevant agencies to support the Ministry in the implementation of the watershed management plan, as watershed management is a cross-sectoral approach. I am certain that this plan will contribute to our long-term vision of enhancing water security in the country.

Yeshey Dorji

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ROYAL GOVERNMENT OF BHUTAN
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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 many reports of water shortages across the country. The recent reports of increasing incidences of water sources drying in several parts of the country have aggravated the growing concern of water shortages. On the other hand, the use of water has greatly increased with the rise in developmental activities and this trend is expected to continue in the future. Nevertheless, it is because of our visionary leaders that we have a series of Policies, Acts, Regulations and Rules that aim to provide maximum protection of our environment that will ensure the adequate supply of high quality water 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 endeavor.

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. 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 particularly 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 being systematically assessed for status and condition.

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Ministry of Agriculture & Forests
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It is my pleasure to convey that WMD under the Department of Forest and Park Services has prepared watershed management plan for Lower Chhoekhor Watershed, Bumthang. 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. Let me take this opportunity to particularly urge Bumthang Dzongkhag Administration and other relevant agencies within the sub-basin to incorporate the activities of this plan into their twelve five-year plan. I am confident that this integrated and holistic plan will enhance the provision of watershed goods and services to benefit the communities of Lower Chhoekhor and Chamkhar municipality. 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.

Rinzin Dorji

SECRETARY

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FOREWORD

The sustainable management of watersheds is critical for the enhancement of local livelihoods, the provision of habitat for wildlife and biodiversity conservation and for ensuring continuous flow of rivers for hydropower generation. Watersheds can also provide an avenue for aesthetic beauty, recreation opportunities and ecotourism. Therefore, the protection of the natural resources in our watershed is essential to maintain the health and wellbeing of all living things, both now and in the future. Most of the settlements in Bhutan are located either on one or other watershed, and the production of agriculture is dependent on the quality of watersheds.

Considering the importance of protecting watersheds, the watershed management approach to natural resource management was adopted as one of the priority focal areas of the Department of Forest & Park Services (DoFPS). This approach provides a holistic way to assess the environment, identify problems, establish priorities for preservation or restoration, and to implement solutions based on a holistic and cross-sectoral manner. Therefore, the Watershed Management Division was created in 2009 with the vision "to ensure effective and integrated watershed management to maintain and improve water & watershed conditions and contribute to sustainable livelihoods through provision of watershed services". Since its inception, the Watershed Management Division has played its part in adopting appropriate polices and strategies to guide the process forward. This includes the development of a Roadmap for Watershed Management, and Guidelines for the Classification of Watersheds.

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ROYAL GOVERNMENT OF BHUTAN
Ministry of Agriculture and Forests
Department of Forests and Park Services

The Watershed Management Plan for Lower Chhoekhor, Bumthang was developed through the project on “Ecolife: Sustaining ecosystems for livelihood”. Initially the rapid assessment and classification of watersheds for the Chamkharchhu sub-basin was carried out in 2015. The plan outlines the implementation of activities based on locally appropriate strategies to ensure sustainable management of the watershed. The plan is an outcome of extensive consultations at Dzongkhag and Geog levels, as well as technical field assessments guided by watershed management specialists and the Watershed Management Division.

I would like to congratulate Watershed Management Division and its team for coming up with the watershed management plan for Lower Chhoekhor watershed, with financial support from WWF Bhutan through the project on “Ecolife: Sustaining ecosystems for livelihoods”. I sincerely hope that respective stakeholder agencies identified in the plan successfully implement the identified activities and thus contribute to the effort of managing the watershed on a sustainable basis.

Phento Tshering
DIRECTOR

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ACKNOWLEDGEMENTS

This watershed management plan is the outcome of strong support of all the line agencies linked to the watershed management plan. The dzongkhag administrations and respective gewogs of Bumthang and Zhemgang dzongkhag(s) rendered necessary support in deputing the RNR staff for rapid assessments of the watersheds along Chamkharchhu sub-basin, which enabled the selection of Lower Chhoekhor watershed for management planning. The field assessments for the watershed management plan were carried out by a core team with members from the Watershed Management Division, Dzongkhag Forestry Sector, Bumthang, Bumthang Division and RNR staff of lower Chhoekhor geog. The team was also supported by the municipality engineer and Dzongkhag Environment Officer of Bumthang dzongkhag.

The watershed management planning involved several rounds of consultations with other relevant stakeholders starting from the identification of issues, activity formulations and final endorsement. The initial plan was drafted by the Watershed Management Division with inputs from the field assessment outcomes and other relevant sectors. The activities for interventions were designed by a team facilitated by specialists and staff from WMD. The structure and content of the plan was guided, and the overall plan peer reviewed by Dr. Don Gilmour, Watershed Management specialist attached to the Watershed Management Division through Australian Volunteer for International Development. The plan was reviewed within WMD and endorsed by Technical Advisory Committee (TAC) of the Department of Forest and Park Services.

The plan was financed by WWF Bhutan office through the project on “Ecolife: Sustaining ecosystems for livelihood”. The Watershed Management Division would like to acknowledge the support, cooperation and contributions of all relevant sectors, organizations and individuals in the entire planning process.

EXECUTIVE SUMMARY

The Lower Chhoekhor watershed is located in Bumthang dzongkhag, within the Chamkharchhu sub-basin, which is part of the larger Manas river basin of Bhutan. The Chamkharchhu sub-basin covers four geogs of Bumthang and three geogs of Zhemgang. The rapid assessments of watersheds in 2015 indicated that the watersheds in the Chamkharchhu sub-basin are either pristine or normal in the current circumstances. This included the Lower Chhoekhor watershed which was assessed as 'normal'. However, the stakeholder consultation workshop selected the Lower Chhoekhor watershed for detailed assessment and management planning based on socio-economic reasons and expected future developments. The socio-economic changes are likely to increase pressure on the use of natural resources in general and on water resources in particular and this is expected to grow in the years ahead. There is a possibility of shortage of quality water in the future for both domestic and irrigation purposes. Therefore, the plan is developed for the following two purposes:

- Continue protection and conservation of the watershed to maintain its environmental health

- Prevent degradation from present and future human activities.

Therefore, this plan differs from some other watershed management plans that focus on identifying and mitigating degrading influences. Rather, this plan will act to prevent the current condition of the watershed from becoming degraded in the future.

For the purpose of the plan, a core team was formed with representatives from relevant sectors to carry out field assessments with technical support from the Watershed Management Division. However, the team sought the endorsement through stakeholder consultations with the involvement of all relevant sectors at various stage of the plan. The issues with explicit links to the provision of watershed goods and services were identified from the stakeholders with field validation by the core team.

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 to improve the condition of the watershed. The plan identifies the agencies

responsible for integrating activities into their own plans and programs with technical assistance from relevant departments and ministries. The verifiable indicators in the LFA matrix will assist in monitoring and evaluation tasks. The Lower Chhoekhor watershed management plan has been endorsed by the Technical Advisory Committee (TAC) of the Department of Forest and Park Services.

This plan like any other watershed management plan is not a standalone plan, but is an amalgamation of the activities identified as being necessary to minimize degradation of the watershed in the future. These activities are expected to be incorporated into area based planning frameworks (Five Year Plans and Annual Plans) of dzongkhag, geog and other agencies. The monitoring and evaluation of the plan will be carried out by WMD in collaboration with line agencies. The duration of the plan is for five years and will be revised if necessary.

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Lists of acronyms

AI	Artificial Insemination
BDWQS	Bhutan Drinking Water Quality Standards
BFD	Bumthang Forest Division
CCVA	Climate Change Vulnerability Assessment
CF	Community Forest
DFO	Divisional Forest Office
DoFPS	Department of Forestand Park Services
EFRC	Environment Friendly Road Construction
FMU	Forest Management Unit
HWC	Human Wildlife Conflict
LFA	Logical Framework Analysis
LFMP	Local Forest Management Plan
M & E	Monitoring and Evaluation
MoAF	Ministry of Agriculture and Forests
NCHM	National Centre for Hydrology & Meteorology
NEC	National Environment Commission
RGoB	Royal Government of Bhutan
RNR	Renewable Natural Resource
SRF	State Reserve Forests
WCNP	Wangchuck Centennial National Park
WMD	Watershed Management Division
UWICER	Ugyen Wangchuck Institute for Conservation and Environmental Research
TAC	Technical Advisory Committee
WWF	World Wildlife Fund
WUA	Water Users Association

1. INTRODUCTION

1.1 Policy setting

Sustainable management and rehabilitation of degraded watersheds have been integral parts of the policy framework in Bhutan for many years. Watershed management themes appear in most of the policy and legal documents concerned with the management of renewable natural resources. The Article 5 of the Constitution of the Kingdom of Bhutan, 2008 explicitly states that the Parliament may, by law, declare any part of the country to be critical watershed, indicating the importance of watersheds management in the country. The significance of managing watersheds is also highlighted in Bhutan Water Policy 2007. The Water Act 2011 and Water Regulation 2014, mandates Ministry of Agriculture and Forests (MoAF), Department of Forests and Park Services (DoFPS) to develop and implement watershed and wetland management plans. The Forest and Nature Conservation Rules and Regulations of Bhutan (FNCRR 2017) provides legal provisions to DoFPS to carry out assessment in the River basin by classifying watersheds into Critical, Degraded, Normal and Pristine in line with the Forest Management Code and the technical guidelines for watershed management. The FNCRR 2017 also clarifies that the primary focus of watershed management plans is to restore the degraded or critical watersheds to normal or pristine condition by addressing degrading influences. The Management Plans also details the implementation arrangement including interventions to be carried out and the agency responsible for each activity**.** The FNCRR 2017 also highlights the requirement to carry out Monitoring and Evaluation as per the prescription in the Management Plan and to evaluate the effective implementation of the Management Plan.

In preparing watershed management plans, consultation with local communities and other stakeholders as part of the assessment process is considered as paramount important. The Bhutan 2020 Vision states that the effective management of watersheds must be considered as a key component of efforts to place the nation's development on a sustainable path. The Road Map for Watershed management in Bhutan 2011 emphasize on need to provide strong policy support to deal with the critical issues of watershed management in order to enhance coordination and capacity building for operationalizing and monitor watershed management activities efficiently. One of the program under the draft 12th Five Year Plan is on integrated watershed management which underscores the significance of watershed management in the upcoming five year plan.

1.2 Context of watershed management plan

1.2.1 Rationale for planning of Lower Chhoekhor watershed

The rapid assessment of watersheds along Chamkharchhu sub-basin were carried out with the use of Watershed Classification Guideline 2010 (WMD) which indicated all eleven watersheds as either pristine or normal (Annex 7.2). Therefore, the lower Chhoekhor watershed was selected for management planning through numerous stakeholder consultation, based on the following socio-economic reasons:

- Increasing trends in the population of Chamkhar town and surrounding area
- Expanding town area with new town plan under process
- Increasing tourism infrastructures such as resorts with rise in tourism activities. There is an increasing trend in the number of tourist arrivals in Bumthang Dzongkhag from 2010-2013 (NSB 2014)
- Increasing number of pilgrims owing to existing religious institutions and religious sites
- Changing farming practices which requires more irrigation and water such as agricultural intensification and paddy cultivation in the recent decades (conversion trends from subsistence to commercial agriculture).
- Expanding agro- and other cottage industries in the watershed area

The above changes are likely to increase pressure on the use of natural resources in general and on water resources in particular and this is expected to grow in the years ahead. There is a possibility of shortage of quality water in the future for both domestic and irrigation purposes.

1.2.2 Purpose of the management plan

The Road Map for Watershed management in Bhutan 2011 (WMD 2011) indicates that "WMD would not produce watershed management plan *per se r*ather the plan is essentially made up of an amalgamation of many activities which have an explicit link to watershed management objectives that find their expression in existing planning frameworks". (p. 64). The assessment indicates that the Lower Chhoekhor watershed is in the 'normal' state in the current situation. However, it is worthwhile to develop the plan based on the socio-economic reasons and rationale for watershed selection stated in 1.2.1. Therefore, the plan is developed for the following two purposes:

- Continue protection and conservation of the watershed to maintain its environmental health

- Prevent degradation from present and future human activities.

Hence, this plan differs from many other existing watershed management plans that focus on mitigating the currently identified degrading influences. Rather, this plan will act to prevent the current condition of watershed being degraded in future.

2. DESCRIPTION OF WATERSHED AREA

2.1 Geophysical and administrative description

The Lower Chhoekhor watershed is one of the eleven watersheds along Chamkharchhu sub-basin It is watershed no. 56 of the 186 watersheds identified in the country(Fig. 1 A) covering an area of 10064.19 ha. It constitutes 3.8 and 6.6% of Bumthang dzongkhag and Chhoekhor gewog respectively. While the watershed area is located at 27° 33' 16.75" N 90° 40' 44.77"E and 27° 37' 16.90"N 90° 47' 08.82" E , the physical boundary starts from the confluence of Dhurchhu and Chamkharchhu (in the north), following the ridges of Pedsilling and Kikila and ends at the confluence of Chumeychhu and Chamkharchhu (South) (Fig. 1 B). The elevation of the watershed ranges from 2478 masl to 4119 masl.

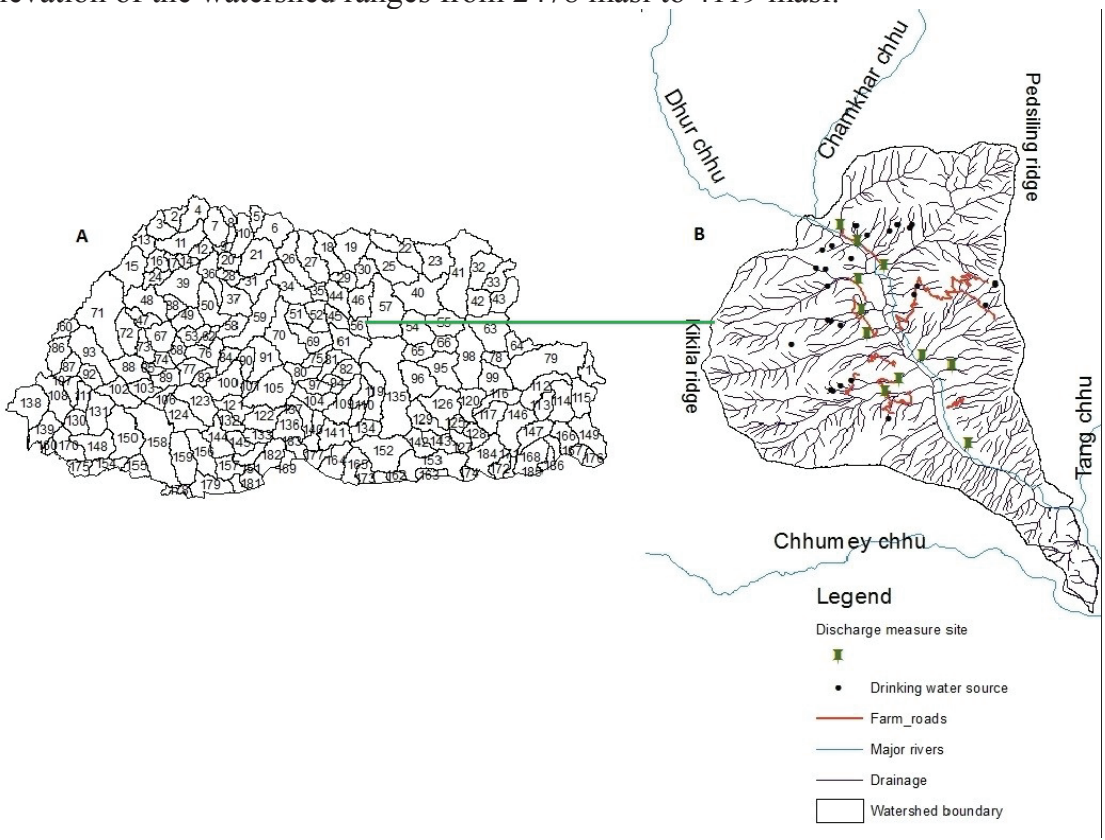

Figure 1: Watershed map of Bhutan (A) & Location map of Lower Chhoekhor watershed map (B).

2.2 Water sources

A total of 5471 people depend on municipal water supply connected mainly from three streams. The two sources are located within the UWICER preserve area, which accounts to dependency of 68% of town community while 9% of the town population depends on Nasiphel (Rongrongchhu) stream. However, 1583 people outside the municipal area depends on 27 other water sources (24 springs, 3 streams). The questionnaire survey 2016 accounted for a total of 7103 population residing within the watershed inclusive of both resident and floating population (Table 1)

Table 1: Household and population depending on the different water sources, April 2016.

Water Source	Village	No. of meter user (hh)	Population	Percentage%
Lamigonpa streams (2 streams)	Jakar Lhakhang	54	545	68%
	Chamkhar	96	964	
	Chamkhar town	139	590	
	Jakar	26	255	
	Jalikhar	75	496	
	Bathpalathang	20	127	
	Jakar HSS	10	641	
	Wangdicholing	67	1215	
Rongrong stream	Upper Dekiling	29	213	9 %
	Lower Dekiling	41	106	
	Jambay Lhakhang	18	319	
Outside Municipal (28 sources)		232	1632	23%
Total		807	7103	100%

2.3 Water discharge

Discharge of major streams within the watershed area was measured to assess the overall quantity of water and to understand the water balance considering demands of the population (Table 2). However, only one time discharge measurement could be conducted and may need several measurements across different seasons to authenticate the water supply over the year. The water availability as per one time discharge measurement is 101 million liters per person per day for the watershed

communities, which is much higher than per capita water availability of 16000 liters per person per day globally (FAO 2014).

Table 2: Water discharge measurement, May 2016.

Sl.No	Name of Stream	Discharge m^3/sec	Discharge l/sec
1	Rongrong stream	0.069735057	69.74
2	Lamigonpa right stream	0.077549066	77.55
3	Lamigonpa left stream	0.080326249	80.31
4	11 streams combined	2.082770576	2082.77
Average discharge/second		2.310380948	2310.38
Daily discharge/hour		8317.371411	8317371.41

2.4 Water quality

Water quality is one of the key indicators of a healthy watershed. In order to assess the quality, the laboratory result for water sample analysis conducted by Wangdichholing hospital, Bumthang (Feb-Aug 2016) was referred. The water quality parameters in terms of pH and chlorine content is within the acceptable value, although the chlorine content was on the higher side in the month of May and July 2016. The turbidity is very low over the seven months (Fig. 2). Therefore, the readings of three water quality parameters (pH, chlorine & turbidity) of water (some at source and some at tap or end) are well within the acceptable limits set in the Bhutan Drinking Water Quality Standard (BDWQS, pg. 11). The other physical parameters in terms of colour and odour were all within non objectionable limits. The microbiological parameter (*E. coli*) readings were zero. Therefore, the quality of water measured at source and tap were all acceptable from February-August 2016. The detail observations of the three water quality parameters are in Annex 7.3.

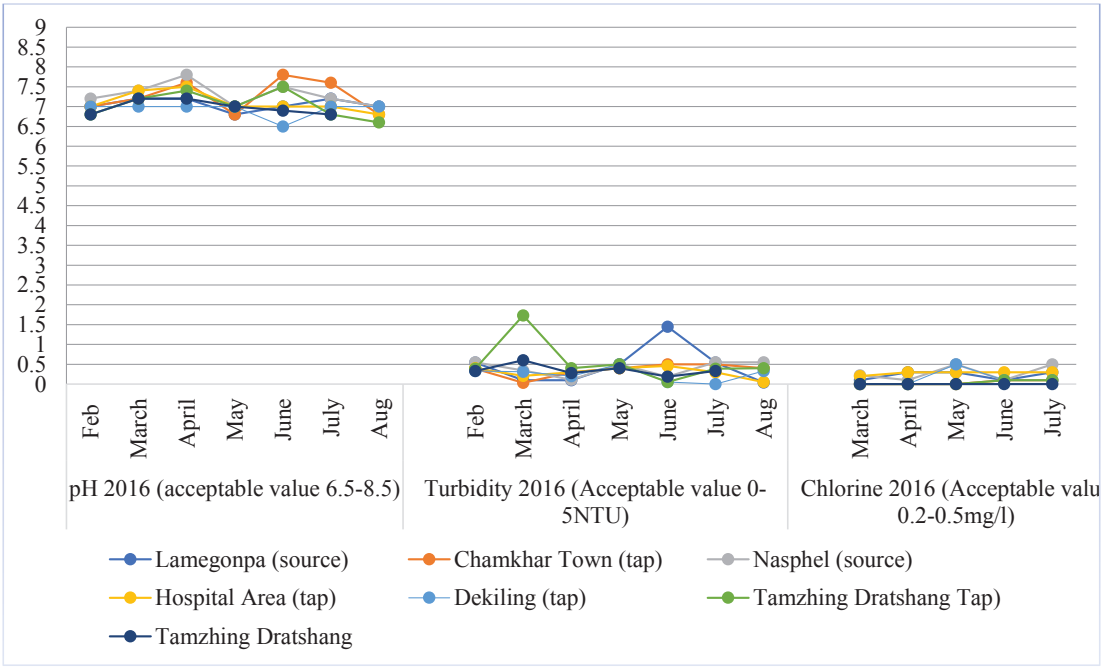

Figure 2: Trends of three drinking water quality parameters from Feb-Aug 2016 (data source: Wangdichholing hospital, Bumthang).

2.5 Landuse types

The watershed comprise of ten land use types of which blue pine forests and mixed conifer dominates with 62.8% and 22% respectively. Mixed conifer species consists of only spruce and hemlock. Only 5% of the watershed area is under agriculture production, while there is minor quantity of broadleaved species consisting of Rhododendron and Oak. The different land use types in the watershed are in Fig. 3.

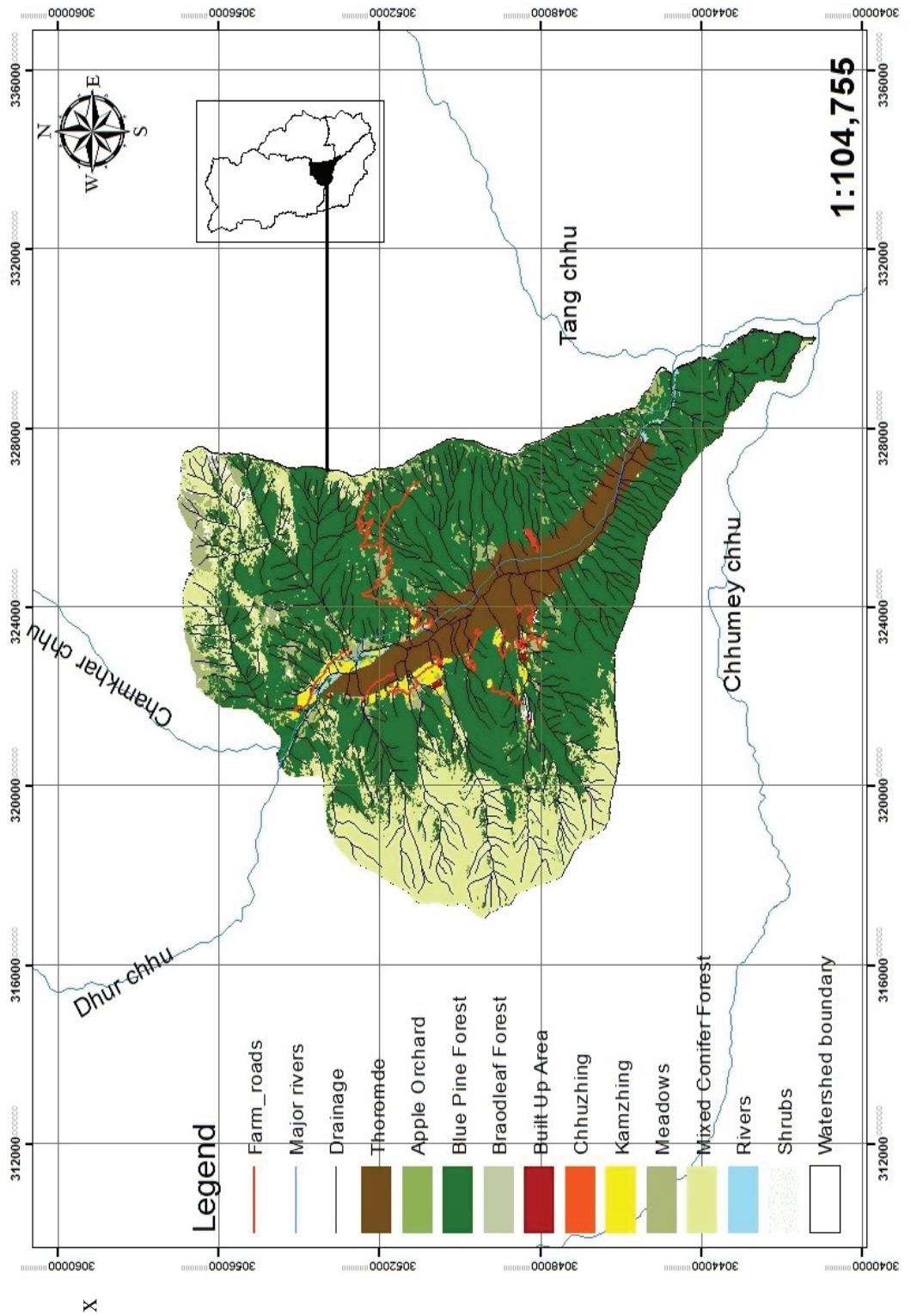

Figure 3: Land use map of Lower Chhoekhor watershed.

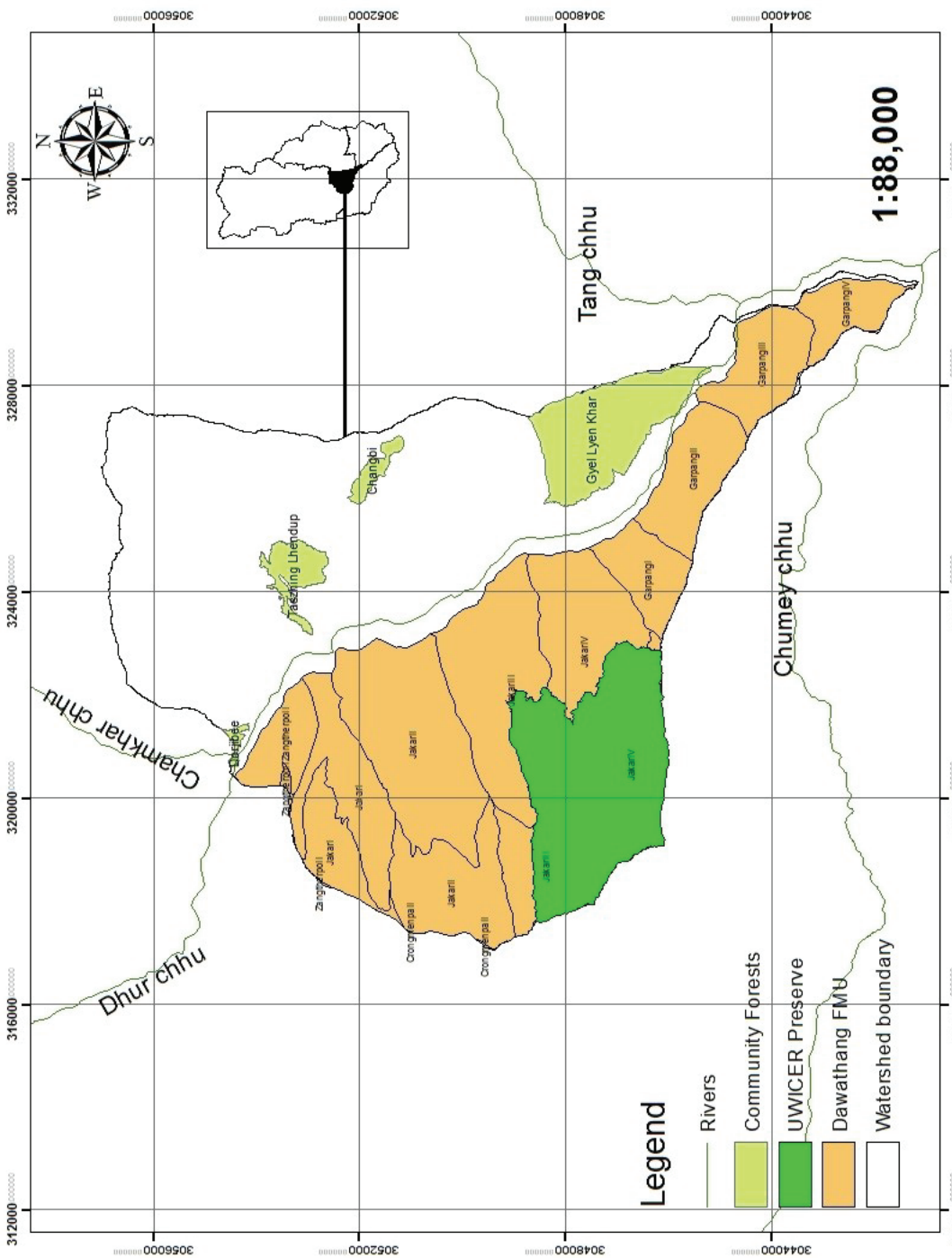

Figure 4: Forest management regimes in the watershed.

2.6 Forest management regimes

There are three different forest management regimes within the watershed, which are described below. In the watershed area, 7007.4ha of SRF is currently under community forest management regimes and Dawathang forest management unit (FMU) inclusive of UWICER preserve area . The different forest management regimes and area coverage of each forest regimes in the watershed are in Fig. 4 and Table 3 respectively.

Table 3: Area of existing forest management regimes.

Forest Management Regimes	Area (ha)
Dawathang FMU[1]	5272
Community forests (Changbi, Dorjibee, Gay-Lyen-khar, and Tamzhing Lhundup)	633.9
UWICER Preserve Area	1101.4
Total	7007.4

2.6.1 Forest Management Unit

Three Blocks of Dawathang FMU namely Garpang Block (Four Compartments), Jakar Block (Four Compartments) and Zangtherpo Block (One Compartment) with a total area of 6373.43 ha constitute 52.35% of the watershed area (Fig. 4). The management of the FMU is guided by Dawathang Forest Management Plan with a plan period from 2011 to 2020. Currently, the FMU is in the second plan period. Two Compartments (III and IV) in Garpang Block have part of their areas falling under Protection Management Circle (Soil Protection). Portion of Compartment I, II, III and IV of Jakar Block has been completely allotted for rural use. Besides, the areas along perennial streams and rivers are designated under Riparian Reserve Protection Function whereas those along National highways are maintained as highway buffer. Areas categorized under these function have restriction on commercial use and no tree felling is permitted.

In the FMU plan, the area comprising of human settlement, cultivation land and infrastructures are categorized under Non-production Management Circle. The remaining area left after delineation of Protection and Non-production areas area

[1] The total area of Dawathang FMU falling in the watershed area is 6373.43 ha. The area of 5272 ha is excluding UWICER preserve area (1101.43 ha) which is within the FMU in the watershed.

categorized as Production Management Circle. The Watershed Management Interventions within the FMU as per Dawathang FMU Management Plan are

- Restriction of tree feeling for commercial as well as local use within 100 feet (30 m) of the bank or edge of any river, stream, water course and water source.

- Intensive cattle grazing are restricted for hygienic reasons within the buffers maintained around local drinking water sources.

- The establishment of infrastructures like logging roads, establishment of log ponds, housing, sawmill and other utilization units, camp-sites, log landing etc. is strictly prohibited within the buffer maintained on either side of the rivers, streams and water source.

- Areas with very steep slopes (slopes greater than 45°) and areas with indication of slight to moderate erosion are designated as soil protection function and felling of trees for commercial as well as local use is not permissible.

- As the FMU area is treated as watershed conservation function, the clear felling of natural forest is prohibited. However, local forest use is permitted with regulated cattle grazing.

2.6.2 Community Forests

Participatory forest management through four community forests (CF) namely Changbi, Dorjibee, Gay-Lyen-khar and Tamzhing Lhuendup, constitutes 6.3 % of the watershed area (Table 4). The total of 161 households are engaged in managing the CFs with an area of 633.97ha. The establishment of CF within watershed dates back to 2009 and latest being 2015 (Table 4). The plan period for CF is for 10 years as per FNCRR 2017. The restoration of degraded forest land and protection of water source are important interventions of the CFMGs, besides sustainable wood and NWFP utilization

Table 4: Details of Community forests falling in the watershed.

Community Forests	Est Year	HH	Area (ha)	Objectives
Tamshing-Lhuendup	2009	32	104.85	Sustainable management CF resources for varied needs of the communities
Dorjibee (partially)	2012	30	13.06	Protection of CF from forest fire and illicit extraction Generate income for CFMG
Gyal-Lyon-Khar	2012	87	471.67	Institutional and technical capacity development of the CFMG in managing CF
Changbi-Trashigatshel	2015	12	44.39	Improvement of forest stand by applying timely tending operation Reclamation of degraded forest areas by promoting natural regeneration
Total		161	633.97	

2.6.3 UWICER Preserve Area

The Preserve Area allotted for research purposes falls inside the compartment III and IV, Jakar block of Dawathang FMU which was delineated by UWICER with Bumthang Territorial Forest Division. The original 238.5 acres of the land was registered in the Institute's name during cadastral survey. However, with the new mission and mandates of the institute (Research, Education and Training), the remaining 427.5 acres of forest area and additional forest area of approximately 2000 acres were proposed. Different sections of the research forest are set aside and subjected to silvicultural treatments considering forest sub-types, species diversity, uses and social context of the forest. The drinking water sources to Chamkhar municipality are located within the preserve area and therefore forests around the water sources will require proper management for water sustainability.

2.7 Agriculture cropping pattern

The shift in the agriculture pattern from subsistence to commercial crops is one reason for selection of Lower Chhoekhor watershed as discussed in 1.2.1. The Paddy cultivation started in Bumthang with the research on 18 exotic paddy varieties by Research Centre, Jakar in 1998. Paro-China and Chummro are the two promising varieties. Paro-China variety was first cultivated in Tang and Chhoekhor Geogs in

six acres of farmers' land in 2004, yielding 1681 kg/acre[2]. The objectives of initiating paddy cultivation in Bumthang area are to

- replace fallow land dominated by *Yushina spp* by agriculture crops
- diversify crop production opportunities
- take advantage of topography for mechanizing the cultivation of paddy

The total area of 84.59 acres of land are under paddy cultivation as of 2010 benefiting 120 households and the paddy cultivation both in terms of area and households tend to have increased (Fig 5). The record with the Agriculture sector, Lower Chhoekhor geog shows that the cereals and other vegetables are also cultivated quite extensively which requires water for production.

Figure 5: Trends of paddy cultivation in the watershed area (data source: Dzongkhag Agriculture Sector, Bumthang).

[2] Abstract from the Dzongkhag Agriculture Sector's presentation

2.8 Climate

In the last 20 years, the temperature in Bumthang showed increasing trends, although it is not significant. (Fig. 6), while the trends of rainfall has remained more static (Fig. 7). The increasing trends of temperature may lead to disturbances in the different components of watersheds and affect the quality of watershed services. The Climate Change Vulnerability Assessment (WCNP and WWF 2011) (of which Chhoekhor geog was also part of study area) indicated that communities are already experiencing higher temperatures, more erratic rainfall patterns, less snowfall, and changes in the intensity of frost. The change in climate in Chamkhar valley is also being perceived by the communities such as warmer winters, and lesser snowfall which is also being correlated by hydro-meteorological data (Dorji 2014).

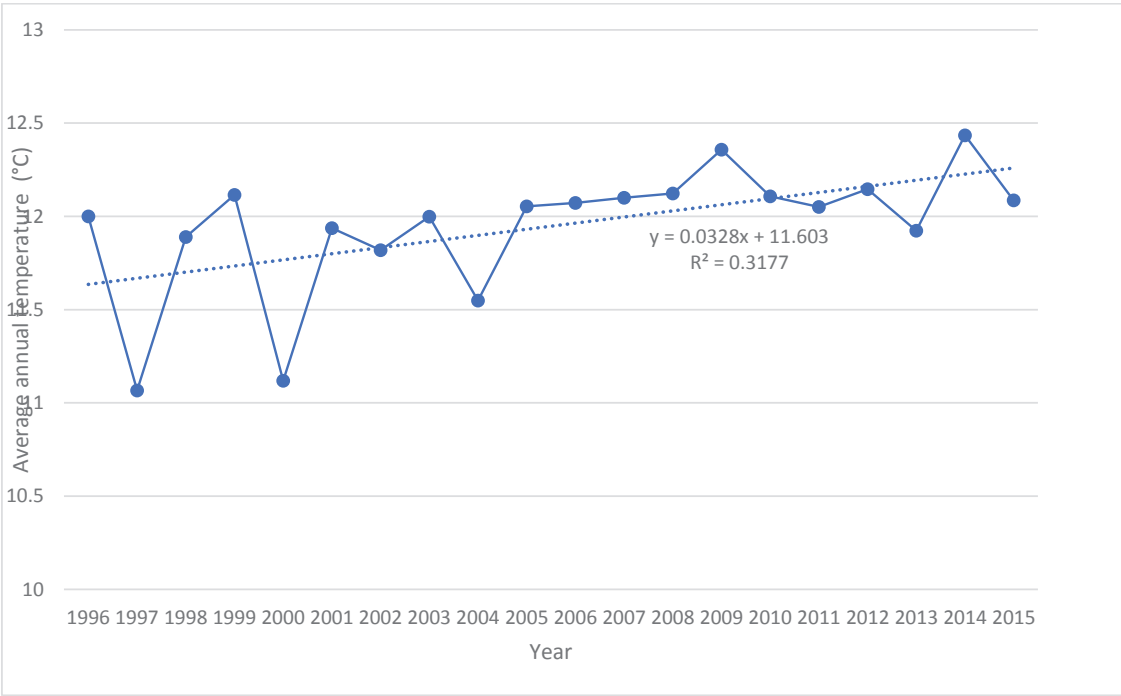

Figure 6: Temperature trends in Bumthang in the last 20 years (data source: NCHM).

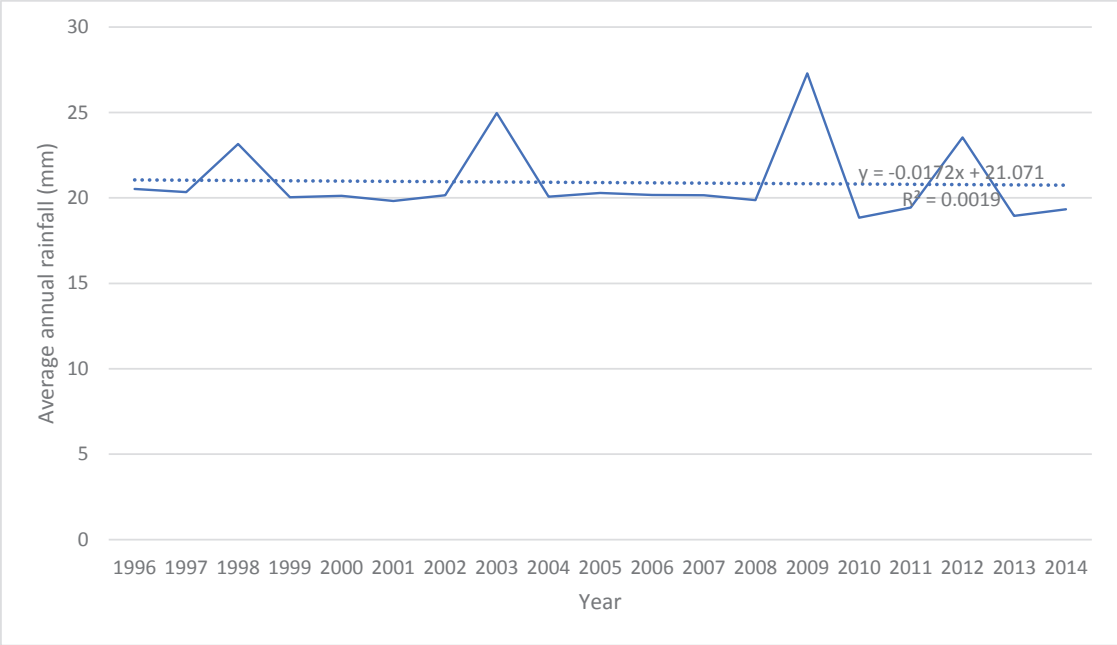

Figure 7: Rainfall trends in Bumthang in the last 20 years (data source:NCHM)

3. ISSUES IMPACTING WATERSHED SERVICES

The management planning of the selected watershed started with identification of issues in the watershed through workshops involving all relevant stakeholders. The issues related to different dzongkhag sectors, municipality, and communities, territorial division and UWICER, were screened based on their linkages to watershed goods and services. The detailed issues identified by stakeholders are in Annex 7.4. The issues with explicit link to Lower Chheokhor watersheds were segregated in to three focal problems during the LFA exercise as in Fig 17. Therefore, the activities were translated from prioritized issues which were validated through surveys by the field team members.

Human Wildlife Conflict (HWC) was raised repeatedly as an issue of concern. However, no linkages of HWC to degrading influence of the lower Chhoekhor watershed was seen. Although, HWC appeared as concern at the national level, it was not relevant to address within the watershed plan.

3.1 Wastes

3.1.1 Background

Solid waste management is one of the environmental problems faced by the Municipal office and the Bumthang Dzongkhag at large. The Dzongkhag has inadequate institutional arrangements and facilities for providing solid waste management services. For instance, the Municipal provides only basic collection and transportation facilities within its municipal jurisdiction. There are no municipal collection bins and treatment facilities set up currently. The solid wastes collected are disposed off at the solid waste disposal site at Garpang. The solid waste disposal site is basically an open dumping site within an area of 3 acres (Fig. 8).

3.1.2 Record of solid wastes

The Municipal Office of Bumthang lacks proper solid waste data. However, considering the frequency and amount of waste collected, an approximate amount of eighty-eight tons of waste are disposed monthly to the solid waste disposal site in Garpang. The challenges faced by the Dzongkhag related to waste management under the Waste Prevention and Management Regulation (WPMR), 2012 are:

- Lack of municipal collection bins & communal bins;
- Lack of waste collection and transportation services from Gewog
- Inadequate infrastructure at the disposal site;
- Waste nuisance created by animals;
- Littering at public places;
- Illegal waste dumping along the highways and water bodies; (Fig. 9)
- Car washing in water bodies.

With an increasing generation of solid waste and lack of manpower and inadequate budget under Municipal's Operation and Maintenance, providing efficient municipal facilities in term of waste management is challenging. The Dzongkhag Administration plans to solicit funds from external agencies to address the waste issues.

Figure 8: Solid waste disposal site.

Figure 9: Illegal dumping of wastes (A) Garpang, (B) Kikila, (C) PWD labour camp, (D) Jalikhar turning 1, (E) Jalikar turning 2, (F) Jalikhar turning.

3.1.3 Initiatives for waste segregation and recycling

Besides, conducting periodic cleaning activity, Bumthang Dzongkhag also organizes regular campaign to promote the concept of waste segregation and recycling. A private firm viz., Green Bhutan Waste Management has started its Recycling Unit at Garpang. The firm buys and collects segregated from Thromde area. In addition, upon request from the Gewogs, wastes are collected from Chhoekhor Gewog. Some scrap dealers collect scraps from the solid waste disposal site at Garpang and from the schools. All schools within lower Chhoekhor wastershed area practice segregation and recycling. They have set up segregation shed within their school campus (Fig. 10). Even every Chiwog has segregation shed each. However, the transportation and reaching these wastes to disposal site is an issue.

Figure 10: Waste segregation house in schools (A) Wangdicholing LSS & (B) Jakar HSS.

3.2 Grazing

Free grazing of livestock in open forest land is one of the issues raised which could lead to pollution of unprotected drinking water sources. Nonetheless, overgrazing was not an issue in the watershed as the number of improved breed cattle are increasing over the years with a consequent decrease in the local cattle population. With the reduction in local cattle population and other initiatives such as fodder development by the Department of Livestock, open grazing may not be an issue in the future.

3.3 Drinking water

Notwithstanding the water quality discussed in 2.4, murky drinking water during monsoon season is a concern. It is attributed to absence of sedimentation tank, location of municipal water source at 600m below UWICER campus and free grazing cattle around water sources described in 3.2.

3.4 Irrigation channels

Insufficiency of irrigation water is due to the poor irrigation infrastructures in Wangdicholing, while Jalikhar faces acute shortage due to inadequate discharge of water to the area. Currently, there are nine irrigation channels in the watershed with the total length of 12.83 kms. The irrigation channels are mostly shorter ones with longest channel of 3.2 kms in Gonkhar area (details in Annex 7.7). The irrigation channels are mostly earthen and connected by wooden channels at places where earthen channels are not feasible and the earthen channels are more susceptible to water loss through seepage which can trigger soil erosion process (Fig. 11). Thus proper management of irrigation channels is critical for effective management of water and surrounding watershed.

Figure 11: Landslides caused due to water loss from irrigation channel (A) and wooden irrigation channel (B), Tamzhing, April 2016.

3.5 Plant chemicals

There was concern on increase in the use of chemical fertilizers and pesticides for cereal and horticulture crop production and the likelihood of polluting the ground water and spring water sources. No study has been carried out to support these suggestions. However, the record from the agriculture sector, Bumthang indicates a

trend of increase in supply of plant protection chemicals in Chhoekhor geog (Fig. 12). Therefore, the issue may require interventions in the future.

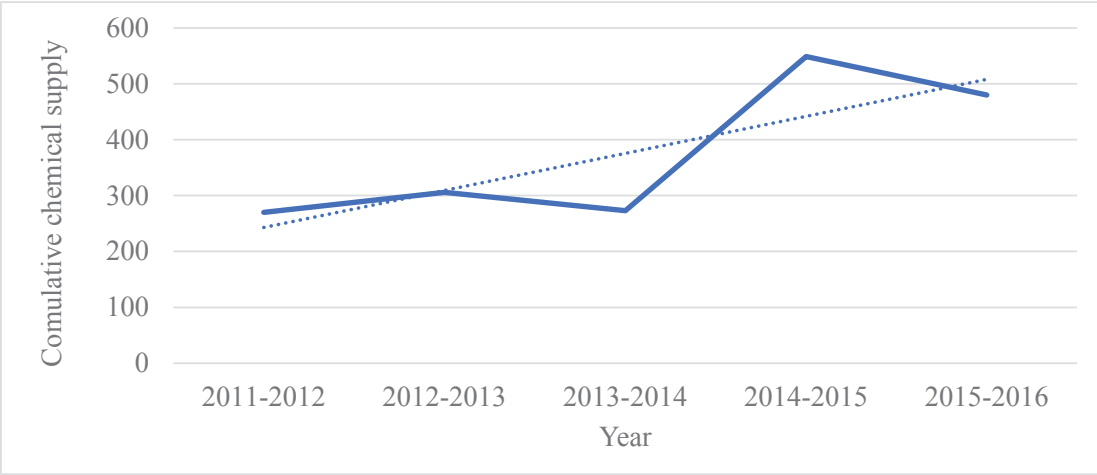

Figure 12: Cumulative supply of plant protection chemicals for agriculture crop (data source: Gewog Agriculture Sector, Chhoekhor)

3.6 Farm roads

There are twelve farm roads in the Lower Chhoekhor watershed connecting different villages. The total length of the roads is 51.5 km which benefits 484 households. The details of the farm roads status are in Annexure 7.5. These farm roads lacks proper drainage system and stone soling (example in Fig. 13), causing landslides in the surrounding areas, thereby possibility of impacting the watershed services. Therefore, the construction and maintenance of quality farm roads in line with EFRC guideline is vital (Visser et al 2005).

3.7. Illegal logging

Although illegal logging cases are registered with Bumthang Territorial Division, the record indicates that it is not very severe at the moment. However, illegal felling and extraction of forest products within the watersheds needs to be monitored seriously especially those nearer to water sources. Over the years, there has been an increase in farm road construction, making the interior areas of the forest accessible to people for timber extraction. This has led to an increase in illegal felling of trees. Moreover, as the vegetation within the watershed comprises highly desirable Blue pine, frequency of illegal logging activities has increased.

Minimizing illegal felling and extraction of forest products within the watersheds are being ensured through various means, especially those forests nearer to water sources. Strict surveillance is carried out to reduce illegal activities within the watershed. The illegal felling of trees near water sources are monitored by the Unit Office (Divisional Office) and the communities. The forestry staffs are also made aware of the compliance of the strict rule during making of trees to maintain appropriate buffers along rivers, perennial streams and drinking water sources.

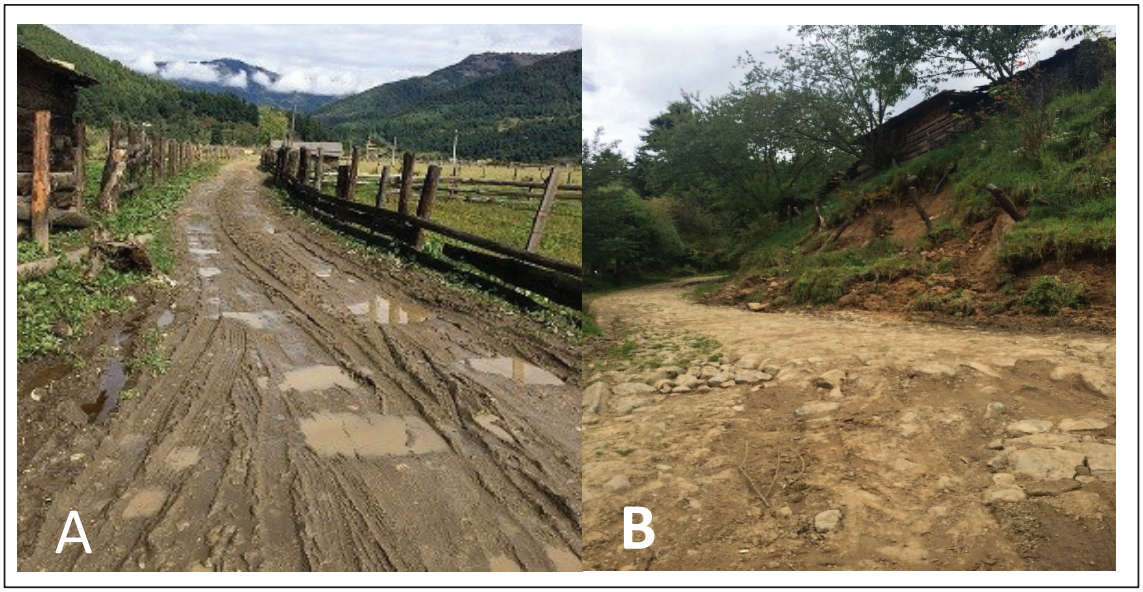

Figure 13: Poor drainage farm road, Jambaylhakhang (A) and Landslides triggered by farm road, Takershong (B), 2016.

3.8. Effluent discharge

The effluent from the Chamkhar municipality is being directly discharged in to Chamkharchhu river. The construction of a tertiary treatment plant is a high priority to maintain water quality of the Chamkharchhu sub-basin to prevent ill-impacts on the aquatic ecosystems and downstream users. The issue is beyond the scope of addressing within this watershed management plan (Annex 7.1) and will require separate intervention by the concerned authority.

3.9. Forest fires

Forest fire outbreak is not a major issue within the watershed. The report from Dzongkhag Forestry sector indicates that forest fire occurs only once or twice a year

in small pockets. However, some concerns were raised on the continuation of the forest fire prevention advocacy.
Considering the composition of most of the forests (i.e Blue pine forest), forest fire has always been concern. Through advocacy and the formation of Chiwog, Gewog and Dzongkhag Level Forest Fire Management Committees, it is predicted that the incidences of forest fire will further reduce.

4. WATERSHED MANAGEMENT PLANNING PROCESS

4.1. Rapid assessments of watersheds along Chamkharchhu

Rapid assessments of watersheds in the Chamkharchhu sub-basin were carried out in 2015 by Dzongkhag Forestry Sectors and Gewog RNR extension agents of the Bumthang and Zhemgang dzongkhags facilitated by WMD. The rapid assessment and classification of watersheds were carried out using 'Guideline for Classification of Watershed 2010 (WMD). A total of 194 streams falling within 11 watersheds were assessed in Bumthang Dzongkhag and three gewogs of Zhemgang dzongkhag along Chamkharchhu sub-basin (Fig. 14).

4.2. Stakeholder consultations

The plan was developed using participatory processes involving all relevant stakeholders. The rapid assessment of watersheds along Chamkharchhu sub-basin started with stakeholder consultations inclusive of local government representatives. The Lower Chhoekhor watershed was selected for management planning in a stakeholder consultation workshop involving all relevant stakeholders throughout the Chamkharchhu sub-basin The watershed management planning and field assessments were carried out by core team members (discussed in 4.3) facilitated by WMD. In general, stakeholders involved throughout the process were local government, geog RNR staff, dzongkhag RNR sector, environmental sector, municipality and city representatives, divisional forest office, and parks etc. Their involvement throughout the process is expected to enhance ownership of the plan during implementation (some examples in Fig. 15 & lists of stakeholder consultations are in Annex 7.8.

Figure 14: Rapid assessment of watersheds in Bumthang (A) and Zhemgang (B).

Figure 15: Stakeholder consultations during the process of watershed management plan development.

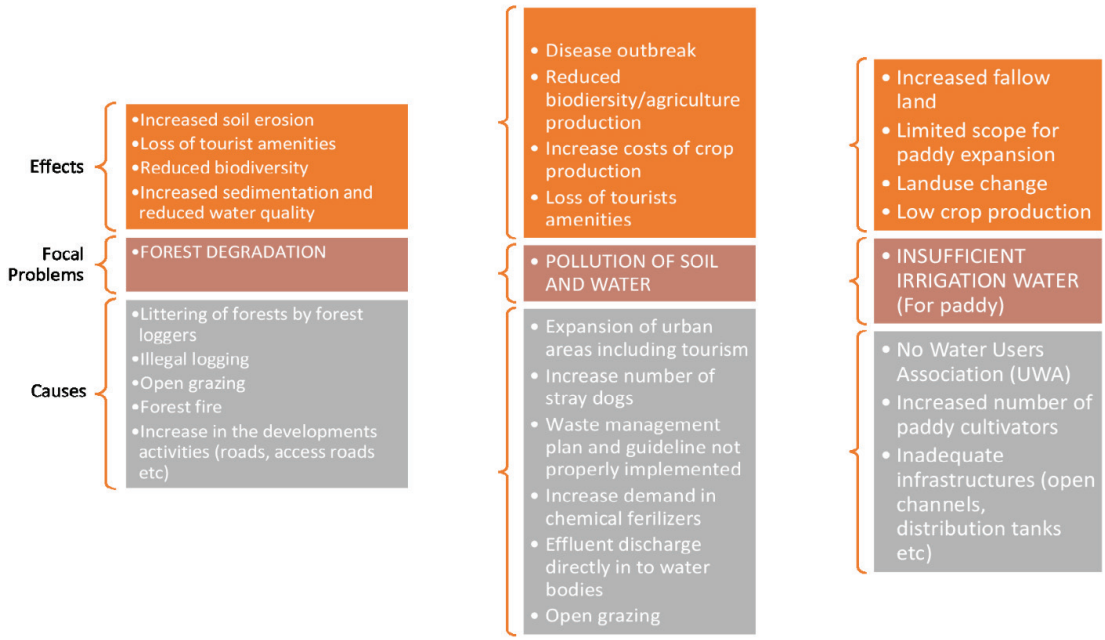

Figure 16: The focal problems, causes and effects identified during LFA exercise.

4.3. Formation of planning core team members

The detailed assessments of the Lower Chhoekhor watershed were carried out in close collaboration with the field offices. The field assessments were led by Dzongkhag Forestry sector in the year 2015 and supported by members of the core team. The Watershed Management Division in consultation with the stakeholders formed a 'core team'. The team formation was also in line with the ministry's policy to decentralize field implementation activities and to enhance capacity development of field officials. WMD in the majority of cases acted as technical advisor cum facilitator in the entire planning process.

The technical 'core team' consisted of following:

- Watershed Management Division, Thimphu (facilitator and technical support)
- Dzongkhag Forestry Sector, Bumthang (field assessment lead)
- Dzongkhag Administration, Bumthang (Agriculture, Livestock, Environment, Engineer)
- Territorial Forest Division, Bumthang
- Ugyen Wangchuck Institute for Conservation and Environmental Research, Bumthang

The core team was responsible for carrying out detail assessments of the watershed, and technical planning. The core team conducted consultations with higher level stakeholders from time to time to update the watershed management planning status, discuss and make decisions. Besides, dzongkhag engineering sector, Bumthang was also involved during the survey of farm roads, irrigation channels and for cost estimations.

4.4. Survey, data analysis and field validations

Based on the stakeholder consultations and advice from technical expertise, field surveys were carried out as part of detailed assessment of the watershed area. Data gaps were identified during Logical Framework Analysis (LFA) exercise (described in 4.5) which indicated need for additional field surveys. The GIS mappings were conducted by the Dzongkhag Forestry Sector in consultation with WMD.

4.5. Logical Framework Analysis (LFA) exercise

The Logical Framework Analysis (LFA) was adopted in deriving the logframe matrix, which is the core of this management plan for implementation. The LFA exercise was carried out within a technical group inclusive of field core team members with diverse backgrounds, and was strongly participated by each member and lead by a facilitator (Some LFA proceedings in Fig 17). The results of the LFA exercise were compiled in the form of logframe matrix (detail in Annex 7.1) with the formulation of goal, objectives, outputs and activities from the issues, all probable effects and causes of the focal problems (Fig. 16).

Figure 17: LFA exercise under process.

4.6. Endorsement and approval of Watershed Management Plan

The plan was drafted by Watershed Management Division supported by the planning core team members. It was subsequently endorsed by stakeholders through consultation workshop, followed by endorsement by the Technical Advisory Committee (TAC) of the Department of Forests and Park Services.

5. LOWER CHHOEKHOR WATERSHED MANAGEMENT PLAN

5.1. Goal

Lower Chhoekhor watershed managed to maintain healthy ecosystems yielding high quality water, to enhance ecotourism and contribute to community wellbeing in the context of climate change[3]

5.2. Objectives and Outputs

Objective 1. Forest areas in Lower Chhoekhor watershed managed to minimize degrading influences (actual and potential) in conformity with FNCRR.

Output 1.1: Territorial division staff and communities with capacity to plan, implement, and monitor forest management plans (FMU, CFs, LFMP, Forest fires).

Plans already exist for FMUs, CFs and Forest Fires in the watershed, but there is a need to develop management plans for areas outside those covered by the existing planning frameworks (i.e. Local Forest Management Plans). The sustainable management of all regimes will depend on the technical capacity of planners and implementers to incorporate watershed management principles into their plans. Therefore, there is need for training and refresher courses on silvicultural systems, preparation of operational plans for FMUs, Local Forest Management Plans, Community Forest Management Plans and forest fire plans.

Output 1.2: Local Forest Management Plan (LFMP) operational for Lower Chhoekhor watershed.

Forest areas outside existing management regimes in the watershed lack a scientific management plan. For sustainable management of the resources and to prevent future degradation, it is vital to prepare Local Forest Management Plans for these areas.

[3] These activities will contribute to the adaptation and resilience to climate by the communities within the watershed.

Output 1.3: Knowledge of the effectiveness of forest management plans.

This watershed management plan is an amalgamation of many activities that are designed to address issues identified during the planning process. Some of these activities are (or will be) incorporated in various forest management plans covering Forest Management Units, Community Forests, and Local Forest areas. For the purposes of future revision/amendment of the watershed management plan, it will be useful to conduct a study to assess the effectiveness of activities in addressing issues identified in the watershed management planning process, such as regeneration after logging, buffer zone management and compliance with watershed management principles, etc.

Output 1.4: Roads within Lower Chhoekhor watershed constructed and maintained in conformity with EFRC guidelines.

Farm roads with poor drainage and lack of proper soling was identified by stakeholders as an issue of concern that could lead to degradation of watersheds by increasing erosion and stream sedimentation. Activities to improve road drainage and rehabilitate cut and fill areas will decrease erosion and consequent stream sedimentation.

Objective 2. To maintain quality of drinking water within the limits set by Bhutan Drinking Water Quality Standards 2016.

Output 2.1: Waste in the Lower Chhoekhor watershed managed in conformity with waste regulations 2012.

Waste around water sources associated with open cattle grazing and stray dogs adversely affects water quality. Therefore, activities are required to reduce the number of free ranging cattle and stray dogs to protect water sources from pollution.

Output 2.2: Water tapping point above settlements (Lamaegonpa and Dekiling)

The drinking water source for Chamkhar municipality being located below the UWICER, Lamaegonpa, was highlighted as an issue of concern. There is a need for a common water tapping point above the Institute to prevent any likely impact on the water quality.

Objective 3: To provide irrigation water for present and future needs .

Output 3.1: Infrastructure for irrigation water in place for present and projected future demands.

The insufficiency of irrigation water was attributed to poor irrigation infrastructure such as earthen irrigation channels and wooden channel connections in some sections of the channel system. Activities to improve the irrigation infrastructure are important to ensure irrigation water for present and future needs.

5.3. Activities

The outputs and activities to achieve the objectives and contribute to the goal along with verifiable indicators, responsible agencies and an indicative budget are in Annex 7.1. This is the core part of the watershed management plan for implementation.

5.4. Implementation mechanism

The plan should be implemented from July 2018-June 2023 (12th FYP). The implementation activities in the plan should be mainstreamed in to five year and annual plans of the dzongkhag, gewog, Bumthang Forest Division and Watershed Management Division as indicated in logframe matrix. The CFO, Bumthang Territorial division will take the overall ownership of the plan and coordinate with Dzongkhag Administration to incorporate the identified activities in to FYP. The total fund required for implementation of the plan is estimated at Nu 46.62million.

5.5. Monitoring and Evaluation

The current plan is for a five years period. The monitoring and implementation of the activities will be carried out by identified agencies in logframe matrix. Evaluation of the impact of the management plan and extent to which it has achieved its objectives and contributed to the overall goal will be carried out by WMD. The plan will be reviewed and amended by WMD in collaboration with field offices based on the feedbacks from monitoring and evaluation reports. WMD shall carry out monitoring and evaluation in collaboration with Bumthang Forest Division.

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7. ANNEXES

7.1. Logframe matrix with activities, outputs and indicative budget

Outputs	Activities	Verifiable indicators	Responsible agency/person for implementation	Local area based plan	Budget[4] (M Nu)
1. *Objective 1.* Forest areas in Lower Chhoekhor watershed managed to minimize degrading influences (actual and potential) in conformity with FNCR.					
1.1. Territorial division staff and communities with capacity to plan, implement, and monitor forest management plans (FMU, CFs, LFMP, Forest fires)	1.1.1. Carry out 2 times training course on silviculture systems to forestry staff (40) and 3 CFMGs	Training report	Bumthang Territorial Division	Bumthang Territorial Division annual plans	2.0
	1.1.2. Carry out refresher course on preparation of annual Operational Plans for FMU) for 20 staff	Training report	Bumthang Territorial Division	Bumthang Territorial Division annual plans	0.4
	1.1.3. Carry out training on Local Forest Management Plan for 20 staff	Training report	Bumthang Territorial Division	Bumthang Territorial Division annual plans	0.4
	1.1.4. Carry out refresher course on CF management planning (20 staff)	Training report	Bumthang Territorial Division	Bumthang Territorial Division annual plan	0.4
	1.1.5. Carry out awareness programs on forest fire (one time)	Report	Bumthang Territorial Division	Bumthang Territorial Division annual plans	0.3

[4] The indicated budget is approximate only and will differ at the time of implementation of the work activity.

	1.1.6. Procure forest firefighting equipment	Procurement lists	Bumthang Territorial Division	Bumthang Territorial Division annual plans	0.4
1.2. Local Forest Management Plan (LFMP) operational for Lower Chhoekhor watershed	1.2.1 Prepare Local Forest Management Plan (LFMP) for forest areas outside management regimes within the watershed	Management Plan	Bumthang Territorial division	Bumthang Territorial Division annual plan	0.2
	1.2.2 Implement the LFMP	Resource allotment record	Bumthang Territorial division	Bumthang Territorial Division annual plan	0.1
1.3.Knowledge of the effectiveness of forest management plans	1.3.1 Assess the effectiveness of FMU, CF plan, and LFMP (regeneration after logging, maintaining stream buffer, compliance with watershed protection activities)	Assessment report	Coordinated by Bumthang Territorial Division (consisting of team from WMD/SFED/FRMD)	Bumthang Territorial Division annual plan	0.2
1.4.Roads within Lower Chhoekhor watershed constructed and maintained in conformity with EFRC guidelines	1.4.1 Construct drainage for the farm roads and approach roads	Field report	Dz. Administration(User's group) and thromde	Dz Annual Plans and thromde plans	12.81 (Estimates in Annex 7.5)
	1.4.2 Maintain drainage for the farm roads	Field report	Dz. Administration(User's group) and thromde	Dz Annual Plans and thromde plans	
	1.4.3 Carry out bio-engineering works along roads 51.5 km	Field report	Dz Administration(User's group) and thromde	Dz Annual Plans and thromde plans	1.3 (Estimaes in Annex 7.6)
	1.4.4 Form farm road user's group	No. of user's groups	Geog Adm. (Agriculture)	Geog Annual Plans	0.1
2. *Objective 2.* To maintain quality of drinking water within the limits set by Bhutan Drinking Water Quality Standards 2016					

2.1. Waste in Lower Chhoekhor watershed managed in conformity with waste regulations 2012	2.1.1. Endorse and implement waste management plan in SRF	Compliance report	Bumthang Territorial Division	BTD annual plans	1.0
	2.2. Conduct awareness cum cleaning campaign on waste management in Bumthang municipal area	report	Dz. Adm. (Environment), Bumthang and Municipality	Dz. Annual plans	0.15
	2.2.1. Construct tertiary treatment plant [5]	Plant constructed	Dz. Adm (Municipality and Environment)	Dzongkhag Plan	Beyond the scope of the plan
	2.2.2. Conduct sterilization campaign of dogs twice year	Sterilization report	Dz. Adm (Livestock sector)	Dz. Annual plans	0.40/year
	2.2.3. Conduct AI services to reduce free range grazing	Record of AI services	Dz. Adm (Livestock sector)	Dz. Annual plans	0.5
	2.2.4. Develop improved pasture to reduce free range grazing	Acreage of improved pasture	Dz. Adm (Livestock sector)	Dz. Annual plans	1.0
	2.2.5. Sterilize scrub bulls	Annual livestock census	Dz. Adm (Livestock sector)	Dz. Annual plans	0.3
	2.2.6. Conduct AI refresher course (6 AI technician)	Training report	Dz. Adm (Livestock sector)	Dz. Annual plans	1.0
2.2 Water tapping point above settlements (Lamaegonpa and Dekiling)	2.2.7. Identify common water tapping point for UWICER and municipal at Lamaegonpa	Agreement document	Dz. Municipal	Dz. Annual plans	0.05
	2.2.8. Procure material and construct reservoir	Reservoir/tapping point	Dz. Municipal	Dz. Annual plans	0.3
	2.2.9. Relocate water tapping point at Rongrong chhu for municipal and rural use	New tapping point	Dz. Municipal	Dz. Annual plans	0.05
	2.2.10. Procure material and construct reservoir	New tapping point	Dz. Municipal	Dz. Annual plans	0.3

[5] This is considered high priority for maintaining water quality. But it is beyond the scope of watershed management plan.

	2.2.11. Fence drinking water tapping point	Fence	Dz. Municipal	Dz. Annual plans	0.1
Objective 3: To provide adequate irrigation water for present and future needs					
3.1 Infrastructure for irrigation water in place for present and projected future demands	3.1.1 Conduct community consultations on irrigation water demand.	Consultation record	Dz. Adm (Agriculture Sector)	Dz. Annual plans	0.20
	3.1.2 Carry out the study of trends of the irrigated cropping pattern and water need through surveys (such as paddy, vegetables, fodder crops, horticulture, etc)	Study report	Dz. Adm (Agriculture) in collaboration with Livestock Sector), Bumthang Territorial Division, and DoA (Engineering cell)	Dz. Annual plans	0.60
	Repair 12.83 kms of irrigation channels	Kms of repaired channels	Dz Adm. (Agriculture)	Dz Annual Plan	20.76 (Estimates in Annex 7.7)

7.2. Result of rapid watershed assessments

The report compiled by watershed management division indicates that total of 194 streams/tributories were assessed along Chamkharchhu sub-basin. 176 were assessed by Bumthang Dzongkhag Forestry Sector while 18 were assessed by Zhemgang Forestry Sector. the report indicates that all watersheds along the Chamkharchhu sub-basin are in good condition with the score of all assessed streams above normal or pristine. None of the streams assessed falls in critical category. 54 streams were pristine while 140 were assessed normal in Chamkharchhu sub-basin.

Table 5: Condition of watersheds along Chamkharchhu sub-basin

Condition	Bumthang	Zhemgang	Total streams
Pristine	54	0	54
Normal	122	18	140
Critical	0	0	0
Total streams	176	18	194

Total=11 watersheds in Chamkharchhu sub-basin

7.3. Observations of water quality parameters (pH, turbidity, chlorine), Feb-Aug 2016

Measurement Point	pH (acceptable range 6.5-85)							Turbidity (0-5)							Chlorine (0.2-0.5)					
	Feb	Mar	April	May	June	July	Aug	Feb	Mar	April	May	June	July	Aug	Mar	April	May	June	July	Aug
Lamegonpa (source)	7	7.2	7.2	6.8	7	7.2	7	0.54	0.1	0.1	0.5	1.45	0.54	0.04	0.1	0.3	0.3	0.1	0.3	0.2
Chamkhar Town (tap)	7	7.2	7.6	6.8	7.8	7.6	6.8	0.39	0.03	0.3	0.4	0.5	0.5	0.4			0	0.1	0.1	0
Nasphel (source)	7.2	7.4	7.8	7	7.5	7.2	7	0.55	0.34	0.11	0.5	0.19	0.55	0.55	0.22	0.1	0.5	0.1	0.5	0
Hospital Area (tap)	7	7.4	7.5	7	7	7	6.8	0.4	0.21	0.3	0.4	0.46	0.3	0.05	0.2	0.3	0.3	0.3	0.3	0
Dekiling (tap)	7	7	7	7	6.5	7	7	0.33	0.31	0.2	0.5	0.05	0	0.33			0.5	0.1	0.1	0
Tamzhing Dratshang Tap)	6.8	7.2	7.4	7	7.5	6.8	6.6	0.39	1.73	0.4	0.5	0.05	0.39	0.4			0	0.1	0.1	0
Tamzhing Dratshang (source)	6.8	7.2	7.2	7	6.9	6.8		0.33	0.6	0.28	0.4	0.19	0.33		0	0	0	0		

7.4. Issues from the stakeholders, stakeholder consultation workshop

Chiwog	Issues	Location	Causes	Solution
Norgang	unsafe drinking water	Changwa, Norbugang, Jambaylhakhang	lack of land cover	1. Plantation filtration tank at source 2. water treatment
Thromdey	insufficient irrigation water	Wangdicholing	seepage	maintenance of drainage system
5 chiwogs	human wildlife conflict	5 chiwog	1. Rise in wildlife population 2. Easy availability of food 3. human encroachment	1. Electric fencing 2. Study wildlife population dynamics 3. Wildlife population thinning
5 chiwogs	illegal logging	5 chiwogs	1. Easy access to market 2. Increase in developmental activities 3. Rise in use of bukhari 4. Increase in number of power chain users	1. Strict monitoring 2. strict implementation of policies and rules 3.Promote community vigilance
5 chiwogs	poor waste management (both terrestrial and aquatic)	2 chiwogs	1. Inadequate facilities such as low collection frequency/insufficient dustbins/lack of transport 2. Mind set 3. resource constraint	1. Enhance waste management facilities 2. Allocate sufficient resources (both human & financial) 3. continued awareness
5 chiwogs	Heavy usage of chemical fertilizer	5 chiwogs	1. Easy access & availability 2. Non-compliance to green polices 3. Insufficient awareness 4. Enhance productivity	1. Promotion of organic farming 2.setup demo plots and enhance advisory programs 3. Subsidized organic fertilizers 5.promote farmyard 6. promote recycling manure of kitchen waste to organic fertilizer
5 chiwogs	Open grazing :creating nuisance and waste	5 chiwogs	1. adjoining rural-urban boundary 2.Developments 3.Religionous sentiments	1. Awareness 2. Impose fine 3. comply with DT resolutions
Thromdey	effluent discharge directly into water bodies	Thromdey	1. Lack of awareness 2. lack of water treatment plant	1. Enhance awareness 2. Designate proper waste (liquid) disposal site. 3. Proper sludge treatment plant.

7.5. Farm roads status and maintenance estimates

Chiwog	Name of FR Connecting Chiwog	Start point	End Point	Length (km)	HH Beneficiaries	Year of Construction	Maintenance		Distance (m)	Budget Estimate (Nu. in M)	Remarks
							Yes	No			
Chokhhortoe	Chokhortoe	Zangtherpo	Thangbi	17	146	2003-2004		□			budgeted in 2016-17
Nasphel	Dorjibee	Tamshing	Dorjibee	5.7	64	2003-2004	□		450		Pangray to Dorjibi
STONE SOLING (3m WIDE & 0.25m THICK) INCLUDING STONE EDGING										0.45	
V-SHAPED EARTHEN DRAIN (DEPTH 0.5m & 0.6m WIDE)										0.01	
TOTAL										0.46	
Thromdey	Gadong	Jakar Lhakhang	Gadong	1.5	32	2003-2004	□		560		
STONE SOLING (3m WIDE & 0.25m THICK) INCLUDING STONE EDGING										0.56	
V-SHAPED EARTHEN DRAIN (DEPTH 0.5m & 0.6m WIDE)										0.01	
TOTAL										0.57	
Nasphel	Norgang	Jambay Lhakhang	Norgang	1.06	30	2005-2006	□		730		
STONE SOLING (3m WIDE & 0.25m THICK) INCLUDING STONE EDGING										0.73	
V-SHAPED EARTHEN DRAIN (DEPTH 0.5m & 0.6m WIDE)										0.02	
TOTAL										0.74	
Tamshing	Tekarshong	Riribee	Tekarshong	1.8	13	2005-2006	□		1150		
STONE SOLING (3m WIDE & 0.25m THICK) INCLUDING STONE EDGING										1.14	
V-SHAPED EARTHEN DRAIN (DEPTH 0.5m & 0.6m WIDE)										0.03	
TOTAL										1.17	
Tamshing	Pesiling – Changbi	Changbi	Pasiling	8	22	2006-2007	□		1500		

STONE SOLING (3m WIDE & 0.25m THICK) INCLUDING STONE EDGING										1.49	
V-SHAPED EARTHEN DRAIN (DEPTH 0.5m & 0.6m WIDE)										0.04	
TOTAL										1.53	
Nasphel	Kharshingtsawa	Jakar dzong	Kharshing tsawa	2.3	38	2007-2008		□			Budgeted in 2016-17 (package)
Chokhh ortoe	Nasphel	Dekiling	Nasphel	3	26	2008-2009	□		1700		
STONE SOLING (3m WIDE & 0.25m THICK) INCLUDING STONE EDGING										1.69	
V-SHAPED EARTHEN DRAIN (DEPTH 0.5m & 0.6m WIDE)										0.04	
TOTAL										1.73	
Nasphel	Poengana	Bemzur	Poengana	2	15	2010-2011	□		840		
STONE SOLING (3m WIDE & 0.25m THICK) INCLUDING STONE EDGING										0.84	
V-SHAPED EARTHEN DRAIN (DEPTH 0.5m & 0.6m WIDE)										0.02	
TOTAL										0.86	
Nasphel	Changwa	Nasphel	Changwa	3.1	35	2011-2012	□		2100		
STONE SOLING (3m WIDE & 0.25m THICK) INCLUDING STONE EDGING										2.09	
V-SHAPED EARTHEN DRAIN (DEPTH 0.5m & 0.6m WIDE)										0.05	
TOTAL										2.14	
Thromdey	Wangdicholing- Jateng	Hotel Ugyenling	Jateng	2	37	2011-2012	□		1450		
STONE SOLING (3m WIDE & 0.25m THICK) INCLUDING STONE EDGING										1.44	
V-SHAPED EARTHEN DRAIN (DEPTH 0.5m & 0.6m WIDE)										0.04	
TOTAL										1.48	
Tamshing	Tamshing	Tamshing	Jaslurthang	2	20	2014-2015	□		380		
STONE SOLING (3m WIDE & 0.25m THICK) INCLUDING STONE EDGING										0.38	
V-SHAPED EARTHEN DRAIN (DEPTH 0.5m & 0.6m WIDE)										0.01	
TOTAL										0.39	

Nasphel	Norgang-Zargangtakpa	Norgang	Zargnagtakpa	1	6		□		1000		Pliable only in Winter
STONE SOLING (3m WIDE & 0.25m THICK) INCLUDING STONE EDGING										1.00	
V-SHAPED EARTHEN DRAIN (DEPTH 0.5m & 0.6m WIDE)										0.02	
TOTAL										1.02	
Nasphel	Jamaby lhankhar-Norgang	Jamabylhakhang	Norgang	1.06			□		700		
STONE SOLING (3m WIDE & 0.25m THICK) INCLUDING STONE EDGING										0.70	
V-SHAPED EARTHEN DRAIN (DEPTH 0.5m & 0.6m WIDE)										0.02	
TOTAL										0.71	
		Total		51.5	484.0				12560	12.81	

7.6. Estimates for bioengineering works of farm roads

Estimates as per chapter V, Bio-engineering/land management works of "Norms and standards for Nursery and Plantation 2016" (SFED, DoFPS)

Location: Farm roads

Area: 51.5 Km

Daily wages: 215/Day

Sl. No.	Items of Work	Units	Man-Days for Bio-engineering	Rate (Nu.)	Total Amount (Nu.)
1	Cutting				
a	Cutting and collection of live/vegetative cuttings from forest and siding in one place	Man-Days	258	215	55470
b	Manual carriage of live/vegetative cutting from forest to road head and from road head to site (1Km)	Man-Days	129	215	27735
c	planting of cuttings with making of crowbar hole	Man-Days	258	215	55470
Subtotal-A					138675

2	Bamboo rhizome				
a	Uprooting, collection and siding of bamboo rhizomes in gunny bags from forest	Man-Days	321	215	69015
b	Manual Carriage of bamboo rhizomes from forest to road head and from road to site (1Km distance)	Man-Days	321	215	69015
c	Digging of pits for bamboo rhizomes	Man-Days	321	215	69015
d	Planting of bamboo rhizomes	Man-Days	350	215	75250
				Subtotal-B	282295
3	Grass slip				
a	Collection of grass slips (5 bundles)	Man-Days	500	215	107500
b	Carriage of grass slips (1 Km distances)	Man-Days	250	215	53750
4	Wilding				
a	Uprooting, collection and wrapping of wildings in gunny bags	Man-Days	250	215	53750
b	Manual carriage of wildings from forest to road head and from road to site (within 1Km distance)	Man-Days	250	215	53750
Subtotal-C					268750
5	Check Dams				
a	Dry rubble stone check dam	Man-Days	800	215	172000
b	Log check dams	Man-Days	800	215	172000
				Subtotal-D	344000
6	Material Cost				
a	Logs (154.89 per CFT)	CFT	1000	154.89	154890
b	Nail	Kgs	15	125	1875
c	Binding wire	Bundle	1	550	550
				Subtotal-E	157315
7	Cost of Nursery Tools				
a	Sickle	Nos.	5	150	750

b	Axe	Nos.	3	600	1800
c	Knife (Patang)	Nos.	6	500	3000
d	Prunning Scissors	Nos.	2	2000	4000
e	shovel	Nos.	10	500	5000
f	Spade	Nos.	10	150	1500
				Subtotal-F	16050
				Grand Total	1207085

7.7. Irrigation channels status and maintenance estimates

Name of the Irrigation channel	**length (KM)**	**Present status**	**Year of renovation**	**Usage**			**Maintenance**		**Distance (m)**	**Budget Estimate (Nu. in M)**	**Remarks**
				Horticulture	Cereal	Pasture	Yes	No			
Jakar-Chamkhar	1.50	Functional	2005-2006	□	□	□		□	1100		
HAND EXCAVATION OF TRENCHES FOR IRRIGATION PIPES										0.20	
LAYING OF IRRIGATION PIPES (HDPE PIPES PRESSURE CLASS 6kg/sq.cm 225mm)										3.06	
TOTAL										3.25	
Nasphel-Wangdich oling	1.00	Functional	2005-2006	□	□	□	□		850		
HAND EXCAVATION OF TRENCHES FOR IRRIGATION PIPES										0.15	
LAYING OF IRRIGATION PIPES (HDPE PIPES PRESSURE CLASS 6kg/sq.cm 225mm)										2.36	
TOTAL										2.51	
Pangrey and Dorjibee	0.93	Functional	2005-2006	□	□	□	□		760		Require pipe due to fragile landscape and damage by livestock

HAND EXCAVATION OF TRENCHES FOR IRRIGATION PIPES										0.14	
LAYING OF IRRIGATION PIPES (HDPE PIPES PRESSURE CLASS 6kg/sq.cm 225mm)										2.11	
TOTAL										2.25	
Changwa	1.00	Functional	2003-2004	□	□	□	□		590		
HAND EXCAVATION OF TRENCHES FOR IRRIGATION PIPES										0.11	
LAYING OF IRRIGATION PIPES (HDPE PIPES PRESSURE CLASS 6kg/sq.cm 225mm)										1.64	
TOTAL										1.74	
Tamzhing Kenchosum	1.00	Functional	2003-2004	□	□	□	□		850		
HAND EXCAVATION OF TRENCHES FOR IRRIGATION PIPES										0.15	
LAYING OF IRRIGATION PIPES (HDPE PIPES PRESSURE CLASS 6kg/sq.cm 225mm)										2.36	
TOTAL										2.51	
Kharsum	1.00	Functional	2003-2004	□	□	□	□		680		
HAND EXCAVATION OF TRENCHES FOR IRRIGATION PIPES										0.12	
LAYING OF IRRIGATION PIPES (HDPE PIPES PRESSURE CLASS 6kg/sq.cm 225mm)										1.89	
TOTAL										2.01	
Jalikhar	2.20	Functional	2005-2006	□	□	□	□		1200		
HAND EXCAVATION OF TRENCHES FOR IRRIGATION PIPES										0.21	
LAYING OF IRRIGATION PIPES (HDPE PIPES PRESSURE CLASS 6kg/sq.cm 225mm)										3.33	
TOTAL										3.55	
Gonkhar	3.20	Functional		□	□	□	□		150		Require additional pipe
HAND EXCAVATION OF TRENCHES FOR IRRIGATION PIPES										0.03	
LAYING OF IRRIGATION PIPES (HDPE PIPES PRESSURE CLASS 6kg/sq.cm 225mm)										0.42	
TOTAL										0.44	
Wangdicholing-Jakarlhakhang	1.00	Functional	2005-2006	□	□	□	□		840		

HAND EXCAVATION OF TRENCHES FOR IRRIGATION PIPES										0.15	
LAYING OF IRRIGATION PIPES (HDPE PIPES PRESSURE CLASS 6kg/sq.cm 225mm)										2.33	
TOTAL										2.48	
TOTAL	12.83								7020	20.76	

7.8. Record of stakeholder consultations

Date	Place	Stakeholders	No. of participants	Output
March 2015	Thimphu, WMD	CFO, Specialist, and other staff of WMD	12	Start of the project Awareness on watershed & PES Team formed to conduct awareness and train on Guideline for Classification of Watershed
April 2015	Bumthang	Dz. RNR Sectors, Dz. Env. Officer, Dzongkhag Engineer, Territorial Division, Tshogpas, Geog RNR staff, Gups, UWICE, RDC Jakar, WMD	30	Project start information Awareness created for on Watershed and PES Mapped Chamkharchhu tributaries in different geogs
	Zhemgang	Dz. RNR Sectors, Dz. Env. Officer, Dzongkhag Engineer, Territorial Division, Geog RNR staff, Gups, , Tshogpas, WMD	35	Project start information Mapped Chamkharchhu tributaries in different geogs
April 2015	Bumthang	DzFO, Geog RNR staff, WMD	25	Trained on use of 'Guideline for Classification of Watershed' and to assess the watershed
	Zhemgang	DzFO, Geog RNR staff, WMD	14	Trained on use of 'Guideline for Classification of Watershed' and to assess the watershed
Octobe r 2015	Thimphu (WMD in-house)	CFO, Specialist, and other WMD staff	12	Probable selection of watershed by function for detail planning in Chamkhar town watershed. Likely expansion of town in the future from tourisms, domestic airports, resorts and Buddhist institutions.

November 2015	Bumthang	RNR sector heads, Geog RNR extension agents, Dz. Environmental Officer, and Gog Adm. Officers of Bumthang an Zhemgang, UWICE, RDC-Jakar, WMD	40	Result sharing of rapid watershed assessment report with stakeholders Chamkhar town watershed selected for detailed assessment by function Field core team for detailed assessments formed (Dz, TDs, UWICE, Respective RNR, WMD)
March 2016	Bumthang	RNR sector heads, Geog RNR extension agents for Chhoekhor, Dz. Environmental Officer, and District Engineer, Municipality, Territorial division and DzFOs of Bumthang and Zhemgang, UWICE, WMD	20	To update and review the progress of detail watershed assessment To identify the missing data and information gaps To seek any issues and problems related to watershed regimes within watershed from the stakeholders for the management plan
June 2016	Paro	RNR sector heads, Geog RNR extension agents, Dz. Environmental Officer, and District Engineer, Territorial division and DzFOs of Bumthang and Zhemgang, UWICE, WMD	18	Status update of Ecolife project, sharing of the results and lessons from water source survey and mapping and future interventions, Finalization of new activity proposal from Bumthang division for WWF Pre-write-shop for upcoming watershed management plan, review of data progress, identify data gaps, plan for next write-shop
May 2017	Bumthang	RNR sector heads, Geog RNR extension agents, Dz. Environmental Officer, and District Engineer, Territorial division and DzFOs of Bumthang and Zhemgang, UWICE, WMD	15	Stakeholder consultation and endorsement of the plan
June 2017	Thimphu	TAC members	12	Validation of the watershed management plan by Technical Advisory Committee (TAC), Department of Forests and Park Services, MoAF