BHUTAN: NAPA PROJECT PROFILE

BHUTAN

NAPA PRIORITY PROJECT NO. 1

DISASTER MANAGEMENT STRATEGY- PLANNING FOR FOOD SECURITY AND EMERGENCY MEDICINE TO VULNERABLE COMMUNITIES.

RATIONALE

In times of disasters due to landslides, flood, drought and other forms of natural disaster, it is not only human lives that are endangered as an immediate impact of the hazard, but more often how well relief efforts are coordinated that determine the success or failures in managing disasters.

A well managed relief strategy will not only require a rapid response team in health services with the capacity to institute effective Emergency Medicine and First Aid, but also a well planned food reserve and distribution network to operate efficiently for at least six months.

For example the climate related disasters of the six eastern Dzongkhags in 2004 witnessed major loss of lives, damage to properties and houses, loss of over 660 acres of agriculture land, and loss of standing crops for over 1430 households. Infrastructure such as irrigation channels, power transmission facilities, bridges, farm and feeder roads were significantly damaged**.**

In order to cope with such vulnerabilities from climate change impacts, it is imperative to establish both a network of food reserve stocks in key areas of eastern Bhutan with an efficient distribution system to cover a minimum of six months period; and an emergency medicine and first aid to cater to the vulnerable groups.

DESCRIPTION

Objectives

The objective of the project is to plan and implement components of the national disaster management strategy as concerns emergency food security, medicines and first aid in few pilot districts in eastern Bhutan.

Activities

- Mapping of vulnerable areas of potential land slide and floods in the vicinity of settlements
- Identification of potential areas for resettlement of villages
- Put in place a National Disaster Management Strategy
- Formulation of National Emergency Medical Services Strategy at National as well as Dzongkhag level
- Consolidating and strengthening institutional arrangements at national and local levels – for example creation of rapid response for food distribution and medical teams at all levels
- Training of Emergency Medical Teams (EMTs) in country
- Procurement of equipment – ambulance, communication sets, equipment, First Aid Kits, EMT Uniform, teaching materials
- Introduction of EMS in pre-service curriculum at Royal Institute of Health Sciences (RIHS)

Inputs

Inputs include technical and financial assistance, equipments and institutional support.

Short term outputs

- Information on cause-effect relation on physical changes caused by various factors such as population pressure, deforestation, over-grazing, intentional forest fires and poor land management is available;
- A national disaster management strategy policy and strategy in place;

- Immediate response to any disasters;
- Many lives saved due to immediate medical intervention;
- Enough human resource trained in managing disasters.

Long term out puts

- A rapid food distribution system to cover a minimum of six months period in any given situation in place facilitated through a network of food reserve stocks in different parts of the country;
- Clear policy directives and institution of functional support and management structures established;
- Well-defined operational plans and systematic implementation strategies established;
- The health sector emergency plan closely linked with the other national disaster plans which will/may be put into operation by the Royal Government ;
- Functional Trauma centers strengthened and established;
- Health Department in collaboration with the Dzongkhag health sectors ensures a heightened level of preparations in order to respond optimally for any disaster situation;
- Adequate community understanding and participation sought so that there is critical support in terms of providing physical support and blood donations;
- Institutional arrangements at national and local levels in place for rapid response for food distribution and medical services in case of natural disasters through climate change.

IMPLEMENTATION

Institutional arrangements

The project will be implemented by the Ministry of Home and Cultural Affairs in partnership with Ministry of Agriculture, Ministry of Health and other stakeholders such as the Ministry of Works and Human Settlement, Dzongkhag (Local) Administrations and relevant communities.

Risks and barriers

There are no major risks foreseen in the implementation of the project.

Monitoring and evaluation

Monitoring and evaluation of the project will be carried out as per the normal RGOB procedure.

COST

The project cost is estimated at USD 620,000

Budget breakdown

Activities	Year 1 (USD)	Year 2 (USD)	Year3 (USD)
A. Food security			
Survey and data collection for the study on cause and effect of physical changes caused by various factors such as population pressure, deforestation, overgrazing, intentional forest fires and poor land management	23 255	-	-
Draft report and workshops on the above study, publication	-	18 600	-
Formulation of a national disaster management strategy and policy (workshops and seminars)	-	14 000	-

Institutional support to MoHCA and MoA for emergency disaster management	-	-	23 255
Subtotal	**23 255**	**32 600**	**23 255**
B. Emergency medical			
Formulation of National Emergency Medical Services Strategy - consultative workshop	10 000	10 000	**-**
Training of Emergency Medical Teams (EMTs) in country	30 000	30 000	**-**
Training of Medical Doctors & Nurses on Trauma Management in country	20 000	20 000	**-**
Training of Trainers (TOT) on EMS	30 000	30 000	**-**
Observation Tours to other centers in the region	25 000	25 000	**-**
Strengthening the 3 Trauma Centres	60 000	60 000	**-**
Training of Ambulance drivers on basic first aid	5 000	5 000	**-**
Strengthen the medical rehabilitation center at Gidakom	30 000	30 000	**-**
Procurement of logistics – ambulance, communication sets, equipment, EMT & First Aid Kits, EMT Uniform, teaching materials	60 000	60 000	**-**
Sub-total	**270 000**	**270 000**	**-**
Total (A+B)			**619 110**

BHUTAN

NAPA PRIORITY PROJECT NO. 2

ARTIFICIAL LOWERING OF THORTHORMI GLACIER LAKE

RATIONALE

Based on the detailed assessment[1] of hazard potential of Raphstreng and Thorthormi glaciers and its lakes, it was found that there is the probability of a worse case scenario in the near future of a Glacial Lake Outburst Floods or GLOF – possibly occurring in the next ten years originating in the Thorthormi area, unless urgent mitigation measures are taken. Near the terminus of the Thorthormi glacier several interconnected surpraglacial lakes have been observed; due to fast melting these lakes are expanding rapidly and it is assumed that soon these lakes will form one large proglacial lake. The worst case scenario being that a combined GLOF of these lakes could result in a flow of over 53 million cubic meters of water- that is more than twice the volume of the 1994 Luggye GLOF event with unimaginable consequences down stream. Thus to reduce the risk of a future GLOF originating at the Thorthormi lake, it is seen that means of artificial lowering should be explored.

DESCRIPTION

Objective

The main objective is to lower the water level of the Thorthormi Lake by excavating an artificial channel- widening of the existing outlet channel.

Activities

- Plan of field work and logistics;
- Finalization of the design of spillway channel;
- Stability assessment of the spillway channel;
- Coordination with Dzongkhag and *geog* officials;
- Recruitment of labour (20 working groups of 14 workers each);
- Establish water diversions, by building coffer dam, to allow dry working conditions for building of outlet channel;
- Stabilization of channel side slopes;
- Handing over to local officials for monitoring and maintenance.

Inputs

The main inputs include human labour, financial resources, excavating tools and equipment, cable car, computers and accessories.

Short-term outputs

- Water diversions built and functioning
- Outlet channel built
- Lowered water levels of Thorthormi and adjoining lakes
- Staff trained to monitor and maintain the artificial lowering systems

[1] Brauner et al (2003), Technical GLOF Mitigation Measures Thorthormi Outlet, Dept. of Geological Science, University of Vienna, Austria, October 2003.

Potential long term outputs

- GLOF threat from Thorthormi and adjacent lakes reduced below danger levels
- Knowledge and experience in artificial lowering of lakes that can be useful for lowering of water levels in other potentially dangerous lakes across Bhutan

IMPLEMENTATION

Institutional arrangements

The main institution for the implementation of this project will be the Department of Geology and Mines in coordination with Ministry of Agriculture, and Department of Local Governance (Disaster Management Office); also the involvement of the districts of Gasa and Punakha, and the local communities of the Lunana area.

Risks and barriers

- Actual depth of lakes and surface slope are not known- only assumptions made;
- Climate and altitude (above 4000m.a.s.l) make for harsh working conditions;
- Optimal period of working is only about 6 months in a year (May-June- mid October);
- Logistics, 6-7 days trekking from nearest road, all materials and equipment must by manually carried to lake site;
- Possible lack of full local participation from the *geogs* for supply of adequate manpower;
- Timely completion of planned work.

Monitoring and evaluation

Monitoring will be done by the Department of Geology and Mines.
The project steering committee will evaluate performances on a quarterly basis via meetings on progress and expenditures.

COST

Funds for the project are estimated at USD 3,190,000

Budget breakdown

Activities	**Year 1** (USD)	**Year 2** (USD)	**Year 3** (USD)	**Year 4** (USD)
Labour Cost	412 558	412 558	412 558	412 558
Transportation costs (Yak and horses)	57 720	36 632	36 632	36 632
Helicopter transport of PE pipes	97 674	-	-	-
PE low pressure pipes	25 116			
Medical equipment	5 813	1 162	1 162	1 162
Provision	34 883	34 383	34 383	34 383
Technical equipment	93 023	23 255	23 255	23 255
Rental charges for storage place in project site and at Thimphu, insurance for transportation of equipments	23 255	23 255	23 255	23 255
Improvement in trekking route	4 651	2 325	2 325	2 325
Contingencies (Assumed based on information from Raphstreng Lake mitigation and Austrian expeditions (20%))	15 093	106 813	106 813	106 813
Capacity building		50 000		

Total Project Cost	**769 790**	**690 384**	**640 384**	**640 384**

BHUTAN

NAPA PRIORITY PROJECT NO. 3

WEATHER FORECASTING SYSTEM TO SERVE FARMERS AND AGRICULTURE

RATIONALE

Agriculture depends on the mean climate of a particular region. Each production unit of agriculture has its own climate requirement for growth and development; and any large-scale deviation exerts a negative influence. Extreme climate conditions also negatively impact agricultural production through the development of pests and diseases. Although natural disasters resulting from climatic extremes cannot be averted, their destructive impacts in terms of losses in production and productivity can be greatly minimized. Planning and management for adaptation, prevention and mitigation of extreme events are crucial for the safety and well-being of the vulnerable communities who live in disaster-prone areas.

Accurate and timely information on extreme meteorological events is critical to farmers in maximizing their production by making appropriate decisions in their production environment, setting up protective mechanisms and scheduling inputs and activities effectively. The successful development of Bhutan's agricultural economy is, therefore highly dependent on the use of climatic and synoptic weather information, particularly on adverse meteorological factors. Such information can be used in the development of proactive and responsive adaptation strategies that can minimize the adverse impacts of extreme climate conditions.

Agriculture in Bhutan is completely dependent on the prevailing weather conditions determined largely by the influences of high Himalayas and the South-west Monsoon circulation. Notwithstanding the magnitude and spatial characteristics of the system, even a slight deviation in the monsoon onset and retreat can result in significant changes in agricultural productivity. Without the capacity to monitor and understand the dynamics of these weather manifestations, efforts to modernize and sustain agriculture for national food security and as a rural economic sector will not bring about expected returns. Delayed monsoon may result in agricultural drought while an early one may hinder production activities and favour development of pests and diseases. For example temperature extremes, especially at the beginning of the growing season, may destroy the production of an apple orchard for the whole year.

A weather detection, monitoring and early warning system can provide reliable and timely information to the farmers to deal with weather and climatic variability and changes. Seasonal forecasts can support long-range, strategic decisions; while weather forecasts can support short-term, tactical decisions in the agricultural production operations. Special weather forecasts provide the input to assist farmers in making decisions on planting/sowing, application of crop protection chemicals, forestry and forest fire operations, product transportation, and post-harvest operations.

Bhutan, to date, does not have a proper weather or climate forecasting capability. The global forecasts provided by outside systems do not serve the needs of agriculture development in Bhutan as they cannot resolve the geophysical complexity associated with the rugged terrain. Building up the communication and computing resources together with the development of technological competence of meteorological technicians and professionals will enable Bhutan to operationalize its own forecasting and early warning system that accounts for its complex forcing systems. The forecasts will be more accurate with more frequent updates at higher spatial and temporal resolutions. In addition, the weather forecast can be customized to produce agro-meteorological data for the Ministry of Agriculture and its stakeholders.

DESCRIPTION

Objectives

- To set up a weather forecasting office (WFO) with necessary equipment and manpower to provide weather and seasonal forecasts for supporting production decisions of the farmers;

- To provide an agro-meteorological early warning system against inclement weather conditions and provide special advisories at different production stages.

Activities

1. Institutional setup with necessary mandate and program policy and development support;
2. Procurement of tools and equipments to fulfil the communication and computing resource needs;
3. Set up one automated and telemetered synoptic station in each Dzongkhag;
4. Link up to the Global Telecommunication System (GTS) of the WMO to receive regular synoptic data;
5. Install a limited area weather model, such as WRF or MM5 to operationalize a computer-based weather forecasting system;
6. Set up a data assimilation system to ingest observational and satellite data to improve the accuracy of model data;
7. Establish Internet link to the global model data providers for initial and boundary conditions input to the mesoscale LAM model configured for Bhutan's conditions;
8. Set up a data processing and dissemination system;
9. Train technicians and professionals in data compilation, processing and preparing weather forecasts;
10. Train professionals in running and maintenance of the forecast models, postprocessing and development of information products/packages;
11. Train farmers and extension workers in the proper use of the information products and advisories;
12. Forecast verification in association with other WFOs in the region.

Inputs

The main inputs include: professional expertise (TA), enabling policy environment, computer hardware and software, synoptic stations, dedicated internet access, training, human resources, finances, administrative and management support. Information and data input includes global/regional forecast and analysis data, satellite data, GTS data, local synoptic data.

Outputs

- An independent weather forecasting office (WFO) established;
- An optimally distributed network of synoptic stations;
- An operational mesoscale LAM model optimized for Bhutan;
- More accurate weather forecasts up to 15 days;
- Seasonal forecasts for the next three months;
- Forecast guidance materials;
- Regular agro-meteorological advisories;
- Special advisories;
- Internet resources including manuals, guidelines, maps, etc.

Long-term outputs

These include, among others

- Higher agricultural productivity;
- Better working conditions;
- Enhanced food security and standard of living;
- Better use of natural resources;
- Reduced damage to the environment.

IMPLEMENTATION

Institutional arrangements

The Ministry of Agriculture shall implement the project with the establishment of a new WFO under it. The synoptic stations in the Dzongkhags will report at three hourly intervals. The information will be uplinked to the GTS and downlink synoptic observations from others by the central data communication system located at the WFO in Thimphu. The model forecast will run once a day assimilating the latest analysis and forecast boundary conditions. The forecasts and advisories will be available within three hours of the completion of model run.

Risks and barriers

- No government approval to establish the weather forecast office;
- Failure in data uplinks and downlinks;
- Internet connection breakdown;
- Instrument and equipment breakdown;
- Insufficient, inadequate or no provision for training of the technicians and scientists;
- Failure to appreciate the economic value of weather services by the Government, research & development workers, and the farmers;
- Failure to educate the beneficiaries on the prudent use of weather information and advisories.

Monitoring and evaluation

Monitoring and evaluation will be done by the MOA via its established procedures:

- Annual progress report and half-yearly financial report;
- Technical and forecast verification report;
- Survey report of the target beneficiaries;
- Socio-economic impact assessment.

COST

USD 420,000

Budget breakdown

Activities	**Year 1** (USD)	**Year 2** (USD)	**Year 3** (USD)
Installation of 20 synoptic stations	200 000	-	-
Set up operational weather model	50 000	10 000	15 000
Information post processing	5 000	5 000	5 000
Development of Advisories	5 000	5 000	5 000
Information Dissemination	5 000	5 000	5 000
Short-term training	50 000	10 000	10 000
Workshops and seminars	10 000	10 000	10 000
Total Project Cost	**325 000**	**45 000**	**50 000**

BHUTAN

NAPA PRIORITY PROJECT NO. 4

LANDSLIDE MANAGEMENT AND FLOOD PREVENTION (PILOT SCHEMES IN CRITICAL AREAS).

RATIONALE

Bhutan is prone to landslides, flood, drought and other forms of natural disasters which cause loss of human life as well as property and damage to the natural environment. The mountain terrain and the scattered settlements make delivery of services difficult. Incidences of natural disasters and effects from impacts of climate change pose challenges to proper land management. The recent fast paced development of the country combined with the various incidences of climate change has made many areas in Bhutan prone to disasters from landslides, mudslides and flooding.

The last decade witnessed the beginning of major landslides and floods owing to increased rainfall and untimely arrival of monsoon. Entire communities are at risk from landslides in Chaskhar (Mongar) and Ramjar (Trashiyangtse) owing to increased frequency and intensity of rainfall. In addition, every year during the monsoon season landslides cause damage to the major highways of the country (especially the Thimphu-Phuntsholing & Riju-Ranjung roads) disrupting communications, travel, trade and
causing substantial economic loss to the country.

The proposed activities are in areas where there is an urgent needs to intervene and these activities could be replicated in other areas in the country incorporating the lessons learnt from these pilot sites.

DESCRIPTION

Objectives

- To predict and effectively intervene in major landslide affected areas of Bhutan. Key areas to focus are: landslide prone areas of Chaskar (Mongar) and Ramjar (Trashiyangtse), and the critical road links from Phuentsholing- Thimphu, and Riju- Rangjung highways.

Activities

- Mapping of vulnerable areas in terms of potential landslide and floods;
- Assessment of spatial distribution of landslide in the selected areas;
- Identification of potential areas for resettlement for vulnerable communities;
- Development of metrological data center;
- Assessment of strength parameter of geological materials;
- Explore early warning technologies for occurrence of landslide;
- Initiate long term collaborative scientific cause-effect study to generate disasters related to river inundation, floods and landslides;
- Implement landslide prevention activities such as cross drainage, plantations and intermediate river training as well as bank and bed protection;
- Institutional capacity strengthening (GIS, geotechnical lab tests, data acquisition and analysis).

Inputs

The inputs include technical and financial assistance, office and field equipments, professional consultants and institutional support.

Short term outputs

- Information on various causes such as: climate change, population pressure, deforestation, over-grazing, intentional forest fires and poor land management;
- Forecasting and early warning system put in place;
- Staff trained to operate and maintain early warning system for landslides;
- Inventory of landslides;
- Landslide hazard zonation and landslide susceptibility maps for the study areas produced;
- Guidelines published on the best practice in the rural access planning and engineering with respect to landslide and slope susceptibility;
- Local land degradation minimized.

Potential long term outcomes

- Proper land management practices developed validated and shared through out the country;
- Local land degradation minimized;
- Erosion control;
- Safe and convenient mode of communication/transportation facilities;
- Increased safety for communication/transportation facilities;
- Development of framework for disaster management system.

IMPLEMENTATION

Institutional arrangements

The project sub-component on Community Protection will be implemented by the Ministry of Agriculture in consultation with the Ministry of Home and Cultural Affairs in partnership withstakeholders such as Ministry of Works and Human Settlement, Dzongkhag (local) administrations and the relevant communities while the other sub-component on Highway/Road Protection will be implemented by the Department of Roads in collaboration with the Department of Geology and Mines, the Department of Energy and the local communities.

Risks and Barriers

- Lack of interest to participate by the rural communities;
- Lack of inputs by various stakeholders not forthcoming.

Monitoring and evaluation

Monitoring and evaluation of the project will be carried out as per the normal RGOB procedure. It will include submission of quarterly progress and financial reports.

COST

The project cost is estimated at USD 0.894 million

Budget breakdown.

Activities	**Year 1 (Part I)** (USD)	**Year 1 (Part II)** (USD)	**Year 2** (USD)
A. Community Protection			
Survey and data collection for the study on cause and effect of physical changes and development of recommendations for Chaskar and Ramjar area.	23 255	-	-

Development of cross drainage and landslide preventive measures (Chaskhar)	-	23 255	-
Development of adequate drainage and plantations (Ramjar)	-	11 628	23 255
Subtotal	23 255	34 883	23 255
B. Highway/Road Protection			
Assessment of landslide	4 651		
Establishing early warning system	348 837		46 511
Strengthening the Geotechnical Unit through procurement of laboratory equipments	69 767		5 814
Capacity building Train staff to man the systems and in all the project activities	69 767		23 255
Professional Service Landslide control Works	23 255		11 628
Project Management Office Equipment Project operation Consultative workshop	139 534		69 767
Subtotal	655 811		156 975
Total (A+B)			**USD 894 179**

BHUTAN

NAPA PRIORITY PROJECT NO. 5

FLOOD PROTECTION OF DOWNSTREAM INDUSTRIAL AND AGRICULTURAL AREA

RATIONALE

Bhutan is prone to landslides, flood, drought and other forms of natural disasters which cause loss of human life as well as damage to property and the environment. The mountain terrain and the scattered settlements make delivery of services difficult. Incidences of natural disasters and effects from impacts of climate change pose challenges to proper land management. The recent fast paced development of the country combined with the various incidences of climate-related events has made many areas in Bhutan prone to disasters from landslides and mudslides.

The last decade witnessed the beginning of major landslides and floods owing to increasing rainfall and untimely arrival of monsoon. Entire communities are at risk in the industrial areas in Pasakha (Chhukha) from landslide and flash floods owing to heavy rainfall and high rates of siltation ; while monsoon flash floods over the years had caused recurrent damage to fertile agricultural land in the Taklai river basin (two Geogs of Chuzagang and Sershong of Sarpang districts). It is estimated that about 1300 ha of cultivable fertile land in the above two geogs could be saved if flood damages could be controlled to allow for a sustained irrigation scheme.

The proposed activities are in areas where there is an urgent need to intervene and these activities could be replicated in other areas in the country incorporating the lessons learnt from these pilot sites.

DESCRIPTION

Objectives

The objectives of the project are to effectively intervene in major landslide and flood affected areas of the country (Pasakha Industrial areas, and the fertile agricultural land of the Taklai river basin) before the areas become both dangerous for human livelihood and infertile for crop productions.

Activities

- Mapping of vulnerable areas in term of potential landslide and floods in the vicinity of settlements;
- Identification of potential areas for resettlement in case of such requirements;
- Initiate long term collaborative scientific cause-effect study to generate information necessary in preparing long term strategies to cope with disasters related to river inundation, floods and land slides;
- Implement landslide prevention activities such as cross drainage, plantations and intermediate river training as well as bank and bed protection in critical areas (Taklai river basin and Pasakha);
- Conduct a detailed study of hydrology and surface water of the Taklai river to determine periodic discharge and flood prediction.

Inputs

The inputs include technical and financial assistance, equipments and institutional support.

Short term outputs

- Information on cause-effect relation on physical changes caused by various factors such as climate change, population pressure, deforestation, overgrazing, intentional forest fires and poor land management;
- Intermediate disaster preventive steps: area maps that show vulnerable sites and places suitable for resettlement;
- Safer areas downstream for both industrial property and protection of agricultural land.

Potential long term outcomes

- Proper land management practices developed, validated and shared through out the country;
- Improved and reliable irrigation canals that can keep large areas of agricultural land fertile and thus increase food production;
- Better knowledge of surface discharge of the Taklai river – that can help in flood predictions and other river training works.

IMPLEMENTATION

Institutional arrangements

The project will be implemented by the Ministry of Agriculture (Taklai River Basin) in consultation with the Ministry of Home and Cultural Affairs and Ministry of Trade and Industry (Pasakha- Singye and barsa Rivers) in partnership with stakeholders such as the Ministry of Works and Human Settlement, Dzongkhag (Local) Administrations and relevant communities.

Risks and Barriers

There are no risks foreseen in implementation of the project.

Monitoring and evaluation

Monitoring and evaluation of the project will be carried out as per the normal RGOB procedure. It will include submission of quarterly progress and financial reports.

COST

The project cost is estimated at USD 0.45 million

Budget breakdown

Activities	**Year 1, I** (USD)	**Year 1, II** (USD)	**Year 2** (USD)
Survey and data collection for the study on cause and effect of physical changes and framing of recommendations (All Sites)	34 883		
Procurement of river training and bed and bank protection machineries (Pasakha, Taklai)	116 280		116 280
Development of permanent diversion headwork for high level intake (Taklai)	58 140	58 140	
Study hydrology and surface water of the Taklai river to determine periodic discharge and flood prediction.	23 255	23 255	23 255
Total	**232 558**	**81 395**	**139 535**

BHUTAN

NAPA PRIORITY PROJECT NO. 6

RAINWATER HARVESTING

RATIONALE

Drought and dry spells are common in the mountainous areas of Bhutan where people depend primarily on rain fed subsistence agriculture. It was, therefore clear that a simple and affordable rainwater harvesting system combined with an integrated approach to improving agricultural production would significantly improve the lives of local farmers. Most farmers have traditionally relied on unfavorably distributed seasonal rainfall. About three-quarter of the rain falls between June and September each year, often in the form of heavy downpours. Due to the rugged terrain and the geological conditions it is both difficult and expensive to divert water from other watersheds. There is water shortage during the most critical part of crop growth and development, particularly during spring when sowing and planting activities are performed. Early or late monsoon can also disrupt the normal schedule of work and progression in the physiological development of plants. Under abnormal weather conditions, water stored during periods of excess availability can safeguard farmers from crop failures, loss of animal productivity and have safe drinking water.

The RWHTs is associated with the process of supplementing domestic/household water requirement through collecting rainwater, treatment and storage as part of a wider drinking water supply program. The purpose in the present context is to ensure that farmers have sufficient water to maintain agricultural production in times of water shortages due to seasonal and inter-annual climate variability or longer-term impact of climate change. Rainwater harvesting may also help control erosion and flooding during periods of excessive rainfall.

There are various technologies adopted successfully in various parts of the world, like:

- Micro-catchment runoff farming water harvesting systems
- Macro-catchment runoff farming water harvesting systems
- Floodwater harvesting runoff farming (also called large catchment water harvesting or spate irrigation)

Some of these techniques and their localized variants are practiced by farmers in Bhutan. However, the scientific rationale and necessary details are often overlooked to effectively realize the potential benefits of these technologies. This proposal is an attempt to bridge the existing gaps and provide an adaptation option to water deficits caused by variability and change in the climate system.

DESCRIPTION

Objectives

To safeguard farmers from water shortages during dry periods and irregularities in the monsoon rainfall, thereby improving household food security and income of farmers living in vulnerable areas.

Activities

- Small scale irrigation development based on RWHTs;
- Strengthen farmers involvement and research and extension services;
- Vulnerability assessment;
- Land survey;
- Rural credit;
- Project management;
- Identification of areas vulnerable to dry spells and erratic monsoon rainfall;

- Arial surveys and evaluation of remote sensing images/photographs to determine areas suitable for water harvesting;
- Assessment of available and proven Rainwater Harvesting Technologies (RWHTs) for adoption;
- Technological adaptation to fit the needs and requirements specific to each vulnerable locations;
- Research new designs and package improved technologies (studying and modeling runoff behavior);
- Establish farmers' capacity to mobilize local resources for technology adoption and actual application;
- Demonstration of emerging technologies like supplemental water system, dual purpose system, combined system, modeling;
- Training farmers in the maintenance of their investments in RWHTs, and effective utilization of harvested rainwater;
- Economic analysis of rain water harvesting techniques.

Inputs

The main inputs are technical expertise; RWHT incorporated structures, farmer's participation, training, research and development, land, labor, finances and credit facilities. Inputs in the technology design include: topography of the area; soil type, texture, water holding capacity, soil depth, infiltration characteristics, hydraulic conductivity; climate data (at least 15 years), evaporation, transpiration; crop, its root depth, growing season, and critical growth stages.

Outputs

- Increased awareness and knowledge of RWHTs among farmers;
- Higher crop and animal productivity under rainfed agriculture;
- Safe drinking water and less health problems;
- Increase in rural income;
- Improved national food security status;
- Synergy with actions under the UNCCD;
- Environmental benefits such as reduced soil erosion, soil salinity and recharge ground water.

IMPLEMENTATION

Institutional arrangements

Implemented by research and development agencies of the MoA in collaboration with farmers, dzongkhag administrations outside technical assistance. Investment in rain-fed areas, policy reform, and transfer of technology such as water harvesting runoff farming require stronger partnerships between agricultural researchers and other agents of change, including:

- local organizations,
- farmers,
- community leaders,
- NGOs,
- national policymakers and
- donors.

Risks and barriers

- Under extreme dry seasons, rain water harvesting may fail;
- Government policy review in view of constructing contemporary irrigation channels vis-à-vis support to runoff farming systems;
- Labor shortage;
- Non-participation from the beneficiaries;
- Cooperation between farmers, the state and the scientific community;

- Insufficient attention to social and economic aspects.

Monitoring and evaluation

This will be done by the MOA via its normal methods of:

1. Progress reports
2. Technical and financial reports
3. Beneficiary interviews
4. Socio-economic impact survey

COST

USD 895,000

Budget breakdown

Activities	**Year 1** (USD)	**Year 2** (USD)	**Year 3** (USD)
Small scale irrigation development based on RWHTs	50 000	100 000	200 000
Strengthen farmers involvement and research and extension services	100 000	150 000	50 000
Vulnerability assessment	25 000	-	-
Land survey	25 000	10 000	-
Rural credit	-	-	150 000
Project management	10 000	10 000	15 000
TOTAL COST	**210 000**	**270 000**	**415 000**

BHUTAN

NAPA PRIORITY PROJECT NO. 7

GLOF HAZARD ZONING (PILOT SCHEME - CHAMKHAR CHU BASIN)

RATIONALE

The Chamkhar Chu River has its source from the glaciers of Gangkar Punsum and the Monla Karchung ranges; a total of 557 glacial lakes have been identified in the Chamkhar Chu Sub-basin with a total glacial lake area of 21.03 sq.km. The whole of Bumthang district is drained by the Chamkhar Chu which flows south towards Zhemgang district to join the Mangdhe chu forming the mighty Manas river. The valley of Jakar today is a key tourist destination both for local Bhutanese as well as for foreign visitors and tourists. The local businesses, hotels, shops, and several cottage industries have steadily increased over the years making it a prosperous district. To the outside world Bumthang is one of the most important Buddhist pilgrimage destinations in the Himalayas as the valley boasts numerous historical monuments, temples, monasteries, and religious sites. Only recently plans have been approved for the town of Chamkhar to be shifted to Dekiling; as with many other areas in the valley this is being done without a proper consideration of GLOF threats. Hazard zonation at this critical stage in the valleys development would prove crucial in the long run, as the valley would be better prepared in the event of a GLOF.

DESCRIPTION

Objectives

The main objective of this project is to prepare a hazard zonation map for GLOF (from Khaktang to Chamkhar town) where the main settlements and developmental activities are taking place at present.

Activities

- Collection of different data set from the field (including data on the existing glaciers and glacial lakes at the headwater), which mainly involves extensive field works
- Comparison of similar works in other regions where similar threat exist and adopt the best suited one for our area
- Acquiring materials for remote sensing works in places of no accessible areas

Inputs

The main inputs in this project includes financial resources, research materials including equipments, human resources and office equipments (computers and accessories) and software for data analysis (like GIS and remote sensing related software).

Short term outputs

- Adopting appropriate methodology for such works that best suits the area;
- Trained staff for handling the equipments and associated software;
- Creating awareness among the people who are settled along the course of this river;
- High quality hazard zonation map delineating areas with high risk, medium risk and low risk area;
- Material for public awareness campaign.

IMPLEMENTATION

Institutional arrangements

The Department of Geology and Mines (DGM) the Ministry of Trade and Industry will be the implementing agent from the Royal Government of Bhutan's side. DGM will work in close consultation with the Ministry of Agriculture, Department of Energy, Department of Local Governance under Ministry of Home and Cultural Affairs and the respective districts.

The main focus will be given at the communities of the area and their participation will be an important part of this project.

Risks and barriers

The main risk will be the lack of local participation from the area.

Monitoring and evaluation

Monitoring will be done by the Department of Geology and Mines and the project steering committee will be formed which will evaluate the performance on either quarterly or 6 months basis through meetings.

COST

The project is estimated to cost about USD 0.232 million

Budget breakdown

Activities	**Year 1** (USD)	**Year 2** (USD)
Field activities (Data Collection on Geotechnical, Geology, Geophysical, Topographical Survey, etc.)	-	38 749.99
Communication: vehicle hiring charges, telephone, internet and postal charges	-	27 272.72
Capacity Building (human resource development and infrastructure capacity development)	84 884.25	56 586.16
Workshops and meetings to review project progress and disseminate project outcomes including publication of final report	10 000	15 000
Total		**232 493.12**

BHUTAN

NAPA PRIORITY PROJECT NO. 8

INSTALLATION OF EARLY WARNING SYSTEMS ON THE PHO-CHU RIVER BASIN

RATIONALE

In living memory there have been several cases of GLOFs in Bhutan. The first studies on glaciers were done in 1960s. There are an estimated 2,674 glacial lakes in Bhutan out of which 562 are associated with glaciers[2]; the latest studies show 24 glacial lakes to be potentially dangerous; not until 1994 GLOF was the dangers taken seriously; the main rivers in Bhutan: Mo Chu, Pho Chu, Mangde Chu, Chamkhar Chu, Kuri Chu and Pa Chu originate from the glaciers and glacial lakes of the Higher Himalayas. It is known that in the last few decades there has been a rapid retreat of glaciers creating many moraine dammed lakes that are increasing in size at a fast rate. Glaciers in Bhutan have been recorded to be retreating at about 20-30m a year mainly attributing to global warming trends.

The 1957 GLOF affected the Punakha-Wangdi valley which destroyed a section of the Punakha dzong; this was caused by the glacial lake outburst from the Tarina Tsho lake in western Lunana. The second flooding that lasted for 5 days- from the same lake in eastern Lunana region again destroyed parts of Punakha dzong. The most recent flood occurred on 7th October 1994 from the partial burst of the Luge Tsho in eastern Lunana; this flood caused loss of life and extensive damage to property along the Punakha- Wangdi valley; the Dzongchu or small dzong was partly destroyed when the Pho chu and Mochu (male and female) rivers joined course above the dzong. A total 91 households were affected by the flood in the Lunana Region. Records show: 12 houses being damaged, 5 water mills washed away and about 816 acres of dry land damaged or covered with silt and sand; 965 acres of pasture land was damaged and covered with sand and silt, 16 yaks were carried away and about 16 tonnes of food grains lost.

A recent study[3] warns of hazard potential of Raphstreng and Thorthormi glaciers and its lakes could become dangerous (as the Luggye 1994 GLOF) in about a decades time (around 2010), unless mitigation measures are taken.

DESCRIPTION

Objective

The main objective is to install a flood warning station on the Pho-chu river basin- specifically above Samdingkha (15-20 km above Punakha) so that Punakha can be warned within about ten minutes of a GLOF.

Activities

- Compare similar work already done in comparative area or region (Nepal, South Tyrolean- Austrian/Swiss hazard zonation plans could be adapted to Bhutanese conditions;
- Mapping the Pho-chu area according to geological, geotechnical and hydrogeological aspects and analyzing soil samples;
- Measuring the area of investigation to calculate flood wave spreading, slope stability and river erosions;
- Working out the sound plan- acoustic warning system according to natural sound level, morphology, damping and weather conditions;
- Projecting the warning system which will include three components: releasing mechanism, connection to the acoustic warning device and determining the location for the acoustic warning devices;
- Construction of a robust water level in the Pho-chu valley;

[2] ICIMOD (2001), Bhutan. Inventory of Glaciers, Glacial Lakes, and Glacial Lake Outburst Floods. Monitoring and Early Warning Systems in the Hindu Kush-Himalayan Region

[3] Dept. of Geology and Mines with Institute of Geology, University of Vienna, Austria, August 2002

- Constructing and commissioning the warning system.

Inputs

The main inputs include human and financial resources, small equipment, vehicles, computers and accessories.

Short-term outputs

- Brief comparative reports of similar systems established in Nepal, Swiss/Austrian situations;
- Flood and hazard zonation maps of Pho-chu valley;
- Early warning systems in place;
- Staff trained to operate and maintain EW system;
- Awareness campaign to residents of the valley on the workings of the EW system and their response and escape routes.

Potential long term outputs

- GLOF and disaster management plans developed;
- An appropriate EW system in place that can be replicated for other valleys in Bhutan;
- Development of the valley including hyrdropower development can efficiently use the results of this project (zonation plans, soils and slope studies etc.).

IMPLEMENTATION

Institutional arrangements

The main institution for the implementation of this project will be the Department of Geology and Mines in coordination with Ministry of Agriculture, and Department of Local Governance (Disaster Management Office); also the involvement of the districts of Punakha, Wangduephodrang and the local communities of the area.

Risks and barriers

The main risks are possible lack of local participation from the districts; malfunctioning of the sound system.

Monitoring and evaluation

Monitoring will be done by the Department of Geology and Mines; the project steering committee will evaluate performances on a quarterly basis via meetings on progress and expenditures.

COST

Funds for the project are estimated at USD 0.40 million.

Budget breakdown

Activities	**Year 1** (USD)	**Year 2** (USD)
Comparative studies to adopt right tool	30 000	
Mapping, data collection and planning for installation of Technical Early Warning System	5000	5000
Procurement & installation of Technical Early Warning System	200 000	100 000
Training on installation and maintenance of Technical Early Warning System	20000	
Workshop/Meeting to create awareness among stakeholders	5000	5000
Professional Services (for setup of the System)	30 000	

Total Cost of the Project	**USD 400 000**

BHUTAN

NAPA PRIORITY PROJECT NO. 9

PROMOTE COMMUNITY-BASED FOREST FIRE MANAGEMENT AND PREVENTION

RATIONALE

Forest fire in Bhutan is commonly noticed and experienced below the altitude of 2500m with more intensity in dry zones especially in the Chirpine forest ecosystem which covers about 1,00,900 Ha. (*Dhital 1997:2*) and to a less extent in the temperate conifer forests. Forest fires are more frequent during winters, when long dry spells cause high day temperate, further exacerbated by strong winds and easy availability of dry fuel wood. With the change in the climate pattern - of late winters are cold and dry unlike in the past when winters used to be cold and wet covered with the snow and the chances of fire was less. Fire incidences in Bhutan usually coincide with the dry winter months which extend from November to May. The extent of the damage depends upon the frequency and intensity of fires and the type of forest, availability of fuel and local climatic factors.

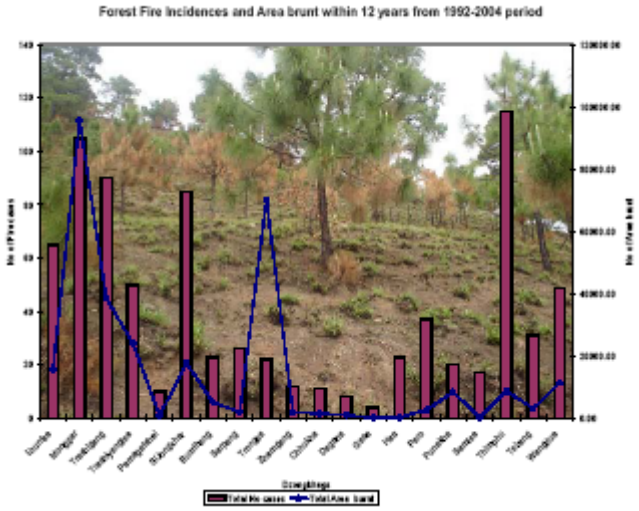
Records reveal that most forest fires are anthropogenic in nature which are mostly caused as a result of fire spilling out of debris burning in orchards and cultivated fields, careless picnickers or campers, children playing with fires and smokers.

Further, records also reveal that fires are also deliberately set to improve grass growth in the natural pasture or to expand pasture areas. While in the Chir pine forest ecosystem, the fires are set to improve lemon grass growth for oil extraction and to protect agricultural crops from wild animals like wild boar, monkey and so on. The intensity of the damage varies from place to place depending upon topography, altitude, climate and type of forests and nature of human settlement. Uncontrolled forest fire, as a result of negligence and lack of effective collaboration with the stakeholders are being recognized as one of the main causes of resource degradation. The forest fire incidences and area affected over the span of 12 years is illustrated below.

In Bhutan, the prevention of forest fire has become an important and challenging program in forest fire prone areas. In order to combat forest fires effectively and enhance smooth implementation of forest fire related activities, forest fire protection and management activities were decentralized at the Dzongkhag level for implementation. Further to motivate and accommodate stakeholder interests, the Department of Forests developed a proposal for the institutionalization of Dzongkhag level forest fire Management committee and *Geog* level forest fire management committee. Terms of reference for the committees have been developed and the Ministry of Agriculture has approved the proposal for implementation.

Despite such arrangements, the nature and frequency of forest fires has not reduced over time and space. This was mainly due to limited budget to strengthen the human resources capacity to coordinate, disseminate forest fire awareness program and supply fire fighting equipment at the field level. Devastation of forests annually by fires may pose significant threat and effect on forest coverage if not addressed properly. With this proposal, it would further strengthen the human resource capacity of the Department of Forest in the management of forest fires.

Forest Fire Incidences and Area brunt within 12 years from 1992-2004 period



DESCRIPTION

Objective

The main objective is to enhance the capacity of Department of Forests and rural people in the management of forest fire using appropriate tools and technology.

Main activities

1. Awareness campaign in the forest fire prone Dzongkhag;
2. Formation of village level forest fire management in the forest fire prone area;
3. Supply of forest fire management tools and technology and physical protection equipment (occupational safety);
4. Dissemination of forest fire management information through different approaches;
5. Strengthening capacity of Dzongkhag forestry sector through study tour visits and short training (aboard and in country).

Inputs

The input includes equipment, human, physical and financial resources.

Short term output:

- The village level forest fire management institutionalized and implemented;
- Reduced incidence of wild fires;
- Forest fire equipment well established and managed properly;
- DoF capacity increased in management of fire.

Potential long term outputs

The out of this project will contribute to the fulfillment of government policy objective to maintain 60% of the land under forest cover. With the experience gathered from implementing the project, it will enhance the DOF in developing a national forest fire management strategy.

Implementing arrangement

The project will be implemented by Social Forestry Division, DoF, Ministry of Agriculture in collaboration with the fire prone Dzongkhags, with involvement of rural people and other allied stake holders.

Risk and Barriers:

- Limited grazing options may lead to frequent forest fire outbreak;
- Farmers dependent on income from lemon grass oil are likely to promote burning of the grass for healthier growth.

Monitoring and Evaluation

The M and E will be done through the following

- Monthly and quarterly narrative report
- Financial reports
- Community feedbacks and case studies report

Further, the social forestry division from time to time will conduct monitoring activities.

COST

The project cost is estimated at USD 0.423 million

Budget Breakdown

Activity	**Year 1** (USD)	**Year 2** (USD)	**Year 3** (USD)
Awareness campaign amongst rural people	6 000	6 000	6 000
Institutionalization of Village level forest fire management in the fire prone area	6 000	6 000	5 000
Forest fire tools and technologies and occupational safety equipment	80 000	80 000	80 000
Capacity building through study tour in forest fire management (aboard and in country)	30 000	40 000	40 000
Use of tools and technology training workshop	6 000	6 000	6 000
Advertisement of Forest fire messages	3 000	3 000	3 000
Publication and case studies	4 000	3 000	4 000
Subtotal	**135 000**	**144 000**	**144 000**
Total			**USD 423 000**