## Recommendations:

- Institute sustainable funding for targeted up-stream land-use management programs by institutionalizing within the framework of Royal Government of Bhutan's Five Year Plans;
- A follow up study to identify the source of sediments (mines, quarries, transmission lines, roads, agriculture etc.) and targets for its management should be undertaken; and
- Evaluate and strengthen water management plans that affect or are affected by hydropower installation and integrate with environmental management plans and programs. Implementation, monitoring and evaluation of these plans should be included in the mandate of the existing river basin management committees.

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***Limitation of the study***: *The study is based on modeling exercise and the model does not take into account any changes that may occur within the predicted time frame. The study forecasts the data based on land-use and land cover change projections estimated from system dynamics model.*

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For more information: http://www.teebweb.org/areas-of-work/teeb-country-studies/Bhutan/

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# IMPLEMENTATION OF **INTEGRATED WATERSHED MANAGEMENT** TO BENEFIT MAXIMUM FROM **HYDRO-POWER IN BHUTAN**

*Ugyen Wangchuck Institute for Conservation and Environmental Research*

*Removing sediments from Chhukha Hydropower Plant*

## Introduction

Royal Government of Bhutan confirmed Bhutan's participation as one of the pilot countries for the European Commission funded project for The Economics of Ecosystems and Biodiversity (TEEB) national implementation study. As part of TEEB country study, a scoping workshop was held in 2014 which recommended TEEB – Bhutan to assess changes in ecosystem services provisioning with hydropower development.

The study used spatial models to understand how upstream land use changes impact the quality of water delivered to hydropower stations in Bhutan. Spatial models were linked to a system model with social and economic variables to ensure relationships between hydropower and socio-economic development were captured to generate more realistic land use scenarios.

Three scenarios were looked at with the base year as 2010 and projected till 2030 to study ecosystem services that may be affected by hydropower development. Eight hydropower plants were considered for the study [3 commissioned; 2 under-construction and 3 planned for construction].

Hydropower plants considered:

- Kuri I Hydropower [Kurichhu drainage]
- Punatsangchhu Hydropower [Punatsangchhu drainage]
- Gamri II Hydropower [Gamri drainage]
- Bunakha Reservoir [Wangchhu drainage]
- Nikachhu II Hydropower [Nikachhu drainage]

Revenue generated and maintenance expenses incurred data from the commissioned plants [Chhukha Hydropower; Kurichhu Hydropower and Dagachhu Kydropower] were used as reference data to project ecosystem services likely to be affected for the 5 hydropower plants. The study projected whole drainage basin's ecosystem services unlike the specific areas as the Detail Project Report (DPR) considers. Three scenarios were considered for the study:
Scenario I – Business as usual scenario
Scenario II – Hydropower dam construction
Scenario III – Hydropower dam construction but with upstream conservation programs: Assumes that 20 percent of the 1 percent electricity sale revenue is invested in up-stream land-use management activities.

The study compared ecosystem services between: Scenario I and II; and Scenario I and III for following ecosystem services:

- Sedimentation control
- Habitat for species
- Regulation of carbon sequestration and storage
- Biological Control
- Timber Production.

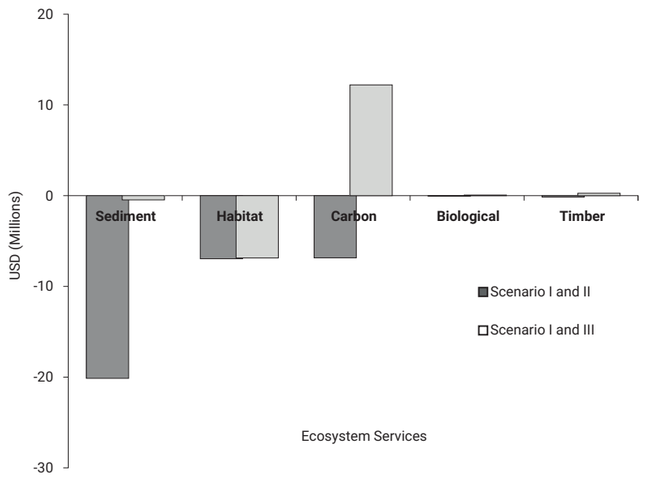
## Key Results

- Five drainage basins may contribute ecosystem services worth [five services] of USD 5 million in 2030 if scenario III is followed;
- Just by constructing hydropower plants without undertaking watershed management practices [Scenario II] these five drainage basins may lose USD 34 million worth of ecosystem services by 2030; and
- Sedimentation control and carbon sequestration stands out to be the most significant ecosystem system services that will bring significant shifts by adopting scenario III.

## Conclusion

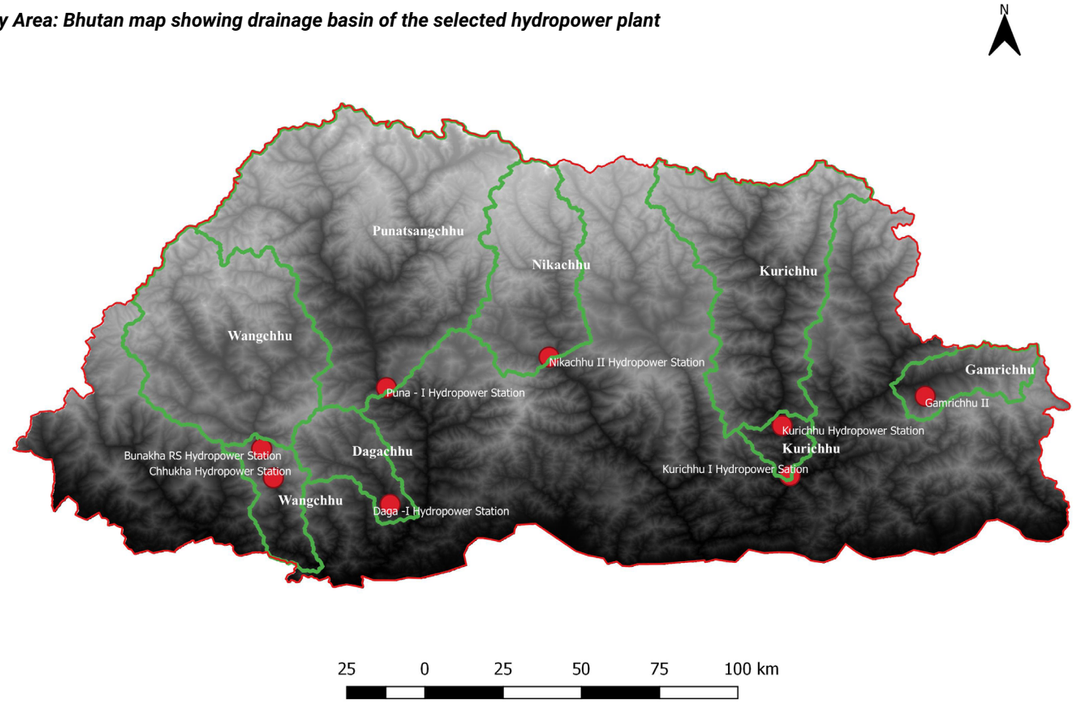
The analysis shows that re-allocating part of the revenues to local environmental preservation can avoid most of the negative impacts forecasted. Investments in reforestation, among other options, would avoid the reduction of forest cover, thereby reducing sediment export and increasing carbon sequestration, providing habitat for species and genetic resources, as well as supporting economic activities (e.g. timber production).The results from the study clearly showed marked effect on the sediment load; habitat quality and carbon sequestration by adopting hydropower development with up-stream land use management.

The study showed the importance of initiating targeted up-stream land use management programs through the introduction of Payment for Ecosystem Services (PES) and to undertake sustainable developmental activities with minimum destruction to forest cover. Article 12.4 of the Sustainable Hydro-power Development Policy 2008 of the Royal Government of Bhutan also necessitates 1% of the revenue generated from the energy sector to be paid to Ministry of Agriculture and Forests to pursue integrated sustainable water resources management. Since the Royal Government of Bhutan is using this plough back mechanism to subsidize electricity to the rural communities, the study looked at what if only 20% of the 1% plough back revenue could be spent on instituting PES. The model suggests that institutionalizing such mechanism would mean increase in economy and environmental benefits and this could help in the development of hydro-power plant for the country. Though, there could be marked ecosystem destruction at the construction sites during the initial phase of development, in the longer run following Scenario III would in-fact prove beneficial. However, this in no way is a statement suggesting to dam more rivers as the model didn't look at the aquatic fauna and the aftermath of bringing down the dam after its shelf-life. Thus, studies should be pursued to look from both economy and ecosystem services aspects to obtain holistic understanding on hydro-power construction; de-commissioning of dams; and also the ecosystem services which are affected at earlier stage of development and at later stage of com-missioning the hydropower.




***Ecosystem services that will be affected in all drainage basins of study area***

***Study Area: Bhutan map showing drainage basin of the selected hydropower plant***




The study demonstrated the importance of considering the study at watershed level during the DPR or Ecosystem and Social Impact Assessment (ESAI) study for any hydropower developmental works unlike the current trend of focusing within the project sites. The study showed the need to undertake broader level of study to clearly project the problems and to suggest mitigation measures for betterment of both the power plants and environment.

***Road construction in Bhutan***