Annexure-4

InVEST Modelling

The State of HP is currently developing a system of Natural Capital Accounts and PES Programme around eco system services that support hydro power production, a major focus for green development. Several departments in the State including Forests, Rural Development and Agriculture are engaged in the activities aimed to improve the conditions of watersheds by implementing soil and water conservation practices. Demand for power is increasing rapidly and hydro power is a major resource which can be developed to meet this demand. Thus, the value of hydro-power eco systems will continue to increase in the coming times. For these reasons hydro power is an ideal sector to act as a pilot for new system of forest account and a new point of focus for targeted land management to provide valuable eco system services. However, in India and around the globe, establishment of PES and other policies is limited by challenges in evaluating eco system services and their contribution to the hydro power sector at both local to national scales.

Hydro power is a key sector where policies impacting landscape management may greatly increase the value of eco system service provided by landscape. In this context well designed policies for land management to benefit the hydro power sector require an understanding of value of eco system services provided by the catchment area for each hydro power facility, distribution of services and their value in terms of how they contribute to efficient production.

Both amount and timing of water and sediment concentration are controlled in large part by the type and configuration of the ecosystems in the upstream watershed. Hydropower ecosystem services can be increased by changing land use, land cover and land management. Conservation and other co-benefits come along with the intentional management of the landscape.

Three different areas in which ecosystem approach will be useful for understanding and maximizing the value of services to the hydropower sector are:

- Maximizing contribution of ecosystem services to potential power production by actively managing land use, land cover and land management.
- Assessing impacts on potential power productions and value due to changes in policy, land management or climate that impacts hydrograph characteristics or sediment loads.
- Assessing land management impacts on potential power production against variation in power demand to determine the value of ecosystem services to hydropower sector.

To this end under one of the DPL TA a study was conducted through Stanford University for valuation of hydropower services in Himachal Pradesh by using InVEST modeling.

Study was conducted in five pilot locations in Satluj basin. This study was to inform designing of a PES Policy around ecosystem services that support hydropower production by

giving a valuation of different ecoservices. It would also help to focus on targeted land management to maximize valuable ecosystem services in the context of hydropower.

This modeling is essentially a combination of two models –RIOS (Resource Investment Optimization System), which gives the greatest ecosystem service returns toward multiple objectives by combining information on biophysical conditions and landscape context that can impact the effectiveness of activities. The output of RIOS model is a map of locations of selected interventions chosen based on ranked cost effectiveness to achieve one or more ecosystem service objectives. RIOS was applied to five hydropower catchments in HP to produce scenario of future landscape, representing different management interventions across a range of budget.

The second modeling is done through InVEST to estimate the potential impacts of RIOS designed portfolios for services relevant to hydro power production.

These are integrated catchment models developed to estimate hydropower ecosystem services and erosion control and produce outputs on an annual time step. These models quantify the change in services based on a baseline condition and various scenarios of land use and management. These models predict the integrated catchment response based on large scale (in both space and time) measurement of catchment characteristics and processes.

Thus, this modeling is useful to enable policy makers to determine the optimal mix of land management strategies and budget allocation to maximize service improvement to support hydropower production in key areas. RIOS has the potential to bring a landscape approach to the existing watershed management and prioritization process, potentially reducing the amount of time spent upfront in costly field assessments by narrowing the range of potential sites considerably. The InVEST modeling outputs gives quantitative estimates of flow and sediment yields.

Application of a landscape-level screening method (RIOS) can identify places where the ecosystem services return on investment is highest. Coupling this with application of an ecosystem services model (InVEST) will allow managers to estimate the improvement in services from implementation of the recommended activities to help justify the costs and extent of such investments.

Although, InVEST modeling has certain limitations in its applicability to the Hydro Power scenario in Himachal Pradesh where most of the projects are run of the river Projects rather than the Reservoir based Projects and consequently, assessment of water flows at a daily or seasonal time step will be more relevant rather than on an annual time step. For this requirement, HPFD would like to go for a model like SWAT, which is more complex but meets this requirement. However, RIOS has the potential to bring a landscape level approach to the existing watershed management and prioritization process reducing the amount of time spent in costly field assessments by narrowing the range of potential sites for interventions considerably. By prioritised catchment interventions, we can target those activities which improve eco system services by promoting infiltration of water and consequently regulating base flow and increasing the lean season flows which are of interest from Hydro Power perspective.

Forest department will further examine this modelling approach to institutionalise some aspects of this modelling as discussed above in future CAT plan formulations as also in prioritising the ongoing interventions with reference to optimizing the return on investments.

The above approach may also be used to help implement impact monitoring, by identifying places where impacts are likely to be greatest at the site, micro-watershed, and larger scales, and setting targets, against which, monitoring data may be compared.