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VALUING ECOSYSTEM SERVICES AT A LANDSCAPE LEVEL

THE CASE OF TERAI ARC LANDSCAPE IN UTTARAKHAND

Nilanjan Ghosh, Dipankar Ghose, G Areendran, Divya Mehra, Ambica Paliwal, Krishna Raj, Kiran Rajasekariah, Ambika Sharma, Anil Kumar Singh, Shashank Srinivasan and Sejal Worah

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Institutional affiliation:

Nilanjan Ghosh is Senior Economic Adviser of WWF India, New Delhi; and Senior Fellow of Observer Research Foundation, Kolkata. Email: nghosh@wwfindia.net

Dipankar Ghose is Director, Species and Landscape, WWF India, New Delhi, Email: dghose@wwfindia.net.

Abstract

This paper is an attempt at placing monetary values to services provided by the ecosystem to at the scale of a conservation landscape in order to demonstrate the importance of ecosystem conservation from an economic perspective. With the Terai Arc Landscape (TAL) in the Indian state of Uttarakhand being the study area, the paper considers nine ecosystem services which include water for agriculture, water for hydropower (for the Ramganga Kalagarh project only), nature tourism (for Corbett Tiger Reserve, Ramnagar Forest Division and adjoining areas only), religious tourism (for Haridwar and Rishikesh only), drinking water, micro-climate regulation, carbon sequestration, firewood, and fodder. With 2005 as the reference year, the sum of the values of the ecosystem services was calculated asINR 227.52 billion (US$3.5 billion) in 2005-06. . The value of these services was INR 390 billion (US$6 billion) in 2015-16 and INR 344 billion (US$ 5.29 billion) in 2011-12, using Wholesale Price Index of the new series with 2004-05 as the deflator. These are conservative estimates, given that only nine ecosystem services in the form of provisioning, regulating, and cultural services have been taken into account. Supporting services have been left out to avoid double counting. The nine ecosystem services yield 19% more value than the total income of the study region based on the estimates of district level average incomes. In other words, the population in TAL obtains 19% more benefits (when monetized) than what it earns from occupations (or the economic sector). The community, especially the poor will therefore lose out a substantial amount of their "GDP" or incomes provided by the ecosystem if these services are destroyed or disrupted through land use change or other factors. This loss (and potential compensation) is usually not taken into account when planning and executing economic development strategies for the region. If properly accounted for (and this paper includes only a partial accounting), the costs of conventional development planning would outweigh the benefits of maintaining ecosystem services.

1. INTRODUCTION

1.1 Landscape Conservation

The species-area curve that describes the fundamental relationship in conservation and ecology, demonstrates that species diversity and population size are largely a function of area (Rosenzweig, 1995). Large landscape conservation is essentially an effort to match the scale of conservation with the imperative to work at larger scales to sustain ecological functions and the processes that maintain natural and human systems over the long term. In that sense, large landscape conservation reflects a paradigm shift away from park-based approaches to conservation to ones that consider the connectivity across a range of landscape and land-use types, and the need for adaptive governance frameworks, nested across a range of scales (Curtin and Tabor, 2016). There is a growing consensus that protected areas alone are an insufficient solution to biodiversity conservation (Lindenmayer & Franklin 2002; Lindenmayer et al.2006). Large landscape approach of conservation helps in restoring and sustaining connective between Protected Areas (Ament et al. 2014).

The landscape approach, as developed by WWF and IUCN, provides a framework for making landscape-level conservation decisions. The importance of such a landscape approach is that it contributes to conservation initiatives at a broader ecosystem scale, examples being WWF's eco-region conservation programme and the ecosystem approach promoted by the Convention on Biological Diversity (CBD). Planning and working at a landscape scale requires integrated approaches with decision-making that goes beyond sectoral boundaries, taking into account priorities of multiple stakeholders.

1.2 Ecosystem Services Valuation

Natural ecosystems provide human communities with goods and services free of cost, which are often known as ecosystem services. .These services include provisioning of clean water and air, food, energy, decomposition of waste, climate regulation and soil formation. Though the important contribution of the natural ecosystem to human society has been reported in scientific literature for many decades, the concept of ecosystem services got better clarity in the Millennium Ecosystem Assessment (MA 2005). The most critical conceptual breakthrough was made in the MA (2005) by classifying ecosystem services into four major categories, namely, provisioning(food, water and fishery),regulating(climate regulation and carbon sequestration),supporting(nutrient cycles and crop pollination) and cultural(spiritual and recreational benefits, tourism). The Economics of Ecology and Biodiversity (TEEB) (2010), while synthesizing work in this field, revised the MA definition to remove "supporting services" and replace it on the one hand with "habitat services" and on the other hand with "ecosystem functions" that "are defined as a subset of the interactions between ecosystem structure and processes that underpin the capacity of an ecosystem to provide goods and services".

Proper delineation of "ecosystem services" through publications like MA (2005) and TEEB (2010) helped in understanding the direct linkage between human society and biodiversity: for every bit of existence of human society, there is a critical need for the biodiversity as a "stock" to exist, to ensure the "flow" of these ecosystem services. TEEB (2010) recognised that these ecosystem services are "GDP of the poor", as the poor's incomes and survival are dependent on the ecosystem. While recognising the importance of food-chain in the context of the ecological balance so as to ensure the integrity of the ecosystem structure and functions in order to ensure the flow of ecosystem services, conservation goals become important. For sustainable management of the natural resources like forests, wetlands, rivers, etc. one needs to set the right conservation goals for flora and fauna, which through their natural functioning, support and sustain these resources, and provide ecosystem services. Societies, economies and businesses therefore inextricably depend on biodiversity through a well-defined supply-chain, whose recognition is obscure in the public domain, especially in India and the developing world (Ghosh 2015).

On the other hand, since these ecosystem services are provided free, the importance of biodiversity conservation and their roles in provisioning these services were often not appreciated by human society. The importance of goods and services is readily understood only when they fetch values or prices in the market. For reasons of being perceived as "abundant", ecosystem services do not have markets, and hence do not fetch market prices. As a result, the conservation goals set for the natural ecosystem often do not seem to be the priority of human society, and businesses. It is for this reason that monetary values are assigned to ecosystem services.

Valuation of ecosystem services provides a mechanism for optimizing investments in biodiversity conservation and directing them to where they are most useful (Kinzig et al. 2007). Given society's increasing demands for employment, income and infrastructure, development decisions tend to maximize short-term economic gains. Prices generated for natural resources often do not reflect the true social costs and benefits of resource use, conveying misleading information about resource scarcity, and provide inadequate incentives for management, efficient use, and conservation of natural resources (Panayotou 1993, Ghosh 2010). The literature base on valuation of ecosystem services starting from Costanzaet al. (1997) presents itself in abundance (Bockstael et al. 2000; Hannon 2001; Farber et al. 2002; Limburg et al. 2002; ; Sukhdev 2008; Badolaet al. 2010; ; Costanza et al 2014,). Studies on valuation of ecosystem services in India are also abundant (Chopra and Adhikari 2004; Das and Chopra 2012; Verma et al 2015; and Ghosh et al. 2016).

Most of these studies have essentially looked at a specific ecosystem (forest, wetland, etc.). However, at a landscape level, a broader aspect encompassing a combination of diverse ecosystems and their associated services is examined. This calls for a framework that is more encompassing than the ones used in other studies. Due to the vastness and heterogeneity, of a landscape, the economic valuation method has to be based on a host of assumptions, thereby rendering it the position of approximation. The concern of scale is very important in such considerations.

- One needs to note that the value of ecosystem services simply states how valuable a natural resource or an ecosystem is to an individual or to a community, or to an economy. Therefore, values of the ecosystem services depend on the scale in which the benefits are obtained. The importance and rationale of valuation of ecosystem services are given below. Valuation of ecosystem services at a landscape scale offers a basis of understanding the role that the landscape plays in the livelihoods and sustenance of human community in and around the landscape. Moreover, some landscapes have tributaries and catchments of rivers, which mostly have serve geographies far away from the landscape. Valuation at a landscape scale can raise public and political awareness on the importance of the resources and region under consideration.This may help in critical decision-making on investments in the landscapes that would affect the ecosystem in an adverse way and/or influence landuse change for industrialization, urbanization or linear infrastructure development. Valuation can also be used to seek compensation for land use change in a conservation landscape, and a prohibitive value might be able to provide positive argument for relocate an industry or realign a linear infrastructure.

- Valuation can guide legal proceedings for determining damages where a party is held liable for the loss to another party: In legal proceedings, where one party has caused losses to another party, there remains the need to evaluate the loss (in most cases, in monetary terms) and the offender is made to compensate the affected party for the value of the damage. This can also happen for environmental resources. At a landscape scale,if upstream activities affect downstream areas and communities negatively, a value of the damage due to loss in ecosystem services or other economic services needs to be obtained, so that policies regarding compensation can be formulated.

- Valuation of ecosystem services at a landscape scale helps revise investment (infrastructure development) decisions that might otherwise ignore the effects on ecosystem services thereby hampering community well-being.Investment decisions on public goods and utilities in many developing nations often ignore the adverse effects on environment, thereby causing a disruption in the ecosystem. While taking investment decisions on certain public utilities, assessment of these ecological costs needs to be considered. Efforts need to be put by the decision makers to ensure that the ecosystem services are not compromised. It might happen that the ecological cost might be large enough to exceed the apparent economic benefits. Investment decisions need to be revised under such circumstances.

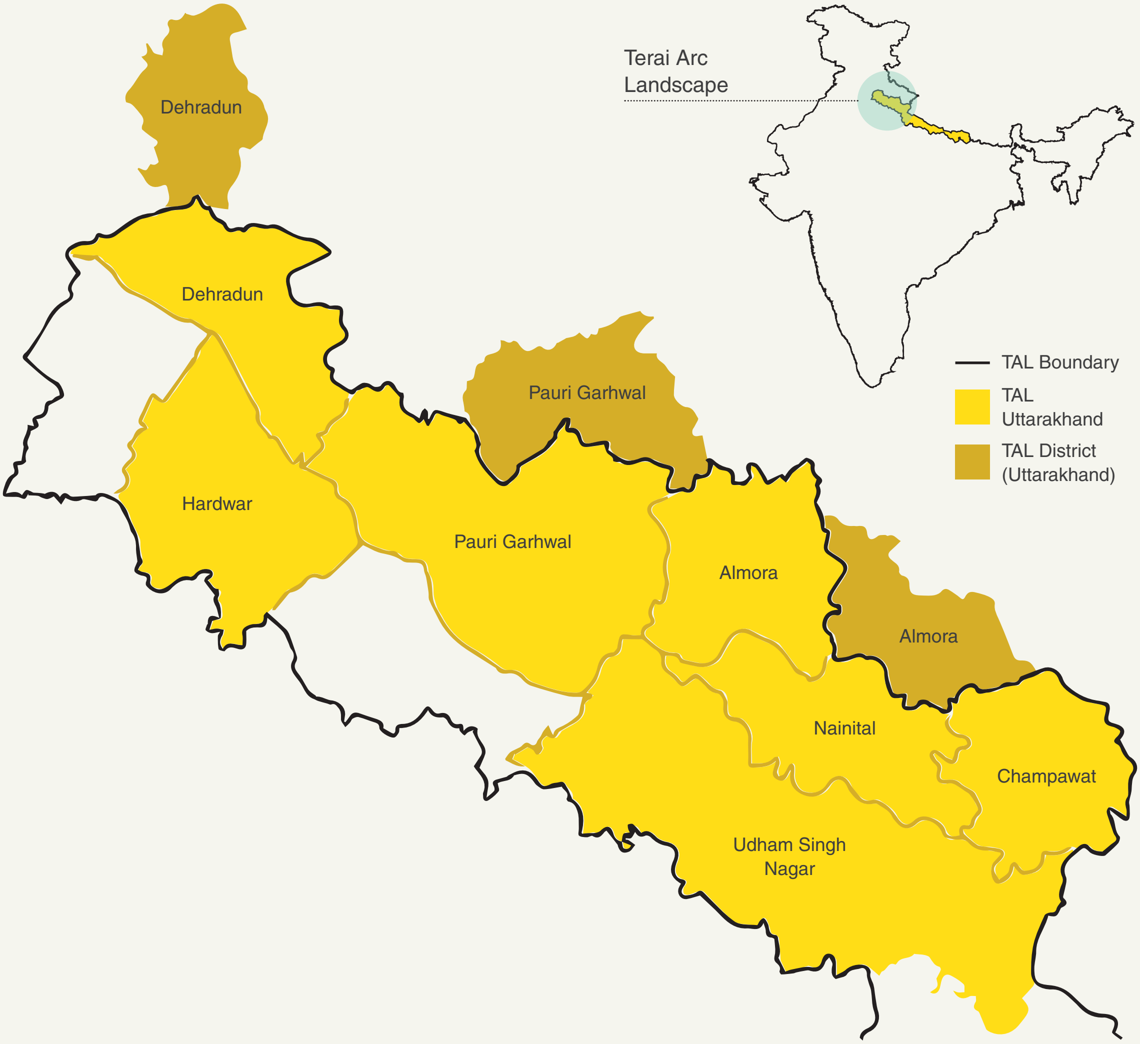
- Valuation reduces market failures and enhances the scope for market creation. There are goods for which markets do not exist, e.g. – air and water. As a result, of non-existent markets, there is no market clearing price. However, over time, as some resources are becoming scarce, better resource management calls for the creation of markets. Valuation of the resource helps this process. This is also true for certain public goods and services.

- Valuation helps in better appreciation of the conservation programs that are implemented for safeguarding the various components of the ecosystem: Conservationists are often branded as ‘anti-development’for voicing their concerns about development programs that adversely impact ecosystems. Valuation of ecosystem servicescan provide much needed arguments for maintaining of these services for the benefit of society in the long term.

2.MATERIALS & METHODS

2.1 Study Areas

The present study was carried out for a portion of the Terai Arc Landscape within the Indian state of Uttarakhand. Johnsinghet al. (1999) described the extent of the Terai Arc Landscape in northern India, covering the states of Uttarakhand, Uttar Pradesh and Bihar and the bordering areas of Nepal, based on the distribution of tiger, elephant and rhinoceros. The entire stretch of the Terai Arc Landscape (TAL) is spread over approximately 49,500sq.km.and stretches from Nepal's Bagmatiriver in the east to India's Yamuna river in the west. TAL in India covers approximately 30,000sq.km. The natural vegetation in TAL-India consists of sal forests, sal mixed forests, riverine forests, mixed forests, grasslands and open scrubs. Some of the charismatic mega-fauna in TAL-India includes the tiger (Pantheratigris), Asiatic elephant (Elephasmaximus), greater one-horned rhinoceros (Rhinoceros unicornis), swamp deer (Cervusduvauceliduvauceli) and the Gangetic dolphin (Platanistagangetica). TAL is drained by major rivers likethe Sharda, Kosi, Ramganga, Gandak, Bagmati, Sonanadi, Rapti, and Saryu. TAL in India has 12 Protected Areas (PAs) which are Rajaji National Park and Tiger Reserve, Corbett National Park and Tiger Reserve, Sonanadi Wildlife Sanctuary, Nandhaur Wildlife Sanctuary, Pawalgarh Conservation Reserve, Pilibhit Wildlife Sanctuary and Tiger Reserve, Kishanpur Wildlife Sanctuary, Dudhwa National Park and Tiger Reserve, Katerniaghat Wildlife Sanctuary, Suhelwa Wildlife Sanctuary, Sohagibarwa Wildlife Sanctuary and Valmiki National Park and Tiger Reserve covering a total area of 5,897sq. km. The Uttarkhand region of TAL, which is the focus of this study, has an area extent of 18,496sq.km (fig.1). It encompasses 7 districts and five Protected Areas, Rajaji, Corbett, Sonanadi, Pawalgarh and Nandhaur.



TAL in Uttarakhand is among the most densely populated rural areas in the country as more than 8 million people reside here (2011 census). During the last two decades the population in TAL has increased by as much as 54.2%, which is 9% above the national average. Most of the poorer communities in TAL depend on the forest for their subsistence. Firewood, fodder and grass for thatching and rope making are the significant resources extracted from the forests. Wild fruits and berries, honey, medicinal plants, and leaves are some non-timber forest products (NTFPs) which are also extracted from the forests and these also contribute to the household economy of rural populations. Natural resource based occupations are predominant across TAL-India. Only 7% of the population uses purchased fuel such as liquefied petroleum gas (LPG), coal and kerosene in the entire TAL-India, the remainder use firewood collected from the forests. However, the figures in the study area would be different from the figures of the overall TAL. One needs to note here that the entire districts of Dehradun, Hardwar, Pauri Garhwal, and Almora do not fall in the TAL region. This is clarified in Fig. 1.

2.2 Methods of Valuation

We have placed values on nine ecosystem services of the TAL. These are provisioning services like, water (used for agriculture, hydropower, drinking water), fuel wood, and fodder, regulating services like carbon sequestration, and microclimate regulation, and cultural services like tourism (nature and pilgrimage). . These have been estimated in the 2005-06 prices using standard valuation methods, as discussed below. Then the values of 2010-11 and 2015-16 have been arrived at by using Wholesale Price Index (WPI) as deflators.

2.2.1 Water for agriculture: Valuation of water for agriculture was carried out using Production Function Approaches (fitting Cobb-Douglas production function and obtaining scarcity values) and Crop-Water Requirements. Slope coefficients from a panel data regression was used to arrive at the marginal product. The theoretical Framework for production function has been calculated as follows:

$Y_{ist} = \lambda . W_{ist}{}^{\alpha} \ldots(1)$

Y_{ist} = production of the ith crop for season s in year t;

W_{ist} = Water use for the ith crop for season s in year t;

λ and α are the parameters.

Further, $W_{ist} = \omega_i . A_{ist} \ldots(2)$

ω_i = Crop - Water Requirement for ith crop;

A_{ist} = Area under the ith crop for season s in year t;

The log - linear format of the production function is

$\ln Y_{ist} = \ln \lambda + \alpha . \ln W_{ist}$

$$or, \frac{\partial Y_{ist}}{\partial W_{ist}} = \alpha . \frac{Y_{ist}}{W_{ist}} = \frac{\alpha}{\omega} . \frac{Y_{ist}}{A_{ist}}$$

Estimate α from time - series data or through benefit transfer.

$$\text{Value of irrigation water will be} = \sum_i P_i . W_i . \frac{\partial Y_i}{\partial W_i}$$

2.2.2 Water for hydropower: Value for hydropower (only for the Ramganga-Kalagarh hydropower project) was assessed using Benefit Transfer Approach (considering the values from Badola et al 2010 and Verma et al. 2015) and using deflators.

2.2.3 Drinking Water: Shaban and Sharma (2007) present an estimate of per capita per day consumption in the urban centres of the region. It needs to be noted here that the municipal corporations or municipalities cannot cover the entire study region. Therefore, considering that the average water consumption in the region per capita per day as 100 litres, and the cost of treatment being Rs. 10 per litre as used by Verma et al (2015), we have multiplied the cost by the total number of population. Then, we have added a consumer surplus, which is around 10% of the cost (obtained from meta-analysis), which reflects on the consumers' willingness to pay

2.2.4 Fuel and Fodder: For calculating cost of firewood, secondary data on firewood consumption was regarded along with price of firewood from primary data. Product of secondary data on fodder consumption (Dhanaiet al. 2014; Sati and Sang 2012; Verma et al. 2015) was regarded along with price obtained from primary surveys in the field.

2.2.5 Carbon sequestration: Carbon sequestration was measured through InVEST and then using pricing scheme from VER markets. Since CER markets are depressed, and definitely not a right reflection of the importance of carbon sequestration to human community, we considered the CER prices prevailing in 2005-06, which were 10 USD/ ton. Incidentally, the prevailing EU VER price is also found to be moving approximately in that range over the last 2 years (Forest Trends Marketplace 2015).

2.2.6 Microclimate Regulation: The water bodies essentially regulate the climate in its catchment by enhancing the evapo-transpiration process. On the basis of literature survey, we find that the value of micro-climate regulation service of the ecosystem varies from 50USD – 440 USD per hectare (see Pearce 2001; Constanza et al 1997; Gallai et al 2008; Torras 2000, Ranasinghe and Bambaradeniya 2012). As a conservative estimate, we have taken 50 USD as the minimum cost saving per hectare, and around 1.5 kms of radii around water bodies have been considered to be positively affected by micro-climate regulation.

2.2.7 Forest-based Tourism: We considered forest-based tourism only for Corbett Tiger Reserve. A survey of 200 tourists revealed that they are spending to the tune of Rs. 20000.00 for a trip on an average. Given the number of tourists in 2005-06, we obtained the total spending in 2005-06, and added 15% consumer surplus obtained from from benefit transfer approach of Badola et al.(2010) and Ghosh et al. (2016). The total number of tourists were obtained from park authorities.

2.2.8 Religious tourism: Hardwar is an important location of religious tourism. Primary survey results of 1000 tourists were used for expenditures for religious purposes. This has been divided into foreign and domestic tourists. The average spending per tourist travel cost is being multiplied by total number of tourists obtained from the department of tourism, government of Uttaranchal. In various cases, previous studies' results from Badola et al. (2010), Sati and Sang (2012), Dhanai et al.(2014), and Verma et al. (2015) were considered. Since their estimates are not computed at the landscape level, in this paper we have tried to extrapolate them to arrive at tentative estimates.

3. RESULTS

3.1 Value of Ecosystem Services of Terai Arc Landscape

Given the above analysis, the value of the ecosystem services is calculated as given in the following table.

Item	Value in 2005-06 (Rs. million)
Water for Agriculture	13886.82
Water for Hydropower	440.68
Carbon Sequestration	66078.20
Tourism (Corbett)	3680.00
Drinking Water	2785.64
Fuelwood	41995.50
Microclimate Regulation	48011.40
Fodder	3015.54
Religious Tourism in Hardwar	47623.51
Total	227,517.28

The sum of the values of the nine ecosystem services in 2005-06 was INR 227.52 billion (US$3.5 billion). The same value turned out to be INR 390 billion (US$6 billion) in 2015-16, and INR 344 billion (US$5.3 billion) in 2011-12by using Wholesale Price Index of the new series with 2004-05 as the deflator.

These are conservative estimates for various reasons. First of all, we have confined our analysis to a few selected ecosystem services , and have not extended it to obtain the full gamut of the servicesprovided by the ecosystem.. We have considered only nine ecosystem benefits and not the other ecosystem services like

climate regulation, flood control, and many other services that Verma et al. (2015) considered while calculating economic valuation of select Tiger Reserves in India. This was more so because of the heterogeneity of the ecosystem that would have made estimation a complex affair. Secondly, there remains the problem of double counting while considering the supporting services of the ecosystem. To remove that possibility completely, we have not considered any supporting service in the analysis. Thirdly, while we have considered only certain aspects of the cultural services, e.g., religious tourism has been considered only for Hardwar, and nature tourism has been considered only for Corbett Tiger Reserve and the buffer and adjoining areas where the tourism has developed. There are many other aspects of nature tourism, e.g. Nainital, by itself, is a major tourist destination. Fourthly, the value of the benefits obtained by communities downstream of the landscape has not been considered. Carbon markets have been taken at one of the lows at USD 10 per ton of CO2.[1]

3.2 The Ecosystem Dependency of the region

In 2005-06, the total income of the TAL districts, as estimated by us, was INR 191 billion. This is based on the estimates of population given by Census 2001, and district per capita income estimates by the Central Statistical Organisation. . Therefore, the nine ecosystem services (estimated as INR 227.52 billion) yielded 19% more value than the total income of the region. It can therefore beargued that if the landscape ecosystem is destroyed through land use change, one needs to compensate the local community in TAL Uttarakhand by spending 19% more than the total value of the economic output of the landscape.

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1. In any case, as argued by Ghosh (2010), the price reflected by the carbon market always remained lower than the actual value of carbon sequestered. Essentially, the sequestered CO2 actually is a global common good, and it brings with itself benefits like diminishing the morbidity, lowering health costs, enhancing productivity, which are hardly appreciated by the market forces. It was further argued that the price of the carbon credit depends more on the economic activities, and the associated market dynamics, and has less to do with the service provision. Still, we have taken that in order to get some indication of the value, more so in absence of any other related alternate price mechanism.

4. DISCUSSION

This paper discussed the importance of valuation of ecosystem services at a landscape scale. The values that we have arrived at are approximations, conservative, and “tip of iceberg” estimates. Yet, they are indicative of the fact that the contribution of the TAL ecosystem in Uttarakhand to the human community is at least INR 390 billion or USD 6 billion, which by itself is higher than the income of the community of the region.

It is clear that the population as a whole derives more value from the ecosystem than the economy.It is in this context, we also bring in the idea of the “GDP of the poor”, as ecosystem services havebeen defined in the framework of TEEB (2010). The poor are more dependent on the ecosystem services than the rich (Martinez-Alier 2011).

More than half the population in the TAL – Uttarakhand is living below poverty levels and an earning member of a household earns as little as US$ 1.9/day. The ecosystem dependency of these households is higher than those earning average per capita incomes. Hence, any policy towards land-use change in the landscape and ground actions leading to land use change in the wildlife habitats and corridors should be considered very carefully. One needs to take into account the scarcity value of the ecosystem services, i.e. the economic value loss with ecosystem service loss, as it is the poor who suffer the most from the loss in ecosystem services.

While land use change is planned, one needs to assess on how much of the habitat will be destroyed due to that. In those cases, poorer people will lose out a substantial amount of their “GDP” or “incomes” provided by the ecosystem, and they need to be compensated for the loss to the tune of the damage caused to them. However, this compensation would not take into account other economic impacts from the loss of services such as flood control, water recharge, and soil retention, which could lead to huge costs due to disasters incurred such as floods and landslides.

It therefore becomes important that the results of such an analysis is shared with policy makers to demonstrate that, in terms of economic development, it is critical to take into account the net cost of losing ecosystem services and the impacts of this on the rural poor. If a real valuation and a long term development perspective is taken, then it will be clear that the cost of damaging ecosystems and disrupting their services will be higher than the short term gains from some planned projects.

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Why we are here

To stop the degradation of the planet's natural environment and to build a future in which humans live in harmony with nature.

www.wwfindia.org

WWF-India Secretariat
172-B Lodi Estate
New Delhi 110003
Tel: 011 4150 4814 Fax: 011 4150 4779

WWW.WWFINDIA.ORG