Executive Summary

Economics of Desertification, Land Degradation and Drought in India

Vol II: Six micro-economic case studies

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Executive summary of the six case studies on land degradation and desertification (Volume II)

We provide below an executive summary of the six case studies carried out across India in a range of ecosystems and terrain types including rangelands, forests and agro-ecosystems that encompass both montane areas and the plains. These case studies pertain to the major causal reasons of degradation including water erosion, salinity, salt water intrusion in coastal areas, vegetal degradation, sodicity and wind erosion in the States of Madhya Pradesh, Gujarat, Andhra Pradesh, Uttarakhand, Uttar Pradesh and Rajasthan. These studies involving primary surveys were carried out in more than 1000 households and utilized a range of approaches including a systems dynamic approach, travel costs as well as studies on interventions targeted at particular causal mechanisms (the 'preventive approach'). The results of these individual case studies are summarized below.

Modeling the grassland degradation of Banni using system dynamics: An investigation into the ecological and economic causes and impacts of grassland degradation in Banni

The Banni grasslands located in Kachchh district of Guarat, in India were once known as Asia's finest grasslands. In the last few decades however, they have been severely degraded, with grassland productivity falling from 4000 kg/ ha to 620 kg/ ha between 1960 and 1999.The people of Banni, known as Maldharis have been living as nomadic or semi-nomadic pastoralists for hundreds of years, relying mainly on livestock breeding as their source of livelihood. This grassland degradation poses a serious crisis for them. The danger is further exacerbated as the numbers of livestock have increased in the last decade, with the advent of dairies in Banni. This has made the sale of milk and milk products highly profitable. The invasion of the grasslands by the woody species of *Prosopis julifliora is* seen by the Maldharis as one of the primary causes for the degradation of Banni grasslands.

In this study, we present Banni as a complex system and have used system dynamics to model its ecologic-economic interactions resulting from grassland degradation, and to generate future scenarios. We have also carried out an economic valuation of Banni to obtain the present value of its future economic gains under two scenarios, 1) Business As Usual (BAU) and 2) '*Prosopis* removal policy' scenario. Our modeling results, consistent with the Maldharis' perceptions, indicate that *Prosopis* invasion is indeed the major cause for the degradation of Banni, and the economic valuation indicates that *Prosopis* removal is a favourable policy option for sustaining the livestock economy and halting grassland degradation. The per ha costs of land degradation are estimated at INR 27,645 per hectare, accounting for the difference in total benefits between a business as usual scenario and a *Prosopis* removal scenario. However, we would like to emphasise that due to an information gap, lack of data and uncertainty about various models parameters like future rainfall variability, out-migration due to fodder deficits, our model is by no means predictive. The results are only an indication of, or a foresight into, the overall situation that is likely to unfold in Banni in years to come.

Losing the benefits of forests to degradation? A case study from Tehri Garhwal, Uttarakhand

Vegetal degradation has been pegged as the second leading cause of land degradation in India accounting for 8.91% of the total geographical area (TGA) in 2011-13 according to one source (SAC, 2016). Vegetal degradation is the primary cause of degradation in Uttarakhand and has increased from 545610 ha in in 2003-05 to 606616 ha in 2011-13 (SAC, 2016), i.e. from 10.2% to 11.34%. This is also evident from the decrease in dense forests in 77% of the districts of the State (FSI, 2015). The value of Uttarakhand's forests in 2011 was estimated at Rs 1186259 million yielding a per capita figure of Rs 117610 (TERI, 2014). Overexploitation of forest resources contributes to forest degradation in the State, despite their enormous economic value. Physical accounts for the forests of Uttarakhand from 2000-01 to 2010-11, indicate that the demand for fuel wood accounts for the largest share of change followed by diversion of forest land for non-forest use. In 2010-11, fuelwood production was estimated to be 26610 cubic meter stacks while the estimated household consumption was 3013660 cubic meter stacks (TERI, 2014)[1] pointing to grossly unsustainable fuelwood harvests. This huge burden of fuelwood harvests leads to forest degradation impacting the lives of scores of people who depend on these forests for myriad ecosystem services. In this case study, we attempt to determine the value of forests in the Dhanulti and Devalsari area of Tehri Garhwal, Uttarakahand to local communities and to tourists and what their degradation implies in terms of lost revenues from recreation or foregone provisioning services from fuelwood and fodder. In addition, using a mix of primary and secondary data and remote sensing assessments, we determine the costs of forest degradation in Dhanulti and Devalsari from 2001-2015.

A total of 151 households were surveyed to determine their dependence on forests, as well as for a ranking of their perceptions on the value of the forests which was captured using a Analytic Hierarchy Process. A travel cost assessment of 157 tourists to Dhanaulti was also carried out to determine the recreation value provided by the forests of this area. Most of the households (87%) were dependent on fuelwood as their primary fuel source and forests were indisputably the main source of firewood with the most pressure imposed on Reserve Forests. The households collect an average of 1500±130.63 (SE) kg of fuelwood per household per year. The total dry fodder consumption was 1128 kg per ha. The local people valued the forests for their biodiversity, their ecotourism value and their contribution to local livelihoods. In terms of products derived from the forests, the people expectedly ranked fuelwood the highest followed by timber and fodder. A travel cost analysis provided an individual consumer surplus of Rs 918.75 and a total consumer surplus of Rs 24,186 per ha of forest area.

The present value of recreational benefits is Rs 3,13,320 per ha of forest area (discount rate of 4%). The costs of forest degradation for Dhanaulti and Devalsari from 2001-2015 using values obtained from the primary survey for fodder, fuelwood and ecotourism (recreation) and secondary values from Verma (2014) for the remaining ecosystem services are Rs 97.8 million. We calculated an NPV over 25 years using a 4% discount rate as per Verma (2014). The loss in in NPV of forests from 2001-2015 is 0.049 million per ha. The results from this

[1] The study estimated fuel wood consumption based on the NSSO (2009/ 10) data on monthly per household consumption of fuel wood (193.15 kg for rural and 124.71 kg for urban) for Uttarakhand (TEDDY 2011-12, page 295); Conversion factor of 1 cubic meter=725 kg (FAO, 2012) was used and number of households using fuel wood for cooking (Census 2011)

study underline the high costs associated with forest degradation. It also strengthens the conclusion of other studies from Uttarakhand that one of the primary causes of forest degradation in the State is fuelwood collection.

The study also estimated the costs of forest degradation and reclamation for Dhanaulti and Devalsari in 2030. The results indicated that it costs far less to reclaim the area than it does to degrade it. While the costs of degradation for these areas was projected to be Rs 1087.8 million in 2030 (at 2013 prices), the cost of reclamation at Rs 113.4 million is only 10% of the costs of degradation.

The Role of Farm Bunds in Enhancing Agricultural Productivity and Farm Incomes through Reduced Water Erosion in the Indore district of Madhya Pradesh.

Water erosion is a major contributing factor for land degradation and desertification in India. Madhya Pradesh (MP) is one of the prominent states that is highly vulnerable to water erosion. Under the Integrated Watershed Management Programme (IWMP) farm bunds have been constructed in Madhya Pradesh to control water erosion. This study measures the impact of farm bunds in controlling water erosion in case of Indore district of MP, through a sample of 225 farmers (including 150 farmers with the intervention and 75 farmers without the intervention-the control group). The study finds that the intervention has significant impacts in controlling water erosion in case of soyabean and wheat which are major crops in the study area. In case of these two crops, farmers have been benefitted by these farm bunds in terms of improvement in productivity as well as savings in cost of cultivation. In other words, on average, a farmer with farm bunds has higher productivity (average productivity is 2.82 qnt/ ha for the intervention group vis-à-vis 2.49 qnt for the control group in case of soyabean and average productivity is 6.15 qnt/ ha for the intervention group vis-à-vis 4.77 qnt/ ha for the control for wheat) and lower costs of cultivation (average cost of cultivation is INR 5981 per ha for the intervention group and INR 8051 per ha for the control group in case of soyabean while the average cost of cultivation is INR 4314 per ha for the intervention versus INR 5473 per ha for the control in case of wheat. Therefore, the average profitability per unit of land for an average farmer in the intervention group (INR 2192 per ha for soyabean and INR 3940 per ha for wheat) is higher than that of the control group (INR 524 per ha for soybean and INR 751 per ha for wheat). These savings in average cost of cultivation and gains in average productivity are the cost of land degradation in the absence of water erosion control interventions.

The extent of water erosion in the State of Madhya Pradesh in 2030 is projected to increase linearly to 1138402 ha. Reclaiming these eroded areas in 2030 at the rate of Rs 15,000 per ha will be Rs 17076 million at 2015 prices.

Reclaiming Sodic Land in Mainpuri, Uttar Pradesh – A Case Study

Sodic soil characterized by excessive sodium is considered to be an important impediment to agricultural productivity. Of the total area of the country that is degraded due to sodicity, Uttar Pradesh, Punjab and Haryana are the most severely affected. To treat sodic soils, the Uttar Pradesh Land Reclamation Project implemented by the Uttar Pradesh Bhumi Sudhar Nigam has been operational since 1993, and is currently in its third phase. UPSLRIIIP is a package intervention to reduce sodicity with four key components – on-farm development,

improved drainage systems, agricultural support systems, and an institutional strengthening mechanism for improved market access. This study measured the impact of on-farm interventions to reduce sodicity among the programme beneficiaries by comparing a total sample of 337 households including 205 in the project area and 132 in the control group, before and after the intervention.

The study finds that the intervention has significant impacts in reclaiming sodic soils, which in turn resulted in the enhanced productivity of rice and wheat. The land with highest sodicity which was left barren before the UPSLRIIIP intervention had at least two crops (*Kharif* and *Rabi*) that were cultivated annually. The severity of sodium in the soil was found to have an inverse relationship with percentage change in productivity i.e. higher sodicity resulted in low productivity. The research design allowed estimation of change in productivity in slightly and moderately sodic soils due to the reclamation effort under UPSLRIIIP. The productivity of slightly sodic plots improved by 2.18 t/ ha for rice and 0.82 t/ ha for wheat. For the moderate sodic plots the productivity improved to 1.04 t/ ha. Farmers with sodic plots incurred a loss in net returns from agriculture. In slightly sodic soils this was e. INR -5847/ - per ha which increased in moderately sodic plots to INR -17743/ - per ha, with no income derived from severely sodic plots. The net return of revenue after reclamation increased to INR 1623/ - per ha for slightly sodic, INR755/ - per ha for moderately sodic and INR 870/ - per ha for severely sodic soils. The annual cost of degradation was estimated for control villages as Rs. 223.05 lakhs.

We develop two scenarios for area impacted by salinity/ alkalinity in Uttar Pradesh in 2030. In one scenario, salinity/ alkalinity impacted land is projected to drop to 0 in 2019 itself. Therefore in 2030, Uttar Pradesh would have no alkaline land and all land would be reclaimed by 2019. Hence no costs of reclamation in 2030 would be applicable. However, given that this scenario appears to be a bit optimistic, we generate a second scenario where the degraded area decreases proportionally every eight years.The cost of reclamation norms for alkaline/ saline land is Rs 60000 per ha in 2016 prices[2]. Therefore, the cost of reclaiming lands degraded by salinity/ alkalinity in Scenario 2 in 2030 is Rs 3199 million in 2016 prices.These figures suggest that salinity in Uttar Pradesh is being addressed successfully.There is need for a detailed review of the process by which salinity/ alkalinity in the state is being addressed and an understanding of the reasons for the success of the initiative versus other land degradation causes.

Economic benefits of addressing soil and water salinity through sub-surface drainage: A case study from the coastal croplands of Andhra Pradesh

A questionnaire-based survey was conducted among the farmers of the Kalipattanam village of Mogultaru tehsil, West Godavari district of Andhra Pradesh to understand the cost of land degradation in the coastal area owing to waterlogging from saline sea water intrusion to the crop land. Flap gates and sub-surface drainage (SSD) system were installed in selected farmers' land 10 years earlier under the Andhra Pradesh Water Management (APWAM) project. Flap gates were installed to restrict the mixing of saline river water with irrigation water. Farmers with these interventions formed the 'intervention group'. The control group included farmlands outside the APWAM project area but in the same village as the intervention group. Based on the soil salinity of the crop lands in the area, crop lands were

[2] http://agricoop.nic.in/sites/default/files/rps_guidelines%20(2).pdf

classified under five different groups: a) not saline (< 3.0 dS m^{-1}), b) Moderately saline (2.1 to 4.5 dS m^{-1}), c) Saline (4.6 to 6.0 dS m^{-1}), d) Highly saline (6.1 to 8.0 dS m^{-1}) and e) extremely saline (> 8.0 dSm^{-1}). The study suggests that introduction of flap gate + SSD system has significantly reduced the soil salinity over flap gate only and control area. Each level-increase of salinity reduces the net annual profit of farmers' by INR10045 ha^{-1} and are the costs of land degradation for agricultural productivity in the absence of the intervention. However, there was no significant difference in crop (rice) productivity in the land area under flap gate only and flap gate+SSD area. This suggests that although flap gate + SSD systems reduce the soil salinity level, flap gates are sufficient to improve the productivity of the degraded croplands of the area with comparative lower cost than the flap gate + SSD system. More research is required to ascertain if this is true in a range of local conditions as this can considerably reduce the costs of reclamation.

The extent of waterlogged areas in the State is projected to increase linearly in 2030 to 148782 ha and the cost of reclamation is Rs 7439 million at 2013 prices.

Foregone agricultural benefits due to wind erosion: The case of shelterbelt plantations in Jaisalmer, Rajasthan.

The western part of Rajasthan is clothed in rolling dunes for almost its whole expanse. Due to the inhospitable climate the people of the area earn their livelihoods primarily with pasture animals and on one crop per year, but sustenance is difficult. The agricultural productivity in the region remains limited due to an unconducive environment, limited choice of crops and aberrant weather conditions. In this study, we determine the costs of wind erosion for agricultural productivity. We do this by ascertaining enhancements in agricultural productivity brought about by shelterbelt interventions that reduce wind erosion. The three main sources of household income are crop production, livestock rearing and off-farm income. All the respondents reported that plantation of shelterbelts have not only helped in anchoring the sand dunes in the area but also proved beneficial in providing fuel wood, livestock fodder and timber, while reducing wind speed. Approximately 84% farmers have received additional benefits such as better ground water availability and improved soil texture for production. With the presence of shelterbelts the farmers have higher production for two major crops, Guar (cluster bean, *Cyamopsis tetragonoloba*) and Chana dal (*Cicer arientum*). Input costs are also less for both crops in the intervention areas. For Guar, the total cost for shelterbelt farmers is Rs. 1756.39 per hectare as compared to non-shelterbelts Guar farmers (Rs 2464.7 per ha). In case of Chana, farmers input costs on average are Rs 2000 lower for those with shelterbelts. This increase in revenue coupled with reduced costs has a beneficial impact on the income of the farmers. These results suggest that tree plantations on the fields act as a boon for the farmers in earning them additional revenues.

The extent of land that is projected to degrade in 2030 shows a linear downward trend (14862424 ha). The cost of reclaiming this degraded land in 2030 is Rs 309323.9 million at 2014/ 2015 prices.