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Participatory and Conventional Biodiversity Assessments: Creating Awareness for Better Natural Resource Management

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Abstract: Common grazing land in a cluster of villages of Bundi district in the hot semi-arid region of eastern Rajasthan, was degraded due to high grazing pressure. A community initiative, facilitated by an NGO, regenerated half of the grazing land by adopting social and biophysical interventions. A participatory assessment of the regenerated and the degraded grazing land, involving a team of ecologists, microbiologists and community members was undertaken to know the impact of the collective action. This paper discusses the results of the assessments and argues that community initiatives combining social and biophysical measures can yield best results to raise awareness of the communities for rehabilitation and conservation of biodiversity in fragile ecosystems.

Key words: Participatory, conventional, biodiversity, grazing land, rehabilitation.

Ecological diversity hosts many species that supply products for food, medicines, housing, cultural artifacts, genes for breeding programmes, trade, as well as the processes and functions that support productive ecosystems. Biodiversity supports or enhances livelihoods - especially of poor sections of the society. Biodiversity also provides them crucial safety nets in the contexts of external shocks such as droughts.

The Well-being of Nations report published in cooperation with IUCN in 2001 confirms that human and ecosystem well-being are intimately entwined, and validates the need to plan and manage for ecosystem protection and human development simultaneously with equal weightage. While only 2-10% of all the species on the earth are known, scientists recognize that full surveys of biodiversity are not feasible owing to time and resource constraints. There is a lack of agreement amongst scientists about which assessment methodologies should be applied, and the various indicators that might act as proxies for biodiversity.

Participatory biodiversity assessment (PBA) provides a way of reconciling the need for national assessment, monitoring and reporting with the increasing focus on involvement of all relevant stakeholders and particularly indigenous/local communities. PBA can provide short-cuts to scientific assessments; provide data useful to local resource managers in a way which scientific assessment is not; link in to scientific information which is relevant to local needs; enhance inclusivity of decision-making.

Since mid-1990s numerous watershed development projects came in operation, however, in majority of cases ecosystem approach was missing. The ecosystem approach is a strategy for integrated management of land, water and biological resources that promote conservation and sustainable use in an equitable way. The term 'ecosystem' does not necessarily correspond to the term 'biom' or 'ecological zone', but can refer to any functioning unit at any scale (Ramakrishna *et al.*, 2000). Development of about half of the 90 ha common grazing land through integrated watershed management approach in Goverdhanpura under Thana watershed in Bundi district of eastern Rajasthan is an example of ecosystem approach through the participation of the local herders and grazers (Wani *et al.*, 2004).

This paper summarizes the strategies adopted by the community to restore degraded common grazing lands. It delineates the process of getting the community to evaluate its collective endeavor.

Materials and Methods

Thana, Govardhanpura and Gokulpura cluster of villages, spread over 1356 ha, of which 95 ha is common grazing land, represent SAT area in Bundi district of eastern Rajasthan. Annal rainfall ranges from 400-500 mm with maize, pearl millet, wheat and chickpea as major crops grown. The soils are degraded, and represent shallow to medium deep clay loams and silt loams. The terrain is undulating and grazing lands are highly degraded due to high grazing pressure. Common grazing in this cluster was generally devoid of good quality fodder. The only source of open grazing, the common grazing land was so degraded that most fodder and grasses that grew were neither palatable nor sufficient to the livestock, the main stay of the livelihoods of the poor of this area.

BAIF Institute of Rural Development, an NGO implementing the project, recognized the problem and engaged with the community. The people reciprocated positively and agreed to part with half of the common grazing area for rehabilitation. The stakeholder community consisting of grazers, herders and farmers agreed to fence the 45 ha grazing land, not to allow any grazing in that area by enforcing physical and social fencing and also rehabilitate the fenced area. Villagers contributed labor to erect stone fencing, and construct soil and rainwater conservation structures (200 staggered trenches, 290 percolation pits, and 6 gully plugs) to arrest runoff and increase infiltration. Villagers planted grasses, saplings all over the area through community participation. Mortality of the saplings was very high in the first year due to severe degradation. Stone bench terraces, contour trenches and catch pits were laid out for *in situ* moisture conservation. This increased survival rate of the saplings in subsequent years. Despite consecutive droughts (from 2000 to 2003), the area turned lush green in stark contrast with gray area across the fence.

There was a perceptible improvement in the density of vegetation in the protected grazing land in contrast to the unprotected one The vegetation attracted many birds and animals to shelter. Prominent among these are blue bulls. At this juncture the Tata-ICRISAT-BAIF-ICAR project staff undertook the whole process evaluated and got it recorded and evaluated by the villagers who were instrumental in the successful rehabilitation of degraded grazing land through participatory process. The objective of this exercise was to create awareness in the community and facilitate the members of the community to understand the worth of the efforts put in by its collective action

The entire 45 ha area was divided into six blocks considering the topography, soil type and vegetation in consultation with the project staff (Fig. 1). The villagers named the blocks in the local dialect.

Block 1: *Aadibali* is an elevated area with a gentle gradient on all sides, shallow soil spotted with white stones. The area is covered with mostly *Cenchrus setigerus* (dhaman) grass and the native *Prosopis cineraria* (khejri) species

Block 2: Same as the above except that it has a gentle gradient

Block 3: *Tapari wala Dhala Bardi* is a fairly flat land with shallow soil and white stones.

Block 4: *Nala Bardi* is a valley with a small stream running across it. It has fairly flat land with deep soils and good vegetation.

Block 5: *Dev Dungari* is a highly stony and steep hillock. It has very good cover of plants due to the stone bench terracing as a means of in-situ moisture conservation.

Block 6: *Lamdi Guddy* has sparse vegetation and has little or no soil on it. It has stone sheets running beneath.

Six project staff and six villagers with good knowledge about the local flora and fauna were grouped into a team of two members each, a villager and a project staff, and was randomly allotted one block in the rehabilitated grazing land. The village team members were administered a simple questionnaire by the project staff before setting out to enumerate the flora and fauna in the block. The details of the participatory survey are provided in Table 1. A group led by an ecologist assessed the biodiversity in 45 ha grazing land. Microbial diversity in the soil was also assessed in degraded and rehabilitated grazing lands by analyzing the soil samples collected from the site of study adopting dilution plate method.

Results

PBA outcome

The community identified 25 plants, herbs, shrubs and trees as useful during the assessment (Table 1). All the respondents agreed that the common grazing land was covered with local vegetation and that there were abundant grasses and fodder available in the area. They all felt that the reasons for its degradation were: increased pressure of human and livestock population, frequent droughts, cutting of trees and no replanting and no protective measures from the community. All of them, however agreed that there was greater awareness about rehabilitation of degraded lands in the community after the rehabilitation of a part of their grazing land. The villagers also suggested measures like erecting physical and social fencing and stall-feeding of animals. They also suggested that the benefits of conservation initiatives should reach all the sections of the community so that the community participates in such efforts. They were proud that their efforts had helped regenerate useful grasses and fodder plants and rehabilitate wild animals such as jackals, foxes, mongooses, hares,

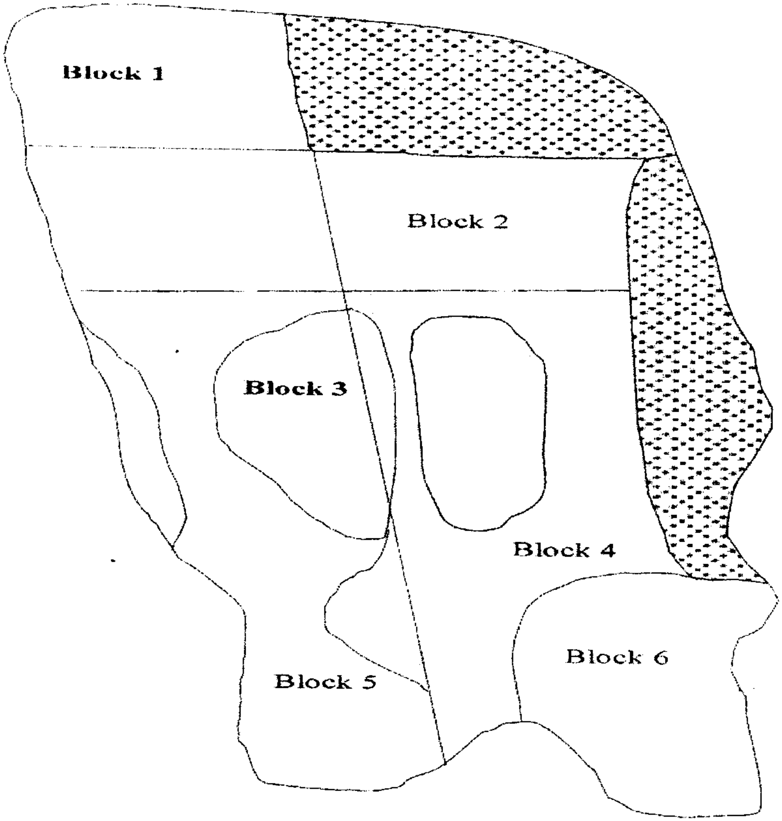

Fig. 1. Sketch of the rehabilitated grazing land.

monitor lizards and some rare birds. They were also worried that the population of blue bulls (*nilgai*) was rapidly multiplying in the rehabilitated common grazing land as this provided them with good cover for their breeding and rearing their young ones. *Nilgai is* known to destroy standing crops in farmers' fields and its increased number can pose danger to their farm output.

CBA outcome

Since biodiversity is sum total of different kind of diversities, e.g., species diversity, genetic diversity, life form diversity, floristic diversity, functional diversity, etc., and even cultured diversity, it was not possible to evaluate every constituent. To discuss biodiversity in present silvopasture we took floristic diversity and species diversity of woody and herbaceous vegetation and, dominance- diversity curves of herbaceous vegetation. Beta diversity, dominance concentration (Cd), Species Diversity Index (H') was calculated following Whittaker (1975), Simpson (1949) and Shannon and Wiener (1963), respectively. Besides this, an attempt was made to assess the below-ground diversity, that is, soil microbial diversity in the rehabilitated grazing land in contrast to the degraded one.

Floristic diversity

In general, biodiversity implies richness of species and their fair representation. The rehabilitated grazing land expressed good of floristic diversity with 20 species of woody taxa. Twenty five per cent of the species belonged to family Leguminosae/ Mimosoideae and the woody species represented 11 families/sub-families. The woody species were distributed among 12 families/sub-families and 36 herbaceous species, distributed among 24 families, were found in the rehabilitated grazing land. Family Cyperaceae represented maximum percentage of herbaceous species. Rest of the families had either one or two herbaceous species. Thus, from floristic point of view, rehabilitated grazing land was found to be quite rich, as it contained 54 plant species, while had only 9 in open degraded area plant species.

Species diversity

Sagar and Singh (1999) considered species diversity as approximate proxy of biodiversity. The term is 'biodiversity' or 'species diversity' means the number of different species and the relative abundance of different species found in a given area. The species richness or alpha diversity is simply the number of species. The richness of woody species varied from 3 to 11 in different habitats on rehabilitated grazing land. Between habitat diversity (Beta diversity) for tree layer was found to be 2.2. When dominance concentration (Cd) and diversity (H') were worked out for different habitats for woody species in developed silvopasture, an interesting picture emerged. Maximum Cd was observed on Guddi site, but the site also supports good diversity. Maximum H' was found on eastern upland site, however, Dev dungari site also expressed comparable H' value. Minimum H' within the developed pasture was recorded on entrance gate-upland site possibly due to biotic pressure. The high Cd and low H' values on open degraded area reflected the heavy exploitation of woody biomass.

In the case of herbaceous vegetation, species richness or alpha diversity varied from 13 on Guddi site to 20 on plain land site within the rehabilitated grazing land. Between the habitat diversity (Beta diversity) of herbaceous vegetation worked out to be 2.32. Within the developed silvopasture, Cd was maximum on plain land site and surprisingly this site had also highest species diversity largely due to very high number of herbaceous species. In general, all the sites/habitats of developed silvopasture had H' value 3.0. On open degraded land Cd value was relatively much higher and value of H' was relatively low. This indicated the severe degradation of herbaceous vegetation outside the developed pasture. Moore (1985) stated that microclimate substantially affects the species diversity and further emphasized that even little variation in microclimate is enough to alter diversity patterns in small areas like that of present Bundi watershed. Plain area located in little depression supported maximum herbaceous biomass and species diversity due to moisture retention for longer periods. On an average, the species diversity was 3.437 and dominance concentration was 0.124. These values clearly reflected a very high degree of diversification of herbaceous vegetation on entire developed silvipasture.

Table 1. Plant species identified by the village community and their botanical names

Local name	Botanical name	Uses
Khejadi	*Prosopis cineraria*	Fodder, timber and fuel
Kher	*Capparis decidua*	Fodder
Neem	*Azadirachta indica*	Fodder, medicine, timber
Dhallar	*Dichrostachys nutans*	Fuel, fodder
Khair	Acacia catechu	Fodder, timber
Dhokada	*Anogeissus latifolia*	Farm implements
Goya	To be identified	Fodder
Dasoon	To be identified	Farm implements
Sailooni	To be identified	Farm implements
Khejada	*Acacia leucopholia*	Bullock cart part
Subabul	*Leucaena leucocephala*	Fodder and fuel
Sisam	*Dalbergia sissoo*	Timber
Lapada	*Aristidia funiculata*	Fodder
Charchada	To be identified	Spine
Aandhi jhada	To be identified	Used as anti venom
Doodhi	*Euphorbia hirta*	Fodder
Jaal	To be identified	Medicine
Ber	*Ziziphus* spp.	Fruit and fodder
Pattar suli	To be identified	Fodder
Dhaman grass	Cenchrus setigerus	Fodder
Koli kanda	To be identified	Medicine
Malich ghas	To be identified	Fodder
Ksheen ghas	To be identified	Fodder
Chidiya ki kakadi	To be identified	Wild fruit
Chirphoti	*Physalis minima*	Spine

Dominance-diversity Curves (d-d Curves)

Dominance-diversity curves for herbaceous vegetation on the basis of relative biomass values for all the sites except open degraded grazing land exhibited more or less log normal distribution indicating relatively stable population. This indicated that several herbaceous species were sharing relatively low importance values (biomass) or more or less similar range of importance values. The d-d curve of open degraded land site is closer to geometric series. Whittaker (1975) opined that communities having low diversity exhibit geometric series due to ruthless exploitation of herbaceous vegetation resulting in severe loss of biodiversity

Assessment of below-ground microbial diversity

Microbial biomass C (460 μ C g^{-1} soil) in soil samples collected from rehabilitated area was 32% higher than the biomass C in soil samples collected from degraded area (288 μ C g^{-1}) (Table 2). Similarly biomass N was also 37% higher in rehabilitated (38 μ Ng^{-1} soil) area than degraded area (26 Ng^{-1} soil). The samples obtained from rehabilitated areas howed 12% higher bacterial population ($10x10^5$ CFU g^{-1} soil) than in the open grazing lands ($88x10^4$ CFU g^{-1} soil). The fungal population was 59% higher in the rehabilitated lands ($37x10^3$ CFU g^{-1} soil) compared to soil from open grazing lands ($15x10^2$ CFU g^{-1} soil). The actinomycete population was 39% higher in rehabilitated grazing lands ($57x10^3$ CFU g^{-1}) compared to open grazing lands ($35x10^3$ CFU g^{-1} soil).

In all 21 strains were isolated from rehabilitated soil, where as 18 strains were isolated from degraded soils. The bacterial isolates were tentatively identified as organisms, which belong to the genera *Azatobacter, Rhizobium, Pseudomonas, Xanthomonas, Enterobacter, Azosprillium, Streptomyces, Brandyrhizobium, Nitrosomonas, Nitrobacter, Klebsiella, Erwinia, Serratia.*

A total number of 18 genera (*Absidia, Alternaria, Aspergillus, Badarisama, Cladosporium, Drechslera, Fusarium, Gilmaniella, Mucor, Periconia, Penicillium, Rhizopus, Stachybotrys, Torula, Trichoderma, Thermomyces, Scopulariopsis, Syncephalastrum*) were isolated from rehabilitated area. From the degraded area a total number of 6 genera (*Alternaria, Aspergillus, Cladosporium, Fusarium, Mucor, Penicillium*) were identified.

Discussion

The villagers identified 25 types of trees, shrubs and bushes from within the rehabilitated common grazing land and enlisted their use as fodder, for agricultural implements, timber, medicine and fencing. The adjoining area across the fence did not have any of these economically important plant species and the members of the community recognized that the sole cause for regeneration of useful plants was their collective action. Thus, the community members agreed to strengthen their resolve to reinforce measures for rehabilitation of common grazing land. The team that employed conversional biodiversity (CBD) assessment identified over 50 species from the rehabilitated common grazing land in contrast to 9 identified from the adjoining unprotected common grazing land. However, the community members could not name all the plant species identified by the CBD team. This exercise was equally educative to the community as well as CBD experts as there was a large scope for convergence for both. PBD emphasized the utility point of view while CBD stressed species diversity. Both have certain distinct

Table 2. Biological parameters in soil samples collected from rehabilitated and degraded grazing lands

Parameters	Soils in rehabilitated area	Soils in degraded area
Biomass C (μg C g^{-1} soil)	460	287
Biomass N (μg N g^{-1} soil)	38	25
Bacteria (CFU g^{-1} soil)	$10x10^5$	$88x10^4$
Fungi (CFU g^{-1} soil)	$37x10^3$	$15x10^2$
Actinomycetes (CFU g^{-1} soil)	$57x10^3$	$35x10^3$

advantages. PBA is important from community capacity building point of view and in inculcation sense of ownership. It helps the communities to understand, appreciate, assess, monitor and conserve the biodiversity available in their ecology. This social capital is essential for local efforts to protect and conserve the environment that has a significant bearing on the livelihoods of the poor households that depend on such resources. In the process, it provides the community with an opportunity to come together for a purpose and invest in collective action.

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