



Full Length Research Article

ECOLOGICAL RESTORATION OF ARID LAND: A PILOT APPROACH IN GREAT RANN OF KACHCHH, KACHCHH DISTRICT, GUJARAT, INDIA

Vijay Kumar, V. and *Arun Kumar Roy Mahato

Gujarat Institute of Desert Ecology, Mundra Road, Bhuj-370001, Kachchh, Gujarat, India

ARTICLE INFO

Article History:

Received 27th September, 2016
Received in revised form
22nd October, 2016
Accepted 19th November, 2016
Published online 30th December, 2016

Key Words:

Rann,
Restoration,
Biodiversity,
Kachchh.

ABSTRACT

The Greater Rann of Kachchh (GRK) is a marshy and highly saline area characterized by flat terrain, harsh climate and ecologically fragile due to very low soil moisture and high soil salinity. Therefore, an attempt was made on a pilot scale to reclaim the Rann and accelerate the natural recovery process of two bets (upland area), namely, the Kuar and Mori bets. Some traditional techniques of land resource practices were applied for reclaiming the area in year 2001 and 2007. In total, 1776 ha area has been reclaimed under the project, evidenced by increased in dense scrub forest and grassland to 667% and 44% and number of plant species increased from 113 in 2001 to 261 in 2007. The results of the study are found to be highly successful, which is evident from the development of vegetative cover and increase in soil fertility, which in turn improved ecology of the area.

Copyright©2016, Vijay Kumar and Arun Kumar Roy Mahato. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

INTRODUCTION

Reclamation is "the process of altering a site to produce a specified historic ecosystem. The intent of the work is to emulate the natural structure, function, diversity, and dynamics of a defined, indigenous ecological system" (Munro, 2006). Restoration of ecosystem functions or natural recovery following degradation is a slow process; it depends on time and space, and is influenced by geographical, climatic factors and ecological conditions of the site (Singh and Jha, 1992). Therefore, a successful restoration / reclamation programme attempts to accelerate the natural recovery process through eco-friendly exercises in order to achieve the goal in a short time. Until recently, the success in obtaining higher productivity in arid and semi-arid regions came through the traditional techniques of land resource conservation (Altieri and Toledo, 2005). Cubitt and Mountfort (1991) defined Rann of Kachchh as "a desolate area of unrelieved, sun-baked saline clay desert, shimmering with the images of a perpetual mirage". The monotonous flatness, salinity, and the unusual inundation have rendered the Rann as a place of mysterious ground. In spite of its unusual position and character, Rann has hardly been studied and continued to be only feebly understood.

***Corresponding author: Arun Kumar Roy Mahato,**
Gujarat Institute of Desert Ecology, Mundra Road, Bhuj-370001,
Kachchh, Gujarat, India.

The 3rd Five Year Plan of Planning Commission (1960), Govt. of India emphasized a pilot project for examining the methods and economics of reclaiming desert lands in a portion of the Rann of Kachchh through suitable soil conservation measures including afforestation and pasture development. With the above background, the project on "*Integrated Rann Reclamation and Development in Kachchh District, Gujarat*" was initiated on a pilot basis to assess the possibilities of developing the degraded saline land and enhance the ecological status of Rann. The aim of this project was to create a long-term sustainability in the project area by reclaiming the saline soil through various soil amendments and water conservation techniques which may render the habitat conditions suitable for developing vegetative cover and ecological advancement. For the pilot experiment, two bets in the GRK namely; Kuar and Mori Bets, covering a total area of 1440 ha (940 ha in the Bet area and 500ha adjoining the Bets in the Rann area) were taken and the reclamation experiment was conducted between 2001 and 2007.

Study Area

Kachchh district located on the north-western part of Gujarat State in India which is entirely falls under the arid biogeographic zone (Rodger and Panwar, 1988) of the country. The district is poorly endowed in terms vegetation cover, as about 51% area is covered by saline deserts (Greater and Little Ranns) along the northern and eastern part of the district (GUIDE, 2007).

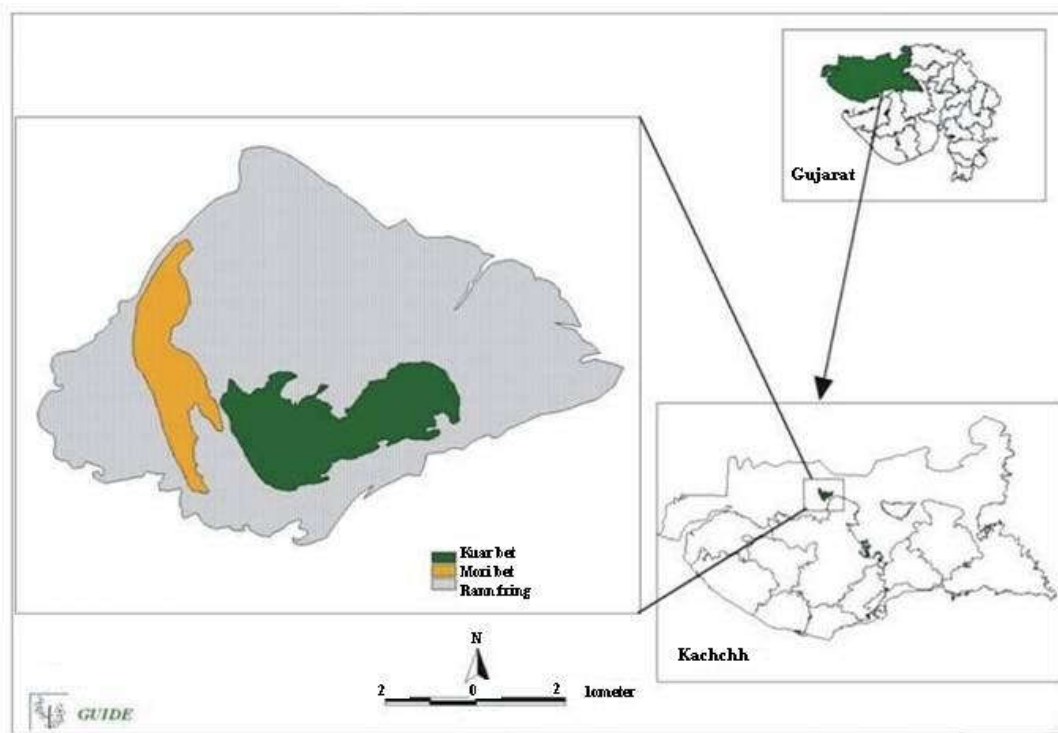


Figure 1. Location of the Study Area (Kuar Bet & Mori bet) in Kachchh, Gujarat

Land cover type	Area (Ha) in 2001	Area (Ha) in 2006	Area (Ha) in 2009	% change in area
Dense Scrub	91 (7%)	200 (15%)	698 (53%)	667%
Grassland	366 (28%)	778 (59%)	528 (40%)	44%
Barren Land	857 (65%)	234 (18%)	83 (6%)	-90%
Other	10	113	15	
Total Area	1324	1325	1324	

Table 2. Changes in vegetation cover in the study area between 2001 and 2006

S. No	Life Forms	2001		2006		% change in no. of Species
		No. of Species	Relative Dominance	No. of Species	Relative Dominance	
1	Grass	12	11%	50	19%	316
2	Herb	47	42%	138	53%	194
3	Shrub	27	24%	37	14%	37
4	Tree	18	16%	18	7%	0
5	Climber	9	7%	18	7%	100
	Total	113		261		131

The Greater Rann of Kachchh (GRK) is a unique landscape with unusual geomorphic terrain and is the only saline and marshy desert of the world (Maurya *et al.*, 2002). It is characterized by flat topography, rising barely above the sea level with average height up to 4m above MSL. The GRK extends to about 290 km from east-west with width varying from 30 to 100 km, spanning over an area of about 16,780 km² (GUIDE, 2007). In GRK, there are slightly raised isolated patches of land raised few meters (5-7m) above the Rann surface which are known as 'bets' (Islands) or 'dhoi'. The experimental study was carried out two important bets namely; Kuar bet and Mori bet located in the central part of GRK (Figure 1). The temperature of the area was predominantly high and it reaches a maximum of 48-49^o C during May-June and winter temperature goes down to 10^o C with January and February being the coldest months. The average humidity is about 60 per cent, which ranges between 0.8 to 98 per cent. During summer, dust-laden winds are very frequent and the average wind speed recorded during winter, summer and monsoon is 16, 24 and 9 km/hr respectively (GUIDE, 2007).

The soil type of the Rann varies from sandy loam to silty clay to clay in texture, and is slightly lighter in the lower layers. The soils are generally stratified and its compactness and impervious layer varying in thickness of about 0.15m to 1m (MFACDC, 1966).

MATERIALS AND METHODS

In order to restore the productive and protective functions, a degraded land needs human assistance, i.e. protection, pre-treatment for habitat rectification such as soil moisture conservation amendments, slope modification, nutrient and organic matter amendments, etc. (Singh and Jha, 1992). Further, soil, water and vegetation are the most vital natural resources for the survival of man. To obtain optimum production of vegetation, the other two resources, i.e. soil and water, will have to be managed efficiently. The aim of the project was to create a long-term sustainability in the project area by reclaiming the saline soil through various soil amendments and water conservation techniques which may

render the habitat conditions suitable for developing vegetative cover and ecological advancement. The implications are: First, development of vegetative cover would reduce the saline underground water coming on the surface through capillary action and thereby improve the soil quality; Second, soil amendments would create a suitable moisture regime for growth and production of plant species; Third, addition of mixed leguminous plants will help in improving the soil fertility of the area and support further vegetative growth; Forth, apart from the land improvement and ecological sustainability; and Fifth, the development of vegetative cover would also help in enhancing the faunal diversity of the area. In all the process, only natural rainfall was harvested through various soil moisture conservation amendments for land reclamation and vegetative cover development. The following planned experiments were carried out to restore the degraded saline wasteland, of GRK. The activities carried out are described as below:

Experimental Activities for Land Reclamation

Looking at the topography of the project area, contour bunds and earthen bunds were constructed for soil and water conservation in the entire Kuar and Mori bets and adjoining Rann area. As part of rain water harvesting and improvement of soil moisture, earthen check dams, storage tanks and open tanks were developed in the project area. Apart from the above, nallah bunds, staggered trenches, continuous staggered trenches, loose boulders and silt traps were also developed in many parts of the Kuar/Mori bets for land reclamation. Further, large numbers of earthen mounds were also developed in the high saline Rann for vegetation development on an experimental basis. To improve the vegetative cover, saplings of tree species including; *Acacia nilotica*, *Salvadora persica*, *Suaeda* sp., *Tamarix aphylla*, *Phoenix* sp., *Casuarina* sp., *Delonix* sp., *Azadirachta indica*, *Aloe barbadensis*, *Acacia senegal*, *Grewia tenax*, *Prosopis cineraria*, *Albizia lebeck* and *Parkinsonia aculeate* naturally found in vicinity of the area were planted. In addition, saplings of *Agave* and *Aloe* were also planted during the monsoon season on hilly and barren area for erosion control and development of green belt. Vegetative cuttings of *Commiphora wightii* were planted on rocky barren area. Seeds of different grass, shrubs and tree species were broadcasted in the project area with healthy/nutritive soil for reclamation purposes especially in newly developed barren sites or non productive lands. It improved the ground cover and fodder resources with a view to stabilize the bet and the fringes of the Rann areas. The project activities and results were regularly monitored.

RESULTS AND DISCUSSION

The outcomes of the above activities are described under sub-section below:

Land Cover Development

In total, 1776ha (1,324 ha in Bets and 452 ha in Rann proper) area has been reclaimed under the project during the period between 2001 and 2007 (Table 1). The comparative analysis of the post monsoon imageries of 2001 and 2009 highlights the results of the reclamation activities of bets and Rann areas. Dense scrub has been increased from 91ha to 698 ha (+667%) and grassland from 366ha to 528ha (+44%), while the barren area has been reduced from 857ha in 2001 to 83ha in 2009

(-90%) (Table1). Excellent ground cover in the project area has been developed through soil amendments and water conservation measures and development of grass, herbs, shrubs and trees.

Change in Floristic Diversity

The result highlighted that a total of 261 species of plants recorded in year 2006 (after amendment) compared to 113 species in year 2001(before amendment). The phytosociological data, the density of trees increased from 15/ha in 2003 to 145/ha in 2006, while the shrub density has increased from 181/ha in 2003 to 3292/ha in 2006 (Table 2). Similarly, the grass cover increased from 8% in 2003 to 46% in 2006 and herb cover has increased from 1% in 2003 to 12% in 2006. The biomass developed in the project area at the end of the project was 1,659 tones (at the rate of 1152kg/ha of grass fodder) annually. The enormous seed production and tillers of grass species would further increase the biomass production to the tune of 2 to 3 times in the successive years (GUIDE, 2007).

Changes in Faunal Diversity

A total of sixteen species of herpetofauna (15 species of reptiles and one species of amphibian) belonging to 13 genera and 9 families were recorded during the year 2001. Out of which, 14 species were recorded during the year 2006. This may be due to dense vegetative cover which decreased the visibility of the same. Further, 13 species of mammals were recorded during the year 2001, which increased to 14 species in 2006. Among the mammals, Chinkara is the dominant one present in the area. The indirect evidences (density of pellets) collected in the study area highlight that the population of Chinkara is increasing in the project area which is evidenced from the distribution of direct and indirect evidences obtained from all the habitats of the project area. The average pellet density increased from 4,117 in 2003 to 9,095 in 2006.

Among the bird species, total 46 species belonging to 34 genera and 21 families were recorded during 2001 which increased to 49 species belonging to 42 genera and 25 families in 2006. It was found that, the species richness not varied significantly between the study period however, abundance of species increased during the study period ranging from 53% to 71% in various habitats of the project area which clearly indicate that the food availability increased in the area. On analysis of the status of bird species based on foraging guild, it was found that all categories foraging guilds like aquatic, carnivorous, granivorous, insectivorous and omnivorous birds were present in the study area. Interestingly, insectivorous and granivorous birds were dominant during year 2003 and 2005; while in year 2006, omnivorous species were dominated in all the habitats due to availability of diverse food resources in the area has changed the species composition.

Conclusion

The changes shown in the result have enhanced the environment and ecology of the area which are reflected by the enrichment of floral and faunal diversity and vegetation cover after the restoration activities. The change in ecological setup of the area has enhanced the biological resources and created many livelihood opportunities and economic development to the area.

Acknowledgement

Authors are grateful to the Director, Gujarat Institute of Desert Ecology for providing infra-structural facilities and his encouragements. We are thankful to Ministry of Rural Development, Govt. of India for funding this project. We are grateful to Prof. Uriel Saferiel, Bengurian Institute of Desert Research, Israel for his valuable guidance and suggestion to conduct the study. We are also grateful to the experts of various field includes Prof. V. L. Chopra, Planning Commission, New Delhi; Dr. S. P. Vyas, CAZRI; and Gujarat Ecology Commission who helped in many way to conduct the project and study. Finally we are thankful to the entire project staff involved in this project that helped in successfully completing the work.

REFERENCES

- Altieri, M. A., Toledo, V. M. 2005. Natural Resource Management among Small-scale Farmers in Semi-arid Lands: Building on Traditional Knowledge and Agroecology. *Ann. Arid Zone*, 44(3&4): 365-385.
- GUIDE, 2007. Integrated Rann reclamation and Development in Kachchh district Report. Gujarat Institute of Desert Ecology, Bhuj
- Kar, A., Garg, B.K., Singh, M. P., Kathju, S. 2009. Trends in Arid Zone Research in India. Central Arid Zone Research Institute, Jodhpur.
- Maurya, D. M., Thakkar, M. G., Chamyal, L. S. 2003. Quarternary geology of arid zone of Kachchh: Terra Incognita. *Proc. Indian Nat. Sci. Acad.*, 69 A (2): 123-135.
- MFACDC, 1966. Reclamation and development of the Great Rann of Kutch. Ministry of Food, Agriculture, Community Development and Co-operation, Govt. of India, New Delhi.
- MoEF, 2001. Status of Desertification, Volume-I, India's National Action Programme to Combat Desertification, in: The Context of United Nations Convention to Combat Desertification (UNCCD).
- MoEF, 2010. Elucidation of the 4th National Report submitted to UNCCD Secretariat 2010, Centre for Environment Education (CEE), Ahmedabad.
- Mountfort, G. R., G. S. Cubitt and M. Marel 1991. Ongerept India: de biologische diversiteit van India en Nepal. M & P.
- Munro, R.N., Deckers, J., Behailu, M., Haile, M., Poesen, J., Nyssen, J. 2006. Soil and erosion features of the central plateau region of Tigray –learning from photo monitoring with 30 years interval. High Land 2006 International Conference - Mekelle, Ethiopia.
- Rodgers, W. A., Panwar, H. S. 1988. Planning wildlife protected area network in India, Wildlife Institute of India (WII), Dehradun
- Roy, B., Merh, S. S. 1977. Geomorphology of the Rann of Kachchh and climatic changes, in: Agarwal, Singh, J. S.; Jha, A. K. 1992. Restoration of Degraded land: An over view, in: Singh, J. S. (eds.), Restoration of Degraded land: Concepts and Strategies, Rastogi Publication.
