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Applications of Vetiver Grass (*Chrysopogon zizanioides*) in Eco System Based Disaster Risk Reduction - Studies from Kerala State of India

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Abstract

The correlation between ecosystem and disasters are widely documented but inadequately integrated in to disaster risk reduction initiatives and developmental programmes. The present work examines the scope of vetiver system as a natural solution for various environmental risk reduction activities. The Vetiver System (VS), which is based on the application of vetiver grass - a perennial grass of Indian origin (*Vetiveria zizanioides L Nash*, now reclassified as *Chrysopogon zizanioides L Roberty*), was first developed by the World Bank for soil and water conservation in the mid 1980s. It is a very simple, practical, inexpensive, low maintenance and incredibly efficient means of natural disaster reduction. The two case works in the study reported here documents the success of VS application in the state of Kerala in India and the implementation strategy for the vetiver system in the fields with the collaboration of Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA). The study also identifies the potential entry points of VS in the ecosystem based disaster risk reduction (Eco-DRR). Integrating local level disaster risk reduction activities in the national level programmes will ensure the sectoral integration in DRR initiatives. Vetiver system can very effectively be used as a cost effective and efficient Eco DRR technology that can address both long term and short term risk with ecosystem management.

Keywords: Vetiver system; Eco-DRR; Case studies; MGNREGA

Introduction

Eco-DRR is the sustainable management, conservation and restoration of ecosystems to reduce disaster risk, with the aim to attain sustainable and resilient development [1,2]. A well managed ecosystem can reduce physical exposure to natural hazards by serving as natural protective barriers and provide protection against common natural hazards such as floods and landslides [3] and these are viewed to be cost effective and are a no regret investment [4]. The lack of identification and development of suitable flora systems is the main crisis in the recent Eco-DRR advancements (Figure 1).

The vetiver grass (*Chrysopogon zizanioides*) belongs to the Poaceae family and is a unique tropical plant of Indian origin that has been proven and used in some countries as the source of vetiver essential oil and many other environmental applications [5-7]. The vetiver is a very tolerant plant to the extreme climatic conditions such as prolonged drought, flood, submergence and extreme temperatures from -15°C to +55°C, wide range of soil pH from 3.3-12.5 without soil amendment and is highly tolerant to hazardous metals [8]. It has a very high tensile strength of 85.10 ± 31.2 compared to other grasses [9]. The current applications of this plant include clean-up tool for heavy metal contaminated iron ore mine-soil [10], micro pollutant leaching control [11], treatment of wastewater from an institutional kitchen [12] and remediation of hazardous pesticides like Endosulfan [13]. But the Eco-DRR potential of vetiver grass system is not much explored by the research community. Disaster risk reduction practices and environmental management are not well connected in India and there are not many strategic entry points and platforms for integrating environment and risk reduction dimensions. Creation of a multi-disciplinary community participatory approach will reduce the gap among sectors with a view to increasing effectiveness of risk reduction. In the last few years the ecosystem-based approach has received much attention in the disaster risk and climate change communities in the country, but there are still many needs in research and practice. The present study is a detailed examination of Eco-DRR applications of vetiver system in an Indian context.

Figure 1: Field Photographs.

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Research Questions

1. Can vetiver grass be successfully using for ecosystem based disaster risk reduction activities?

2. How can a field implementation practice for vetiver system be developed in the Indian context?

Materials and Methods

Methodologically speaking, the research focuses on the two main intents of the vetiver system, (1) the two case studies and (2) the development of field implementation practice.

Case Studies

In preparing each case study special attention was placed on the analysis of efficient risk reduction management mechanisms, in order to highlight the effectiveness of vetiver system techniques for dealing with the particular vulnerability. Detailed field visits were made in the month of May 2016 to Punchavayalkattu region of Neendoor Panchayath in Kottayam district and Twyford tea estate region of Elappara Panchayath, Idukki district, both in Kerala state, India. Seasonal floods and landslips, respectively, are the major environmental hazards in these regions. Self-report measures such as personal interviews and focused group discussions with local people, agricultural officers, and elected representatives of local governments, engineers and environmental specialists were carried out (Table 1).

Development of field implementation practice

For this purpose, a national level law known as Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) which aims to enhance livelihood security in rural areas by providing at least 100 days of wage employment in a financial year to every household whose adult members volunteer to do unskilled manual work was approached. After successful discussions, a detailed project was submitted to the village level authorities of MGNREGA for the implementation of vetiver system in the field. A vetiver nursery were set up in the Mahatma Gandhi university campus at Kottayam in Kerala, by considering soil type, topography, shading and irrigation facilities to provide sufficient stock materials for vegetative culture propagation of vetiver and to ensure good quality and sufficient number of slips. The banks of River Pamba situated in the Ranni-Perinadu village of Kerala were selected for the trial implementation of vetiver system. The Pamba River is the third largest river in Kerala and is severely polluted due to an annual religious mass gathering [14-16]. The ability of vetiver system in river water purification and associated hazards mitigation has been well studied by various scholars [17-20]. Around seven hundred vetiver slips were planted in the Pamba river bank with the active support of twenty MGNREGA workers in November 2016. The active participation of MGNREGA officers, field workers, elected representatives and local peoples made the field implementation of VS a success (Figure 2). The initiative was covered by the major newspapers in the state.

Discussion

Present disaster risk management activities in India, primarily focus on the structural aspects of disaster management and ecosystem based interventions have been lacking [6,21]. The vetiver grass focused on the current study has excellent Eco-DRR efficiencies. Successful application of the VS can reduce or even eliminate many types of natural hazards such as landslides, mud slides, road bund instability, and erosion [22-24]. The application of vetiver grass along muddy roadside (case study I) and in the tea plantation (case study II) are found

Figure 2: VS field implementation through MGNREGA.

to be very effective in order to prevent bund erosion and land slips respectively. Vetiver hedges are used for protecting road embankments and are cost effective, require less maintenance and are labor intensive. The potential of VS as low cost bioengineering technique was first addressed by the World Bank for soil and water conservation in India in the 1980s [25] but its application regarding Eco-DRR is very limited. Well-managed ecosystems can act as natural infrastructure, reducing physical exposure to many hazards and provide some livelihood options to the local community [26]. Several studies and research documents explain the societal applications of vetiver plant such as in oil production [27-30], as cattle feed [30], soil and water conservation tool [31], as a green fuel [32], as a cement replacement building material [33], as an anti-termite insecticide [34], vetiver-clay composite storage bin [35] and as ornamentals [36]. Hence Eco-DRR initiatives with the VS implementation not only offers an opportunity to strengthen natural infrastructure and human resilience against hazard impacts, but also generates a range of other social, economic and environmental benefits for multiple stakeholders. Serious consideration of the role of ecosystem for DRR components such as hazard mitigation, livelihood security and resilience to disasters came about only over the last decade within the DRR community [37,38]. The vetiver grass technologies can provide cost-effective and sustainable solutions to reduce the impact of a number of natural hazards and disasters. In order to ensure that investments in ecosystem management are effective, a variety of new DRR tools and approaches aiming long term reflections and capacity development of stakeholders need to be designed and tested [39-41]. A successful implementation practice is the corner stone of any Eco-DRR activity. Field execution in connection with well-established national level programmes such as MGNREGA will strengthen VS based Eco-DRR initiatives. As per the MGNREGA, creation of durable assets and strengthening of livelihood resource base of the rural poor is a main objective of the scheme. The multiple benefits of vetiver system include disaster risk management, ecosystem management and social development sectors. The main components in each sector are recounted in the Figure 3.

Limitations of the Study

The integration of VS to the Eco-DRR approach has certain limitations. In the establishment phase the vetiver grass is intolerant to shading and the Vetiver System is effective only when the plants are well established. Maintaining health and composition of vetiver hedges is very important for the effective risk reduction. This needs a continuous monitoring post implementation. Most of the people in vulnerable areas are unaware of the importance of ecosystem management for DRR and projecting the economic value of eco-system services is

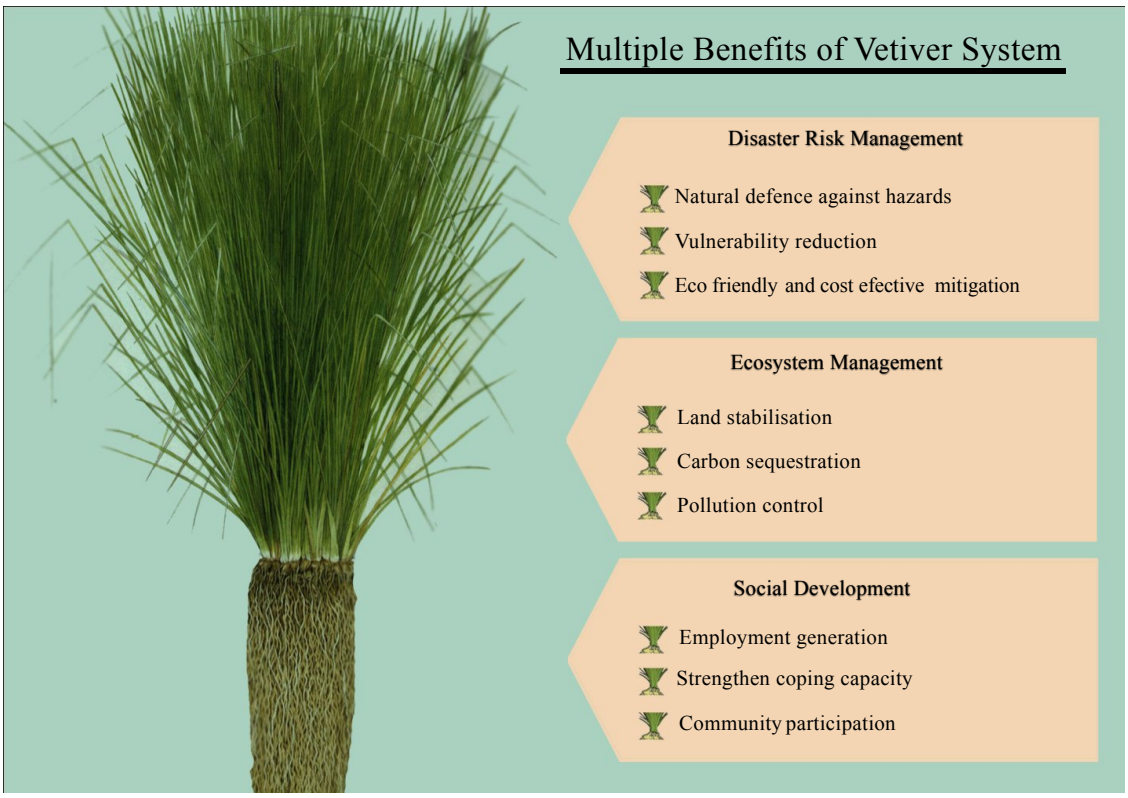

Figure 3: Multiple benefits of VS.

	Case study I: VS technology for the control of seasonal flooding and bund erosion in the elevated road section of Neendoor area in Kottayam district.	**Case Study II**: Use of VS against various natural hazards in Tyford tea estate region in Idukki district.
Background	Location 8°40′46″N 76°30′24″E This case study gives an overview of natural hazards in the region and success of VS based solutions for risk reduction.	Location 9°37′0″N 76°58′0″E This case study features protection of highland landscapes from hazards such as heavy soil erosion and landslips using VS applications.
Problem statement in the region	The area is low elevation, (0-5m above MSL) and recurrent flooding happens here every year during monsoon and hence the road needed to be raised by 3-5m. Due to the clayey instable soil type, severe bund erosion reported as a major problem in the province.	Soil erosion and land slips are the major problem in tea plantations especially in the replantation stage. Hilly slopes of Western Ghats and heavy annual rainfall are the other causative factors for these natural hazards. Every year huge property loss and environmental degradation take place here.
Measures implemented	The local self-government in the area implemented a project named Punchavayalkattu and they planted Vetiver hedges along the 750m stretch of a road in 2005.	Vetiver was introduced to the Twyford tea estate in 2010 and planted as a contour hedge along the boundary portions.
Implications for Ecosystem-based DRR	The VS implemented portion of the elevated road is well protected from bund erosion and associated hazards.	The Vetiver system successively prevented the soil erosion and landslip problem in the observed portion of the tea plantation. Vetiver hedges are not developed as a weed; rather it prevents the entry of weeds.
Lessons learned	Vetiver system is very efficient in preventing mud slip and soil erosion in the low lying areas. And the local communities are well aware about the applications of VS and are planning to apply it in their own farmlands.	The Vetiver system could be used to replace mechanical engineering works such as contour bunding and have multiple environmental applications in soil degradation, loss of soil fertility, ground water recharging and water quality enhancement

Table 1: Case study results.

very important in today's market driven society. Multi departmental collaborations are needed for effective VS implementation.

Conclusion

Ecosystem based regional developmental programmes are emerging worldwide and hence green technologies and systems for the prevention and mitigation of natural hazards need to be developed. There is a need to highlight the importance of a unique grass like Vetiver that has many unique characteristics. The two case studies in the present study support a problem-based learning approach in Eco-DRR and VS can play a key role in disaster mitigation and vulnerability reduction. Today authorities are looking for new solutions in DRR activities because conventional engineering approaches are insufficient, especially in a densely populated tropical country like India. The VS applications is a long-lasting, cost effective, community-based and environment friendly bio-engineering tool for natural disaster mitigation and infrastructure protection. The best practice identified and developed through this study (VS implementation through MGNREGA) can be easily implemented in Indian circumstances with the active support of the local population.

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