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Exploring Linkages between Regenerative Capacity of Coastal Ecosystem and Sustainable Livelihood – A New Insight

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ABSTRACT: Urbanization in Indian context is more complex and driven by number of anthropogenic factors having negative impacts on the biological diversity of coastal ecosystem and livelihood of local people. With a growing realization enhancing the regenerative capacity through increasing the resilience can be effective and efficient way to conserve the coastal ecosystems and support sustainable livelihoods. The policies and implementations of ecosystems restoration are to be formulated for enhancement of regeneration capacity in the context of the increased dependence of humans for their well-being on coastal ecosystem services. The objective of the paper is to understand and analyze the concept of regenerative capacity of coastal ecosystem and to explore the linkages between functions of coastal ecosystem and livelihood of local people. The study of the paper reveals a high level of overall dependences on coastal ecosystem services for livelihood.

I. INTRODUCTION

The recent increase in the world population has magnified the effects of economic activities on natural resources and coastal ecosystem is one amongst it. India coastal line is characterized by a variety of ecosystems and resources that are very complex with the most productive ecosystems on the earth and has attracted the population seeking livelihood opportunities (Sanjay Rode; 2011). The human exploitation and conversion of the ecosystems of the world is causing widespread biodiversity loss and declines in ecosystem condition, leading to reduced provision of ecosystem services resulting in poor livelihood opportunity (James M Bullock *et al.,* 2011). Adding to this challenge, it raises a question about future sustainability of ecosystem that necessitates the role of regeneration in ecosystem. The objective of the paper is to understand the importance's of coastal ecosystem function in providing livelihood and long term maintenances of coastal profile. The paper also discusses the role of regenerative capacity of coastal ecosystem in providing sustainable livelihood opportunities to local community.

II. COASTAL ECOSYSTEM – DEGRADATION & REGENERATION

The coastal areas are usually characterized by two distinct facts: one, the concentration of large part of growing population on the coastal area and second, availability of rich natural resource. These two facts have a larger role in maintaining the profile of the coast. The problem of declining trend in ecosystems can be addressed through better understanding of their benefits that humans are getting and the impacts of human activities on ecosystems (Cork *et al*., 2001). During the process of urbanization, economic development and quality of life improvement are considered as major goals, and their impacts on ecological systems have often been neglected (Zang S *et al*, 2011). Much of the economic activities along the Indian coastal line are likely to put pressure on the coastal ecosystems. It is important to maintain a balance between the ecology and economy in the region to ensure sustainable development. Most coastal states in India have not been able to maintain the balance between economy and ecology, resulting in serious problems with respect to life and livelihood of coastal population on the one hand and sustainability of the development on the other hand (Sanjay Rode, 2011) Many initiatives including convention on biological diversity, Millennium Developmental Goals (MDG) and inter governmental science –policy platform on biodiversity and ecosystem services, have addressed these impacts on coastal ecosystem by linking the conservation of biodiversity with the provision of ecosystem services to support the sustainable development and poverty reduction (Jeffrey D Sachs *et al.* 2009).

Ecosystem Regeneration is the "process of assisting the recovery of an ecosystem that has been degraded, damaged or destroyed" (SER Primer, 2004). To effectively regenerate an ecosystem it is to restore the functions lost by the ecosystem, or replacing it entirely by another ecosystem by doing so the concerned functions are fulfilled. Ecosystem regeneration should be an important component of conservation and sustainable development programmes so that the livelihood of people depending on these degraded ecosystems can be sustained.

III. METHODOLOGY

This study is carried out in three stages. To focus on coastal ecosystem and its regenerative capacity firstly it is important to understand the broad definition of ecosystem's resilience and regeneration. Understanding the concept of resilience describes the capacity of the ecosystem to withstand, recover from or regenerate in response to turbulent conditions. Secondly, detailed analysis is conducted for coastal ecosystem processes and function from which various services are derived. Sudden disruption in the ecosystem function or process needs to know how these changes will directly or indirectly impact the people. To capture these changes significant drivers are identified that plays an important role in ecosystem service and human well-being. Thirdly, to develop a multi-dimensional approach that encompasses the constituent and determinants of human well-being. Hence forth the study explores a linkage between regenerative capacity of ecosystem services how degradation majorly influences resource dependent community. Finally a review of various responsive options to address ecosystem degradation is done to highlight effective strategies for sustainable livelihood. The paper also draws on cases of coastal cities to illustrate the livelihood status of ecosystem dependent communities.

Resilience and Regenerative capacity : Resilience, is the potential of a system to remain in a particular configuration and to maintain its feedbacks and functions, and involves the ability of the system to reorganize following disturbance-driven change (Carpenter *et al;* 2001). Regenerative capacity is an aspect of resilience, defined as the process of renewal, restoration and growth that makes an ecosystem resilient to natural fluctuations or events that causes disturbances or damage. Every single living organism is capable of regeneration but it is also stated that the capacity of coastal ecosystems to regenerate after disasters and to continue to produce resources and services for human Livelihoods can no longer be taken for granted (W Neil Adger *et al,* 2005). Coastal ecosystems are influenced by dynamic biophysical and social factors which require understanding factors triggering for desirable transformation.

Coastal ecosystem functions, services and human wellbeing: Humans rely on the natural resource base for mere survival and for higher degree of well being. Healthy ecosystem provides humans with a wide range of ecosystem services. Therefore the maintenance of the health of coastal ecosystems is vital for human well being in the coastal cities of India. For this it is required to understand the various factors that contribute to the coastal ecosystem and human well being.

Significant drivers of change: A comprehensive listing of recent trend in changes to coastal ecosystem along with potential drivers of changes is tabulated in Table 1 to understand the complex interplay among ecosystem services and human wellbeing.

Detection of significant changes and discoveries of coastal ecosystem causes through environmental monitoring is essential for establishing and measuring outcomes of policies that aim to maintain and sustain services by coastal ecosystem (James Ecloem, 2012).

Linking coastal ecosystem and livelihood: Ecosystem's continuous supply of services is integral to provide many material factors essential for human well-being, one such is livelihood.

Table 1: Dynamic state of coastal ecosystem and their potential drivers.

Coastal ecosystem	Dynamic state	Recent trend in change	Potential drivers
Mangroves[*1]	Improving	(1987 - 2013) mean annual change 24.25 ± 82.57 km2	•Urban development • Over exploitation
Coastal lagoon[*2]	Deteriorating / Stable	Average sediment accumulation rate 12.34 and 7.85 mm yr	• Pesticide pollution • Sewage pollution • Oil spill • Eutrophication
Estuaries[*3]	Deteriorating	Waste water discharg0.01 106m3/day	• Discharge of civil and industrial effluents • Growth of water hyacinth

(Source: [*1] Sahu SC et al 2015; [*2] R Ramesh et al 2001; [*3] Satish R Shetye, 2011)

A livelihood comprises of capabilities, assets and activities required for a means of living. A livelihood is sustainable when it can cope with and recover from stresses and shocks maintain or enhance its capabilities and assets, while not undermining the natural resource base. The material aspects of human well-being have been defined as including adequate livelihood, sufficient nutritious food, shelter, access to goods (Butler *et al.* 2003). The services provided regulates the production of ecosystem goods, the natural products harvested and used by humans. Several studies have indicated the complex links between ecosystem services and poverty. It also meant to have some overlaps between indicators of ecosystem services and those of poverty and livelihood. Despite the growing interest and extensive efforts in coastal ecosystem service research in the past decade, the regenerative capacity of the coastal ecosystem and their linkages between ecosystem services and human wellbeing is rare in existing literature, may be largely due to quantitative indicators and integrated models. The restoration of natural resources, including its ability to renew or regenerate itself, represents core aspects of sustainability. Hence, reliable measures of supply and demand on the natural resource by humans are necessary for driving policies for sustainability (M Wackemagel *et al,* 2004). Coastal ecosystem suffers a lack of recognition in regenerative capacity including vital services such as providing food, livelihood and carbon capture. Figure 1 presents the different constituents, determinants and dimensions of the livelihood identified through extensive literature review that are closely related with coastal ecosystem service.

Need to improve livelihood through ecosystem approach : To develop a sustainable livelihood it is important to address the fundamental social, economic and ecological drivers that affect coastal communities and livelihoods (Robert S Pomeroy, 2013). In order to address the drivers an ecosystem based approach through policy intervention strategy need to be followed (Spalding MD *et al,* 2014). Ecosystem-based approaches have emerged as a promising strategy to increase the resilience of ecosystems and support sustainable livelihoods and a number of communities have begun to utilize natural processes through ecosystem restoration and management realignment (PEDRR, 2010). They address the crucial links between biodiversity and sustainable resource management providing multiple benefits.

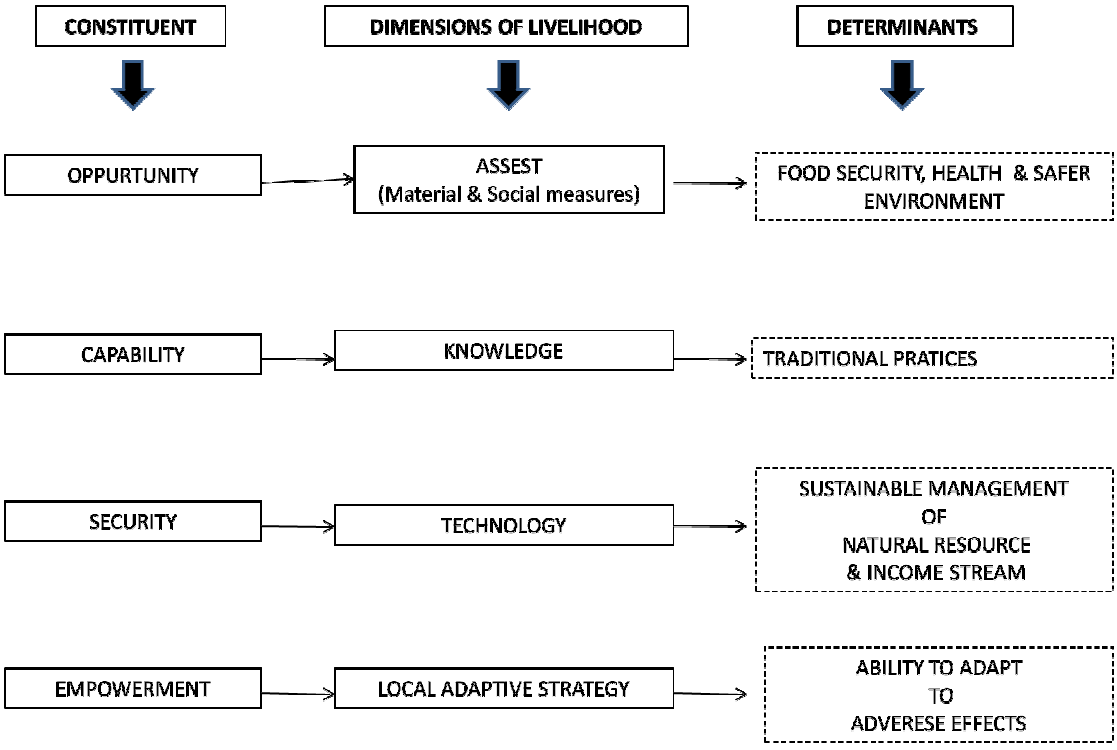

Fig.1. Schematic representation of linkages between determinants and dimensions of livelihood. (Source – UNEP, 2004; Duraiappa, 2002).

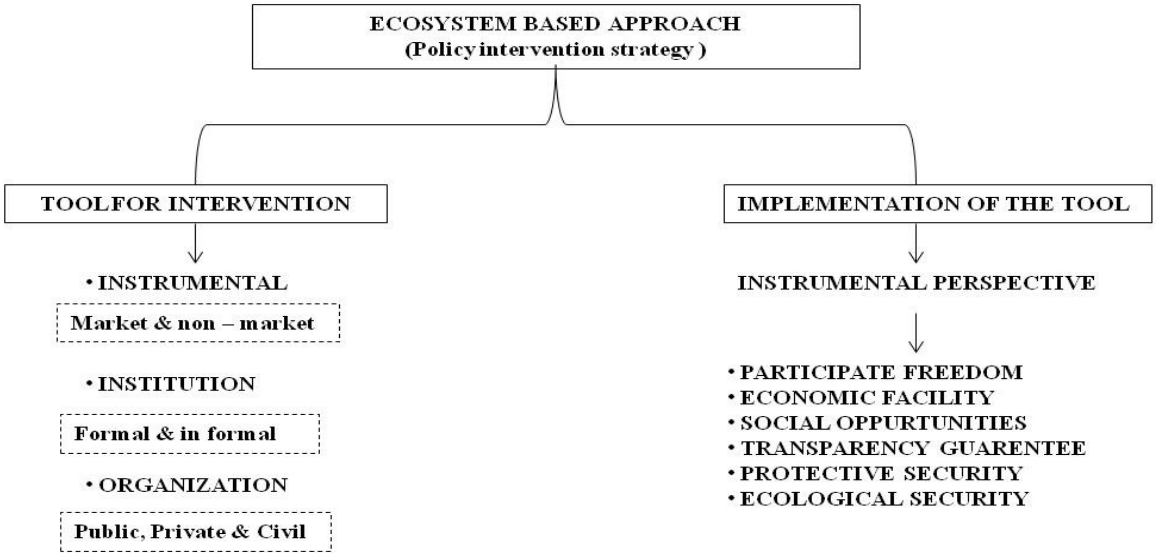

Fig. 2. A schematic representations of different components of policy intervention strategy through ecosystem based approach. (Source: UNEP, 2004; Sen AK, 1999; Duraiappa, 2002).

is required for a successful policy intervention is shown in Fig. 2.

The tools for intervention include instrumental, institution and organization. Majority of policy options are approached in a partial manner with focus either on the development of an instrument or an institution to achieve an outcome. The other component deals with the suitable or enabling condition to implement these tools. Here much focus is made on instrumental perspective as a means to achieve a desired human well-being.

This process of policy interventions builds on the understanding to strengthen and revitalize coastal communities by means of assessing the most promising livelihood options (Robert S Pomeroy *et al,* 2006). Within the instrumental freedom ecological security is defined as the provision of ecological safety factors to the community who depend on ecosystem services for achieving livelihood which is one of the constituents of well-being (Duraiappa, 2002).

IV. COASTAL ECOSYSTEM SERVICE IN CONTEXT TO INDIAN SUBCONTINENT

The regenerative concepts and challenges are studied for the three major coastal cities of India, Mumbai, Kolkata and Chennai. The identified outcome of case studies highlights the functions, services, benefits and threats to the coastal ecosystems.

Mumbai. Dharavi Bet Island is known for the fishing occupation along the coastal line. The major threat was the violation in coastal regulation zone that has let the developers acquires acres of land. Other reasons include over fishing affecting the replenishment of fish stocks destroying the coastal ecosystem. The decline has led artisanal and small-scale fishers to seek for alternate livelihood. The excessive demand for space in the island to accommodate increased population has resulted in the destruction of mangroves through reclamation of wetlands (V.S. Nikam *et al;* 2008). The current scenario, if left unchecked has the potential to lead to a loss of livelihoods. It is a must to implement effective governance options and promote the inclusion of restoration in adaptation strategies for the betterment of ecosystem dependent community.

Kolkata. East Kolkata Wetlands are used to treat city's sewage, whereby 250 million gallons of sewage is used for traditional fishing and agriculture. The majority of communities are dependent by practicing pisiculture and other traditionally inherited practices that includes pond effluent based paddy cultivation, garbage based vegetable farming are integrated with fishery that makes the production processes complementary to each other (Debanjana Dey, 2013). Due to urbanization wetlands are converted into urban settlements drastically disturbing the ecological system and the traditional economic activity less profitable making poor livelihood status of the people dependent. The dumping of the waste into the wetland creates a major link to the livelihood of the people living for farming.

Chennai. Pulicat lagoon is a small marine basin with a majority of people dependent for their livelihood. Fishing is the main revenue-generating activity for the nearby villages.

Nutrient enrichment caused by aquaculture effluents, lime shell mining activities and unregulated fishing are the main threats around the site. These are said to have depleted the fishery resources and to hinder bird congregations (K. Saravanan *et al*, 2013). Further it is important to restore the habitats and biodiversity of Pulicat Lake along with alternative livelihood. In doing so would help to maintain and enhance the diversity and distinctive nature of flora and fauna population in Pulicat Lake.

V. IDENTIFICATION OF REGENERATIVE METHODS

Different types of restoration techniques identified through literature are tabulated in Table 3 for different coastal ecosystems.

Table 3 : Coastal ecosystem and types of restoration to regenerate.

Coastal ecosystem and services	Type of restoration
Mangroves[*1] • Food, fuel, timber and non timber products • Carbon sequestration	Andhra Pradesh, India Restoration technique involve by digging canal to direct the flow of water through the mangrove area that aim to restore the ecology function as well sustainable livelihood of Bhairavalanka village
Lagoons[*2] • Storm buffering • Fishery production • Enhanced water quality • Nutrient uptake	The Alfacada coastal lagoons, Spain Delta del Ebro The restoration is done by improving the hydrological network of the lagoon which recover the hydrological connectivity and the ecological quality of the coastal lagoons.
Estuarine[*3] • Water filtration • Habitat protection.	European estuaries Strategic placement of protective backwaters has been effectively used to prevent shoreline retreat. Doing so, large amount of estuarine marshes would be protected from further shoreline erosion

(Source: [*1]Rama Subramanian et al, 2004; [*2]Carles Ibanez, 2014; [*3]Jean-Paul Ducrotoy, 2010)

There are two ways of restoring the ecosystem one involves the restoring the function since these ecosystem poses complex interactions, such as resilient food webs and nutrient cycle which needs to be resumed in a restored environment. Other approach is to recreate disturbance regimes, of temporary environment change that encourage historical succession patterns for example, in estuaries, releasing large amount of water from reservoir pushes the sediments downstream.

VI. CONCLUSION

The paper advocates an ecosystem based approach to actively restore a degraded ecosystem and support the sustainable livelihood. This is because there are not many interpretations of restoration providing diverse insights that are required to regenerate a degraded ecosystem for a long term change. And to actively restore a degraded ecosystem it is must to analyze the spatial and the historic components to know the extent to which these coastal ecosystems would regenerate. Finally the paper suggests that active management of ecosystem and its implications in policies and planning could enhance the regeneration of ecosystem to offer a high diversity of ecosystem services as well to maintain a clear link with the livelihood pattern for reduced poverty line.

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