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Maintaining Natural Capital Stocks: An Insight into Traditional and Modern Approaches

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Abstract

Natural capital refers to the natural environment around us that provides the goods and services to sustain life on this globe and includes soil, air, water, plant and animal biomass, forests, fish populations and mineral deposits. Sustainability could be defined as the level of consumption that satisfies the demand of the present without compromising the need of the future generations and not demeaning natural capital stocks. A serious threat to the current framing of natural capital is its apparent seclusion from financial capital and mainstream economic and social activity. This seclusion leads to indiscriminate use of nitrogen fertiliser to increase productivity per unit area in crop fields or decreased protein returns in aquatic habitats ultimately leading to ecological mayhem. However, indigenous people living in traditional societies are found to have strong conservation ethics arising out of their age-old ecological knowledge, protecting natural capital in their native homeland. The sacred groves in India, Tukano Indians in North West Brazil, tribesmen in TransFly region in Papua New Guinea, Masai in African Savanna are some of the examples. This article highlights some of the novel approaches adapted to protect natural capital and includes Payments for Ecosystem Services (PES) and natural capital accounting. PES are evolving as a creative and motivational strategy for natural capital conservation in many parts of the world, especially in Latin America. The natural capital accounting assign monetary value to natural capital and could bridge the apparent seclusion of natural capital from financial capital. The national Governments and world leaders are taking a broader perspective to look into the options of sustainable development to maintain natural capital stocks and many such projects are put forth in different countries. The Millennium Ecosystem Assessment and Sustainable Development

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Goals lead to a system of largescale management called the Ecosystem Approach involving multiple stakeholders. The primary goal is protecting ecosystem components and processes for the long term, keeping an eye to the present needs also. The PES and natural capital accounting are two important gauge of sustainability protecting mother nature from indiscriminate handling by its most rational offspring

Introduction

Natural capital embraces the living and nonliving components of ecosystems that contribute to the generation of goods and services for people but excludes human beings and articles made by them. Natural capital refers to the natural environment around us that provides the goods and services to sustain life on this globe.[1,2,3,4,&5] It includes soil, air, water, plant and animal biomass, forests, fish populations, mineral deposits, etc. Natural capital stock can be classified[6] as (i) Renewable or active which can harness solar energy and hence self-maintaining, like forests; (ii) Non-renewable or inactive or passive which were created a long time ago in geological periods, like petroleum deposits. Capital assets could otherwise be classified as (i) Manufactured capital like factories, houses, machines, (ii) Financial capital like monetary wealth, (iii) Human capital like knowledge, skills, etc., (iv) Social capital like institutions, social bonding etc.[7] All these forms of capitals interact to form goods and services that support human civilization. For example, timber harvesting in a forest depends on a coordinated effort of different types of capitals like, availability of mature timber (natural capital), skill, identification and experience of logging (human capital), machines and logistic support (manufactured capital as well as financial capital).

Nature withstands the quality of the air, water and soil on which mankind thrives, provides freshwater, ensures pollination, controls pest and minimizes the devastation caused by natural hazards through various ecosystem processes. Forested riparian buffers minimize soil erosion, siltation and improve quality water for people downstream; oceans and forests help in carbon sequestration as much as 5.6 gigatons of carbon per year which is equivalent to 60 percent of anthropogenic emissions around the world and regulates climate; mangroves stabilize the shoreline and reduce the impact of storms on human settlements; over 75 percent of global food crops, including fruits, coffee, cocoa, and almonds, is dependent on animal pollination, over 2 billion people bank on forest wood as their chief energy source, over 4 billion people solely depend upon natural medicines for their health care.[7&8] However, the interdependence of nature and human wellbeing is not well recognized until now leading to the rampant destruction of natural capital in a highly nonsustainable manner for the sake of meagre financial gain.

Sustainability could be defined as the level of consumption that satisfies the demand of the present without compromising the need of the future generations and not demeaning natural capital stocks. Human civilization is now passing through a phase where the limiting factor in economic activity is not man-made capital any more but the remaining natural capital left. Economic efficiency and good economic decision making are not possible until and unless all of the costs and benefits, especially those impacted by natural capital are considered or included in prices. The human population has grown 2-fold in the last 50 years, leading to nearly 4-fold growth of the global economy and a nearly 10-fold proliferation in global trade resulting an enormous upsurge in demands for energy and resources.[8] Despite the World Economic Forum's initiative to address environmental concerns among the top 10 global risks for business,[9] the apparent seclusion of natural capital from business capital could not be overcome.[10] This seclusion always puts concerns about natural capital and ecosystem services in the backseat behind agriculture, finance, and industry; it overlooks the contribution of indigenous people and puts forth the interests of urban brouhaha. This hypothesis could be established from some of the recent technological advancements, like green and

blue revolution ensuring food security to mankind and ultimately leading to environmental mayhem as follows.

Advance Agricultural Technique Deteriorating Natural Capital:

Instance 1: Blue Revolution on Our Blue Planet

The 2030 Agenda for Sustainable Development[11] sets goals for the fisheries and aquaculture sector ensuring nutrition and food security for all and affirming sustainable use of natural resources. FAO recorded 28.7 million tonnes of food fish production from mariculture along with 11.6 million tonnes from coastal aquaculture in 2016,[12] representing nearly 40 percent of total global capture fishery production providing livelihood to 59.6 million people in this sector. While many view aquaculture as a blue revolution, the impacts of aquacultures on the environment are poorly assessed. To accelerate production per unit hectare in the water bodies, various unsustainable aquaculture practices were introduced leading to reduced protein return (as low as 1.4%), diminishing water quality, potential pathogen invasion, and destruction of wild fish stock[13] with the intensification of aquaculture practice as noted in table 1.

Table1: Environmental impacts of different type of aquaculture practices13

Type of Aquaculture Practice	Sustainability level	Increases influx of wastes in nearby areas	Threat to wild population invasion	Potential pathogen	Protein return
Extensive	Most sustainable	Low	Low	Moderate	11-100%
Semi intensive	Somewhat sustainable	Moderate	Moderate	Moderate	2 -10%
Intensive	Not sustainable	High	High	High	1.4 – 3%

Instance 2: Over Dosage of Nitrogen Is the Revolution Green

In last 50 years, world agriculture production has been triplicated.[14] The credit goes to the alterations in cropping systems generally noted as the Green Revolution involving high yielding crop varieties, more and more use of pesticides and synthetic nitrogenous fertilizers.[15,16&17] Nitrogen is an important macro plant nutrient essential for growth and development.[18] Natural mechanisms for soil nitrogen fixation include non-symbiotic and symbiotic fixation by microorganisms and atmospheric deposition with rainfall.[19&20]

Table 2: Nitrogen Use Efficiency (NUE) and average grain yield per hectare in different parts of world.[14,22,25&26]

Name of Country /Continent	Nitrogen use efficiency (NUE)	Average grain yield/ Hectare
India	30%	2.4 tons/ ha
China	25%	4.7 tons/ ha
Africa	72%	1 ton/ ha
USA	68%	7 tons/ ha

The flipside of the coin of the green revolution, however, is the fact that less than half (47%) of the nitrogen added globally through synthetic fertilizer onto the cropland is being accommodated into harvested crops today and rest being lost into the environment (Table 2) deteriorating natural capital resources. This leads to air pollution, leaching of nutrients, eutrophication in adjacent water bodies, algal bloom ultimately killing aquatic biota.[21&22] Scientists are repeatedly pointing to the underexploited potential of symbiotic nitrogen fixation[23] in the soil since most of the countries

have only a few percent of arable land cultivating leguminous crops. Enhanced symbiotic nitrogen fixation might be accomplished by either cultivating more leguminous crops, at least in rotation or by the application of short-duration legume green manures in soil.[24] Side by side, the International Nitrogen Management System is also proclaiming for the application of livestock manure, treated human sewage instead of synthetic fertilizer,[25&26] to minimize wastage of food and adapt all other necessary alterations in our lifestyle to reduce nitrogen footprint.

Traditional Ethics to Protect Natural Capital Stock

Worldwide approximately 300 million people are living in societies that practice a traditional way of life in rural areas with relatively little influence of modern technologies and are referred to as Indigenous people or Native people.[27] These people occupy 12-19% of earth's total land surface and are the vital stewards of the environment protecting 80% of the planet's biodiversity.[28] Many traditional societies have strong conservation ethics arising out of their age-old ecological knowledge to protect natural capital enforced by village rules under the guidance of local leadership, including the sacred groves all over India to protect forests and natural vegetation,[29&30] "Shingo Nava" in traditional Nepalese Sherpa villages[31] to minimize indiscriminate fuelwood collection etc. Such groups can be a true partner in developing conservation strategies[32] avoiding the problem of ecocolonialism. Side by side, the economic needs, goals and opinions of indigenous people are now often included in conservation management plan creating Extracting Reserves and Biosphere Reserve programmes.[31]

Instance 1: The Case of Tukano Indians of North West Brazil

The Tukano Indians, living in the inter-fluvial regions of the Amazon in small groups, can sustainably utilize resources available in tropical rain forests.[33] The Tukano Indians survive on root crops and riverine fishes. They nurture a strong religious and cultural belief that the forests along the Upper Rio Negro belong to the fishes and human being can never ever cut the forests.[31] They have also designated refuges for fishes and fishing along 40% of the riverine margin is permissible by village rules. They follow swidden cultivation as their traditional indigenous agricultural system. This system involves cutting and burning a patch of forest to proclaim a small field called swidden, resulting in an apparently nutrient-rich ash layer to make the swidden fertile and simultaneously getting rid of possible weed and pest invasion, growing crops for a few year periods, and then moving on to a newer swidden, allowing the forest to rejuvenate for 15 years or more before it is cleared again.[34] Amerindian swiddens are typically small, polycultural plots. Their dietary staple, Bitter cassava, is densely planted over the entire swidden. Other crops, such as sweet potato (*Ipomoea* sp.), taro (*Colocasia* sp.), pineapple (*Anana sativa*), chili peppers (Capsicum annuum), arrowroot (*Marantar uiziana*), mafafa (*Xanthosoma mafafa*), lulo (*Solanum* sp.), bananas, and plantains, are interplanted depending on microenvironmental conditions (such as drainage and ash concentration). The long fallow period improves soil fertility and other physical characteristics, allows nutrient accumulation and eliminates agricultural pest populations. As a result, the Tukano Indians live with the environment protecting natural capital stock, like forests with many useful plants, soil, fish biomass, river water, etc.

Instance 2: The TransFly region in Papua New Guinea: The Tribesman Eager to Protect Biodiversity

The TransFly ecoregion is a biodiversity hotspot characterized by wetlands, grassland and tropical rainforests, being home to many endemic species including the magnificent Birds of Paradise. The New Guinea tribesman have long hunted the Birds of Paradise (male) for their extravagant feathers which were used for traditional headdresses. Over 60 different groups of indigenous people either live or have cultural ties to this area and many of them have joined the World Wildlife Fund (WWF) to protect biodiversity in the ecoregion. They are now eager to learn about the support efforts to maintain the bird population, ensuring limited harvesting of eggs and feathers. From literature it appears that, 97% of the land in Papua New Guinea is under the control of indigenous people including 100 million hectares of incredibly diverse Amazon rain forests and hence the future of natural capital stock including biodiversity of this part of the world appears to be not so bleak.[31]

Instance 3: The Masai and Desertification in African Savanna

The Serengeti plains of Tanzania are famous for its wildlife resources all over the globe. This dry African Savanna grassland is covered with two types of vegetation: grasses cover the vast open plains of the southeast while *Acacia* sp. is more common in the central region. The Serengeti National Park is rich in wildlife - including zebras, giraffes, lions, elephants and famous for the migration of over 2 million wildebeest. The Masai tribe of the Kenyan Serengeti practice nomadic farming, allowing vegetation to regrow whenever the farmers move on to new pastoral patches. The colonial masters tried to concentrate the Masai and other nomadic pastoralists into group ranches to facilitate market-oriented livestock production while enclosing their former pastures into national parks and game reserves. Thus, the original inhabitants are left with curtailed access to local common property resources like, water, fuelwood, pasture, wildlife and even their customary rights of movement as a result of the creation of protected area boundaries. Some of the Masai's traditional lands were allocated to European planters for the sake of "more productive" commercial planting and that leads to the removal of natural vegetation and exhausting available soil nutrients disturbing the ecosystem processes (Figure 1). With the establishment of Serengeti National Park in the 1950s, the state further tried to exclude the Masai without recognizing the fact that they coexisted with the region's wild game for thousands of years. This exclusion leads to further marginalization of Masai farmers into smaller patches of land and reduced access to drinking water resources and grazing land amidst dry savanna grasslands. With the introduction of wildlife oriented tourism in the 1960s, some tourism revenues were handed over to Masai district councils as an incentive to win their acceptance of the newly created reserves at the cost of their marginalization and sedentarization at their age-old homeland.[35]

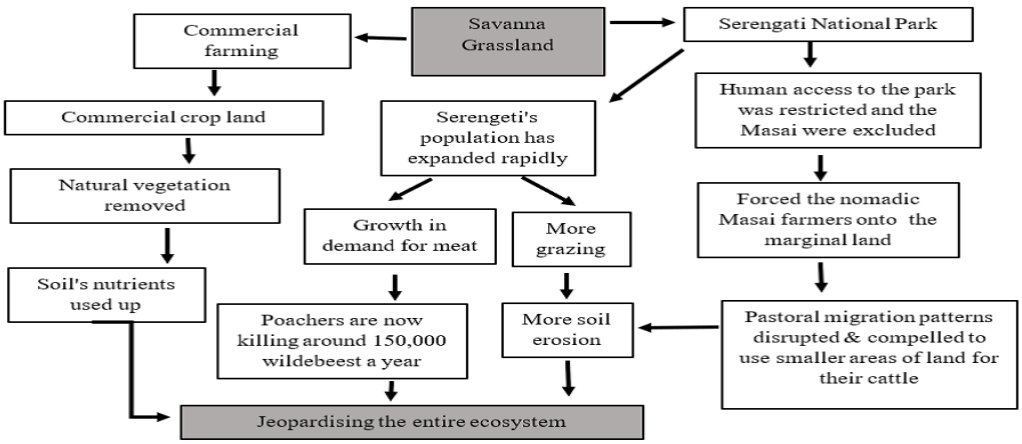

Fig. 1: Impact of commercial farming and exclusion of native Masai population due to establishment of Serengati National park in Savanna grassland

To sustain the wealth of Serengeti for generations to come, the natural capital of African Savanna has to be safeguarded through the following strategies:

- Minimize whole tree harvesting to prevent deforestation, soil erosion.
- Reduced burning of grassland to avoid wildfires.
- Crop rotation to maintain nutrients in the soil.
- Stone lines along the soil contours to keep it in place, minimize erosion ensuring community participation.
- Judicious management of grazing land to avoid overgrazing.
- Employment of local people in ever-growing wildlife centric tourism so that some of the financial rewards trickle down to the original

inhabitants.
- Awareness generation programmes for local communities.
- Last but not least, respect for local cultures and age-old traditional customs.

Novel Approaches to Value and Protect Natural Capital Stocks :

Approach 1: Payment for Ecosystem Services (PES)

Payments for Ecosystem Services (PES) are emerging as a creative motivational strategy for natural capital conservation in different parts of the world. PES schemes proclaim a theory of paying individual stakeholders or communities for maintenance and safeguard of natural capital so that everyone else can enjoy the goods and ecosystem services emanating from them.[36] This strategy involves for the first time direct payments to individual landowners and local communities by the beneficiaries enjoying goods and services originating from natural capital stock. PES could also be considered as an appreciation to the land owners for being good environmental stewards and is gaining momentum, today.

A water fund is getting a foothold in Latin America for protecting watershed services following PES model. In the Andes region, a natural agglomeration of wetlands and forests[37] at higher altitude ensure improved water quality[38] for the millions of people downstream in the inter-Andean valleys through restricted soil erosion and nutrient retention through natural filtration. Water funds are being established as an incentive to the upstream landowners to appreciate their environmental stewardship to improve watershed management by the users downstream. Such water funds for maintaining water quality[39] are being established at Cali, Colombia, with support from the Cauca Valley sugar cane producer's association (ASOCAÑA), a sugar cane growers association (PROCAÑA). The downstream landowners had invested in sugarcane plantations and realized that they need to protect the water supply. Hence, they set up a water user association that established a series of initiatives targeting upland landowners, including social programmes involving education and training, a reforestation programme and intensive agriculture to improve water quality and reduce erosion. This water fund was being developed by the water users downstream to improve watershed management with an aim to regulate water flow, protect biodiversity, provide natural filtration and ground water recharge.[39] All the money raised by this water use association were spent on the upland areas as per PES model.[40]

Approach 2: Natural Capital Accounting (NCA)

Monetary evaluation of ecosystem services often helps to ascertain the actual significance of natural capitals. Market and nonmarket valuation techniques are utilized for this purpose and these have led to a novel system of natural capital accounting (NCA). This has led to the development of different accounting frameworks. "Inclusive wealth," is one of them. This hypothesis takes into account all types of capital assets: human, manufactured, social, and natural capital.[41&42] Larger inclusive wealth means stronger will be the "productive base" to sustain human civilization in the long run. This can be considered as a measure of sustainability, although the precise valuation of natural capital is arduous.[42]

Table 3: Initiatives across the globe to conserve natural capital stocks

Sl No.	Name of Country	Programme details
1.	China	• The Sloping Land Conversion Program, involving 120 million households to convert approximately 9 million ha cropland into forest and grassland; afforest approximately 12 million ha barren land.[44] • Launching a network of "Ecosystem Function Conservation Areas" to focus on conservation for public benefit.[45] • Track ecosystem services and natural capital through a new metric, "gross ecosystem product," to be reported alongside Gross Domestic Product or GDP.[46]

2.	United Kingdom	• Conducted a national-scale assessment of status and trends of ecosystems, services, and impacts.[47] • Set up a Natural Capital Committee[48] that reports to the UK Government Economic Affairs Committee, not the UK Environment Department.
3.	United States of America	• US Federal agencies have begun to incorporate ecosystem service information into decision-making and natural resource damage assessment through National Research Council.[49] • A White House interagency committee is exploring further steps and recent legislation directs consideration of ecosystem services in decision-making.[50]
4.	Portugal	• The Gulbenkian Foundation in Portugal has set up the Marine Ecosystem Services Partnership to share ecosystem service information.[7]
5.	Sweden	• Ecosystem services are being progressively incorporated into urban planning and green area management.[51]
6.	South Africa	• Ecosystem service planning is concomitant with development planning influencing decisions in water management and allocation processes, poverty alleviation,[52] disaster management,[53] and land-use planning.[54&55] • Value of ecosystem services in coastal zone management is taken care of to achieve the preferred balance between tourism, fisheries, and coastal protection goals for the country.[56]
7.	Costa Rica	• Transformed itself from having the world's highest deforestation rate to one of the few countries with net reforestation statistic. • Increased forest cover on farmland under design of payments for ecosystem services (PES) contracts from 11% to 17% over 8 years.[57] • The program also conserved and regenerated forest on other lands to provide watershed services, biodiversity, and carbon sequestration.[58]
8.	Across Latin America `	• Movement to use payments to secure water for cities. Since 2006, more than 40 water funds were set up (or under development) with systems of payments from downstream water consumers to upstream communities to alter land management and improve water quality and quantity.[38] • Standardized approaches for targeting investments, designing finance and governance systems, and ongoing monitoring are being developed and shared.[59&60]

The Millennium Ecosystem Assessment (MA) (2005)[43] asserted the significance of natural capital and ecosystem services for human life fifteen years ago. It also puts forth evidence that human economic activity is deteriorating most of the ecosystem services leading to a catastrophic situation. This awareness among National Governments, nongovernmental organizations (NGOs), international organizations and business houses are being increasingly incorporated into policy decisions but is not standard practice yet. However, some of the instances are noted in Table 3.

Conclusion

National Governments through out the world formulate effective legislation to protect species and habitats and at the same time allow development for the continued need of the society. However, such efforts sometimes out corner the indigenous inhabitants of the land, like the case of Masais[35] who have traditionally protected the habitat and natural capital available there. An alternative solution to this problem could be to embrace local inhabitants with traditional conservation ethics into the mainstream conservation activity, like the case of tribesmen in Papua New Guinea, joining hand with WWF for conservation of biodiversity.[31] Side by side, replacing traditional agricultural practices with the modern methods ensure food security[12,14] to the ever increasing population at the cost of deterioration of natural resources.[13,21,22]

Resource managers around the world are increasingly urged by the conservation agencies to expand their traditional emphasis on the maximum production of goods (such as timber harvests, crop yield per hectare, etc.) and services (like the number of visitors to Parks) and take a broader perspective to look into the options of sustainable development to maintain natural capital stocks. This viewpoint is encompassed in the concept of ecosystem management, a system of largescale management involving multiple stakeholders, the primary goal being protection of ecosystem components and processes for a long term, keeping an eye to the present needs also. Despite a lack of universal agreement, however, it is clear from the above discussion that, Governments and conservation agencies are strongly embracing the ideas of sustainable development by valuing natural capital stocks through NCA and moving towards ecosystem management. The NCA and PES actually bridges the gap between financial and natural capital by assigning monetary value to the natural capital and ecosystem services emanating from them. The ecosystem approach follows a hypothesis of the conservation of natural resources at a local scale embracing available traditional ecological knowledge. It honors the confines of any ecosystem to deliver goods and services essential for the upkeep of the entire community.

The Vision 2050 document of the World Business Council for Sustainable Developmen[t61] declared their motto as "not just living on the planet, but living well and within the limits of the planet". This vision was further emphasized in an Action 2020 agenda, laying down boundaries for business houses to thrive sustainably on this planet, in tune with United Nation's Sustainable Development Goals.[11] This suggests that present day scientific knowledge needs to inspire each and every policymaker to empathize with natural capital and ecosystem services in their formulations embracing the concept of Green Economy. This paradigm shift sets aside the common misconception of the trade-off between environmental stewardship and economic development. It should always be understood that human civilization is highly reliant on natural capital and the goods and services emanating from them. This is truer for the poorest section of populations as they depend disproportionately on the ecological commons both for livelihoods and for consumption.

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Conflict of Interest

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