

ENVIRONMENTAL IMPACT OF RUBBER PLANTATION: ECOLOGICAL VS. ECONOMICAL PERSPECTIVES

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Abstract – In this paper, we aimed at examining the environmental impact of rubber plantation. We reviewed existing scientific literature and data sources on effects of rubber plantation on environment particularly in south Asia. We observed that, rubber plantation is a real threat for the tropical forest. It is harmful for watersheds and destroys forest ecosystems. It negative effects on hydrological change, severe species, sediment run off etc. It overall affects the habitat and stream hydrology. But the latex has a high commercial value which can support rural people in socioeconomic development. Smallholder farmers' livelihoods affected due to price fluctuations and food insecurity. Thus the paper suggests that effective management and proper sustainable planning is important for minimizing the evil effects of rubber plantation and involvement of rural communities as an income earning making process.

INTRODUCTION

Rubber is an important globally recognised commercial crop and it is source of revenue from many countries (Sarkar, 2011). Natural rubber is an important industry in the world and it producing of numerous products (Alexande and Haran, 2016). In the beginning of the century rubber plantation was started because for its high remuneration and small-scale cultivation also involved. The steady returns for long period also inspire the small-scale cultivators in rubber plantation (Ushadevi and Jayachandran, 2001). Small holding farmers have important contribution in area as well as production of natural rubber (Adikari and Sharma, 2018).

Rubber (*Hevea brasiliensis*) is a fast-growing tropical tree crop. It is basically cultivated for production of latex. Columbus was the first to report about latex in 1496. The real success of rubber plantation started after the industrially cultivation. Because of the white colour of latex, rubber tree also called as white gold (Das *et al.*, 2016). Rubber plantation is expanding rapidly due to rising price of rubber sheet, increasing demand of rubber, government incentives, investment of investor etc. Rubber has quite similar growth needed as oil palm, and other crops, so can be cultivated in the same geographical areas (Manivong and Cramb, 2008).

The basic objective of this paper is to study the environmental impact of rubber plantation.

MATERIALS AND METHODS

The researcher employed a systematic review to bring an understanding the environmental impact of rubber plantations. The researcher preferred systematic review for the empirical study. The paper is based on the secondary information and to ensure the rigour or reliability of this paper, the researcher downloaded Government reports, information from the international scale scales such as report of NGOs, articles of researchers, report of rubber board etc.

RESULTS AND DISCUSSION

The socioeconomics and environmental impacts of rubber plantation have recently been realising. Rubber plantations expanding rapidly as rehabilitation of tribe's people is a matter of concern because it not only takes land from the native forests but also disturb the soil quality and ground water reserve (Ochigbo *et al.*, 2011). The basic difference between rubber plantations with other native ecosystem is its lack of biodiversity and it happens because it grown as monoculture (i.e. growing only

one plant species in an area) (Pushparajah, 1995).

The tropical forest conservation is more environmentally suitable, socially appropriate, and under certain circumstances the best means for preserving biodiversity (Sythud *et al.*, 2015). Large-scale permanent and commercial agriculture, like rubber plantation is a real threat for the tropical forest. Perhaps this is the largest drawback of the rubber plantations from the point of the environment (Sabates, 2008). It has negative environmental effects relating to micro climate change, such as hydrological change, severe loss of species, extinction of local species, sediment run off etc. (Gururaj *et al.*, 1990).

Table 1. Comparing carbon sequestration (tC/hectare/year) of various terrestrial ecosystems. Sourced from Rubber Board 2015. Higher carbon sequestration capacity in natural rubber.

Ecosystem	tC/hectare/year
Tundra	0.1 - 0.3
European forests	0.4 - 0.6
Tropical South American Rainforest	0.71 ± 0.3
Amazon	1.02 ± 0.24
USA forest woodlands	1.4
Various temperate forests	2.5
Successional temperate deciduous forests of the USA	3.7 ± 0.3
Pine forests of USA	3.78 ± 0.16
Natural rubber plantations	7.82

Source: Vongkhamheng, C., Zhou, J.H., Beckline, M. and Phimmachanh, S. (2016) Socioeconomic and Ecological Impact Analysis of Rubber Cultivation in Southeast Asia. Open Access Library Journal, 3: 8.

The above Table shows that rubber plantations establishment could result in a significant reduction in carbon biomass. In many natural rubber producing region it has been found that rubber plantation creating manifold environment intimidations like as deficit of rainfall, depleted ground water level, and increase of annual temperature (Majumder *et al.*, 2014). As demand of rubber increasing day-by-day and it led to rubber more monoculture during the last decade. Scientists have already acknowledged that rubber monoculture reduction water reserves, soil productivity and biodiversity (Chattopadhyay *et al.*, 2005).

Effect on Biodiversity

Loss of biodiversity is probable important dangers linked with extensive rubber plantation (Li *et al.*,

2007). Its unhampered growth has overwhelming environmental effects. The main reasons of this is the root system and leaf coverage of rubber trees (Ziegler *et al.*, 2009). It controls the microclimate that permitting the secondary plants to curl, that erosive impact of rain and protect of soil against dehydration (Kox, 2000). It has been found in Thailand that at least 60 percent biodiversity reduced for rubber plantation with insectivores and frugivores suffering greater losses (Ravallion *et al.*, 2013). For rubber plantation, forest are cleared in many regions and it is not economically sustainable and have negative impact on water balance and soils (Vongkhamheng *et al.*, 2016).

The rubber plantation not only destroyed natural homestead forests, agro-forestry lands (occupied by horticultural plants), but also in some places even forests (both planted and natural) (Chattopadhyay, 1996). Rubber plantations not only increased forest coverage in planted areas, but endanger the local biodiversity (Balagopalan, 1995). So rubber trees should be planted in degraded forests compare to the open, and dense forest. Because rubber tree leaf falls once a year so the standing trees with dry leaf hinder the environment of wildlife/ animals (Fox *et al.*, 2014). For economic profitability, private land owners extending the rubber cultivation land and it will be threat for our ecosystem (Guillaume *et al.*, 2015).

Effects on Water Availability

Compare to other plants, rubber plants require more water, that reduces ground water and also take away from the share of other plants. Soil and ground water contaminating in many rubber processing centre and the latex processing industries discharging partly treated or untreated waste water in the surrounding places which contaminate environment (Jong, 2001). As for rehabilitation of tribal, more land are covering by rubber plantation which vastly reducing biodiversity and potentially having severe consequences on water resources in the region (Jagadale *et al.*, 2015).

Water pollution occurs for latex which consists of rubber, sugar, proteins, resins, ash, and water. Water use for spring-cleaning and producing of rubber sheet and the wastewater caused from processing operations mainly comes from this (George *et al.*, 1988). Rubber processing wastage is a severe environmental problem due to the discharge of highly polluted wastes. The wastes coming out from

rubber processing is thoughtful because of the existence of presence of biological oxygen and ammonia (Gouyon *et al.*, 1993). The wasteliquidated from rubber processing plant is acidic because for use of acid in latex thickening, conservation and blending procedure. The discharge from rubber processing comprises high level of sulfate which comes from sulfuric acid used in the clotting of latex (Diana, 2007).

Rubber is often cultivated in monocultures that exhaust the soil and need a lot of pesticides and fertilizers. This can persuade soil and water pollution and gives negative consequences to the natural environment (Cohen, 2009). Factories use energy and water intensive processes and have negative impact on climate and water use. Such plantation increases risk of landslides due to well managed terrain gully formation under rubber plantation is low (Chamberlain, 2007). Compared to forest land the nitrogen and organic carbon content of soil under rubber plantation is lower (Diana, 2007). It has been found in many rubber dominating regions that there is tendency of water level depletion due to widespread obstacle of sunlight under rubber plantation (Sirirak *et al.*, 2006).

Rainfall depends on the length of the season. The rainfall interception of rubber tree awning is seasonal. The water holding capacity of rubber tree is less. Loss of water of rubber plantation from soil might be negligible but nutrient loss is substantial. The rubber tree tends to reduce the flow of water and also tends to dry the moist land. Thus may influence the regulation of hydrological cycle (Majumder *et al.*, 2014).

Effect on Soil Health

Many researchers have testified the impact of rubber plantations on soil health. Soil erosion is a global problem and rubber plantation can play a role in reinstating soil erosion (Shaji *et al.*, 1994). Rubber tree can reduce erodibility of soil considerably. Oxidation of soil organic matter can reduce and help for built up due to the reducing the soil temperature. It happens due to the shading of the rubber plantation (Satheesh and Jacob, 2011). The enhancement of decomposition of the organic matter, discharge of nutrients, failure of the collective arrangement of the surface soil, due to the impact of rainfall (Satheesan *et al.*, 1993).

Economical Perspectives

Rubber plantation is the source and livelihood of the

rural communities and also help for development of rural areas. Such plantation helps for recovering the ecosystem which are degraded due to shifting cultivation (Alton *et al.*, 2005). Community-based rubber plantation helps for improving of the standard of living of the local people. Many farmers switched to rubber plantation from the traditional farming because for its economic benefits and incentives (Thongyou, 2014). The wastes produced during natural rubber processing can be used for generate biogas that can be used for domestic cooking purposes and also for drying rubber (Thongmanivong *et al.*, 2006).

Due to water pollution from the rubber processing industries, habitat and stream hydrology are badly affected in many countries. It resulting in dramatic degenerations in fish, shrimp, turtles, shellfish and edible stream bank vegetation. It negatively affecting food safety and the livelihood of the people (Lagerqvist, 2013). Smallholder farmers' income is also threatening due to price fluctuations, loss of food security, and various diseases. Environmental problems arising from intensive cultivation of rubber also affect income and livelihood of people in many regions (Baird and Gray, 2014).

Beneficiary Impact of Rubber Plantation

There are also some merits of rubber plantation. The large leaf area index, the biomass production per unit land area and rate of photosynthesis is higher for rubber plantations (Ziegler *et al.*, 2009). For that reason, such tree is more effective candidate for more afforestation of lands and also for precluding degradation of soils. Rubber plantations are also beneficial in improving the chemical (nutrient availability), physical (bulk density, porosity), and biological (soil microbes) properties of the soil (Bhowmik, 2009).

Less amount of chemical fertilizers compares to field crops, low intensity agriculture care, and intake of lower quantity of inputs (like water, insecticides and pesticides) are some other benefits of rubber plantation (Premakumari and Saraswathyamma, 2000). In North-eastern part of India this plantation has a success story for rehabilitation of land less tribal people who were involved in shifting cultivation (Bhowmik, 2009). Rubber plantation has been useful for the restoration of the degraded forestlands and also the possible source of income (Berekaa *et al.*, 2005).

Rubber plantation also is the source of fuel wood

and timber. When rubber trees lose the monetary feasibility in production of latex then logging are basically done. Rubber wood also used for production of furniture (Mali *et al.*, 2006). Rubber wood is often used as fuel in smokehouses and wood-burning dryers. When rubber plants fall due to cyclone or cuts for age of tree, then replanting helpful for the conservation of the environment (Priyadarshan, 2003). Soil binding and reducing the erodibility of soil is another benefits of rubber tree. It helps for reducing the soil temperature which further helps for reduced oxidation of soil organic (Chuan, 2003).

In immature rubber plantation through intercropping crops, like banana and pineapple are grown and rubber planters can earn some extra income by bee keeping for honey, because honeybee attracts for extra floral nectaries in the rubber tree (Chaudhuri *et al.*, 2013). Rubber plantation helps for growth of shade loving plants (like as orchids, medical plants etc.) but many plants cannot grow inside of mature rubber plantation due to lack of lights (Mahmoud *et al.*, 2005).

CONCLUSION AND RECOMMENDATIONS

Rubber plantation negatively effects on biodiversity which lead to reduced total carbon biomass and impacting climate change. It will negative impacts of on biophysical environment and forest environment. The carbon sequestration potential of natural rubber trees is much greater than most tree species commonly used in afforestation programmes. Rubber plantations establishment could result in a significant reduction in carbon biomass, desiccate the region's water systems. Rubber plantation have positive income effects on the rural communities in terms of employment and earning. Farmers are transitioning into plantation monocultures from shifting cultivation and other plantation for this reason.

Considering the negative effects further alteration of forests into rubber plantations needed to be controlled. Intercropping between rubber with crops such as banana, coffee and agar to support livelihood and to minimise environmental stress. Government supported research should be generating new rubber varieties which are suitable for the climate and land of the country. The threats to biodiversity and carbon stocks can be mitigate by the substantial increase in natural reserve areas.

Government may diversify the agroforestry

system in such a way that cash crops cannot be monoculture. Government should encourage more research on the ecological and economical effects of rubber plantation on the rural communities.

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