

# International agreements and entry points to adaptation and adoption of modern forest technologies, ecological restoration, climate change, ecotourism and agroforest enterprise based advanced materials of Sri Lanka and Regional Countries

P.N.R.J. Amunugoda <sup>a,\*</sup>

<sup>a</sup> Food Technology Section, Modern Research and Development Complex, Industrial Technology Institute, 503/ A, Halbarawa Garden, Thaladena, Malabe, Sri Lanka

\* Corresponding Author: [neville@iti.lk](mailto:neville@iti.lk)

Received: 15-09-2022, Revised: 18-10-2022, Accepted: 11-11-2022, Published: 27-12-2022

**Abstract:** Sri Lanka showed proven history of conserving richly endowed habitable natural capital that offers many eco-system services and essential launching pad for fast -track growth. This endowment could bring in desired economic and ecological improvements to living standards and for the well- being of future generations by sensibly put into sustainable use. Under the present development activities, country is facing major challenges of increasing severe climate change impacts, energy insecurity and ecological scarcity. Thus, present use of natural capital, carbon sequestration cyclic activities and forest enterprise are not fulfilling the conditions necessary for sustainability. International initiatives that have been taken and entry points for sustainable forest management and establishing of modern forest technologies are briefly discussed in this position paper to scope expansion of forestry enterprise development strategies. Thus, right policies for setting up right institutions of “Forest Development Authority” and “Forest Exchange System” and inter institutional set up of “Modern Forest Technology” for action in plan is justified.

**Keywords:** Sri Lanka, eco-system, Modern Forest Technology, Sustainability

## 1. Introduction

Sri Lanka showed proven history of sustainable development over centuries while conserving our richly endowed habitable natural capital that offers many eco-system services for the well-being of people. The rich stock of natural resources provides the essential launching pad for Sri Lanka’s post-conflict drive towards fast -track growth. Whether this endowment could bring in desired improvements to living standards of people, and more importantly, could it be maintained for the well- being of future generations, is largely a matter of how sensibly it is put

into sustainable use. Drought occurrence are inevitable in almost all regions of Sri Lanka and avoiding drought occurrences giving sever threats to the economy and ecology of Sri Lanka [1, 2]. At this crucial junction of economic crisis, the economic growth of Sri Lanka needs to be steered along an economically as well as ecologically sustainable path using development alternatives. According to ecological restoration of disturbed lands is an important approach to sensitive tourism planning [3]. Recently, the idea of sustainability has given rise to more operational concept of “green growth” which advocates exploring new avenues of growth that ensure continuity of the natural capital stock. Green growth has the potential to be a new engine of growth, a new generation of green employment opportunities and a vital strategy to eliminate remaining persistent poverty. One way of achieving SDG is by introducing modern forest industry with the biodiversity goals. Forest is a foundation of the green economy pillaring much of the ecological infrastructures. Other than the plantation forest, Natural forests of Sri Lanka (Figure 1) are not utilized for timber extraction any more, having reached a critical minimum (Figure 2).

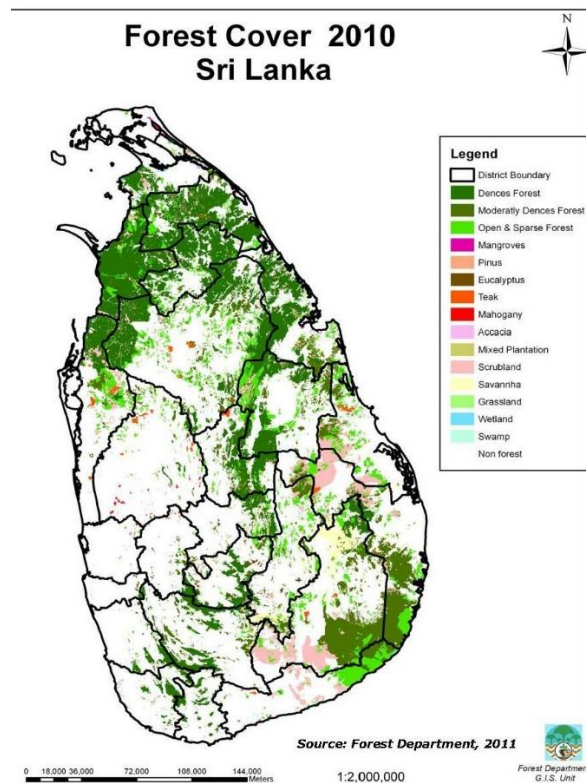


Figure 1. Forest Cover of Sri Lanka - 2010 [4]

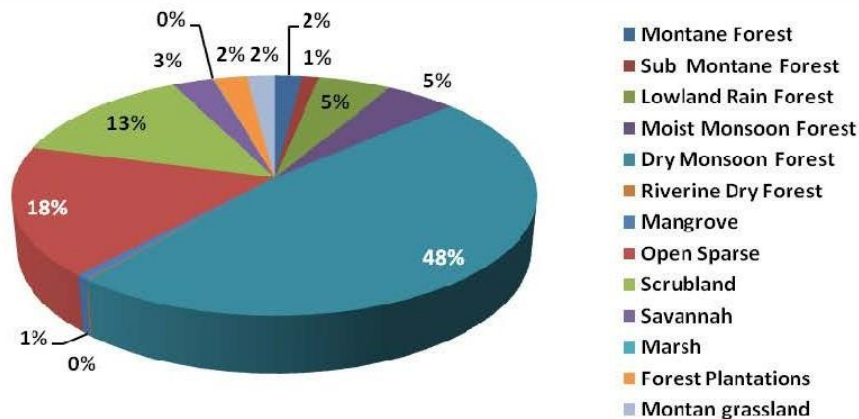


Figure 2. Forest Types of Sri Lanka -2010 - as a % of total forest cover [4]

Outcome of the land degradation and climate change contribute to rural poverty migration and elevated carbon dioxide emissions. To overcome these effects, it needs modified forest and agro-forestry operation with incorporating traditional wisdom with modern scientific innovation via ‘climate and ecological smart’ approaches to shift existing forest extraction and technology-based enterprise into new plateau.

Agriculture sector alone cannot create sufficient employment opportunities and rural economic developments thus need comprehensive modern forestry and modern forest value added product based on SME sector development. The food crop-based mix forest cottage and small-scale industries sector plays an important role in rural economic development through creation of employment opportunities, the mobilization of domestic savings, poverty alleviation, income distribution, regional development, training of workers and entrepreneurs, creating and economic environment in which large firms flourish and contribute export earnings. Forestry SME sector provides high value addition in view of its greater utilization of indigenous machinery, equipment, and raw materials and broad-based capital formation throughout the country and plays a complementary role to large industries through sub-contracting in the areas of engineered wood and wood-based industries [5]. In continuation of focus on ecology, opening up a cluster of advanced special forest products-based manufacturing and ecofriendly service industry is possible and are discussed in this paper with considering the necessities and environmental disasters in the Asian and South Asia regions.

## 2. Environmental Role of Forest Crops

Food tree crops, non-timber forest crops and industry related timber crops-based forest are a foundation of the green economy pillaring much of the earth’s ecological infrastructures. Forest crops play multiple roles while sequestering carbon; offering an alternative renewable

energy, producing oxygen, conserving watersheds, soil and water, purifying and providing fresh water, preventing wind and sand storms, reducing noises, moderating climate, absorbing dust and providing ecological therapy.

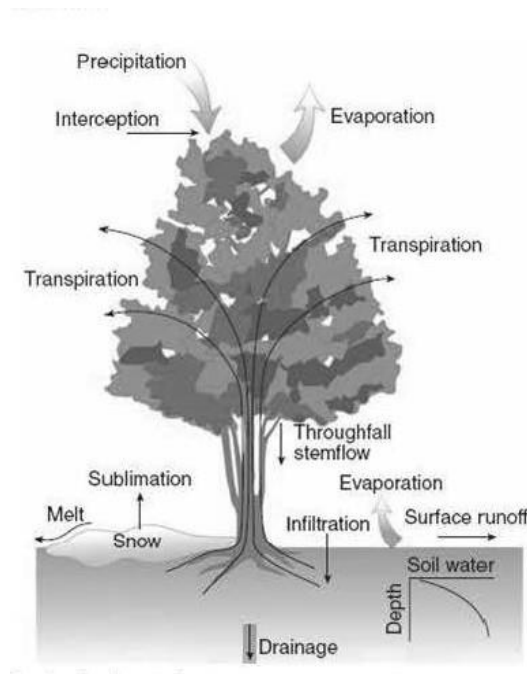


Figure 3. Effect of Trees on Hydrologic cycle [6]

They are useful for restoring degraded lands, thrive on problem soils and steep slopes that are unsuitable for other crops. They are effective windbreaks, and its sturdy rhizomes and roots regulate water flows and prevent erosion and land slips. Forest provides pollution free food, medicine, enhances environment bearing capacity by providing great environmental space for the counter urbanization and development of metropolis. However, the pressure on land is reflected from the forestry perspectives where the forest cover declined throughout the years. The forest cover which was 90% of the country during 1900 when the population was 3.5 million declined to less than 20%. Out of this, 90% are in the sensitive watershed areas showing the importance of relocating or alternate solution with proper plan. The increasing loss of forests for competing land uses for such unplanned development projects is the result of such policy and governance failures that render forest degradation and eventual deforestation. Natural forests of Sri Lanka are not utilized for timber extraction any more, having reached a critical minimum. However, they are still a home to important non-wood forest products (NTFPs) that makes a significant contribution to local economics and providing food, medicinal and health care resources which are emerging as export commodities. Thus, present use of natural capital, carbon sequestration cyclic activities, forest cover and forest cyclic enterprise are not fulfilling the conditions necessary for sustainability and green growth [7]. Outcome of the land degradation,

land clearing for development works and elevated carbon dioxide emissions related climate change impact related natural disaster contribute to food insecurity, rural poverty migration and imbalance of the country economy [8]. This showed the necessity of an innovative forest technology to replace the carbon stocking program using modern forest technology combining food crops considering the whole landscape of Sri Lanka which gives ecological and economic benefits.

### 3. Food Security and Biodiversity Erosion

Food security exists when all people, at all times, have physical, social and economic access, to sufficient, safe and nutritious food which meets their dietary needs and foods preference for an active and healthy life. The status of food security in a country is an important component of development goals. Agro biodiversity provides essential components of healthy environment and sustainable livelihood. Sri Lanka has been identified as one of the countries in Asia with wide diversity of ecosystems possessing very high degree of biodiversity due to wide variation in temperature, rainfall, topography and soil types. However, food supplies in the country is heavily depend on few crops, centered with rice, pulses, veggies and fruits because of the effects of globalization and emerging market economic context that have motivated farmers to cultivate few selected commercial crops. Large number of underutilized herbs, vegetables, fruits and other tree crop species with high nutritional and medicinal values which were grown traditionally in the past can be seen speedy disappearing due to urbanization, modernization of agricultural practices and changing food habits [9]. These species were recognized by the local people throughout the centuries by means of food, nutrition, health, medicinal, cosmetic and economic values for rural micro-entrepreneurs. These species generally occur within the major vegetation types of open canopy forest areas, secondary forests, disturbed grass lands and shrub jungles and neglected improperly managed domestic gardens. It needs a transformation towards landscape-based agriculture system powered by biodiversity and forestry to protect these underutilized crops thereby obtaining its economic benefits via strengthening local market, international supply chain, providing input to agro-industry and ecological benefits. In this sense the ecological farming is an excellent example of indigenous knowledge in nature management schemes practiced in ancient Sri Lanka. The basic concepts of ecological farming compiled as nature farming, consider the nature as a partner not as a competitor in farming. Impact of deviating from ecological farming in Sri Lanka suggest to rehabilitate and integrating holistic nature farming techniques that applied during ancient Sri Lanka with modern farming, agro forestry and modern forestry programs.

### 4. Phyto Remediation and Advance Cellulosic Materials and Engineered Wood

Heavy metal and organic pollutant contamination already pose a severe threat to human and ecosystem health. Large area of soil and water contain high levels of heavy metals such as Cd, Cu, Co, Ni, and Zn and other pollutants. Industrial effluents, agriculture residues, domestic waste water and solid waste have contributed largely to heavy metal contamination on land and

in both surfaces and ground water resources. Organic pollutants include solvents, herbicides, explosives, hydrocarbons and fuel additives. Heavy metals cannot be destroyed but can only be transformed from one oxidation state or inorganic complex to another can be done by bioremediation; the use of natural means to breakdown or degrades hazardous substances into less toxic compounds and repairs environmental damage. Phytoremediation occurs when selected plants are grown in a contaminated substrate, the root system of those plants functions as a highly dispersed, fibrous uptake system to giant underground networks that function as solar-driven pumps that extract and concentrate essential elements and compounds from soil and water. After sufficient growth and metal accumulation, the above ground parts of the plants are harvested and burn it to produce bio-ore, a process referred to as phytomining, a green technology, which requires many cropping cycles to reduce metal concentration. Bioremediation has become one of the most rapidly developing fields of environmental restoration with advances in biotechnology [10-12]. This can achieve the elimination of contamination in many environments with a speed and thoroughness much greater than traditional methods and at significantly lower costs. Adoption of bioremediation can practice under the concept of modern forestry technology.

Biomass has high potential to combat climate warming due to its composition. Two of its unique properties are intrinsic to its carbohydrate-based nature; carbon neutrality and multifunctionality. Through photosynthesis, carbon in plant biomass is recycled from the atmosphere and its release causes no net effect on the atmospheric concentration of CO<sub>2</sub> (carbon neutral). Biomass is an excellent substitute for petroleum in the manufacturing of a large variety of products, such as power, transportation fuel, food, chemicals and bio-products, in addition to construction lumber and paper and bio-fuel. Looking deeper into the basic structures of lignocellulose materials, whose basic structural unit is the cellulose chain that is assembled into nano-scale fibrils. These nanofibrils are composed of two distinct morphological orders, amorphous and crystalline regions. Nano cellulose (i.e. nanofibrils) and nano crystalline cellulose could have great potential for industrial application. Extraction of usable chemicals, fuels, and other products from all source-based organic biomass, to form a carbohydrate-based refinery, that is bio-refinery, a facility analogue to the hydrocarbons-based petroleum refinery. Traditional single-product-centric exploitation of forest source biomass or other source biomass is no longer acceptable in view of the current situation; it is inefficient and wasteful. New approaches should be sought to extend our technological capabilities beyond the conventional ways of using natural resources via change from single-product-centric practice to multi-product-centric operation permitting to engineer stronger, more efficient materials for various needs [13]. This is particularly true for the forest products industry, which has the benefits of tremendous natural resources (plants) as a base for nano-sized elements for building a great variety of products.

## 5. International Initiatives and Entry Points

Many international initiatives that have been taken and provide entry points for sustainable natural stocking, carbon sequestration cyclic activities integrate with forest-based products and services development [14].

The United Nations Environment Programme (UNEP) tasked experts prepared an international legal instrument for the conservation and sustainable use of biological diversity. The text of the Convention was adopted on 22 May 1992 during the Rio "Earth Summit". At the 10th Conference of the Parties in October 2010 in Nagoya, Japan, the 193 Parties to the Convention agreed on a ten-year global strategic plan on biodiversity for the period 2011-2020 with a biodiversity vision for 2050 and defined 20 targets with making use of traditional knowledge. The United Nations Conference on Sustainable Development (UNCSD), was the third international conference on sustainable development aimed at reconciling the economic and environmental goals of the global community. Conference re-directed and renewed global political commitment to the three dimensions of sustainable development: economic growth, social improvement and environmental protection; focusing on reducing poverty while promoting jobs growth, clean energy and more fair, sustainable uses of resources. The Clean Development Mechanism (CDM) of the Kyoto protocol and REDD Program is one of three 'flexible mechanisms' defined under the Kyoto Protocol to the UNFCCC. It allows developed countries to undertake GHG emission reduction projects in developing countries to counteract their own domestic emissions. Each CDM project generates Certified Emissions Reduction (CER) units, where one CER is equivalent to one tone of carbon dioxide (CO<sub>2</sub>) or its equivalent for the other GHGs. CER units can be traded or sold, and finally used by industrialized countries to meet part of their emission reduction targets under the Kyoto Protocol, providing global market for greenhouse gas (GHG) emission reductions. Provision for REDD activities (part of the CDM of the Kyoto protocol) aims to reduce, offset and reserve emissions of carbon dioxide arising from conversion of forests to alternative land uses. This program was motivated by recognition that managing land to retain or increase forests cover is a cost-effective means of stabilizing atmospheric carbon dioxide concentration at 550 ppm by 2050, which is the current aim of global climate change policy. These kinds of activities that might qualify for REDD funding include avoided deforestation, reduced impact logging, and new tree plantations that ameliorate pressure on existing natural forest for fire woods, rehabilitation and restoration of degraded ecosystems, enrichment of planting of monoculture tree plantation with native tree seedlings for multi-species forests. In 1977, the United Nations Conference on Desertification (UNCOD) adopted a Plan of Action to Combat Desertification (PACD). United Nations Environment Program (UNEP) concluded in 1991 and United Nations Conference on Environment and Development (UNCED) that the problem of land degradation in arid, semi-arid and dry sub-humid area had intensified and the question of how to tackle desertification was still a major concern. The conference supported a new, integrated approach to the problem, emphasizing action to promote sustainable development at the community level in the period 2008-2018, including improve the living

conditions of affected populations, improve the condition of affected ecosystems, and generate global benefits through effective implementation of the UNCCD and mobilize resources to support implementation of the convention through building effective partnerships. On September 25, 2015, the UN adopted the Sustainable Development Goals (SDGs). These seventeen goals and corresponding 169 targets outline international development priorities through 2030. They also replace the UN's eight Millennium Development Goals (MDGs), which have driven the development agenda since 2000 and expired in 2015. The SDGs are an improvement upon the MDGs in many ways, creating a positive environment for the post-2015 development agenda. The important SDGS (1, 11,12,13,15) covers end poverty in all its forms everywhere, make cities and human settlements inclusive, safe, resilient and sustainable, ensure sustainable consumption and production pattern, take urgent action to combat climate change and its impact, protect/ restores and promote sustainable use of terrestrial ecosystems, sustainable management of forest, combat desertification, and halt and reserve land degradation and halt biodiversity loss [15, 16]. The governments of 196 countries have signed the Paris Climate Change Agreement. This is a commitment between all signatory countries to progress on the path to sustainable development, to reduce greenhouse gases, limit temperature rises to 2.C (1.5C if possible) of pre-industrial levels, aiming for a zero-carbon future. The Paris Agreement sets out 29 Articles that cover: climate change mitigation, adaptation, finance, loss and damage, technology development and transfer, capacity building, transparency of action and support, stocktaking, and facilitating implementation and compliance. It indicates forest crops can support countries' climate change action plans. These areas are: sustainable forest management, protecting and increasing forest resources as carbon sinks; and access to renewable energy. And, as country climate change plans are refined, investments for forest crops can be targeted for: zero-carbon construction materials; rapid landscape restoration tree crops and forest crops; livelihoods improvement, including job and enterprise creation via Nationally Determined Contributions or country action plans.

## 6. International Bamboo and Rattan Organization

The International Network for Bamboo and Ratan (INBAR, renamed International Bamboo and Rattan Organization since July 2016), and environmental protection. It started as a secretariat supported by IDRC in South Asia and has evolved into a strong intergovernmental network with initially 34 member countries. INBAR is now headquartered in Beijing, China. It counts the Government of China, Canada, Netherlands as well as IFAD among its many supporters. INBAR has activities all over the world. It has a focus on rural development and environmental protection through action research, and on the development of fair worldwide trading systems for bamboo and rattan (Figure 4, 5) in particular through its activities as a CFC International Body.





Figure 4. The Bamboo Carbon Cycle [17]



Figure 5. Global map of distribution of bamboo [18]

## 7. Forest Exchange System

Formation of forest exchange system, a professional market platform for nationwide forestry equity and forest-related trading business, as well as international forestry industry commodity management to capital management via integrating the forest resources of the poverty-stricken regions, is essential for the modern forestry industry development. This emphasis the building of professional forestry enterprises relying on the powerful information platform and service network for forest carbon-sink, reservation and circulation through the carbon sink transaction platform, fund to support education and culture development.

With these international agreements, entry points, country background and potential requirements, it is suggested to design modern forest enterprise that integrate new landscape approaches considering the different landforms and irrigation systems in Sri Lanka with help of traditional wisdom, modern science and constant innovation. Thus, right policies for setting up right institutions of “Forest Development Authority” and “Forest Exchange System” and inter institutional set up of “Modern Forest Technology” for action in national plan is justified based on food tree crops, non-timber forest products (NTFPs) and industry related timber crops considering the different landforms, soil type, water streams, irrigation systems and area specific rural and urban development plan of Sri Lanka. Ranking and categorizing of forest crops, tree crops, NTFP s, fruit crops and underutilized crops for landscape requirement according to their carbon sequestration rate, specific and multi uses, carbon neutrality, renewability, canopy type and height, leaves sizes, color variation, colour changes with the seasons, flowering ability and flower colours, total images of crop and beautifulness should be considered. This program can counterculture starting from every home garden, villages our cities, towns, and: offices, factories, sores, farms, schools, hospitals, and civic buildings, as well as furnishings for more beautiful rural, agricultural and urban landscape that make comfortable environment for all. Forest tower is one of the innovative extreme ends suggested under urban development under modern forest.

This establishment accelerates the development of the beautiful country side with ecotourism [3] where everyone lives happily in their harmonious community and possibility of potential home to start up their own business and every village are beautiful that links to forest industry.

## 8. Conclusions

In an emerging greener economic climate in the forestry sector of Sri Lanka, the apparent failures in policies, governance and markets shows lack of contribution to the GDP via underutilization of the potentiality to obtain win-win effect of ecology and economy. An innovative sustainable forestry development via establishing modern forestry industry sector in Sri Lanka with policies for setting up right institutions for action in plan is quite justified with facilitation from international agreements, lessons learning of climate change disasters

managements, forest enterprise development and collaboration with track record own regional Asian Countries.

## References

- [1] R.D. Chithranarayann, B.V.R Punyawardane, Identification of drought prone agro-ecological regions in Sri Lanka, *Journal of the National Science Foundation of Sri Lanka*, 36 (2008) 117-123. <http://doi.org/10.4038/jnsfsr.v36i2.143>
- [2] W.A.J.M. De Costa, Adaptation of agricultural crop production to climate change: A policy framework for Sri Lanka, *Journal of the National Science Foundation of Sri Lanka*, 38 (2010) 79-80. <http://doi.org/10.4038/jnsfsr.v38i2.2032>
- [3] S. Blangy, H. Mehta, Ecotourism and ecological restoration, *Journal for Nature Conservation*, 14 (2006) 233-236. <https://doi.org/10.1016/j.jnc.2006.05.009>
- [4] R. Volk, H.M. Bandaratilleke, S. Vidanage, Tropical forest and biodiversity analysis, Sri Lanka, Technical report (2012) Research Gate. 8-12. <https://doi.org/10.13140/RG.2.2.27577.42084>
- [5] R. Hashim, O. Sulaiman, The current status of the usage of engineered wood in Malaysia, *JIRCAS Working Report*, 80 (2013) 58-61
- [6] D. O. Ekhuemelo (2016) Importance of forest and trees in sustaining water supply and rainfall. *Nigeria Journal of Education, Health and Technology Research (NJEHETR)*, 8, (2016) 273- 280.
- [7] R. Lal, Soil Carbon sequestration to mitigate climate change, *Geoderma*, 123 (2004) 1-22. <https://doi.org/10.1016/j.geoderma.2004.01.032>
- [8] Climate Change Issues in Sri Lanka, (2016) Institute of Policy Studies, 1-40.
- [9] N. Dahanayake, Some neglected and underutilized fruit-crops in Sri Lanka, *International Journal of Scientific and Research Publications*, 5 (2015) 1-7.
- [10] N. Rajakaruna, K.M. Tompkins, P.G. Paviccevic, Phytoremediation: An affordable green technology for the clean-up of metal-contaminated sites in Sri Lanka, *Ceylon Journal of Science*, 35 (2006) 25-39.
- [11] J.O Bosire, F. Dahdough-Guebas, M. Walton, B.I Crona, R.R. Lewis III, C. Field, J.G, Kario, N. Keodam, Functionality of restored mangroves: A review, *Aquatic Botany*, 89 (2008) 251-259. <https://doi.org/10.1016/j.aquabot.2008.03.010>
- [12] M.I.M. Kaleel, (2013) Growing scarcity of Mangroves: A study of Pottuvil coastal area in Sri Lanka, *International Journal of Environmental Sciences*, 3 (2013) 2261-2267.
- [13] W.R.W. Daud, K. Law. (2020) Current Status and Potential of Research on Lignocellulosic Resources in Malaysia, *JIRCAS Working Report*, 80 42-46.
- [14] Bamboo, Rattan and the UN Framework Convention on Climate Change, (2015) Preparation for the COP21-Paris-Negotiation of the UN Framework Convention on

Climate Change, *Position Paper, INBAR; International Network for Bamboo and Rattan*, 1-5.

- [15] D.K. Joshi, B.B. Hughes, T.D. Sisk, Improving Governance for the Post-2015 Sustainable Development Goals: Scenario Forecasting the Next 50 years, *World Development*, 70 (2015) 286-302. <https://doi.org/10.1016/j.worlddev.2015.01.013>
- [16] Thomas Hak, Savatava Janoscova, Bedrich Moldan, Sustainable Development Goals: A need for relevant indicators, *Ecological Indicators*, 60 (2016) 565-573. <https://doi.org/10.1016/j.ecolind.2015.08.003>
- [17] Bamboo: A strategic resource for countries to reduce the effects of climate change, (2014) INBAR Policy synthesis report 1, 1-18
- [18] Bamboo and Rattan in the World, (2007) China Forestry Publishing House, 1-8.

**Acknowledgements:** Funds provided by the project of “Curing of bamboo culm that suit to tropical environment and bamboo products development” (TG 18/156) is acknowledged.

**Conflict of interest:** None

**About The License:** © 2022 The Author. This work is licensed under a Creative Commons Attribution 4.0 International License which permits unrestricted use, provided the original author and source are credited.