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Innovative Policy to Enable Sustained Conserving of Forest Biodiversity

Md Rahimullah Miah[1,*], Md Mehedi Hasan[2], Md Main Uddin Miah[3], Jorin Tasnim Parisha[4], Md Sher-E Alam[5], Alexander Kiew Sayok[6], Md Shoaibur Rahman[7], Md. Amir Sharif[8], Mohammad Belal Uddin[9]

[1]Department of IT in Health, North East Medical College, Affiliated to Sylhet Medical University, (SMU), Sylhet, Bangladesh. and PhD Awardee from the IBEC, UNIMAS, Sarawak, Malaysia
[2]Department of Law, Green University of Bangladesh, Dhaka, Bangladesh
[3]Faculty of Forestry and Environment, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur, Bangladesh
[4]Government Satis Chandra Girls' High School, Sunamganj Sadar, Sunamganj, Bangladesh
[5]Department of Law and Justice, Metropolitan University, Sylhet, Bangladesh
[6]IBEC, Universiti Malaysia Sarawak (UNIMAS), Kota Samarahan, Sarawak, Malaysia
[7]Department of Agroforestry and Environment, Hajee Mohammad Danesh Science & Technology University, Dinajpur, Bangladesh
[8]Department of Accounting and Information Systems, Begum Rokeya University, Rangpur, Bangladesh
[9]Department of Forestry and Environmental Science, Shahjalal University of Science and Technology, Sylhet, Bangladesh

Abstract Bangladesh is a densely populated country, where forest cover is decreasing day by day. There is an existing outdated policy to protect forests, the implementation of which is harmful overt and covert corruption of protected biodiversity through misuse of wireless sensor technology. Most of the people of the present generation are dependent on this wireless sensor technology, the misuse of the technology is turning dense forests into barren deserts. Research has revealed that cybercriminals are tracking forest cover with wireless sensor devices that cause wildfires, landslides, heatwaves, climate crises, artificial earthquakes, desertification, sensor poaching and digitally killing wildlife. Yet forest policy-makers and administrations are apathetic about appropriate solutions to protect biodiversity through existing laws and policies. Studies show that encroachment by forest criminals is the main cause of deforestation and depletion of forest in a particular GPS location. Scientific and innovative forest policies are urgently needed to solve the current problems, so that unprotected forests can be converted into protected green forests.

Keywords Policy, Technology, Wildfire, Heatwave, Innovative Forest

1. Introduction

Policy is a set of laws, administrative measures, resource holdings, technical guidelines, regulations, procedures, indicators of achievement of goals, formed under the provisions of national relevant laws (CDC, 2020; Miah et al., 2017). This policy deals with leadership development guidelines, self-regulations, nurturing tools, education, training programs to meet the needs, and updates to laws, incentives, or voluntary practices of governments and other organizations (Miah et al., 2018). Forest policy refers to the reorientation of research, education and training to maintain ecological stability through the use of forest land for forestry purposes, development of plantation programs, establishment of modern wood-based industries, preservation of ecological balance and conservation of natural heritage (Miah, 2018). Forest policy decisions are often replicated in the allocation of natural resources. Forest health can be influenced by policies that integrate different sectors, departments and institutions (Miah et al., 2019; Miah et al., 2022). One-third of CO2 emissions from deforestation are linked to international trade (Pendrill et al., 2019). While the motivation for a policy may be of interest to many, forest and natural resource managers must more importantly understand how policies can function effectively within the legislative, regulatory and operational environment in which they are developed.

The Lawachara National Park in Kamalganj subdistrict of Moulvibazar district is in danger as a section of influential people continued grabbing the reserved woodland under the very nose of the forest department authorities. These influential people and musclemen have built resorts and factories on the grabbed lands destroying the ecosystem of the reserved forest (Bangladesh Post, 2022). The government declared approximately a 1,250-hectare area in Kamalganj

* Corresponding author:
drmrmiah@yahoo.com (Md Rahimullah Miah)
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subdistrict as a national park on July 7, 1996 under the Wildlife Act, 1974.Wildlife at the Lawachara National Park includes 460 species – 167 species plants, four amphibian species, six reptile species, 246 bird species, 20 mammal species, and 17 insect species, according to sources at the national park. Though Lawachara has been given the status of national park, but wild animals are still unsafe there. The authorities will also have to take necessary steps to stop the cutting of hills, and trees. To achieve Sustainable Development Goals by 2030, Bangladesh will have to show 16 percent forest coverage. But, currently the country has only 14.1 percent forest coverage. So, there is no alternative to oust the grabbers and illegal occupants from the country's Lawachara National Park at any cost. Besides, legal action must be taken against both the forest grabbers and the people who assisted them in grabbing. The country's total forest area has shrunk by 65,000 hectors in the last 25 years. A total of 13,000 hectors of forest disappeared in the last five years, says a study. To protect environmental balance, a country needs 25 per cent forest land of its total area while Bangladesh has only 14.1 per cent including the leased-out forest land. It needs to be mentioned that more than 65.8 per cent of the country's forest is at risk of high destruction (Islam et al., 2021). Gaps that exist in the government forest policy are themselves additional factors that have contributed to deforestation in State (UNEP, 2001).

The study aims to explore the innovative policy tools that sustain conserving biodiversity within and around the forest area in Bangladesh.

2. Materials and Methods

The study included different materials and methods as following:

2.1. Study Site

The study site was purposefully selected based on a set of conditions like location, suitability, flag species, and stakeholders' attractions to permit the analysis of cases [Miah, 2018]. The study was undertaken at Lawachara National Park (LNP) at Kamalganj sub-district in Moulvibazar of Sylhet division, Bangladesh coordinates with 24°32′12″N 91°47′03″E [Miah, 2017] as the forest conservation case study site (Figure 1). Lawachara National Park is unique in Bangladesh for its scenic beauty and other relevant parameters.

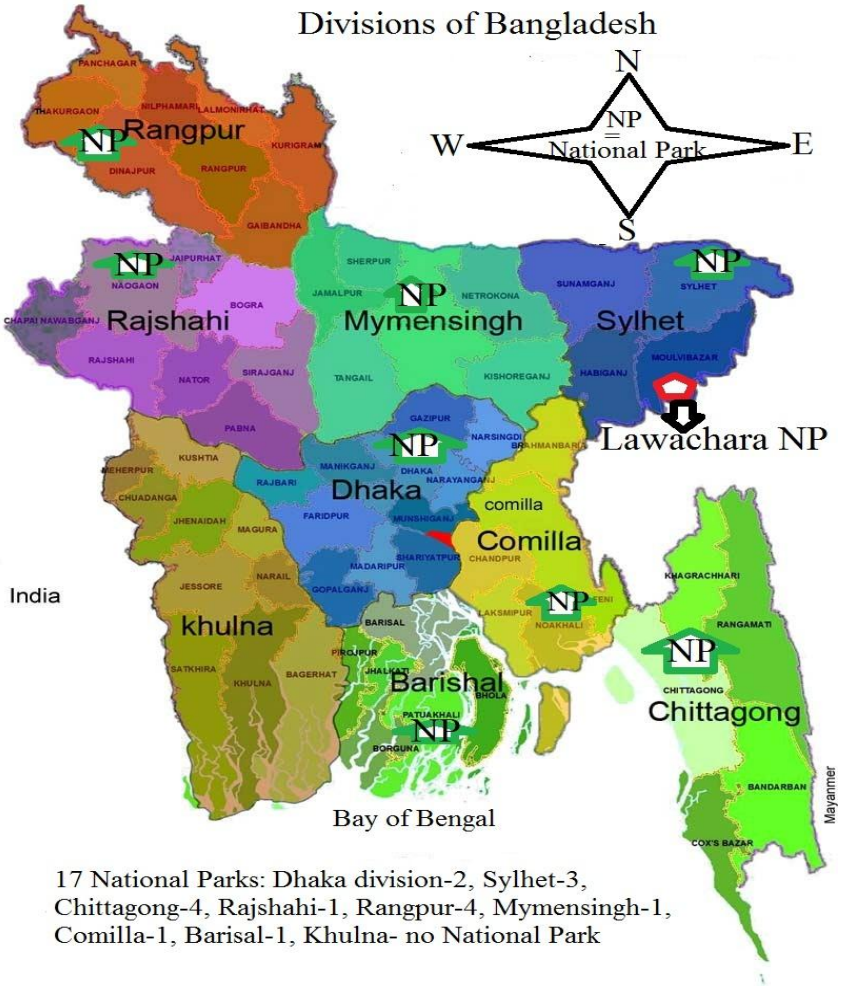

Figure 1. The declared National Parks of Bangladesh (RIMS, 2015)

2.2. Lawachara National Park: Case Study Area

The study was undertaken at Lawachara National Park (LNP) at Kamalganj sub-district in Moulvibazar of Sylhet division, Bangladesh coordinates with 24°32′12″N 91°47′03″E (NSP, 2005) as the forest conservation case study site. The LNP is situated in the Union and sub-district Kamalganj (Figure 2) in Moulvibazar district of Bangladesh (MP, 2006) with indicated parameters as shown in Table 1.

Besides, Lawachara National Park is uniqueness in Bangladesh for its scenic beauty, visitors' attraction and other relevant parameters, which are illustrated in details as follows.

Table 1. Some basic parameters of Lawachara National Park

Sl. No.	Parameters	Characteristics
i.	WDPA ID	142993 (WDPA, 2017)
ii.	IUCN Category	II (National Park category) (PAB, 2016)
iii.	Forest type of Park	Evergreen and semi-evergreen forests (IPAC, 2012)
iv.	Existing Law	The Wildlife Conservation and Security Act 2012
v.	Policy Management	Co-management System Active (CWS, 2012)
vi.	Physiography	Northern and Eastern Hills (IPAC, 2012)
vii.	Bio-ecological Zone	Sylhet Hills (IPAC, 2012)
viii.	Forest Range	Moulvibazar Wildlife Range, Srimangal (IPAC, 2012)
ix.	Forest Beat	Lawachara Beat (IPAC, 2012)

Table 2. Important historical Events in Lawachara National Park

Important Events	Period	Remarks
Historical Mixed Tropical Evergreen Forests.	Before 1848	British East India Company
Cleared the original forest for tea plantation.	1848	British Companies
Bamboo, Cane and other relevant species.	1923	Starting Afforestation
Lawachara Punji Established.	1940	For logging and plantation purpose
Magurchara Punji established.	1950	In connection with Lawachara
Declared Reserve Forest.	1973	By President's ordinance.
Declaration as Lawachara National Park.	1996	By Government
Launching Forestry Sector Project.	1996	Financed by Donor
Preparation of National Park Management Plan.	1996	Organised by BFD and Donor
Magurchara Fire Accident.	1997	Caused by Global Company
Launching Nishorgo Support Project.	2003	Implemented by International Resources Group (IRG)
Formulation of Forest Management Plan for Lawachara National Park.	2006	Organised by Bangladesh Forest Department
Closing of Forestry Sector Project.	2006	Declared by BFD-Donor
3D Seismic survey.	2008	By Chevron Multi-national Company
Closing of Nishoro Support Project	2008	Declared by BFD-Donor
Launching of Integrated Protected Area Co-management Project.	2008	By BFD-IPAC
Established Co-management System at LNP.	2009	By BFD-IPAC
Established Article 18A in the National Constitution for National Park Biodiversity Protection for present and future citizens.	2012	By Bangladesh Government
Established Wildlife Conservation and Security Act 2012 for National Park Protection.	2012	By Bangladesh Government
Enlisted Lawachara National Park ID at World Database on Protected Areas (WDPA).	2014	By WCMC-IUCN
Established Public-Private Partnership Act 2015 for National Conservation Protection.	2015	By Bangladesh Government
Python swallode deer due to associated food shortage for wildlife.	2016	Observed by LNP Administration
LNP encroached land recover from local encroacher.	2017	By LNP Administration and Co-management Team

(Source: NSP, 2006; MP, 2006; WCS, 2012; TCPRB, 2012; IPAC, 2012; WDPA, 2017; ALNP, 2017).

Table 3. Status of Respondents in the studied area

Name of village	Existing Households (NSP, 2006)	Total Existing Member	Number of Respondents	Respondent's rate (%)
Lawachera Punji	23	116	29	25%
Magurchera Punji	41	165	48	29%
Dolubari	84	255	46	18%
Langurpur	92	278	83	30%
Total	240	814	206	25.5%
Other Respondents		247	87	35.22%
Grant Total		1061	293	30.36%

(i) Important Events in Lawachara National Park
(ii) Infrastructure Facilities
(iii) Administration
(iv) Legal Status
(v) Biodiversity
(vi) Human Settlement
(vii) Soil and Topography, and
(viii) Climate.

2.3. Important Historical Events of Lawachara National Park

There are some important historical events of Lawachara National Park, which linked with its historical background (Table 2).

These important events are historical witnesses in connection with National Park's Biodiversity Conservation, Protection, Management and present park conservation policy status to compare other National Park in Sylhet Division of Bangladesh.

2.4. Sample Size and Sampling Techniques

The field survey related to villages, conservation knowledge, biodiversity policy, legal system, national park areas management perspectives and digital conservation. The average sample size is 30.36% with respondents' rate which as shown in Table 3.

Besides, the rest of respondents are 87 including visitors, biodiversity specialist, forest officer, biologist, agriculturalist, ecologist, conservationist, environmentalist, network specialist, software engineer, policy-maker, botanist, zoologist, wildlife manager, co-management team leader, judges, environmental lawyer, indigenous community leader, academicians and NGO officers. Out of 4 villages, Lawachera and Magurchera are inside and Dolubari and Langurpur are outside villages from Lawachara National Park. First three villages are major stakeholders, while last one is minor stakeholder affected to LNP. The study undertook a survey on only four villages from LNP to determine the effectiveness of present biodiversity-related instruments on the ground by looking at data related to legal knowledge, biodiversity conservation policy and national park areas management perspectives of the stakeholders especially the locals including khasia, tripuri and monipuri (NACOM, 2003). Sampling methods used randomly through observations, semi-structured interviews and questionnaires, which selected based on the opinions related to the conceptual questions (Rufford, 2014).

2.5. Tracking Procedure

The tracking procedure comprised advanced wireless sensor technology towards plants, animals and objects including 7 cats and 7dogs at a particular GPS location due to active open eyes, self-voice and active wireless sensor device. The tracking processes were occurred at light and dark environment in the altitude, latitude and longitude locations with BMI categories.

2.6. Conservation Policy Assessment Method

Assessment of conservation policy outputs should preserve decision-making in the political process by State Government and International Collaborative Institutions. It delivers information on to what level the environmental conservation and other relevant objectives of an executed environmental policy have been completed at what costs, and with what effects on all-important themes concerned proposals for the next stage of the related policy cycle (Sauer *et al*., 2012). The assessment process was included into two main levels— (i) basic assessment and (ii) comprehensive assessment. The basic assessment is obtained all cases and is of a multipart character including the three "Pillars" of sustainable development: environmental, economy and institutional-social. The comprehensive assessment is also obtained only if essential by conclusion of the basic critical review. Therefore, Conservation Policy Assessment Method is someway related to a "small" and "prolonged" Regulatory Impact Assessment (RIA) (Sauer *et al*., 2012).

The policy assessment method (PAM) is anticipated to carry outputs that are understandable to policy-makers and experts in several parameters, as well as the public sectors. In opinion, PAM practices organized and easy-to-survey tables, which are to be accomplished systematically. This system consents for the assessment to integrate regular arrangement and procedures simplifying the assessment. Moreover, all the policy assessment steps are also perceptibly documented. The PAM legalizes the definite purpose of competency in the assessment process: clear definition of the roles of the national park managers, executor of the assessment, subjects concerned (stakeholders) and expert reviewers with critical

review of the assessed documentation. As regards the methods used for the actual assessment of the policy implementation effectiveness, both qualitative and quantitative methods are applied. The qualitative methods include, for example, document analysis, and identification of relevant factors for multicriterial analysis, consultations, and comprehensive interviews with experts and subject concerned, etc. The quantitative methods include, in particular, conversions to comparable units used in assessment tables, and also multicriterial analysis techniques. In preparing the assessment, the quality of the data is observed and evaluated. The assessment scale runs from 1 to 4 points (Sauer *et al*., 2012): (a) 4= suitable, (b) 3= in general, (c) 2=undesirable, and (d) 1= no comment. The assessment method designates the rules for assigning points to each of the parameters in much more detail, including quantifying relevant values if appropriate. The basic assessment consists of four phases: (a) Preparatory phase, (b) Data collection and assessment in the particular modules, (c) Overall assessment of the policy and elaboration of a policy rating, (d) Critical review and final assessment of the policy (Sauer *et al*., 2012).

The preparatory phase begins with making a requirement to assess the effectiveness of a policy implementation. Such a requirement may arise from the policy itself or it may be forwarded to the Ministry of Environment and Forests from another organization at the government level like ministries, parliament. It may also arise from non-governmental organizations, political parties, industrial associations, community-based organization and collaborative management committee, etc. The requirement is then reviewed from the viewpoint of the necessity to perform an actual assessment of the relevant policy implementation effectiveness. Reasons for rejection of the requirement may be, for example, the fact that the required assessment already is proceeding as part of reporting to the CBD, that the policy concerned does not fall within the powers of the Ministry of Environment and Forests, that the requirement aims at public resource management rather than an assessment of the effectiveness of the policy implementation, etc. The study assessed at the Lawachara National Park area at Moulvibazar district in Bangladesh, which as shown in Figure 2.

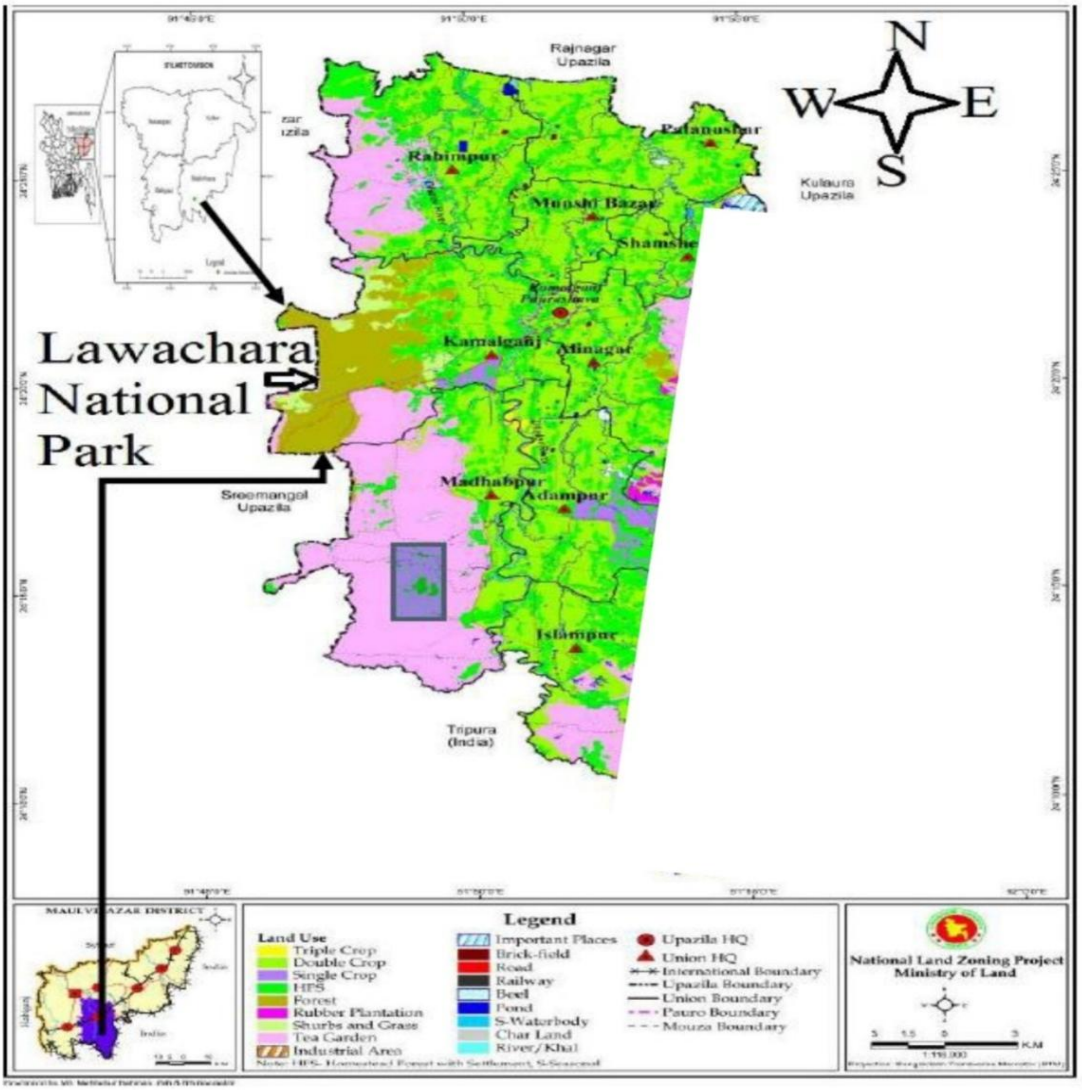

Figure 2. Lawachara National Park at Kamalganj in Moulvibazar, Bangladesh (Source: NLZP, 2018)

2.7. Data Analysis and Interpretation

The research method related to different parameters to enhance data collection, compilation, and interpretation. Quantitative and qualitative related forest policy data were obtained through field observation, interviews, field surveys, focus group discussions, and informal discussion while secondary data were obtained from diverse sources with the forest policy assessment method. The data were compiled and analyzed for presentation and interpretation using standard data analysis software like MS Office Suite 2021 and SPSS ver.27.

3. Results and Discussion

The study was illustrated with diverse parameters, which as shown as below:

3.1. Stakeholder Analysis

Table 4. Societal and economic features of Stakeholders in the Study area (n=293) (Field Data)

Parameters	Socio-economic and demographic indicators	Frequency	(%)
Gender	Male	180	61.43
	Female	113	38.57
Age Class	< 15	52	17.75
	15 to 30	115	39.25
	31 to 45	85	29.01
	45 to 60	31	10.58
	>60	10	3.41
Education	Illiterate	83	28.33
	Primary	48	16.38
	Secondary	58	19.80
	Higher Secondary	44	15.02
	Graduation	60	20.48
Primary occupation	Betel leaf and betel-nut farming	80	27.30
	others	213	72.70
Secondary occupation	Service	77	26.28
	Business	51	17.41
	Agriculture	97	33.11
	others	43	14.68
	None	25	8.53
Average Annual Income (US$)	Total	US$ 2060	-
	Primary	US$ 1558	-
	Secondary	US$ 502	-

The main findings from field observation showed that inhabitants of four villages (Lawachera punji, Magurchera punji, Dolubari and Langurpur) were highly dependent on natural resources of Lawachara National Park (LNP). Due to this high dependency on the national park resources, most of the respondents in four villages admitted to undertake illegal as well as unwanted activities inside the park. For example: illegal logging, poaching, hunting, illicit-felling, encroaching (Reuters, 2007). However, the response patterns from interviews and key informant interviews in four villages indicated that more than 50% of the respondents believed in conservation of LNP's biodiversity. Moreover, Environmental Conservation Policy research findings are about developed models to evaluate the contribution of environmental policy instruments along with information systems for biodiversity conservation towards National Parks in Bangladesh.

Some socio-economic features of stakeholders are illustrated in Table 4 with mentioned indicators and frequencies including gender, education, occupation and annual income of the local people. The study was taken a field survey for the purpose of socio-economic status adjacent villages of Lawachara National Park. From Table 4, the study observed that the ratio of male and female was 61: 39 including local and foreigner stakeholders. Out of them, the maximum aged class range 15 to 30 years and secondary occupation is agriculture (33.11%), whose average annual income US$ 2060. Some respondents depend on Lawachara National Park for the collection of Non-Timber Forest Products (NTFPs).

3.2. SWOT Analysis of Lawachara National Park

Lawachara National Park consists of multi-species including flora, fauna and genetic diversity in Sylhet division. However, this Park's diversity loss due to several reasons, such as: (i) weakness: lack of clarity/ information on how co-management committee and alternative income strategies benefit LNP biodiversity long-term, and (ii) threat: lack of government commitment to conserve biodiversity to enforce environmental laws. For this purpose, the study identified some strength, weaknesses, opportunities and threats which as shown in Figure 3. From the study of SWOT analysis, the scoring value for strength 4, weaknesses 1, opportunity 3 and threat 2, then the calculated value summarized accordingly, as shown in Table 5.

Table 5. Factors scoring of Lawachara National Park through SWOT Analysis

Internal Factors	**Strengths**	**Weaknesses**	**Total**
	32	9	41
External Factors	Opportunities	Threats	Total
	30	28	58

The study identified internal factors 41 and external factors 58 of Lawachara National Park from SWOT analysis. SWOT analysis has shown that the well-established tourism destination with a variety of natural attraction and unique culture of indigenous people having traditional culture are the strengths of LNP while lack of effective visitors' database and fundamental facilities are the major weaknesses. Appropriate ecotourism package development involving co-management team in decision-making are found to be few of the key opportunities whereas tensions, anxiety and insecurity in peripheral areas are the core threats. The study

suggested that it is required more efforts on conservation and ecosystem services for Lawachara National Park biodiversity management, because policy instruments, like legal, social, political, institutional, and informational, connected with co-management team and eco-guide for the conservation perspectives and grant financing.

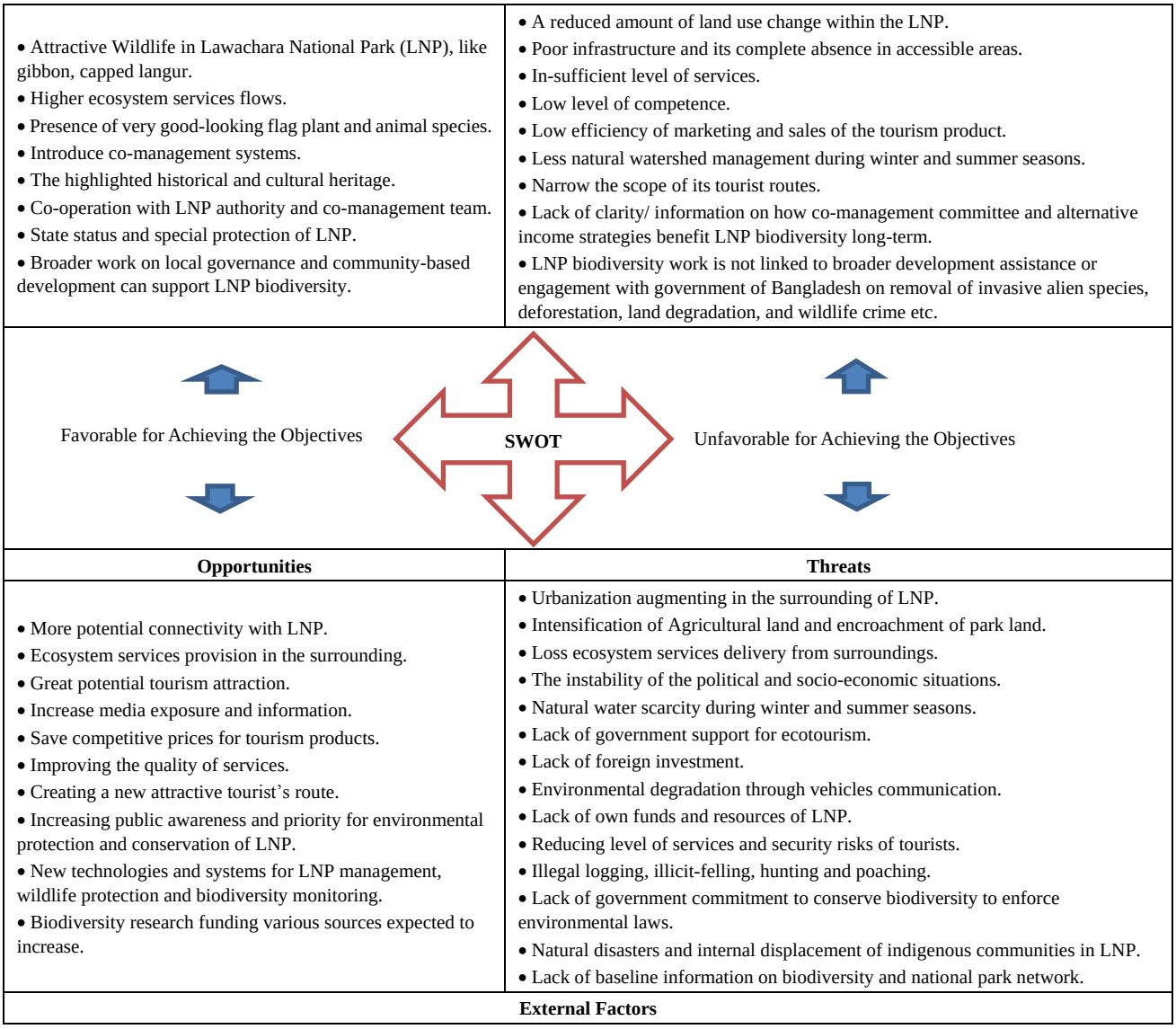

Figure 3. SWOT Analysis of Lawachara National Park

3.3. PESTEL Analysis

PESTEL analysis used to analyse the National Park Management as well as Biodiversity Conservation those related to environmental policy instrument. This analysis helps to assessing the National Biodiversity Conservation Policy on Lawachara National Park Management of Bangladesh in connection with Aich Biodiversity Targets 2020. The PESTEL analysis included the following factors: Polictical, Economic, Socio-cultural, Technological, Ecological/Environmental and Legal in terms of LNP's Biodiversity Conservation which as shown in Figure 4.

The study suggested for development National Biodiversity Conservation Policy and National Biodiversity Database in connection with Aichi Biodiversity Targets 2020.

3.4. DPSIR Analysis

The DPSIR analysis has done to understand the major cause and effect relationships of socio-economic and environmental factors. In this context, the Driving Forces (D)-Pressures (P)-State (S)-Impacts (I)-Responses (R) approach used to provide and communicate knowledge on the state and change of causal factors regarding environmental issues for national park biodiversity conservation. 53 indicators were arranged according to the DPSIR analysis, where as D=8, P=13, S=8, I=14 and R=10, which showed in Table 6 with relevant parameters.

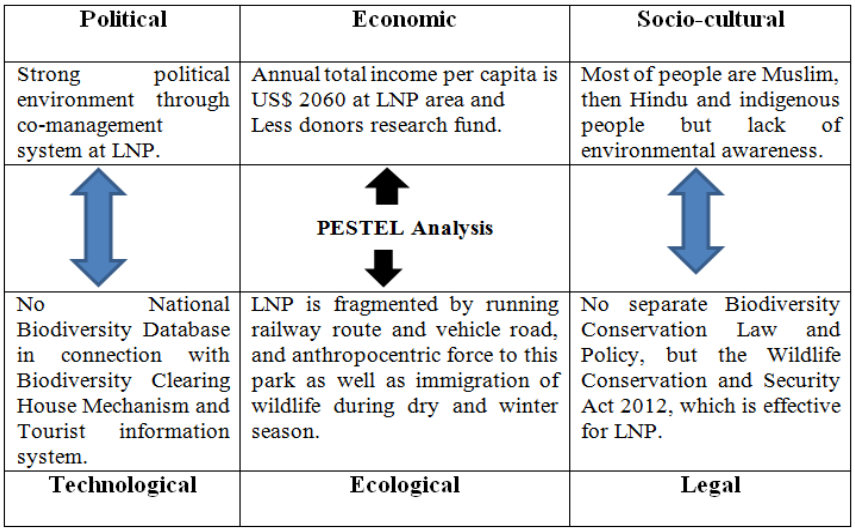

Figure 4. PESTEL Analysis on Lawachara National Park

Table 6. The description of indicators, their category and performance for two periods

Indicators	Description	Category *	Period		Remarks
			1971-2000	2001-2015	
Local Population	Number of community people	D	low	High	↑
Less bio-religious related person for taking decision-making	Number of religious leaders	D	low	Moderately	→
Nepotism in co-management	Political biasness	D	No	Medium (in general)	→
BCHM expert	Number of conservation technologists	D	No	Low	↓
Biodiversity research specialists	Number of researchers	D	low	Medium	→
Negative impact on tourism	Effect of eco-tourism	D	low	Moderately	→
Increase migration of outsider inhabitants	Number of migrants	D	low	High	↑
Agriculture and Tea-estate expansion	Land conversion	D	low	Slightly increase	→
Over exploitation of Park resources	Natural resources	P	low	High	↑
Park land encroachment	Illegal habitat	P	High	Slightly recover	→
Excessive Invasive Alien Species	Species invasion	P	High	Very high	↑
Landscape conversion	Land diversification	P	low	Slightly increase	→
Illegal logging	Illicit-felling	P	low	High	↑
Unseasonal NTFPs collection	Reduction of growth and development	P	low	High	↑
Deforestation	Cleared Park area	P	low	High	↑
Shifting cultivation	Frequency of occurrence	P	low	High	↑
Illegal hunting	Status of wildlife	P	low	High	↑

Indicators	Description	Category *	Period		Remarks
			1971-2000	2001-2015	
Running Railway route and vehicle road	Habitat disturbance and fragmentation by road/route	P	low	Very high	
Noise disturbance	Increase of noise disturbance on wildlife habitat	P	low	High	
Wildlife disease	Disease occurrence	P	low	High	
Domestic grazing	Illegal grazing	P	low	High	
Healthy biodiversity	Plant and animal status	S	High	Low	
Mother tree species	Impact on growth and development	S	High	Very low	
Immigration of wildlife during dry and winter season	Scarcity of water and associated food	S	low	High	
Land degradation	Baren Park area	S	low	High	
Threatened species	Ecological status and pyramid	S	low	High	
Endemic species	Status of macaque and capped langur	S	low	Very high	
Regeneration potential of plants	Failure of establishment of seedling and tending	S	low	High	
Deterioration of vegetation cover	Vegetation status	S	Low	High	
Park Biodiversity	Losses of biodiversity	I	low	High	
Habitat loss	Loss of ecological niche	I	low	High	
Negative impact on healthy environment	Change of park status	I	low	High	
Local socio-economic impacts	Income status of local community	I	low	High	
Landscape fragmentation	Isolated area	I	low	High	
Social unrest	Instability in the society	I	low	High	
Application of conservation technology	Arena of digital conservation	I	No	Low	
Ecotourism services	Status of tourist towards park	I	No	Low	
Bio-environmental education awareness	Consciousness of conservation education	I	No	Low	
Species diversity reduces	Anthropogenic status	I	low	High	
External and internal factors	Status of SWOT approach	I	low	External high and internal low	
Co-management grant financing is higher	Collaborative activities	I	low	High	
Human wildlife conflict	Extend of conflict between local people and Macaque	I	low	High	

Indicators	Description	Category *	Period		Remarks
			1971-2000	2001-2015	
Genetic disorder from vehicles' whistles	Status of growth and development	I	low	High	
Biodiversity conservation law and policy	Legal status	R	No	Integrated but no separate	
Research and Policy gaps	Gap status	R	low	Moderate	
Stakeholder's mobilization	Stakeholder's involvement	R	low	High	
Sectoral integration	Institutional status	R	low	Low	
Biodiversity database administration	Number of Expert	R	No	Low	
Biodiversity Management Institution	Institutional stability	R	No	Need separate	
NBSAP	Biodiversity related action and targets	R	No	Update	
Political commitment	Government ratified with CBD	R	low	High	
Policy scoring higher	Integrated policy status	R	Less	High	
Connection with Global Database	LNP in WDPA	R	No	Medium	

* D represent Driving Forces for the park, P – Pressures on the park, S – Changes in the State of the park, I– Impacts on the park, and R – Responses to park threats.

From Table 6, it calculated for identification of reflection and response from DPSIR analysis. The DPSIR implies categories with different values, for example, Reflections, D=4, P=3, S=2, I=1, and Response, R=10. The study analyzed that the Reflection Value is 101 and Response Value is 100, i.e.

Reflection Value > Response Value. The study identified that less response to Lawachara National Park for decision-making.

3.5. Causes of Biodiversity Loss

The opinions of the villagers, visitors and others on different causes of loss of biodiversity are shown in Table 7. The conservation policy affected the following indicators, such as: (i) poverty/low income, (ii) over inhabitants, (iii) illegal logging/illicit-felling, (iv) hunting and capturing, (v) political reasons, (vi) lack of legal action, (vii) natural calamities, (viii) ecological disturbance, (ix) land conversion, (x) invasive alien species.

Stakeholders' Perception enhances on Environmental Policy Instruments for Conserving Biodiversity and threats to Biodiversity. For example, stakeholders' average opinion on habitat fragmentation and loss is 90%, where maximum between villagers (94%) and minimum in visitors (85%). The study suggested for afforestation /reforestation programme with engagement of stakeholders.

3.6. Status of Invasive Alien Species

Alien species invasions are often detrimental to local flora, fauna, habitat and weather. According to Article 8(h) of the Constitution of CBD, every state party must take strategy plan for removal these species. There are some recognized invasive alien plant species during survey at Lawachara National Park and categorized according to their levels of harmfulness are presented in (Appendix K). A total of 15 plant species were identified in LNP, among of them, top ten harmful species (Table 8) are *Lantana camara* and *Clerodendrum viscosum.*

These ranking identified on the priority of the integrated opinion of Focus Group Discussion (FGD). So, it is urgent necessary for removal IAS from National Parks, as shown in Figure 5. Human activity has introduced a high number of invasive species into park ecosystems (Evans, 2011). Reflection on Invasive Alien Species for removal from National Park depends on strategic plan, financial support, and experts for identification and dedicated manpower, who are enthusiastic to perform these tasks. Different indicators on IAS for removal from National Park are (i) species rare, (ii) species too wide-spread, (iii) public resistence, (iv) collaboration, (v) management method, (vi) expensive, and (vii) mechanical support.

Table 7. Stakeholders' Perception for threatening to Biodiversity

Different parameters regarding loss of biodiversity	Stakeholders' Opinion			
	Villagers	Visitors	Others*	Average
Climate Change driving Biodiversity Loss	88%	93%	95%	92%
Unsustainable Use/Overexploitation	90%	88%	92%	90%
Negative Impact of Invasive Alien Species	87%	94%	95%	92%
Habitat Fragmentation and Loss	94%	85%	91%	90%
Pollution/Nitrogen Posing threat to biodiversity	75%	87%	93%	85%
Limited Capacity including Financial, human and Technical Issues for Biodiversity Loss	88%	82%	94%	88%
Complications in Retrieving Systematic Evidence	86%	94%	96%	92%
Inadequate Consciousness on Conserving of Biodiversity Issue	64%	86%	90%	80%
Constrained National Park's Biodiversity Mainstreaming,	68%	85%	72%	75%
Scrappy Decision-making	62%	76%	90%	76%
Imperfect communications among various department/divisions	54%	88%	92%	78%

* Others are LNP Manager, Co-management Team Leader, Tea-Estate Manager, Eco-guide, Academicians, Researchers, Bio-network specialist, Conservation Educationists, Policy-maker, Environmental Lawyers and Judges.

Table 8. Invasive Alien Plant Species at Lawachara National Park

Scientific Name	Invasiveness	Impacts	Distribution Potentials
Lantana camara	High	High	High
Clerodendrum viscosum	High	High	High
Cassia tora	High	medium	Medium
Mikania micrantha	High	High	Medium
Sida cordifolia	High	Low	Medium
Eupatorium odoratum	High	Medium	Low
Leucaena leucocephala Lamb de wit	High	Low	Low
Acacia auricoliformis Cunn Ex Benth	High	High	Medium
Acacia mangium Wild	High	High	Medium
Eucalyptus camaldulensis Dehnh	High	High	Low

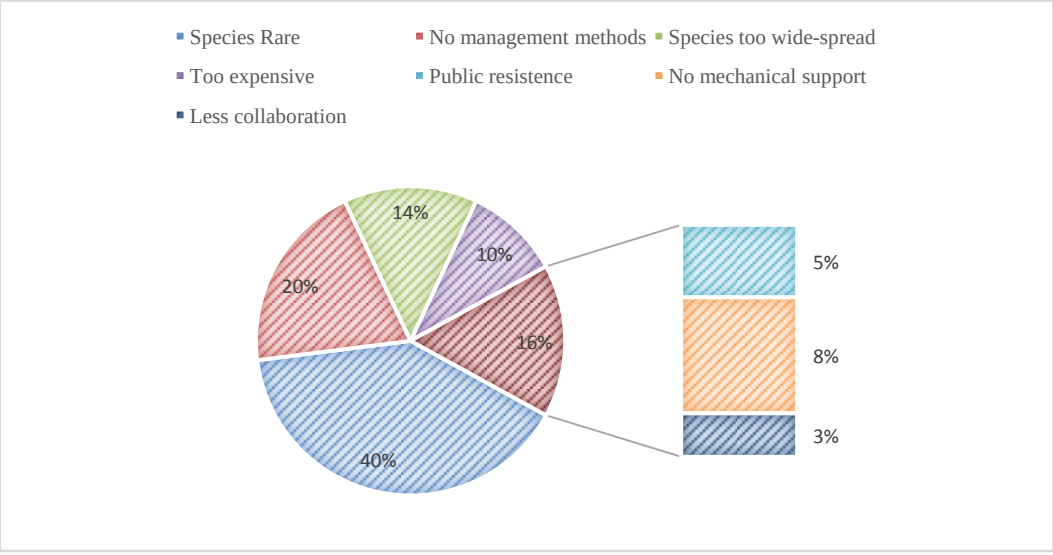

Figure 5. Reflection on Invasive Alien Species removal from Lawachara National Park

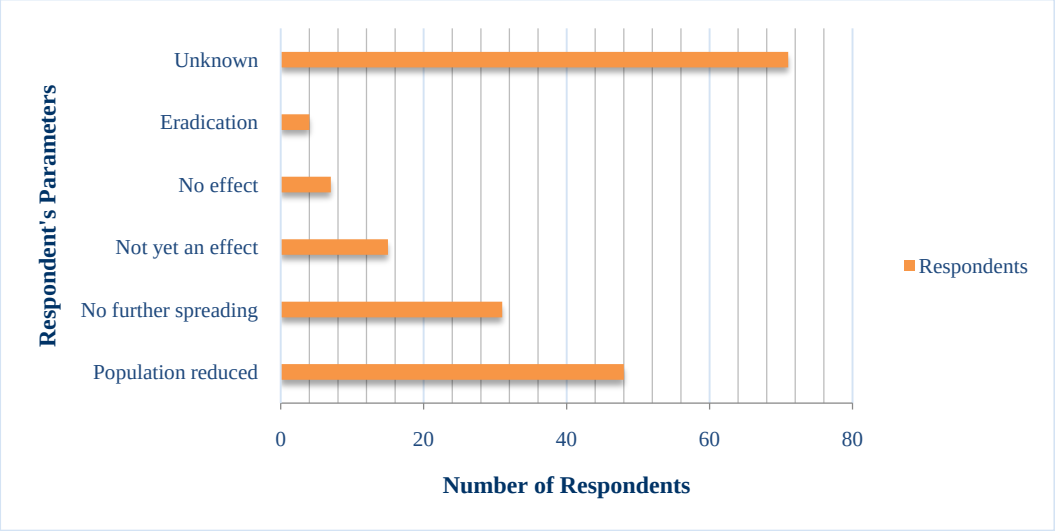

Figure 6. Effective different parameters regarding control of Invasive Alien Species

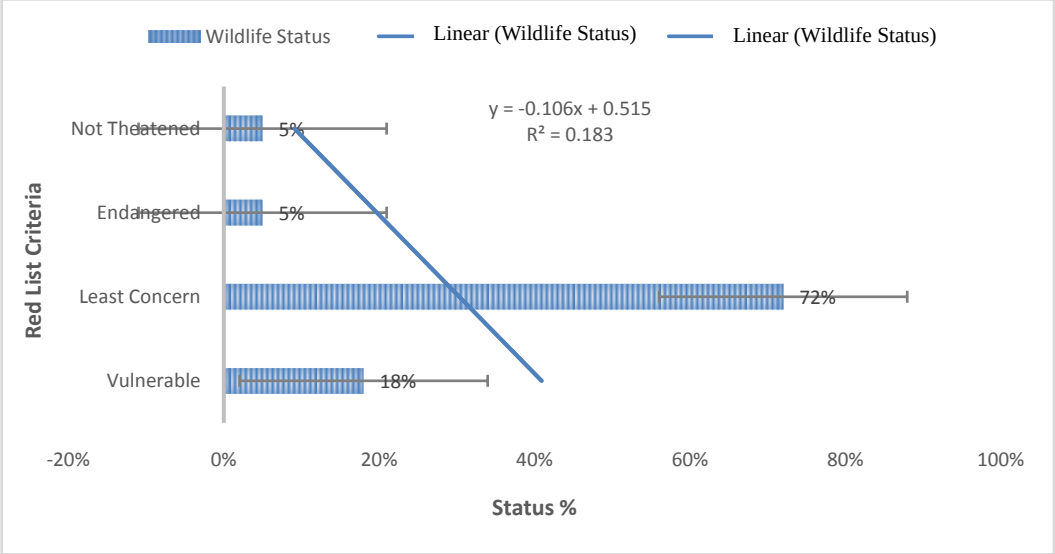

Figure 7. Wildlife Criteria of Lawachara National Park

From the field observation, the present status of controlling of IAS stated, which showed in Table 9.

Table 9. Present status for controlling of IAS on behalf of BD Government

Invasive Alien Species (IAS) related parameters/questions	Measuring scale
In Bangladesh, controlling measure of IAS from National Park?	Low
In Bangladesh, IAS identified at National Park?	No
Does national policies develop for IAS?	No
Does Risk Assessment measure for IAS?	No
Does undertaken the prevention against IAS?	No
Does continue development project of IAS?	Little/No
Does include the issue of IAS in revised NBSAP?	No appropriately

Effective parameters for control of IAS illustrated with respondents' opinion in Figure 6 including eradication status and relevant parameters. Invasive Alien Species are aggressively a mediator of change and threaten native biodiversity in Bangladesh (Afrin *et al*., 2010). The authority of Bangladesh Forest Department took initiative regarding to control of invasive alien species. According to Section 14, prohibitions related to National Parks in sub-section 1(m) that no person shall introduce any alien and invasive species in a National Park. The section 35 of the Wildlife Conservation and Security Act-2012 stated on penalties for contravention of the provisions of section 14 (WCS, 2012).

3.7. Wildlife Critical Condition of Lawachara National Park

From the field observation, sheltered wildlife status of Lawachara National Park (LNP) is captured by threats. These Threats to wildlife and their habitations are multifarious and pervasive in the Lawachara National Park. According to IUCN (2017) these are 39 mammalian wildlife consisted in LNP, out of them, almost 23% of the known species are threatened, 18% are vulnerable as well as 5%

endangered, which as shown in Figure 7. The study showed the status of vulnerable and endangered of wildlife conservation in the LNP with risk assessment. Some wildlife of LNP were killed by Railway and vehicles during movement the road / route (SOD, 2016).

These death wild animals are: Fox, Fishing cat, wild cat, monkey, deer, frog and snakes. These are often run over and killed by vehicles on the road. The study suggested for update wildlife conservation policy formulation in connection with national and global stakeholders' opinions on the priority of Aichi Targets.

Table 10. Severity of road and route impacts on wildlife at LNP

Parameters	More Severe	Severe	Less severe	No comment
Road and Route Mortality	55%	37%	5%	3%
Habitat loss	45%	35%	15%	5%
Habitat disturbance	30%	33%	22%	15%
Habitat fragmentation	42%	35%	21%	2%

Lawachara National Park (LNP) Service Management is challenged to stability tourists and researchers' access with the environmental, social and ecosystem service consequences of motor vehicle use and running railway. Wildlife populations in LNP are in danger to road and route collision. The study of the survey identifies the existing circumstances and wildlife-vehicles conflicts. The accessible transportation systems at LNP were professed to be beyond capacity, with passageway volumes presently high or very high traffic anticipated escalating in the majority means of entrance. LNP unit used some form of mitigation method to reduce the impacts on wildlife. Approximately 55% of the respondents indicated the impacts would merely exacerbate in the next ten years (Table 10).

3.8. Status on Afforestation, Forestation and Reforestation

From the field observation, deforestations increase in the Lawachara National Park. Bangladesh Government takes initiatives for afforestation and reforestation program according to forest policy 1994. Most of respondents' expressed their opinion for these programs on the priority of Aichi Biodiversity Targets 2020, as shown in Figure 8. The study found observed that about 12% of the respondents were informed on afforestation (series 1).

The study found observed that about 12% of the respondents were informed on afforestation (series 1), while reforestation 7% (series 2), forestation 31% (series 3) and deforestation 45% (series 4). The study suggests that afforestation and reforestation programmes augment the dense diversity with selected plant species towards national parks, which mentioned earlier in Forest Policy 1994. The study also advocated that afforestation and reforestation programmes need to augment with multi-species plantation through inspection for and monitoring of unlawful clear-cutting and further conservation events.

3.9. Degree of Threats to National Parks

Protected areas consists of national parks, wildlife sanctuaries, nature reserves and relevant other areas. The total number of protected area records in the December 2016 release of the World Database on Protected Areas (WDPA) is 232,128 comprising of 213,328 polygons and 18,800 points (UNEP-WCMC, 2016).

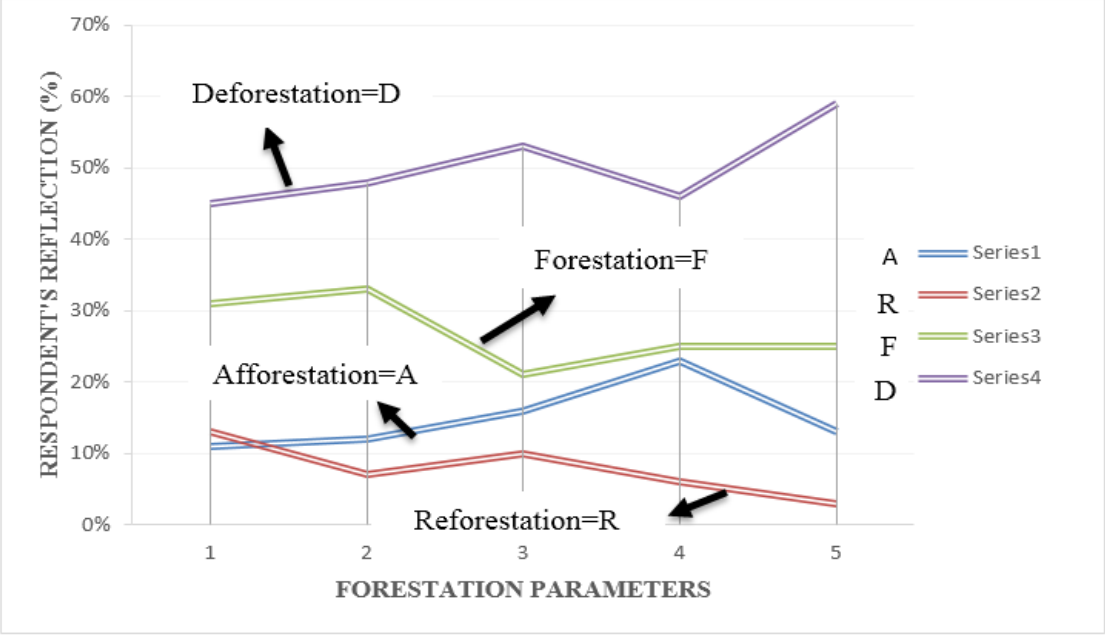

Figure 8. Respondents' opinion on Afforestation, Reforestation and Deforestation

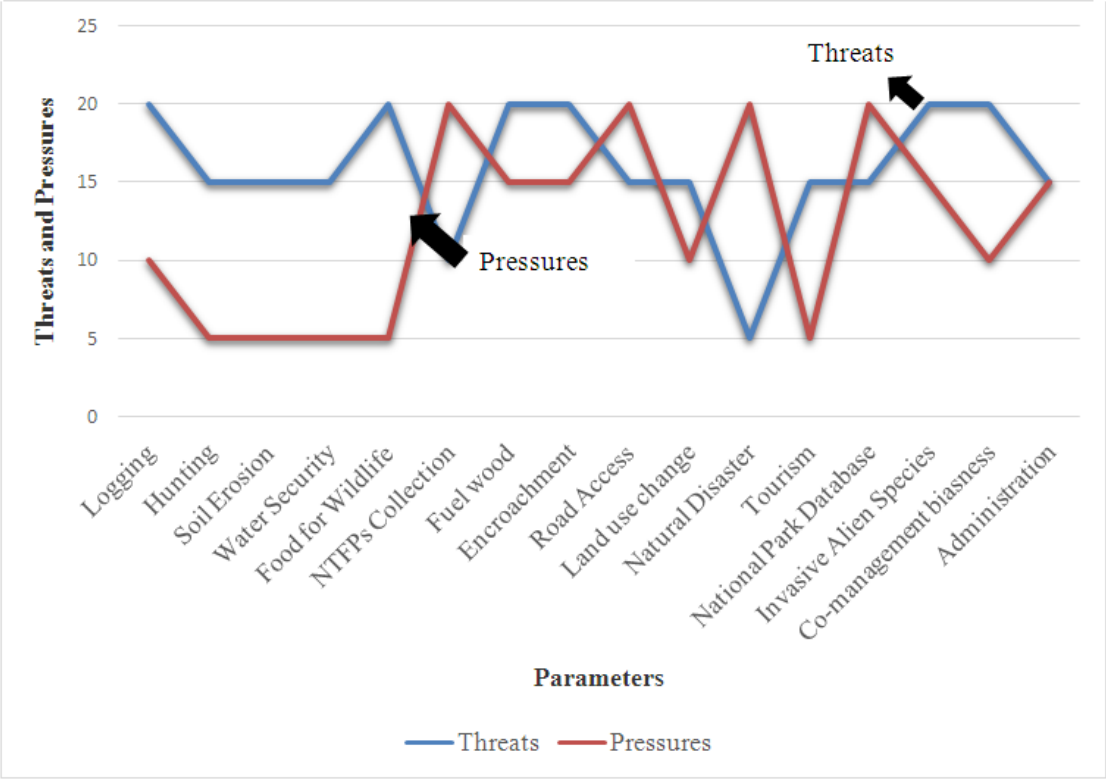

Figure 9. Degree of Pressures and threats on Lawachara National Park

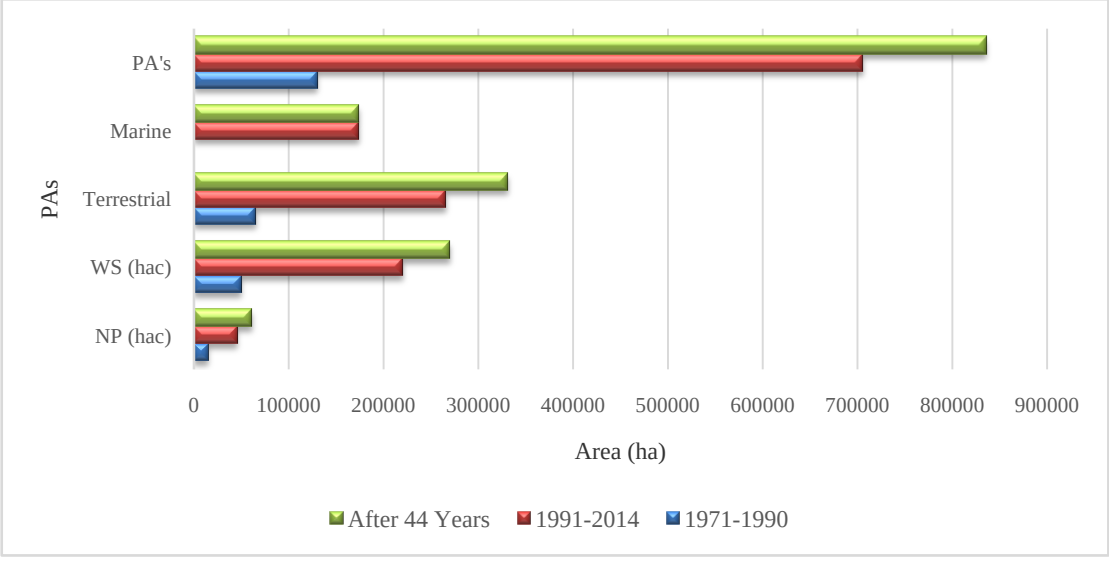

Figure 10. A comparative analysis on different types of protected areas in Bangladesh

Degree of pressures and threats increase day by day on Lawachara National Park (IPAC, 2012), as shown in Figure 9, with compared different parameters towards protected areas in Bangladesh, such as, hunting, illegal logging, access road use inside the park with road transport and railway route.

3.10. Analysis on National Parks and Wildlife Sanctuaries

Bangladesh (BD) was independent in 1971. From 1971 to 2014, government of Bangladesh declared seventeen national parks for conserving of biological diversity, as shown in Figure 10. After 44 years, the BD has 835952 ha protected areas including 60932.33 ha National Parks and 270143.82 ha wildlife sanctuaries. The study suggested that new national parks need to declare through the government of State Party according to ABT 2020 of CBD.

3.11. Biodiversity-Related National Legislation Scoring

The legislation scoring categories and their grading definitions constructed based on discussions with biodiversity and legal experts including both professionals

and academicians in Bangladesh context, as shown in Figure 11. The graph observed maximum weight (%) in Lawachara National Park (LNP) and minimum in Khadimnagar National Park (KNP), where compare with linear, and polynomial trend line for dissemination of present status on legislation scoring. The score of National Park increased gradually. The findings suggest that the Government of Bangladesh targets of fully implementing the biodiversity related policies/laws/ legislations till to date remains substantially unattained. From the study, biodiversity related law, policy, and administrative order etc. produced more or less in several years, but no legislation produced from the period of 1980 to 1989 in Bangladesh.

The result suggests that the existing legislations need to modify for sustainable development of national biodiversity in connection with regional and global perspectives, particularly CBD' requirements.

3.12. Existing Law and Policies Related to Biodiversity Conservation

Existing legislations related to biodiversity conservation, as shown in Table 11, with relevant parameters. The study relates to biodiversity conservation with different articles at the Constitution of Convention on Biological Diversity, such as in-situ, national policy, strategic plan and relevant technology. Every state party develops National Park, national biodiversity related policy and strategic plan through national biodiversity database and clearing house mechanism according to CBD requirements. These requirements enhanced to legislation analysis for conservation of biodiversity towards National Parks in Bangladesh on the priority of regulation, control alien species, regular monitoring through effective research and training, environmental education awareness and sustainable use.

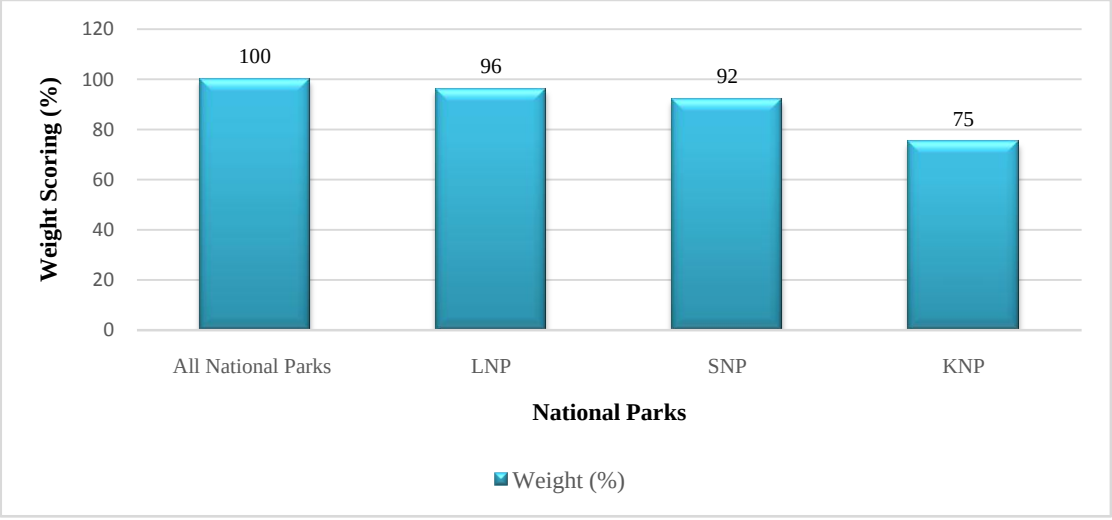

Figure 11. Biodiversity conservation related existing national legislations scoring

Table 11. Policy related characteristics of State Party's National Parks

Parameters	Characteristics	CBD
In-situ	National Park system for special measures need.	Article 8 of the Convention
Strategic Plan	National strategic plans and programmes for conservation.	Article 6 (a)
National policy	Development and implementation of national policies for promoting.	Article 18
Technology	State Parties technologies enhance access for transfer and sustainable use of biodiversity.	Article 16 of the Convention
Exchange of Information	The exchange of information facilitated to the conservation.	Article 17
Control Alien Species	Preventing measure of Invasive Alien Species, which threaten to ecosystems.	Article 8(h)
Resources utlisation	Regulating natural assets confirm their protection and justifiable practice.	Article 8 of the Convention
Traditional knowledge	National legislations enhance the traditional knowledge for biodiversity conservation.	Article 8 (j) of the Convention
Monitoring	Monitoring with sampling techniques enhance biodiversity protection.	Article 7 (b) of the Convention
Incentives	Biodiversity conservation measures encentives with economically and socially sound.	Article 11
Research and Training	Technical education and training established biodiversity conservation.	Article 12 of the Convention
Education and Awareness	Global education and public awareness programmes for collaboration and conservation.	Article 13 of the Convention

Table 12. Laws and policies to protect biodiversity towards National Park areas in Bangladesh

Law/Policy	Year	Perspectives
The National Constitution	2011	Article 18A, 102, 152
The Bangladesh Biodiversity Act, 2017	2017	Chapter 3,4,6,8 and 9.
The Wildlife (Conservation and Security) Act	2012	Section 2(15, 43), 11, 12, 13, 14, 15, 16, 17, 18, 21, 22, 23, 24, 27, 28, 29, 30, 34, and 42.
Bangladesh Environmental Conservation Act 2010 (amendment)	2010	Section 5, 6, 7, 12, and 15
Bangladesh Forest Act (amended)	2000	Section 28, 29, 30, 32, 33, 41, 42, 43, 52, 53, 54, 55, 56, 63, 64, 65, 66, 67, 68
Environmental Policy	1992	Section 5
National Forest Policy	1994	Section 1.1 (a, b, c, and d)
Environmental Court Act	2010	Section 4, 9, 11, 14, 15, 18, 19, 20, 21, and 22
National Biodiversity Strategic Action Plan	2016	Chapter 1, 2, 3, 4, 5, 6, 7, 8.
Compensation Policy for Casualties caused by Wildlife	2010	Section 5, 6, and 7.
Saw-Mill (License) Rule	2012	Section 7, 8, and 9
Forest Products Transit (Control) Rule	2011	Section 3, 4, and 5
Social Forestry Rule (amendment)	2011	Section 4, 5, and 6
Brick Prepared and Kiln Establishment (Control) Act	2013	Section 5, 6, and 8.
The Prime Minister Award Giving Rules 2013 on Plantation	2013	Section A, B, C and D
ICT Act 2013	2013	Section 54, 55, 56, 57
ICT Policy	2009	Section D (9), E (4, 9)
Ecologically Critical Areas Rules	2016	Section 3, 18, 19, 20, 22, 26, 27, 28.
Tea Act 2016	2016	Section 7, 17, 29
National education Policy 2010	2010	Chapter 11, 12, 14, and 15
Water Act 2013	2013	Section 3, 4, 8, 15, 17, 18, and 29.
Protected Area Management Rules 2017	2017	Section 2, 4, 15, 18, 19, 20,21, 24, 29
Plant Quarantine Act 2011	2011	Section 6, 7, 26, 31
The Bangladesh Public Private Partnership Act 2015	2015	Chapter 2, 4,5,6

The conserving parameters of biodiversity laws and policies indicates on the following, such as: (i) *In-situ*, (ii) Strategic Plan, (iii) National policy, (iv) Technology for Clearing House Mechanism, (v) Exchange of Information, (vi) Control measures of Invasive Alien Species, (vii) Resources utilization, (viii) Traditional knowledge, (ix) Monitoring, (x) Incentives, (xi) Research and training, and (xii) Education and awareness.

3.13. Legislation Relevance to Biodiversity Conservation in Bangladesh

New legislation relevance to biodiversity conservation initiatives requires human resources, institutional capacity, and funding for successful development and implementation to identify the people and organization with the interest and expertise to ensure progress on new legislation development related to biodiversity in Bangladesh (Table 12).

From Table 12, the study identified 26 tools for biodiversity conservation on national parks. These are: (i) Constitutional Rights, (ii) Forest, Wildlife and Biodiversity, (iii) Agroforestry, (iv) Industrial ecology, (v) Forest health and environment, (vi) Food energy, (vii) Water development and harvesting, (viii) Forest land, (ix) Fisheries and Livelihood, (x) Associated for wildlife, (xi) Terrestrial Environment, (xii) Transport and communication, (xiii) Green Banking, (xiv) Settlement and community, (xv) Sectoral policy integration, (xvi) Bio-culture and religious, (xvii) Population/ stakeholder, (xviii) Collaborative Management, (xix) Removal of Invasive Alien Species (IAS), (xx) Education and public awareness, (xxi) Dynamic administration, (xxii) Science and Technology, (xxiii) Research and innovation, (xxiv) National, regional and global commitment/agreement, (xxv) Public-private partnership, and (xxvi) Protected Areas Management rules (PAMR, 2017), for example- Lawachara National Park Management Rules. From the study, National Constitution, Wildlife Conservation and Security Act, Forest Act and Policy, Environmental Conservation Act and Policy, ICT Act and related policies, biological diversity Strategic Conservation Plan, Compensation Policy on behalf of Casualties caused by Wildlife, Environmental Court Act, and Brick Burning (Control) Act are the major instruments for conservation of biodiversity at National Parks.

3.14. Produced Quantity of National Legislations

National legislation develops for enhancement of national biodiversity towards National Parks. Biodiversity related national legislation produced maximum within the period of

2010-2016, as shown in Figure 12. The study found that most of legislations related to biodiversity conservation formed after COP-10, in this period, CBD provided circulations to the state parties for update the national legislation for conserving of biological diversity. The Government of Bangladesh produced the Biodiversity Conservation and Security Act 2012 within this period. The study suggested that the government takes initiatives for separate law and policy for national biodiversity conservation towards national parks in Bangladesh.

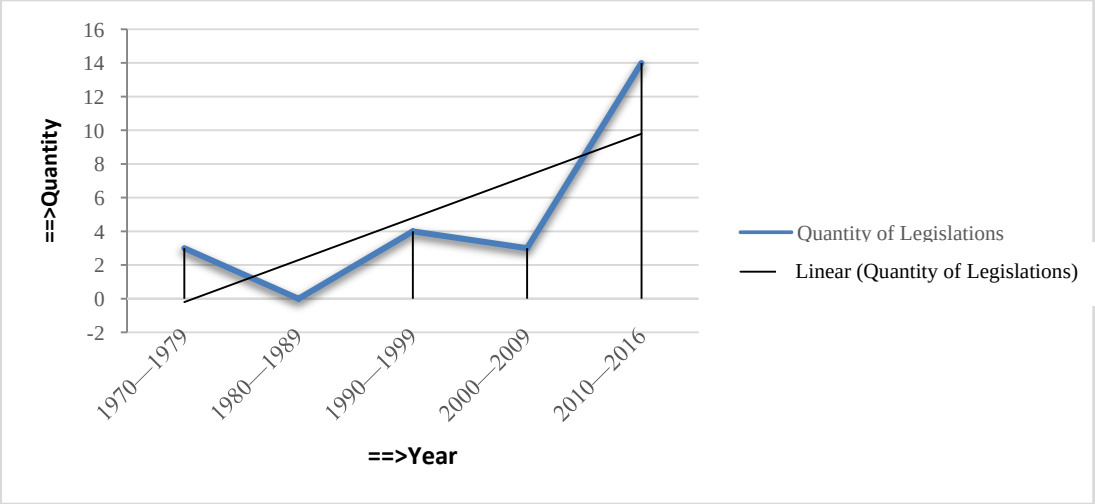

Figure 12. Produced number of biodiversity related legislation in Bangladesh

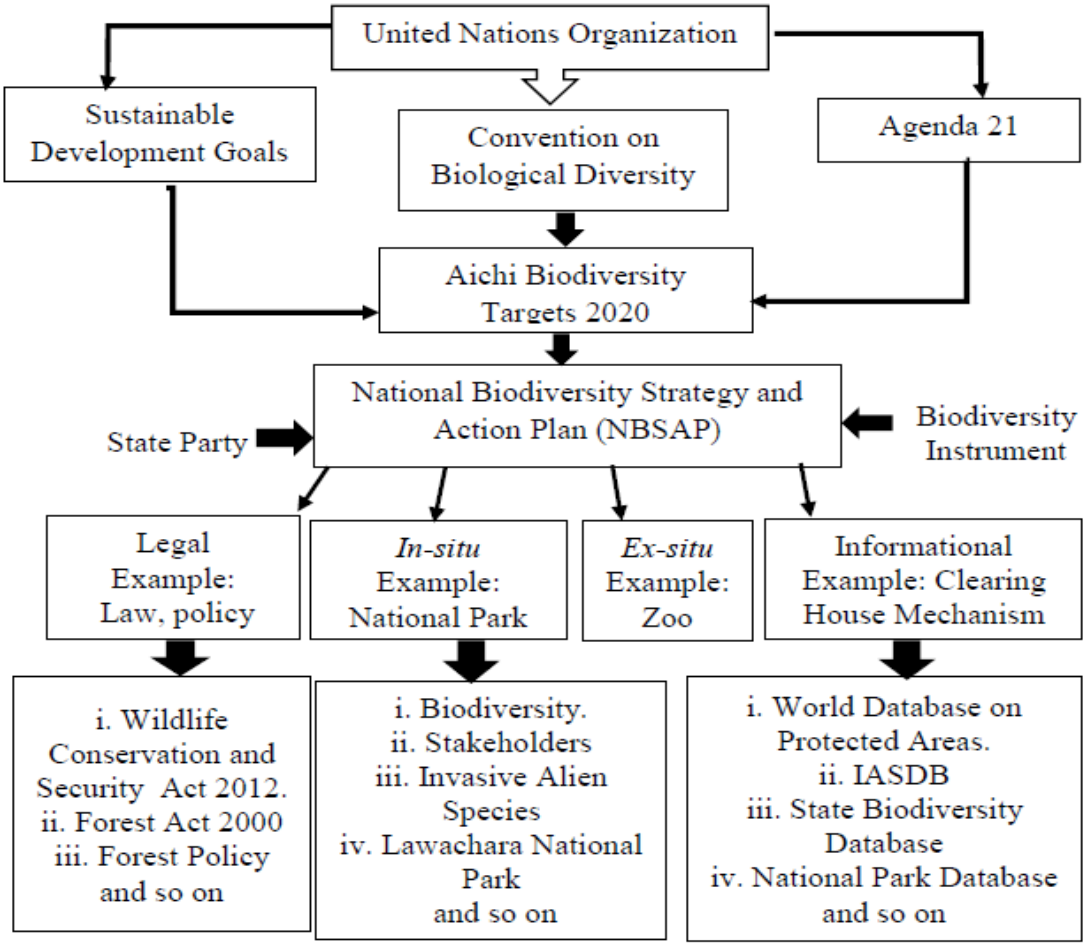

Figure 13. Evolution of Biodiversity Policy Instruments (CBD Secretariat, 2010; Miah, 2018)

3.15. Tourist Attraction

One of the tourist attractions is the National Park. Every day many tourists from local and distant parts of the country visit this place of natural beauty. This number increases several times during festivals. The national park is built around the nature surrounded by plants, animals and birds. But misuse of wireless sensor technology has spoiled the beauty of national parks. The condition of the footpath has broken down and communication has been cut off. Other facilities are also not modern, resulting in loss of biodiversity, digitally wildlife killing, wildfire, man-made heatwave and flash flood (Miah et al., 2016, 2017, 2018, 2019, 2020, 2021, 2022). There has been no planned development in this park for nearly a decade. National parks are losing attraction to many tourists, local and national economic conditions are in crisis. Illegal reliance on forest resources to alleviate this crisis. As a result, the biodiversity of the national park is being destroyed day by day (Miah et al., 2020, 2021, 2022, 2023). Unfortunately, most of the wildlife species are threatened or endangered by humans (Afzal et al., 2022). This requires adequate integrated policies for alternative income generating economic support and biodiversity conservation.

3.16. Evolution of Conservation Policy Instruments

The study showed that United Nations (UN) is the main initiator for global biodiversity conservation. For this purpose, the UNO developed Agenda 21 (UN, 2003) and then organized the Convention on Biological Diversity (CBD) through Earth Summit in 1992. Now the CBD contains 198 state party and agency. The CBD developed Aichi Biodiversity Targets (ABT) 2020 with conservation instruments towards protected areas management of each ratified State Party, which as shown in Figure 13.

The National Biodiversity Strategic Plan is a conservation instrument, mentioned in the Aichi Biodiversity Targets (ABT) which every state party should develop this instrument as a national biodiversity conservation instrument in connection with national parks.

3.17. Innovative Policy

Innovation policy is a continuous process that can lead to the use/abuse of new ideas, new research results or new technologies or administrative procedures and new systems. Innovation consists of a cycle of several steps, namely: generating new ideas, selecting ideas, implementing said ideas, designing new problems, maintaining methods, and promoting new methods to users and verifying feedback. Advanced wireless sensor technology is an innovative concept and everyone is reaping the benefits. But its abuse is also increasing day by day, the effect of which is destroying the current biodiversity, such as climate change, heat wave, flash flood, wildfire, artificial earthquake and landslide etc. Innovative policies are needed to protect forests from these destructive technological effects, otherwise nothing in the world is safe due to misuse of these technologies.

4. Conclusions

In conclusion, Biodiversity loss, deforestation, forest degradation, wildfire, climate crisis and misuse of technology in the environment are the most compelling environmental problems that require immediate curable action through innovative policy adoption. Misuse of advanced wireless sensor technology is putting undue pressure on the world's forest resources. In the absence of adequate policies, these pressures are increasing geometrically, resulting in wildfires, heatwaves, landslides, flash floods and digital killing spiraling unimaginably out of control. Forest policies guide the actions taken in forest management. Policies arise from real or perceived problems.

5. Declaration

Data Availability

The data being used to support the findings of this research work are available from the corresponding author upon request.

Competing Interests

The authors declare no potential conflict of interests in this research work.

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