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Assessing the Sustainability Performance, the Food-Processing Industry through Causal Loop: A Mauritian Case Study

By Yuktishaan Sharma Sumessur & Devkumar S Callychurn

University of Mauritius

Abstract- Sustainability has emerged as one of the megatrends in the food processing industries prevails as one of the most important items on the agenda of many companies. The major sustainability domains: environmental, social and economic aspects are topics that companies are called to focus on nowadays for achieving success. These include, utilisation of resources such as water, energy, working conditions, safety at work, and investments, among others. This research work aims at assessing the sustainability performance of food processing organisations and propose sustainable practices with a focus on environmental, social and economic. The interactions of the sustainable practices from the causal loop diagrams have shown the importance of recycling and reusing of solid wastes, water treatment, investment in renewable energy and continuous improvement of practices and policies through audits.

Keywords: sustainability, sustainability indicators, food processing industries, causal loop diagrams.

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ASSESSINGTHE SUSTAINABILITYPERFORMANCE OF THE FOOD PROCESSING INDUSTRY THROUGH CAUSAL LOOP: A MAURITIAN CASE STUDY

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Assessing the Sustainability Performance, the Food-Processing Industry through Causal Loop: A Mauritian Case Study

Yuktishaan Sharma Sumessur^α & Devkumar S Callychurn^α

Abstract- Sustainability has emerged as one of the megatrends in the food processing industries prevails as one of the most important items on the agenda of many companies. The major sustainability domains: environmental, social and economic aspects are topics that companies are called to focus on nowadays for achieving success. These include, utilisation of resources such as water, energy, working conditions, safety at work, and investments, among others. This research work aims at assessing the sustainability performance of food processing organisations and propose sustainable practices with a focus on environmental, social and economic. The interactions of the sustainable practices from the causal loop diagrams have shown the importance of recycling and reusing of solid wastes, water treatment, investment in renewable energy and continuous improvement of practices and policies through audits. Sustainable consumption and production campaigns through sustainability initiatives is very effective to reduce production intensity, thus, the use of resources.

Keywords: sustainability, sustainability indicators, food processing industries, causal loop diagrams.

1. INTRODUCTION

Over the years, more and more emphasis is being given to environmental issues which have evolved from pollution and the depletion of natural resources towards global issues such as climate change. The most crucial milestones have so far been the identifications of chlorinated pesticides as major pollutants in 'Silent spring' (Carson, 1962), the notion that non-renewable natural resources can become depleted (Meadows, 1962), the introduction of the sustainability concept in the 'Bruntland report' (World Commission on Environment and Development, 1987) and the Marrakech Climate Change Conference (UN, 2016), among other initiatives by world leaders. The last conference was identified as the next crucial step for governments looming at ope the Worldwide population has grown to more than 7 billion today, from about 5 billion people in 1990's and it is estimated that the population will hike more than 9 billion by 2050 (OECD, 2016). Global CO₂ emissions accounts about 3.6 billion tonnes in 2014 which contributes to global warming (PBL, 2015) thus causing environmental

degradation such as climate change, ocean acidification, loss of biodiversity, scarcity of fresh water, ozone depletion amongst others. If the current trend of human activities continues, the planet would not be able to support the continuously growing world population. In addition, human population and economic growth have amplified demand on natural resources, which is becoming scarce. It is obvious that business as usual is not adequate as the world is presently consuming the equivalent of 1.5 planets to back human activities (WWF, 2014). Therefore, at this unsustainable rate, it would require the equivalent of two planets by 2050 (Randers, 2012).

The international agreements impose strict environmental regulations on the human activities in order to push industries to find ways to mitigate greenhouse gas emissions, utilise raw materials efficiently and move towards renewable energies. The rapid development in telecommunication technologies invigorated global sensitisation about the upcoming global crisis, thus, encouraging the mass for demanding green product and services. Therefore, there needs to be a radical change in the ways most industries operate in order to meet demand, abide by regulations and even have a competitive edge amongst competitors. Therefore, eco-efficiency, that is, the practice of lean, cleaner production and eco-design is becoming a major trend in industries. Under these circumstances, it is highly important to develop new business concepts whereby value creation from waste through recycling or reuse forms part of the new wave. The new practices will consume less raw materials, be less dependent on fossils, use more renewable energies, be more eco friendly, also economically and socially equitable. The emergence of the increasing middle class population in the coming years will prove to be detrimental to the current production and consumption pattern, thus, emphasis must be laid on sustainable practices by industries to cope with the upcoming challenges. Svensson (2007) posits that the expectations on adopting and improving sustainability practice were constantly increasing and that both public and private institutions would impose such practices on different business sectors.

One of the sectors where significant questions were raised about sustainability practices was the

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agricultural food industry. There is no doubt that ten years after this acclamation, stakeholders of the industry have worked towards this endeavour, by incorporating social and environmental measures in addition to economic ones. But how far has this initiative been successful, even more so for a country like Mauritius, where the food industry is one of the economic pillars. This research aims to bring answers by assessing the sustainability performance of food processing industries in Mauritius and propose sustainable practices for food processing industries. In addition, the interactions and relationships between the important parameters of the sustainability dimensions, through system dynamics modelling are also probed.

II. LITERATURE REVIEW

a) What Is Sustainability?

Sustainability has become an important issue in all spheres of life. This will be the case for many years to come, or at least until an as yet unknown solution is developed. Sustainability is and will be very crucial for the present generations. How do we define Sustainability? Sustainability remains an elusive concept. It means different things to different people and is difficult to define. Elkington (1998) developed the concept of Triple Bottom Line, which simultaneously considers and balances economic, environmental and social issues from a micro economic point of view. The triple bottom line suggests that firms not only need to engage in socially and environmentally responsible behavior, but also that positive gains can be made in the process (Gimenez et al., 2012).

Sustainability is a widely accepted idea with little guidance about its practical implementation. Semantically, sustainability is a quality that allows preserving, keeping, or maintaining something. In fact, when something is sustainable, it is able to endure or to be kept. It is a common mistake made by many people who believe that the term sustainability is more oriented

towards the environment. Sustainability focuses on safeguarding natural resources against exploitation, in the name of productivity and competitiveness in the industrial world. It is a major concern in many countries and is leading to strict regulations regarding the impact of products during their manufacture, use and end of life (Gunasekaran & Spalanzani, 2012).

This is indicative of the attitude of businessmen towards sustainability at that time. For most of the business executives, even though they know how sustainability issues can affect business risk, reputation, sales and efficiency, they still believe money is their number one priority. In other words, as long as their customers are happy, they see no meaningful way how sustainability can help achieve and exceeds those ends. Since the 1980's, Sustainable Development - concerned with economic, social and environmental development- was considered to be very important and also contemplated as the goal of a desired new industrial revolution, involving advanced as well as new emerging countries (Jovane et al., 2008). Although some people mind-set towards Sustainable Development and the triple bottom line might have changed, there is still probably a big portion of the world's population that today are not bothered about this concept. Clearly many people still have a long way to go in grasping the value of this illusive concept to their organisations and their day to day lives. Hence there is a need to come up with a proper definition of the term Sustainable Development so that the frame of mind of those not yet convinced and still thinking that the term is just a fad, can be shuffled.

Over the years, researchers in the field of sustainability and sustainable development have come up with various connotations to the term as shown in Table 1 below. However each of the definitions of sustainability referred in the table are debatable and can be seen to have often been contextualized, based on the situation where it was used.

Table 1: Some Selected Definition of Sustainable Development from Existing Literature 2.2 Systems Thinking

Author(s)	Sustainability Definitions and Sustainable Development
Bruntland G.H (1987)	The development that meets the needs of the present, without compromising the ability of the future generations to meet their own needs.
U.S. National Research Council (1999)	<i>"The level of human consumption and activity, which can continue into the foreseeable future, so that the system that provides goods and services to the humans persists indefinitely."</i>
Diesendorf (2000)	The goal of sustainable development and this is described as "types of economic and social development that protect and enhance the natural environment and social equity"
Hanley et al. (2001)	A requirement to our generation to manage the resourcebase such that the average quality of life we ensure ourselves can potentially be shared by all future generations.
McMicheal, et al., 2003	<i>"Transforming ways of living to maximize the chances that environmental and social conditions will indefinitely support human security, well-being and health."</i>

Ehrenfeld (2005)	Possibility that all forms of life will flourish forever.
Faber et al.(2005)	"Semantically, sustainability indicates a relationship between an (sustainable) artifact and its environment that exists indefinitely. In other words, sustainability refers to equilibrium between an artifact and its supporting environment, where they interact with each other without mutual detrimental effects. Sustainability explicitly refers to this equilibrium (p. 5)".
Labuschagne and Brent, 2005; MSA, 2008).	Sustainability aims to satisfy economic, environmental, and social goals.
Seliger et al.(2008)	Sustainability is directed at enhancing human living standards while improving the availability of natural resources and ecosystems for future generations.
Johnston (2007)	"It seems clear that sustainability can mean a number of things to a variety of constituencies and, while there may be no objection to the sentiments expressed in the respective definitions, they are far from holistic."
Duque Ciceri, et al.(2009)	A quality that permits to preserve, to keep, to maintain something: when something is sustainable, it is able to be kept.
Feng et al.(2010)	"Sustainability in development as " an organization's ability to advance its economic state without compromising he environment and the social equity that provide the quality of life for all community residents, present or future."
Do (2010)	"The development concept and approach that realize social justice, maintain natural environment, and pursue economic prosperity" with 3P People, Planet, and Profit) and 3E (Equity, Environment/Earth, and Economy).
Ahmed, Deif M.(2011)	"A concept and a paradigm that has its different implementation and interpretation at different fields."

Complex systems can be better understood with the use of Systems thinking, as acknowledged by Arnold & Wade (2015) who also believed that SD can be of great help in looking at the intricacy that the earth will be in front of in the near future. This methodology helps to provide a holistic view (Maani and Maharaj, 2004). Understanding that the elements of a system do not act in isolation, and that overall outcome would be the result of the various interactions among a system's elements, allows us to have a broader perspective of the problem and potentially find solutions that would benefit the system as a whole. Many researchers have come up with different definitions over the years, following the one coined by Barry Richmond, who is believed to be the originator of systems thinking, in 1987, and is defined as follows:

"As interdependency increases, we must learn to learn in a new way. It's not good enough simply to get smarter and smarter about our particular "piece of the rock." We must have a common language and framework for sharing our specialized knowledge, expertise and experience with "local experts" from other parts of the web. We need a systems Esperanto. Only then will we be equipped to act responsibly. In short, interdependency demands Systems Thinking. Without it, the evolutionary trajectory that we've been following since we emerged from the primordial soup will become increasingly less viable."

Since then, scholars have come up with different definitions of systems thinking – from Checkland (1981) to Arnold and Wade (2015).

III. METHODOLOGY

This research was conducted over two phases. First, through a thorough literature review of academic journal articles on sustainability related to system dynamics. Moreover, best practices of sustainability were also obtained from 14 food processing companies surveyed through a devised sustainability performance questionnaire. The Dow Jones Sustainability Index (DJSI) criteria were mainly used to develop the questionnaire.

For data to be collected effectively and efficiently, the design of the questionnaire was a very important task. Since, survey needed to be carried out in food processing companies and the top management representatives were highly busy, thus, having limited time for survey response. Therefore, the questions in the questionnaire were made short, concise and precise.

The second method was the use of causal loop diagrams to map out the interactions of the sustainability practices in real life situations. Therefore, the sustainability practices effects on the system as a whole can be seen and appropriate measures can be taken to cater for the outliers effects. The effects could

be of balancing or reinforcing loops, thus, tailored measures can be implemented with proper KPIs to monitor improvements.

Based on publications related to systems thinking and sustainability, a soft systems methodology, in particular, system dynamics appear to offer a possible way forward for achieving the aims of this research work. The different dimensions of sustainability in the food industry was modelled using the 'VENSIM' software.

IV. RESULTS AND DISCUSSIONS

The interactions among the three sustainable dimensions as shown in figure 1 enable to relate the

cause and effect that the sustainable practices pertain before and after implementation. The environmental, social and economic dimensions are not three separate entities while implementing sustainable practices, in fact, social factors could also affect environmental performance. For example, social issues such as long working hours or unsafe workplace would affect labour productivity. The workers will defect from good operations practices, which in turn would increase resource consumption. Following that the causal loop for each dimensions: Environmental, Social and Economic were worked out.

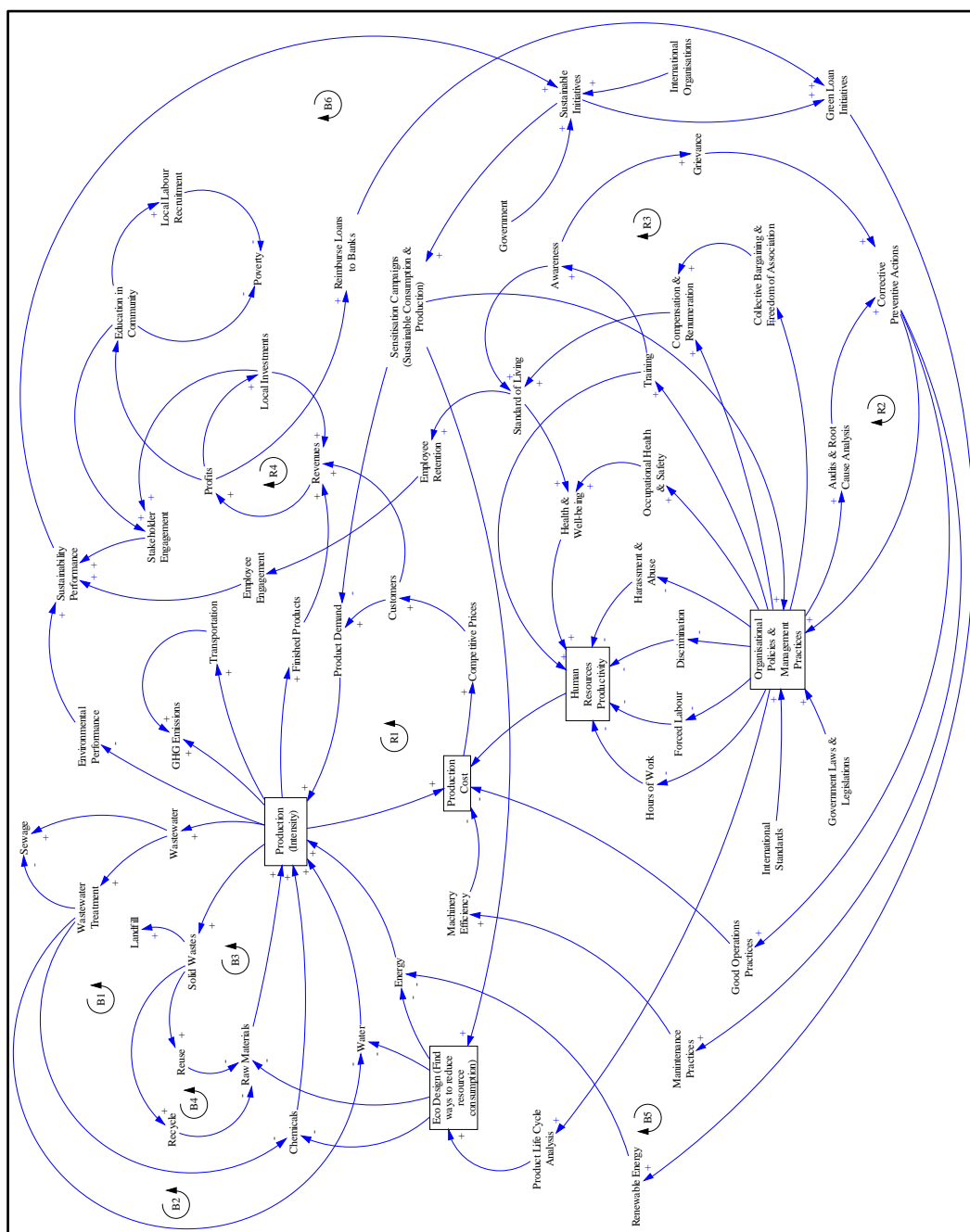


Figure 1: Sustainability CLD

a) *Environmental Dimension*

The causal loop diagram (CLD) for the sustainable environmental practices are shown in figure 2 on the following page. The model demonstrated the challenges faced by organisations in order to achieve a sustainable environmental performance.

The production of food products is intensified due to increase in product demand, which consequently, increase the inputs of raw materials, chemicals, water and energy denoted by plus (+) sign. Moreover, there is increase of outputs such as solid waste, wastewater, GHG emissions, finished products and transportation denoted by plus (+) sign.

However, more solid waste would increase dumping to landfill as well as wastewater to sewage. Wastewater treatment could reduce the amount of wastewater discharged as sewage. Thus, reduction in utility bills of organisations.

However, production intensity would causes production cost to increase and consequently, decreasing the environmental performance. Transportation also causes increase in GHG emissions. Production cost can be reduced by increasing machine efficiency, through good operations practices and human resources productivity.

Moreover, the practice of eco-design during product development enable to reduce consumption of raw materials, chemicals, water and energy. Sensitisation campaigns on sustainable consumption and production could increase development of green products. The use of renewable energy can also reduce dependence on fossils energy.

Additionally, maintenance practices increase the machinery efficiency in order to decrease the production cost. Revenues and profits of organisations are increased because of more customers and finished products. The decrease of production cost would increase the competitiveness of prices.

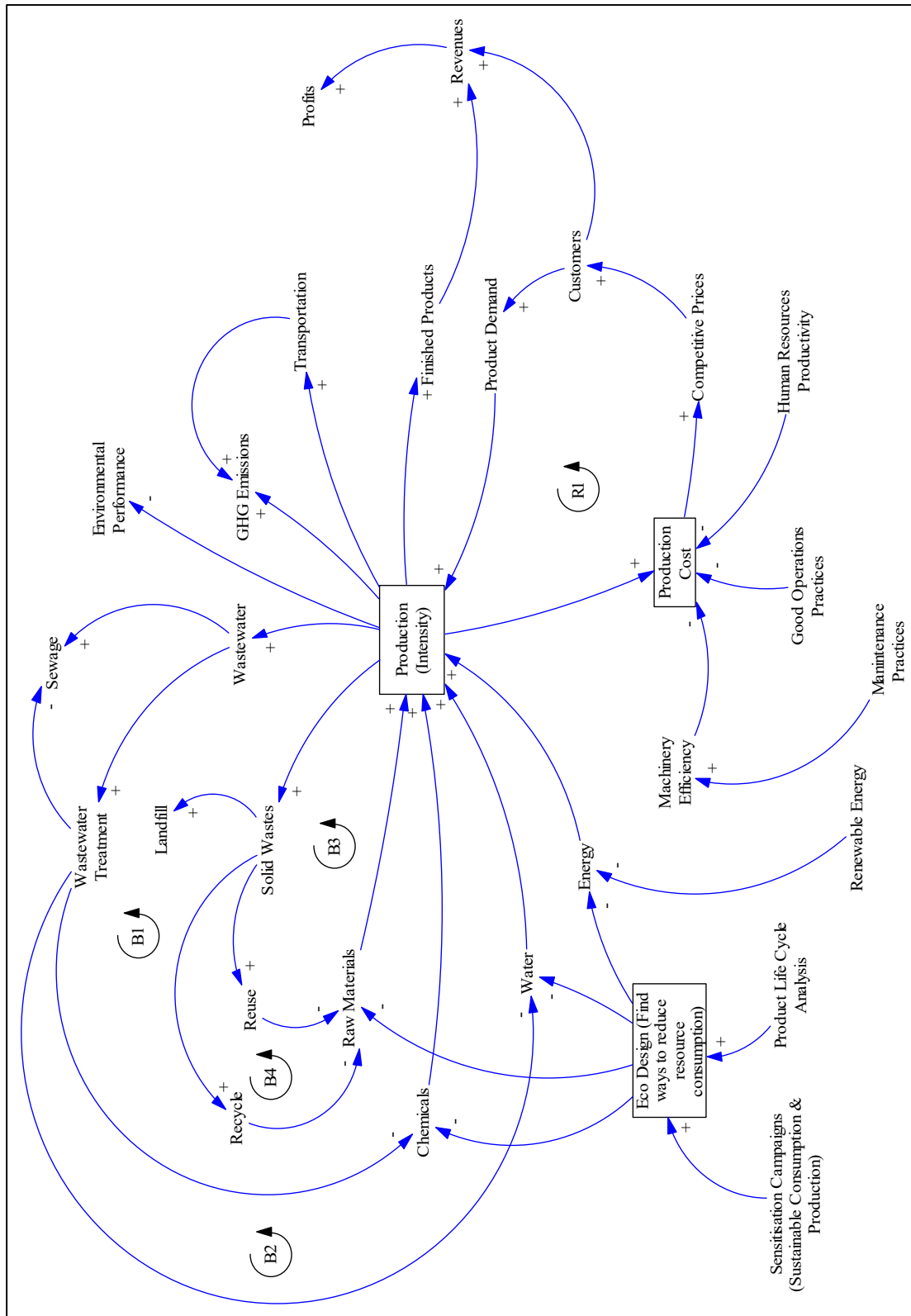


Figure 2: Causal Loop Diagram for Environmental Dimension

Furthermore, the environmental CLD consist of five loops, of which four demonstrating balancing (B) behaviour and one reinforcing (R) behaviour detailed in table 2 below.

Table 2: Environmental Dimensions Loops

Loops	Description of loops
B1	production intensity (+) → wastewater (+) → wastewater treatment (+) → chemicals (-) → production intensity
B2	production intensity (+) → wastewater (+) → wastewater treatment (+) → water (-) → production intensity
B3	production intensity (+) → solid waste (+) → reuse (+) → raw material (-) → production intensity
B4	production intensity (+) → solid waste (+) → recycle (+) → raw material (-) → production intensity
R1	production intensity (+) → production cost (+) → competitive prices (+) → customers (+) → product demand (+) → production intensity

The balancing loops B1 and B2 demonstrate that proper wastewater treatment can recover chemicals and water which can be reused as input, thus reducing water and chemical cost. Additionally, balancing loops B3 and B4 demonstrate that reuse and recycling practices of solid waste can reduce intake raw materials and decrease cost of production.

Likewise, reinforcing loop R1 demonstrate that competitive prices depends on production cost. Competitive prices increase customers which in turn increase product demand, thus, growing the product intensity.

However, reinforcing loop R1 has a rebound effect where competitive price would increase product demand, which would intensify production whereby more resources will be needed during production. Thus, affecting environmental performance and defeats the purpose of good operations practices, human resources productivity and machinery efficiency to decrease cost of production.

b) Social Dimension

The causal loop diagram (CLD) for the sustainable social practices are shown in figure 3 on

the following page. The model demonstrated the challenges faced by organisations in order to achieve a sustainable social and governance performance.

Organisational policies and practices are improved by enforcement of government laws and international standards. Long working hours, forced labour, discrimination, harassment and abuse in workplace is reduced which have negative effect on human resources productivity. Moreover, occupational health and safety cause increase health and well-being, which affects productivity positively.

Likewise, collective bargaining increase compensation, which cause improvement in standard of living, which also have a positive effect on well-being thus, improving productivity. Training increases both awareness which improves standard of living and productivity.

Health and well-being cause rise employee retention, which improve employee engagement. Sustainability performance is improved by both stakeholder engagement and employee engagement. However, the social CLD consist of two loops of reinforcing behaviour as shown in table 3 below.

Table 3: Social Dimensions Loops

Loops	Description of loops
R2	organisational policies (+) → training (+) → awareness (+) → grievance (+) → corrective preventive actions (+) → organisational policies
R3	organisational policies (+) → audits & root cause analysis (+) → corrective preventive actions (+) → organisational policies

Reinforcing loop R2 demonstrate that through policies, training can be delivered to employees which would increase their awareness. Thus, employees would participate in grievance where corrective or preventive actions will be taken upon investigation, also would

update and improve the organisational policies and practices.

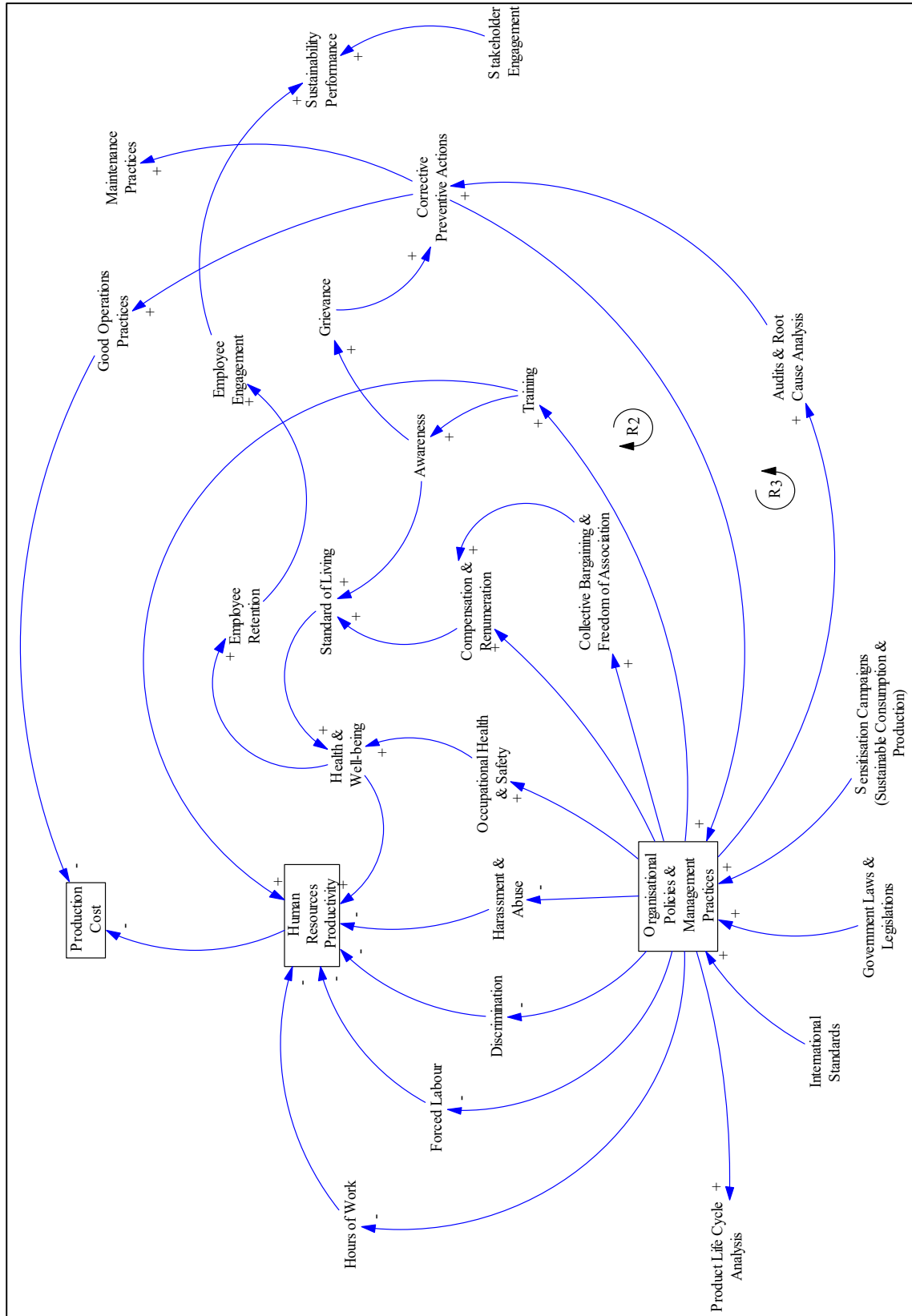


Figure 3: Causal Loop Diagram for Social Dimension

Besides, reinforcing loop R3 demonstrate almost same interaction as loop R1, instead audits and root cause analysis (RCA) would be frequent, thus, continuous improvement of management practices.

c) *Economic Dimension*

The causal loop diagram (CLD) for the sustainable social practices are shown in figure 4 on the following page. The model demonstrated the challenges faced by organisations in order to achieve a sustainable economic performance.

The increase in revenue would cause increase in profits which could be invested in education or sponsorship children of poor families for education and training. Thus, it would help to reduce poverty at the root

cause. Also, this would increase local labour employment over the long run.

Moreover, government initiatives and international initiatives have increased the sustainability opportunities for organisations. Sustainable performance is increased by employee engagement, stakeholder engagement and environmental performance.

Furthermore, the economic CLD consist of three loops, of which two demonstrating balancing (B) behaviour and one reinforcing (R) behaviour detailed in table 4 below.

Table 4: Economic Dimensions Loops

Loops	Description of loops
B5	production intensity (+) → production cost (+) → competitive price (+) → customers (+) → revenues (+) → profits (+) → reimburse loans (+) → greenloan initiatives (+) → renewable energy (-) → energy (+) → production intensity
B6	Sustainable initiative (+) → sensitisation campaigns (-) → product demand(+) → production intensity (-) → environmental performance (+) → sustainable performance (+) → sustainable initiatives
R4	revenues (+) → profits (+) → local investment (+) → revenues

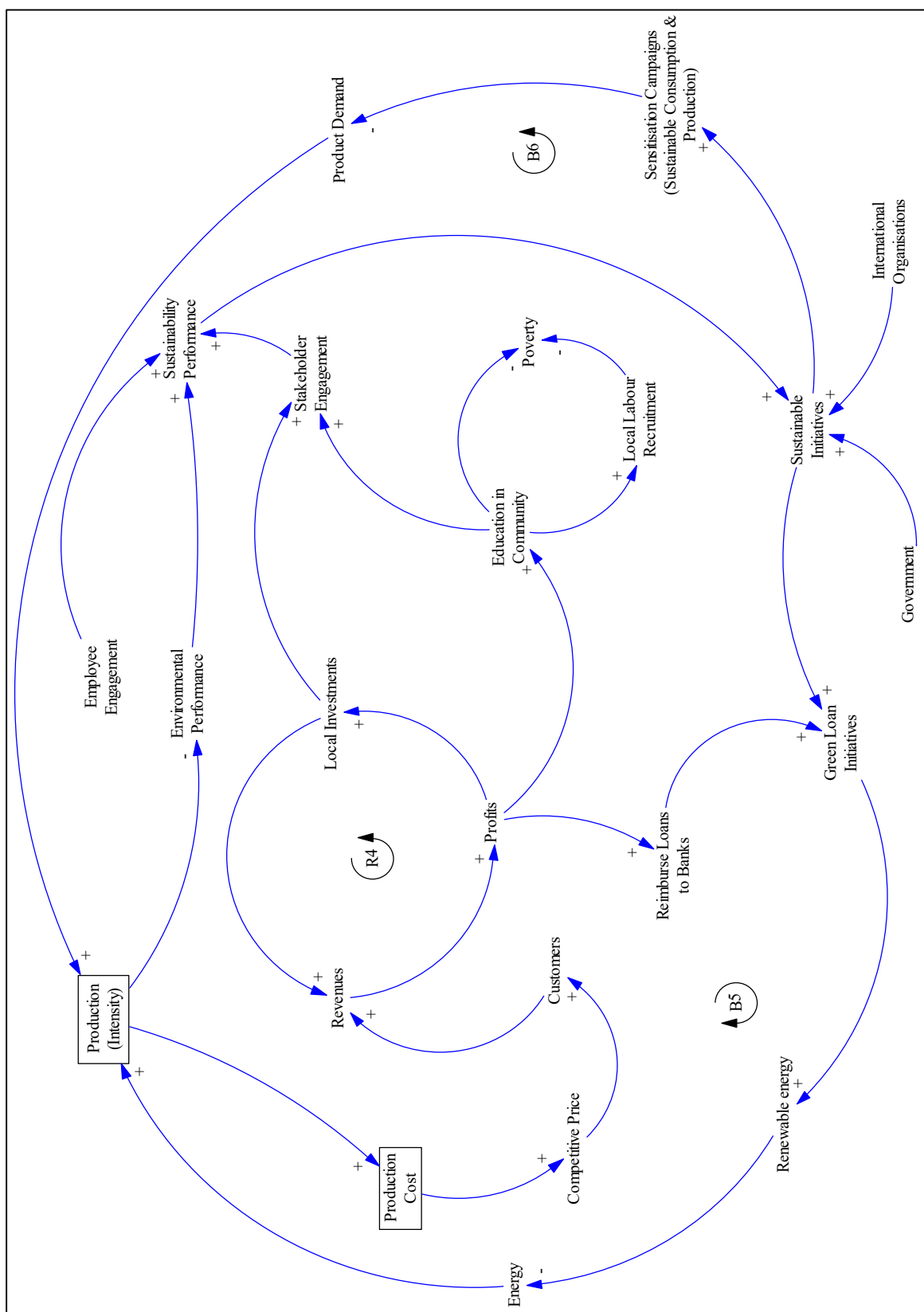


Figure 4: Causal Loop Diagram for Economic Dimension

Reinforcing loop R4 demonstrate that by investing the profits locally either by vertical or horizontal integration strategies could cause increase in revenues over the long run. Thus, investing locally can also encourage other business or employment opportunities which would support the Mauritian market and economy.

Besides, balancing loop B5 demonstrate that the profits obtained from the revenues can be used to reimburse loans to banks, which took part on the sustainability initiatives to provide green loan at low interest rates. The reimbursement of the loans would enable the banks to again fund loans and would enable more companies to seize the initiative to invest in renewable energy to decrease dependence on fossil

energy and decrease production cost over the long run.

Additionally, balancing loop B6 demonstrate that sensibilisations campaigns on sustainable consumption and production from the sustainable initiatives would decrease the product dem and which would also cause decrease in production intensity. Thus, enabling less resource use and consequently solve the rebound effect of reinforcing loop R1 in figure 6.2 of environmental CLD.

V. RECOMMENDATIONS AND CONCLUSIONS

The sustainable environmental targets and practices that need to be implemented are detailed in table 5.

Table 5: Environmental Targets and Practices

Target	Practices	Assessments
Improve management practices	<ul style="list-style-type: none"> Implement environmental, quality or food safety management systems 	<ul style="list-style-type: none"> ISO 14001 ISO 9001 HACCP
Reduce GHG emissions and improve air quality	<ul style="list-style-type: none"> Equip facilities with pollution prevention devices Monitor emissions 	<ul style="list-style-type: none"> Perform regular air test emissions
Reduce energy consumption	<ul style="list-style-type: none"> Optimise lighting systems with energy efficient technologies Install energy efficient cooling and heating systems Maintenance practices to optimise machine efficiency and detect steam or compressed air leakages Install heat recovery and condensate recycling for boilers Invest in VSD for compressor control 	<ul style="list-style-type: none"> Perform energy audit Document every maintenance practices for redundancy check ISO 50001
Reduce water consumption	<ul style="list-style-type: none"> Implement water conservation technologies Maintenance practices to detect water leakages 	<ul style="list-style-type: none"> Perform water audit
Reduce material consumption	<ul style="list-style-type: none"> Implement proper inventory management system 	<ul style="list-style-type: none"> Perform resource audit
	<ul style="list-style-type: none"> Substitute to recycled materials Implement lean production to reduce wastes 	
Hazardous chemical use	<ul style="list-style-type: none"> Maintain proper inventory of all chemicals Maintain up-to-date MSDS Proper disposal of hazardous waste 	<ul style="list-style-type: none"> Comply to OSHA Perform chemical hazard assessment
Reduce solid waste	<ul style="list-style-type: none"> Improves processes through lean Reuse possibilities Recycling program (outsource or internal) 	<ul style="list-style-type: none"> Perform waste audit

Reduce effluent	<ul style="list-style-type: none"> Wastewater treatment to recover water and chemicals Wastewater treatment prior to off-site discharge 	<ul style="list-style-type: none"> Perform wastewater audit
Increase employee awareness on environmental concern	<ul style="list-style-type: none"> Training in good operations practices, use of hazardous chemicals, water and energy use, air emissions, water and effluent management Environmental policies and practices should be communicated in appropriate languages 	<ul style="list-style-type: none"> Training needs analysis
Eco-product design	<ul style="list-style-type: none"> Carry out design for sustainability in product development 	<ul style="list-style-type: none"> Product life cycle analysis
Packaging	<ul style="list-style-type: none"> Aim to reduce or reuse packaging Collect packaging for recycling 	<ul style="list-style-type: none"> Perform audit
Environmental compliance	<ul style="list-style-type: none"> Complaints received should be investigated and resolved Participate in Government or other sustainable initiatives Review environment performance annually Select a team of skilled employees to address environmental concerns and to develop tailor made solutions 	<ul style="list-style-type: none"> Comply to EPA Perform Audits and Root cause analysis
Sustainable supply chain to reduce carbon footprint	<ul style="list-style-type: none"> Documented policies to deal with sustainability compliant suppliers or sub-contractors Proper management of transportation in logistics 	<ul style="list-style-type: none"> Perform life cycle assessment

The sustainable social targets and practices that need to be implemented are detailed in table 6 below.

Table 6: Social Targets and Practices

Target	Practices	Assessments
Improve workplace conditions	<ul style="list-style-type: none"> All labour, health & safety policies and practices should be communicated to all employees All toilets should have running water, ventilated, clean and lighted 	<ul style="list-style-type: none"> Comply to ERA Perform audits
Improve health & safety at work	<ul style="list-style-type: none"> Machinery should be equipped with appropriate safety devices Proper PPE should be provided to employees Noise level should be regularly checked Emergency drills should be conducted at least twice a year Emergency exits should always remain unobstructed and unlocked Every production site should have unlocked 	<ul style="list-style-type: none"> Comply to OSHA OHSAS 18001

Prevent child or forced labour	<ul style="list-style-type: none"> Have anti-child labour policy Workers should be free to resign at anytime without penalty giving a notice Young workers employed should work under proper supervision and guidance 	<ul style="list-style-type: none"> Comply to ERA and OSHA Comply to ILO
Prevent discrimination	<ul style="list-style-type: none"> Have procedures in place for hiring do not discriminate age, gender, disability or religion Have procedures in place for equal pay for doing equal amount of work Employees are permitted to perform religious obligations Female applicants should not be asked about pregnancy status in interview 	<ul style="list-style-type: none"> Comply to ERA Comply to ILO
Improve collective bargaining	<ul style="list-style-type: none"> Workers should be free to join or form trade unions Representatives of trade unions should be voted democratically 	<ul style="list-style-type: none"> Comply to ERA Comply to ILO
Prevent harassment and abuse	<ul style="list-style-type: none"> Have procedures in place for workplace to be free from physical and verbal abuse or harassment Have procedures in place for workplace to be free from sexual harassment Have proper procedures for to deal with complaints related to harassment and abuse 	<ul style="list-style-type: none"> Comply to ERA Comply to ILO
Improve compensation	<ul style="list-style-type: none"> Procedures in place to ensure all employees are paid legal minimum wage and legal overtime rate 	<ul style="list-style-type: none"> Comply to ERA Comply to ILO
	<ul style="list-style-type: none"> Procedures in place to ensure no illegal deductions Procedures in place to ensure leave are provided which they are entitled 	
Reduce long working hours	<ul style="list-style-type: none"> Procedures in place to ensure legal working and overtime hours Procedures in place to give at least one day off in seven Procedures in place all overtime performed are voluntary 	<ul style="list-style-type: none"> Comply to ERA Comply to ILO
Increase accountability	<ul style="list-style-type: none"> Procedure in place to conduct audits for labour and health & safety Corrective actions identified should be implemented Procedures to evaluate and update organisational policies and practices Procedures in place to disclose corruption Sustainability reporting 	<ul style="list-style-type: none"> SA 8000 Root cause analysis Perform audits
Grievance	<ul style="list-style-type: none"> Procedures to bring work related violations in an anonymous manner 	<ul style="list-style-type: none"> KPIs
Increase stakeholder engagement	<ul style="list-style-type: none"> Engage NGO's, community and employees in its sustainability strategies 	<ul style="list-style-type: none"> KPIs

Finally, the sustainable economic targets and practices that need to be implemented are detailed in table 7.

Table 7: Economic Targets and Practices

Target	Practices	Assessments
Invest in localmarkets	<ul style="list-style-type: none"> Utilise local materials Support development of existing or new local enterprises Encourage local production andconsumption 	<ul style="list-style-type: none"> Financial Indicators
Improves Mauritian economy	<ul style="list-style-type: none"> Provide permanent employment opportunities to Mauritians Provide local employment and training 	<ul style="list-style-type: none"> Economic Indicators
Combat poverty	<ul style="list-style-type: none"> Participate in government Marshall plan toinvest in targeted community areas Improve access to education and training 	<ul style="list-style-type: none"> Indicators

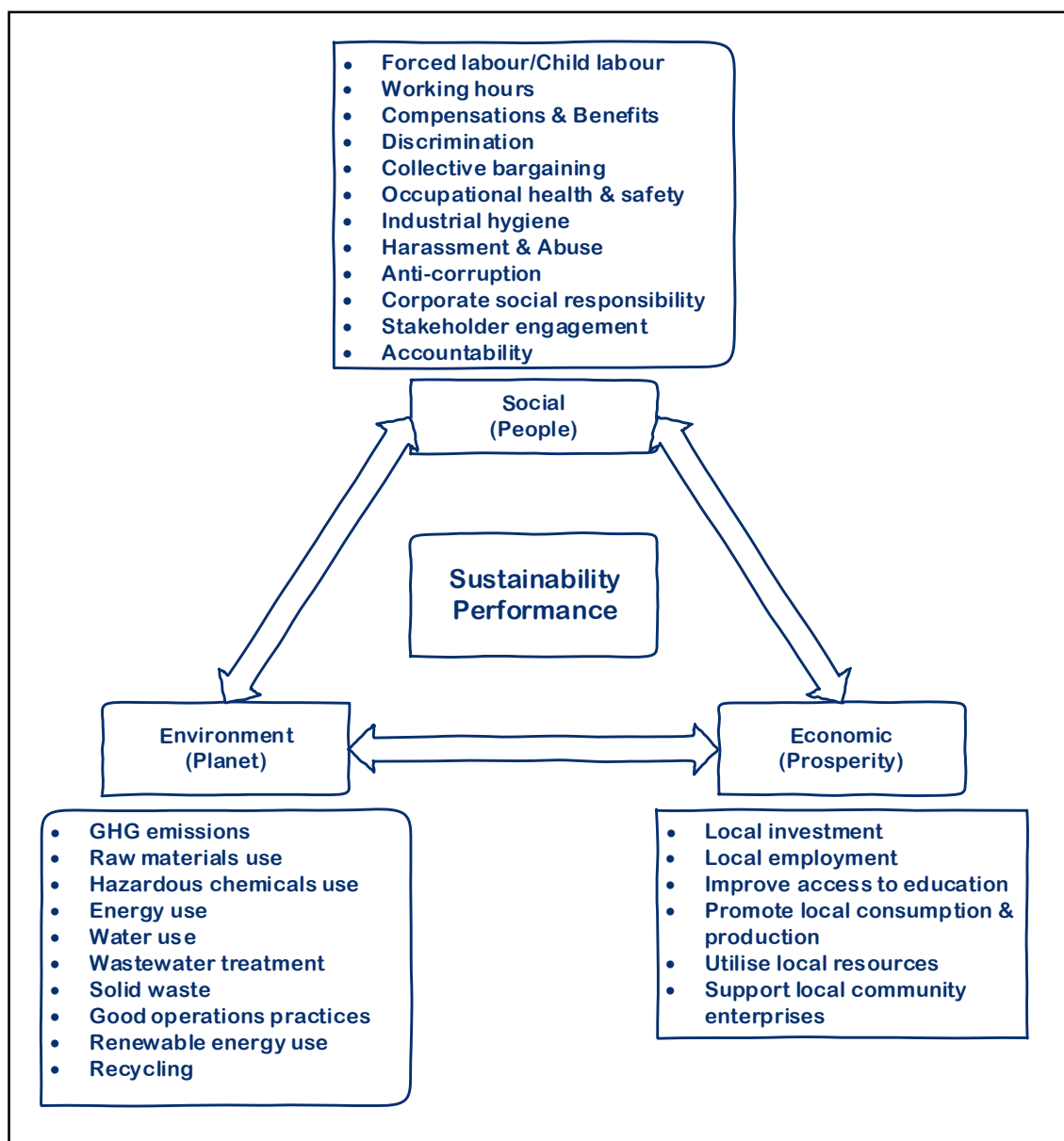


Figure 5: Conceptual Diagram

VI. CONCLUSION

Sustainability can be defined as the development that meets the needs of the present without compromising the ability of future generations to meet their own needs and is prevalent in all areas of business today. The triple bottom line of sustainability need to be implemented in companies if they want to survive in today's market. We have reached a point where companies need to adapt their strategies (operations, processes etc) to the meet the sustainable development goals, else they will not be able to survive.

Proper environmental practices would endow the reduction of water use, energy use, resource use, chemical use, wastewater and solid waste generation which will lead to having better environmental performance. Social practices would enable to inculcate sustainable culture at workplace, improve working conditions, increase safety at work, discontinue harassment, anti discrimination, prevent long working hours, improve compensations and encourage collective bargaining, thus, having better social performance. Decent economic practices such as local investments, support local economy, improve access to education and training would enable to having better social performance. Governance practices such as sustainability reporting and stakeholder engagement would enable to have better sustainability performance. As it is, the business models currently being used by the food industry needs to be rethought and redesigned, taking into consideration the key sustainability elements, as discussed in this paper. The proposed practices in this research work should be used a support to industry practitioners within the food industry to integrate sustainability practices in their day to day operations.

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Climate Vulnerability, Justice, and Financing Nexus: A Case for Optimizing Climate Interventions

By Gordon Kofi Sarfo-Adu & Henry Kwabena Kokofu

Abstract- This study sought to examine the key constraints that affect climate financing; notions of climate justice and injustice as well as how global climate finance can effectively be deployed to meet the coping requirements of vulnerable spaces and groups. The study sought to design a comprehensive framework that will guide stakeholders in the climate finance and climate justice space to help in their research and practice. The study was framed within the qualitative approach and deploys the critical stage review by synthesizing from secondary sources of data. Key indicators were originally elicited in their unclassified form which was subsequently organized into a three-point framework. In other words, effective climate financing that takes into account climate justice requires “*Systems approach*”; “*Verification mechanisms*; and *Equity philosophy*” which we have used to design the ‘the SAVE framework’ well discussed in the paper.

Keywords: *climate actions; interventions; coping; vulnerability; climate justice; equity.*

GJSFR-H Classification: LCC: JC578



Strictly as per the compliance and regulations of:



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Gordon Kofi Sarfo-Adu ^α & Henry Kwabena Kokofu ^ο

Abstract- This study sought to examine the key constraints that affect climate financing; notions of climate justice and injustice as well as how global climate finance can effectively be deployed to meet the coping requirements of vulnerable spaces and groups. The study sought to design a comprehensive framework that will guide stakeholders in the climate finance and climate justice space to help in their research and practice. The study was framed within the qualitative approach and deploys the critical stage review by synthesizing from secondary sources of data. Key indicators were originally elicited in their unclassified form which was subsequently organized into a three-point framework. In other words, effective climate financing that takes into account climate justice requires “*Systems approach*”; “*Verification mechanisms*”; and *Equity “philosophy”* which we have used to design the ‘the SAVE framework’ well discussed in the paper. We conclude that finances flowing from the rich economies to poor and vulnerable regions are only a starting point for effective climate actions, the efficacy of the process depends on the commitment to identify the real vulnerable people and areas; commitment to expend the requisite resources appropriately; the technical capacity to effectively enforce interventions followed by quality assurance measures through sound evaluation and corrective measures.

Keywords: climate actions; interventions; coping; vulnerability; climate justice; equity.

I. INTRODUCTION

The Paris Climate Agreement and the 2030 Agenda on Sustainable Development, encompassing the 17 Sustainable Development Goals (SDGs), were both adopted in 2015. The objective of these global schemas has been to have a global system that has low-carbon imperatives as well as being climate-resilient in its quest to attain sustainable development. Despite these ratifications and agreements, many countries have been extremely slow as they still are engulfed with serious challenges in their effort to embark on measures and interventions to enforce these agreements (UN, 2019). Another factor that has led to the snail-paced progress has been the pussy-footing posture by countries who although have proposed commitments in

Nationally Determined Contributions but have not close to the goal of global temperature to less than 2°C (Höhne et al., 2020; Climate Action Tracker, 2021). The main challenge that affects Parties in their determination to enforce some of these interventions and NDCs has been the issue of finance and inadequate resources. McDonald et al. (2021) report a statement by the President of the COP26, the 26th UN Climate Change Conference who averred “*Unless we get finance flowing, we cannot and will not see the action we need, to reduce emissions, to adapt, and to rise to the growing challenges of loss and damage*” (p.1). Climate finance has been the missing link affecting transitions towards climate resilience, low carbon, and enforcement of Nationally Determined Contributions (NDCs) of Parties, especially those in the developing world. According to Yeo (2019), such a transition to climate-resilient because such transition would require huge sums of dollars to transform these aspirations into actionable programmes. For example, the IPCC has projected that at least US\$ 830 billion in investments would be required between 2016 and 2050 to plummet the incidence of global warming to 1.5 °C by the year 2100 (Masson-Delmotte et al., 2018).

Despite the centrality of finance in meeting objectives of climate resilience, ownership of climate resilient actions calls for alignment between donor countries’ finance and recipient countries’ priorities, including their focus on mitigation versus adaptation (e.g., UNFCCC, 2017; Bouyé, Harmeling & Schulz, 2018). As a recent example, it is worth quoting the COP26 President, who, in the aforementioned conference, stated, “*Finally, a major concern on [climate] finance is improving accessibility. An indicator of the current state of affairs is the low level of finance making its way to the most vulnerable nations*” (Mott McDonald et al., 2021, p.7). There has been particular attention to the developing world because these people are vulnerable and their poverty levels affect the adaptation to climate change, coping mechanisms, and efforts at deploying climate-resilient interventions (Brown, 2011).

Although developing countries are the worst hit by climate change impacts, mitigation, and adaptation measures tend to be hampered by inadequate financial resources (Islaim, 2020; Brandstedt, 2019). Meanwhile,

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the general flow of global climate finance tends to find its way to those areas that are not relatively in dire need and vulnerable positions which raises the question of distributional equity (Islaim, 2020). Even within countries, the fewer available resources may end up not finding their way to the vulnerable and susceptible areas or groups of people but to other places or perhaps for other administrative purposes other than the real interventions thereof (Adger et al., 2006; Barnett & O'Neill, 2013). Even in those circumstances where resources get committed, it is possible to have situations where these climate interventions do not get enforced and monitored effectively which brings about a gap between expectations and actual results (Boyd et al, 2021; Chakraborty et al, 2020). The notion of 'climate justice' is increasingly being used in framing debates and discussions on these questions, underpinned by an expectation that such a justice-based approach would improve the legitimacy of the international climate finance regime, promote consensus and collective action and thus make international climate policies more successful (Baatz, 2018; Gifford & Knudson, 2020; Khan et al., 2020).

Because of the complexity of climate risk challenges that confront developing countries coupled with poor resources, they are likely to result in maladaptation. According to Schipper (2020) maladaptation refers to "when adaptation to climate change goes very wrong," (p. 409) and it involves those occasions when attempts to adapt and mitigate climate change through interventions do not go as planned because they failed to see the bigger picture.

Although the literature has attempted to explore the involvement approaches and justice perspectives of varying non-state actors including NGOs in the environmental sector (Chatterton et al., 2013, Derman, 2014), religious actors (Glaab, 2017) and farmers (Sova et al., 2015), what seems to be a guiding framework which will drum home how donors and policymakers would go about climate financing to promote justice to reduce vulnerability has not been given the needed attention. What occurs is that at the supra level resources get distributed but how best these resources meet the vulnerable groups and spaces to indeed help in adaptation and mitigation interventions remains quintessential. The main objective of this study has been to assess the extant literature to examine the key constraints that affect climate financing; notions of climate justice and injustice and how best global climate finance can effectively be deployed to meet the coping requirements of the vulnerable ones. The study sought to design a comprehensive framework that will guide stakeholders in the climate finance and climate justice space to help in their research and practice.

II. LITERATURE REVIEW

a) Concept of Vulnerability

The IPCC conceptualizes vulnerability to mean the tendency or susceptibility of an entity to be undesirably plagued by climatic forces, which also takes account of its sensitivity or susceptibility to harm, and the unavailability of the wherewithal and capacity to deal with and adapt (IPCC 2014, IPCC, 2007). By way of the equation, vulnerability (V) denotes a body or region's exposure (E) to climatic variabilities including the entity's sensitivity (S) to such variabilities and the adaptive capacity of the said entity to the said climatic changes successfully. This is expressed as $V = E + S - AC$ (Islam & Al Mamun, 2020). Vulnerability thus is an interdisciplinary construct, incorporating both natural (e.g., climatic processes and events) and social dimensions (e.g., adaptive capacity) of climate change impacts. It posits that an entity, despite its exposure to climatic changes, may remain unharmed if it has the requisite adaptive capacity. At the country level, such capacity may include a country's assets and infrastructure, governance quality and effectiveness, scientific robustness, and the educational level of the population (Hughes et al., 2012).

b) Adaptation and Social Justice

In the realms of climate adaptation, and climate-resilient interventions, Adger et al., (2006) argue that a vulnerability analysis avers "all adaptation decisions, such as fiascos and debacles to act, tend to espouse justice implications, both distributive and procedural (p. 15). Arguing from the *distributive justice* perspective, the vulnerability framework focuses on "the social, economic and institutional forces which affect the degree of vulnerability within a particular space or jurisdiction thereby enhancing or worsening choices or alternatives for adaptation" (Kelly & Adger, 2000 p.326). The foregoing on distributional justice reiterates the need to pay peculiar attention to the imbalanced access that different people and farmers have to relevant forces of production such as land, capital, technology, and markets.

The literature (McDonald et al., 2021; Yeo, 2019) has consistently made a case that resources for climate change adaptation have remained extremely lower than mitigation finance even though the general transfer of finance has improved over the years. There are many cases where poor countries that are susceptible to climate vulnerabilities despite their chronological struggles for greater adaptation funding, tend to rather be saddled with growing mitigation funding. This is a clear case of distributive justice.

There has been copious treatise on factors that bring about the flow or distribution of adaptation finance (Doshi & Garschagen, 2020; Mori et al., 2019; Weiler & Klock, 2021), yet only a few of these had focused on the

vulnerability aspect of these allocations (Doshi & Garschagen, 2020; Weiler et al., 2018). These growing studies have resulted in variegated conclusions. Whilst one school of thought observed vulnerability to be associated with a positive impact on adaptation funding ((Betzold & Weiler, 2017; Weiler et al., 2018) reporting; another school of thought observed no impact (Persson & Remling, 2014; Robertsen et al., 2015); a third school of thought observed an insignificant or a negligible impact (Doshi & Garschagen, 2020). Consequently, the quantified impact of these studies has not been consistent; for example, whether the most vulnerable countries receive more or less adaptation funding (Weiler et al., 2018).

There is a growing body of research that focus on distributive justice concerns agitated by in nation-states vis-a-vis other states (Morgan & Was kow, 2014, Okereke, 2010). These studies tend to put a spotlight on the growing disparity in terms of the participation of state actors and NSAs in the UNFCCC activities and the implications for procedural justice and legitimacy. NSAs do not have the same access to formal mechanisms of participation: they can't directly participate in the negotiations and don't experience participatory parity with state actors. However, they can play a role in shaping invisible rules and discourse by engaging with formal participatory mechanisms facilitated by the UNFCCC for the nine recognized NSA constituencies.

i. *Climate Justice*

The climate justice argument assesses compensatory efforts that emanate from advanced industrialized states to vulnerable but developing states to address inequalities in climate actions (Ciplet et al., 2013; Clark, 2012; Hulme, O'Neill, & Dessai, 2011). In other words, adaptation finance initiatives serve as recompense for the disparities of climate change (Barrett, 2014); this involves sums of money available for alternative livelihood programmes in those areas susceptible to drought, sums of money for water conservation and alternative sources, sums of money for flood mitigation, as well as climate-related disaster management

III. METHODS

This study is essentially qualitative and deploys the critical stage review by synthesizing from secondary sources of data. Data were derived from the extant literature (both theoretical and empirical studies), essentially sourced from journal articles and scholarly books to examine the notion of climate justice and the challenges developing countries face in their efforts at adaptation and mitigation to climate change. More importantly, the study assessed literature relevant to enhancing climate justice and funding for NDCs of the developing world especially those with vulnerabilities.

The literature search covered all terms and terminologies as approximately related to climate vulnerability, climate justice, and financing. In the process, we combined adjectives related to common obstacles faced by vulnerable countries in meeting their nationally determined contributions (NDCs). The particular words involved, *inter alia* 'challenges' 'constraints' 'problems', 'setbacks' and 'hindrances'.

Afterward, the study added some words that are relevant to measures for improving the process of climate justice and resource allocation. The words included 'value' 'enhancing' 'promoting' 'successful' and 'effective'.

The different adjectives and the concept of climate justice, finance, and vulnerability were combined variously to derive a pool of critical literature on the study. These three main domains were adopted due to their relevance to the topic and availability to the researchers: Science Direct, T and F online, and Google Scholar. The large pool of resources was primarily sorted for applicability, this we did by flicking through their synopses. After this exploratory procedure, each of the researchers read the synopses independently and thoroughly. At the end of the process, authors convened to exclude duplicates after which narrowed down the list of abstracts required for in-depth analysis. Through these processes and steps, the study has come out with widespread cataloguing of forces that come together to make for climate justice, the flow of climate funds to relevant vulnerable spaces and groups for their adaptation and mitigation purposes. With the aid of tables, we catalogued all the relevant indicators or factors required for enhancing climate justice and climate financing to help vulnerable entities to cope well with climate change. These different indicators which were originally in their raw or unclassified form were subsequently organized or classified into three main themes: *Systems approach; Verification; and Equity philosophy*. This has been developed into the SAVE framework (see figure 1) which has been discussed in section 4.2.

IV. ANALYSIS AND DISCUSSION

This section discusses key challenges associated with climate funds, vulnerabilities, and inequalities involved in the allocation of climate funds. The section does this as a way of demonstrating the inequities and injustice in climate change adaptation and mitigation efforts. More importantly, the study discusses relevant pointers or signposts to ensure effective climate targeting and financing to make for a more just process.

a) *Vulnerabilities and Inequality in Climate Financing*i. *Vulnerable Yet Inadequate Receipts of Climate Funds*

There have been reports of disproportionate allocation of climate funds in which those that are mainly susceptible to climate change impacts tend to receive less funding for their adaptation and mitigation efforts. Deploying the expression or equation of climate vulnerability as illustrated by Islam and Al Manun (2020), this study contends that those regions and people who have greater exposure to climatic changes, with greater sensitivity to such changes tend to have the least adaptive capacity and mechanisms. In other words, the social dimensions of climate change tend to make poorer countries and vulnerable very more susceptible to climate change and variability despite the ecological milieu already making them worse off. Empirical studies (Betzold & Weiler, 2017; Weiler et al., 2018) have observed significant positive impacts of Gross Domestic Product per capita on adaptation aid amounts (see also Islam, 2022). However, other works such as (Bagchi et al., 2016; Mori et al. 2019) have discovered a negative effect of Gross Domestic Product per capita on both mitigation and adaptation aid amounts.

ii. *Variables and Access to Climate Finance Population*

The population size of recipient countries has been a useful indicator that has been extensively regarded in research on both adaptation and mitigation funding disbursement. The rationale is that larger countries require extra support and research provides the positive relationship between this variable and climate funding allocation for mitigation and adaptation purposes (see Halimanjaya, 2016; Weiler et al., 2018).

Regional Location

A different indicator incorporated in the literature is the regional location of recipient countries. For example, states in Sub-Saharan Africa and South Asia are considered to be more vulnerable to climatic changes, and hence, in need of more adaptation funding, yet results are mixed regarding whether these regions receive proportionate amounts of climate funds or not. Whilst others (Weiler et al., 2018; Weiler & Klock, 2021) observed that states in that Africa were positioned to obtain adaptation finance more than their non-African compatriots, other empirical works failed to observe the possibility or probability (Betzold & Weiler, 2017; Robinson & Dornan, 2017).

Social Indicators

On the social front, some climate-vulnerable countries may lack the requisite human resources, skills, and infrastructure to be able to access climate funds. For example, to receive funding, a vulnerable country must be able to articulate and provide evidence of its vulnerability to funders. This may be quite challenging

because of a lack of country-specific historical climate data, skilled human resources, and IT infrastructure (Chase et al., 2020; Fiala et al., 2019), as well as considerable ambiguities surrounding the terms 'climate finance', 'vulnerability', 'mitigation', 'adaptation', and 'development' (Chandler et al., 2002; Hall, 2017;

iii. *Poor Detection Due to Disaggregation Problems*

An empirical study by Islam (2022) made some key observations that were very revealing. He noted that less adaptation and overlap climate funds found themselves in South Asia and Sub-Saharan Africa which were curiously the spatial locations in the world with regions that are very susceptible to climate risks. Ordinarily, those regions (spatial locations) with the greatest vulnerabilities and incidence ought to have the corresponding flow of resources yet the human (social indicators) factor to ensure this flow has been the missing link that tends to affect overall adaptation and mitigation efforts of these poor and vulnerable countries. The empirical study through quantitative computations revealed that although these South Asia and Sub-Saharan Africa were the regions with significant correlations with vulnerability, the same were the regions with the least global climate funds flowing to (Islam, 2022). The author observed significant correlation coefficients ($r = 0.187$) for vulnerability and South Asia with Sub-Saharan Africa recording $r = 0.577$ (p. 13).

This latest empirical work (Islam, 2022) has come to contradict or refute earlier studies (Robinson & Dornan 2017; Weiler & Klock 2021) which had reported insignificant impacts or positive impacts. One may be tempted to make a similar mistake if they lump all countries and sub-regions together as one such as "Africa" or a supra region without necessarily disaggregating to observe the patterns and trends. It is crucial for those respective sub-regions that are most vulnerable and susceptible to be disaggregated and delineated to know the respective interventions and support required to make them effectively adapt and mitigate climate change impacts.

iv. *Poor Detection Due to Disaggregation Problems*

Due to this tendency, Fussell and Klein (2006) contend that developing countries tend to encounter a 'double inequality'; this is because this region has contributed insignificant pollutants and global warming (human-induced climate change), that notwithstanding, this is the region where poor resources and low adaptive capacity tends to make them unable to cope, withstand, make progress and surmount the adverse effects when compared to more developed nation-states.

v. *Injustice Emanating from Processes and Procedures*

This has got to do with those institutions, processes, mechanisms, and procedures used in the decision-making processes of climate change issues.

Procedural justice examines the extent to which these institutions and procedures are fair and demonstrates equity and involvement of all relevant groups and voices (Barrett, 2013; Paavola & Adger, 2006). It is very common to various vulnerable groups, especially the youth whose interests may be left unattended or whose voices are not given much-desired attention.

vi. *Injustice Emanating from the Allocation and Distribution of Climate Resources*

There have been many situations where resources for climate change adaptation, mitigation, and coping strategies tend to be skewed in favour of those who may already be well-to-do or not very much adversely affected in relative terms. This may suggest that those regions and groups who may be very vulnerable and worse hit by climate change may be at the backburner of the flow of climate funds (Agyeman et al., 2016) which obviously will affect their coping abilities, mitigation, and adaptation mechanisms. The idea of distributive justice is concerned with the equitable or even-handed distribution of climate funds and other positive related resources or services which may include, inter alia recovery aid, social programs, and greenways. Additionally, distributive justice contends that those negative consequences which may include inter alia, dumping sites, and toxicity emanating from global production needs to be equitably distributed dumping sites and toxicity in society (Agyeman et al., 2016; Schlosberg, 2009).

What has become the norm is that developed countries, which are blameable for most of the global emissions, tend to have and wallop in the high standard of living that has been necessitated by their history of development from mass production and global emission

and pollution (Schlosberg, 2012). Meanwhile, third-world countries with low historical emissions are rather undergoing severe impacts of climate change, which include incensed precipitation incidence, prolonged droughts, temperature variations and wildfires, and inundations from increasingly severe storm-related flooding and/or sea level rise (Barrett, 2013; Posner and Weisbach, 2014). Disproportions in carbon emissions illustrate a specific case of climate justice (Schlosberg, 2009; Hayward, 2006).

Recognition as justice addresses how a community's reputation or disparaging views held by a government in power that is representative of a demographic majority affect marginalized populations, their challenges, and the outcomes of their claims for equity (Schlosberg, 2009).

b) *Signpost to Promote Climate Justice and Financing to Reduce Vulnerability*

The study has detected the key constraints that affect vulnerable countries and groups concerning climate finance. This section assesses and discusses key measures that will help in framing vulnerability assessment and how best to put in place mechanisms to make effective interventions to optimize the coping, adaptation, and mitigation of vulnerable entities. Gleaning through the extant literature, the following key themes have been elicited from both the theoretical and empirical works to design the framework below. From the extant literature, we observed different indicators or forces which add up to ensure climate justice and climate financing to reduce its impact on vulnerable people. Table 1 below highlights the relevant factors in an uncategorized format.

Table 1: Indicators Relevant to Climate Justice and Financing to Reduce Vulnerabilities

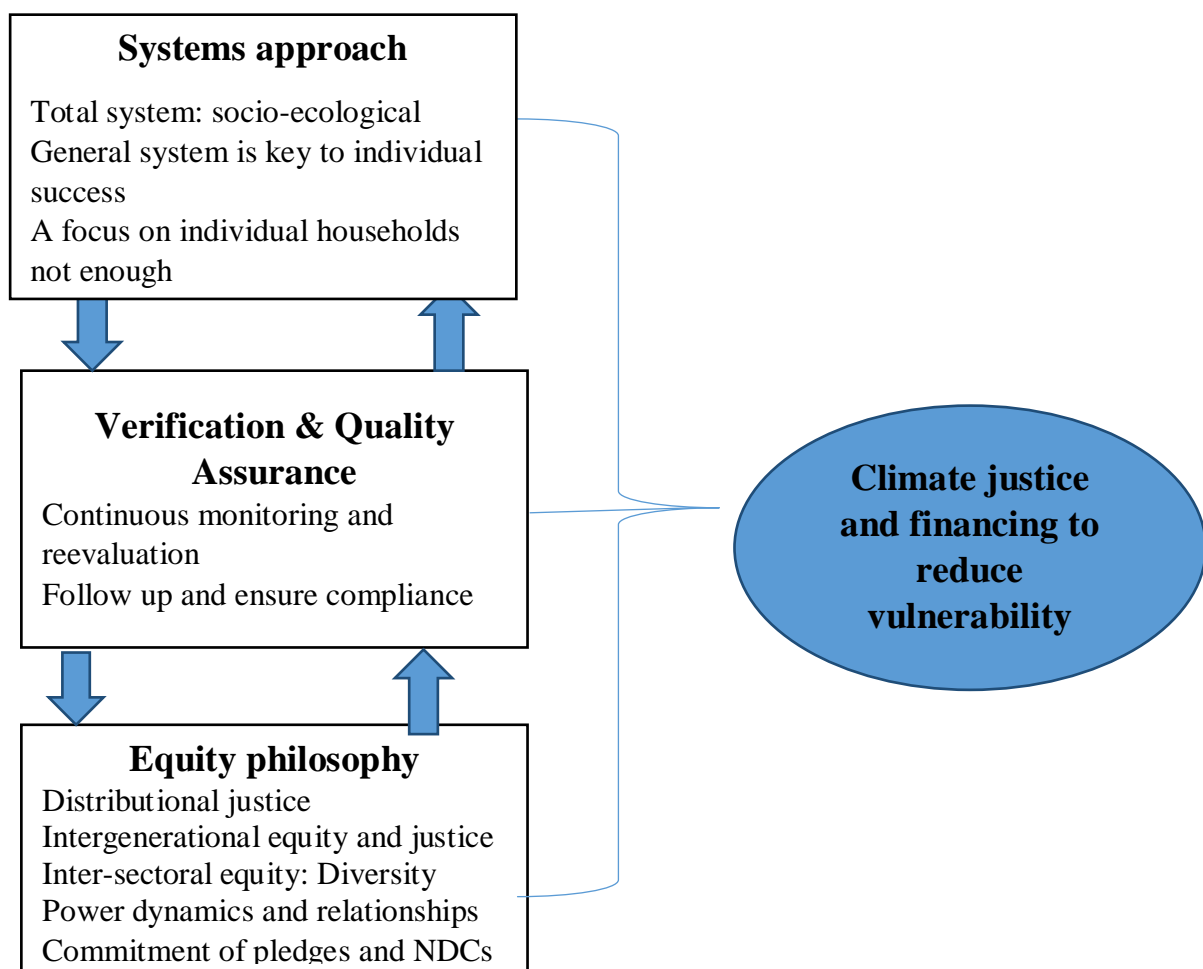
Factors/indicators	Source/references
Total system: socio-ecological	Nelson et al 2007
General system is key to individual success	Eriksen et al, 2021
A focus on individual households not enough	Goulden et al., 2013; Alves and Mariano (2018)
continuous monitoring and reevaluation	Fiala et al., 2019; Chase et al., 2020; Doshi & Garschagen, 2020; Bagchi et al., 2016; Betzold & Weiler, 2017; Halimanjaya, 2016; Robertsen et al., 2015; Robinson & Dornan 2017; Paavola & Adger, 2006)
Distributional justice	Adger et al., 2017; Sovacool, 2013; Brandstedt, 2019; Meikle et al., 2016; Adger et al., 2006
Intergenerational equity and justice	Norton, 2002, Rawls, 1971; Fraser, 2010
Inter-sectoral equity: Diversity	Honneth, 1996, Taylor, 1994, Young, 1990; Adger et al., 2006; Barnett and O'Neill, 2010; Ribot, 2011
Follow up and ensure compliance on implementation of interventions	Boyd et al, 2021; Chakraborty et al, 2020; Yang et al, 2021; Méndez et al, 2020
Power dynamics and relationships	Fraser, 2007; Fraser, 2014
Commitment of pledges and NDCs	Caney, 2010; Moellendorf, 2012; Schlosberg, 2012; Schlosberg and Collins, 2014; Hayward, 2006; Paavola and Adger, 2006

From the raw indicators or factors, the table below attempts at classifying or grouping the indicators under broader three themes.

Systems Approach	Verification	Equity Philosophy
Total system: socio-ecological	Continuous monitoring and re-evaluation	Distributional justice
General system is key to individual success	Follow up and ensure compliance on implementation of interventions	Intergenerational equity and justice
A focus on individual households is not enough		Inter-sectoral equity: Diversity
		Power dynamics and relationships
		Commitment of pledges and NDCs

Table 2: Classified Indicators Relevant to Climate Justice and Financing

The classified or categorized indicators in table 2 have been used to design the SAVE model (figure 1) which has been discussed in section 4.2.



Source: Authors' construct from extant literature

Figure 1: The SaVE model

The SAVE model (figure 1) contends that ensuring climate justice and equity in climate financing reduces the plight of vulnerable groups and regions. When done effectively, it will help optimize the coping strategies, adaptation, and mitigation to the impact of climate change. The model entails ten (10) main

indicators which are crucial in climate financing to ensure equity. These 10 indicators have been classified or organized into three main themes. Consequently, the three main themes give form and nomenclature to the framework: SAVE model;

Expressed in the equation: $SAVE = Sa + V + E$; explained as *Systems approach, Verification, and Equity philosophy* respectively.

Systems approach (Total system; General system is key to individual success; A focus on individual households not enough)

i. *Total System: Socio-Ecological*

To ensure effective climate fund transfer for proportionate coping, adaptation, and mitigation activities, the framing and analysis of the total system remain very critical. There is a tendency to conceptualize the phenomenon in a less coordinated manner. In other words, there are moments where attention is paid to human actions only and not the whole system or interaction of the social and climatic forces that produce synergy whose outcome could be dire or have far-reaching implications. We contend that 'resilience thinking' needs to regard a "vulnerable spatial unit" as an integrated social-ecological system, where we do not only lay emphasis on social (human processes) but on the system as a whole unit, whilst paying more attention to the interaction of its component units. The foregoing has been observed by Nelson et al (2007) who contend such tendency and approach points to a recognition that "the ability to adapt is a function of system components" (p. 400)

ii. *A Focus on Individual Households Not Enough*

More related to the above, the framework contends that those adaptation and mitigation efforts need not only target the individual households but attempts should be made to build the robustness of the system. Once the resilience of the macro system is enhanced, the ability of individuals to cope with their micro issues such as alternative livelihoods can be optimized. Goulden et al (2013) observe "adaptive actions that increase the resilience of households and their livelihoods do not always increase the resilience of the system" (p. 921). This tends to render the former not very efficacious. Consequently, Alves and Mariano (2018) admonish that climate justice needs to be conceptualized as an appreciable complementation or consideration of human development programmes and climate actions. The point is that climate actions have the potential to augment the attainment of human development programmes whilst human development policies tend to augment the effective operationalization of climate actions.

iii. *General System is Key to Individual Success*

Following from the point above, the framework contends that a resilience viewpoint recognizes the inevitability of dynamics in the environment and argues for fixing the resilience and coping ability of the system which can accommodate individual households' welfare. There is a need to have an adaptation system that

stimulates the capability and resilience of the system to support the new dimensions and change.

Verification and Quality Assurance (Continuous monitoring and re-evaluation; Follow up and ensure compliance)

By verification and quality assurance, the framework posits that all procedures and actions are to be enforced tactically taking into account sound technical and implementation models. More importantly, it requires monitoring to verify if stated action plans and programmes are followed keenly and should be given key prominence. It goes without saying that if donors or consultants provide climate funds and put in place no proper mechanisms for formative evaluation which requires regular monitoring and compliance, the intended outcome may not be achieved.

In other words, there is a need to follow up and ensure compliance on the implementation of interventions.

According to Barrett (2013), by ensuring strict monitoring of how climate funds get deployed or utilized at the local level, funders and those with policy oversight can detect the distribution pathways and trails to the most vulnerable states, districts, communities, and real targets. International climate finance transfers disclose whether these resources indeed flow to indeed vulnerable countries; local climate finance undertakings should also control to verify if indeed climate funds are allotted to those regions and districts or communities that are very susceptible to climate change impacts. With these varying and overlapping verification structures and mechanisms, at all points, climate finance will indeed be deployed to those areas where the resources are indeed needed for adaptation and mitigation purposes. According to Paavola & Adger, (2006); the notion of climate justice has been to detect if indeed vulnerability is the chief criterion for distributing climate finance. This point has been corroborated by Ayers (2009) that climate justice suggests vulnerable stakeholders indeed become beneficiaries of climate finance whilst Bird et al (2011) call for equitable apportionment to those countries that are very susceptible or open to climate change impacts. To promote these notions of climate justice requires effective verification at multi-governance levels and to follow-up to the local implementation levels.

Meanwhile, there have been reports of structural capacity constraints which affect climate justice. For example, Fiala et al/ (2019) in assessing the project documents of about 93 Global Climate Fund-supported projects found that 80% were not underpinned by a precise conceptualization of "transformation" whilst 68% failed to incorporate the procedures for evaluating "transformation" whilst only a maximum of approximately 13% had in them quantifiable pointers or procedures for appraising transformation. The foregoing is an indication that most projects on climate finance

tend to be overly focused on the money but the processes and quality assurance measures to ensure the resources lead to an improved change in the lives of vulnerable groups and societies tend to be at the backburner. This point has been corroborated by Chase et al (2020) who observed that many of these projects do not have the relevant capacity to put in place effective project proposals whilst others fail to incorporate chronological data on the climate of the respective data, inadequate or poorly trained personnel and poor technical backgrounds of these individuals. More problematic was poor know-how in monitoring and evaluation of the projects which cumulatively affected the efficacy of their bids to access climate funds and even the outcomes of such projects if they became successful.

Observing the above, Doshi and Garschagen (2020) contend that these structural constraints do not give adequate assurance to donor countries and groups that recipient entities or states would efficiently and effectively enforce and lead interventions that genuinely help vulnerable people and areas to adapt and mitigate climate change which continues to plummet the possibility of accessing such funds.

Receiving countries or states need to demonstrate technical prowess and assure donors of the necessary quality assurances put in place to effectively police or enforce climate funds efficiently and effectively. If reports of corruption are high coupled with conflicts and violence as occur in many of these third worlds, developed countries or funders will not be convinced to release funds as they may regard such as a high risk to their funds or investment (see Betzold & Weiler, 2017; Halimanjaya, 2016). To give the required assurance, there is the need for adaptive governance which places value on intricate knowledge of ecological issues, incessant monitoring, and reviews as the projects kick start, agility, and dynamic learning which can anticipate and navigate through any happenings in the environment to ensure project success (Folke et al., 2005).

Equity Philosophy

The whole notion of climate justice has been centred on doing the right thing and providing resources to those who are indeed vulnerable and susceptible to global climate impacts. Barrett (2013) contends that the distribution of climate finance to the utmost vulnerable spatial locations and groups signifies the preponderance of climate justice as a multi-scalar process and should essentially use vulnerability as an indicator. The above notwithstanding, the extant local literature tends to drum home that other forces determine fund allocation. Particularly, political convenience, interests of policy and political elites, interests of government officials as well as identity benefaction, unfortunately, tend to underpin resource

allocations (Reinikka & Svensson, 2004; Azam, 2001; Posner, 2005).

Barrett (2014) observes cases where instead of funds being channelled to substantially vulnerable districts to address droughts and floods; beside-step those societies and groups undergoing the extreme climate hazards. Rather, the well-to-do areas tend to be given these resources that protect against climate variability and change whilst those communities which are at the bottommost economic, social, and political are at the backburner and these undergo the maximum hostile impacts of climate change which involves *inter alia*: deteriorating farm harvests, fleeting dislodgment, disease epidemic, and deteriorating living condition. He puts it succinctly that "the provision of proportionately fewer funds to those with the highest climate risk indicates the most eligible are given the least resources to address the inequalities of climate change" (ibid p 139).

iv. Distributional Justice

Distributional justice connotes ecological consequences and denotes the degree to which environmental resources, or contrariwise ecological threats or hazards, can be said to be distributed equitably. The notion of climate justice has got to do with intricate virtuous and ethical issues with the adoption of climate coping mechanisms (Adger et al., 2017; Sovacool, 2013).

Other non-state adaptation processes are undertaken by persons and groups with the skillset, interest, capacity as well as resources to engage in these. These are mostly not predominantly susceptible to climate change variability. Cumulatively, the impact of climate finance flowing to private adaptation [resources that go into hands or groups that are not vulnerable but except they find beneficial] tends to compound the inequality argument (Adger et al., 2006). With their connections and sophistication, these private adaptation entities tend to receive climate funds though they themselves are not vulnerable whilst the vulnerable groups may not have access.

v. Inter-Generational Equity and Justice

Intergenerational justice addresses issues of temporal allocation of wealth and tasks between generations. In other words, whilst disbursing the positive aspects or resources, we need to also take into account the needs of generations to come whilst also considering the prevalent fledgling cohorts or population (Norton, 2002).

Intra-generational justice on the other hand has to do with the spatial distribution of resources and consequences between various geographical locations and among varying groups (Norton, 2002). The latter tends side-stepping the varying experiences of various community groups and groups within the country (Fraser, 2010).

It is therefore crucial to take into account the needs of varying groups, minorities, and those that are very vulnerable to climate change impacts when planning the distribution of climate finance. Additionally, in the planning process, the needs and future requirements of the younger generations is to be accounted for.

vi. *Inter-Sectoral Equity: Diversity*

From the foregoing, it goes without saying that there is a need for recognition of different social groups as a precursor to maldistribution (Honneth, 1996, Taylor, 1994, Young, 1990). A justice perspective poses key questions related to who those groups are to adapt to and under what circumstances. In other words, to what extent are the adaption process and mechanisms fair to the bigger society and respective groups and communities? Is there a commitment to demonstrate fairness, or it is underpinned by a rule of thumb that only corroborates the existing structural, economic, and political order where resources flow to the rich and those connected?

Fraser (1995) contends that recognition should be considered alongside distribution, exploring who is included and excluded in decision-making processes. This framework argues for the need to account for the various identity groups and spatial locations as well as minorities who are affected by climate risks to ensure equity in the process.

vii. *Power Dynamics and Relationships*

Fraser highlights the prominence of power in influencing justice (Fraser, 2014). The need to allow various groups and individuals to participate in decision-making processes. The ability to influence decisions and resource flow depends on the extent to which people are made to participate in the process. This point has been observed Fraser (2007) that "the capacity to influence public debate and authoritative decision-making depends not just on rational decision structures but also on power relations engrained in the economic order and social standing" (p.31).

viii. *Commitment of Pledges and Ndc's*

Caney (2010) contends that social justice approaches to mitigation generally put a premium on the 'polluter pays' approach as well as the 'common but differentiated responsibilities' norm. These principles reckon the remarkable responsibility as well as the distinct ability of states to honour some payments using their positioning in the global economic order.

Climate justice research views climate change impacts vis-a-vis those countries, sectors, communities, or individuals that are responsible for the greatest CO₂ and greenhouse gas emissions (Schlosberg & Collins, 2014; Hayward, 2006). Climate justice considers three forms of equity whose violation would constitute injustice that limits the capabilities of an individual or

group to maintain a high quality of life in the face of climate change (Agyeman et al., 2016). A major rationale put forward to explain why advanced countries make available or ought to arrange for climate finance to developing countries involve arguments such as addressing moral imperatives to atone for historical responsibility or culpability in global emissions (Meyer, 2013).

V. CONCLUSIONS AND POLICY IMPLICATIONS

From the framework and discussion, the study makes the following key conclusions and proffers the following policy implications.

Firstly, the study concludes that climate financing has not been adequately used as a tool or mechanism to demonstrate justice and fairness in the global distribution of climate resources. The extant literature could not provide uniform evidence to demonstrate a positive relationship between vulnerability, poor coping mechanisms, and receipt of climate finance. More worrisome is more recent literature even points to negative relationships as sub-Saharan Africa and South Asia which are more vulnerable have been called out due to poor relative receipts.

The study concludes that other factors other than vulnerability underpin the distribution of global climate finance because more vulnerable spatial locations and groups have not been the greatest recipients. This study argues for the need to disaggregate spatial entities to unpack those regions and sub-regions as well as groups that are greatly susceptible to climate impacts to receiving greater flows of climate finance. There is a need to conceptualize vulnerability more effectively. This study agrees with the extant literature that "how vulnerability is defined and measured is key to climate justice as it subsequently affects the types of actions taken to respond to climate change and determines who will benefit and how from these actions (see Burnham et al. 2013 p. 242). This position has been given support by O'Brien et al. (2007) that a localized operationalization of vulnerability emerged as a moral response to observed social inequities in the impacts of social and environmental change" (Eakin et al., 2009: 214).

Secondly, the study concludes that the inability of most groups and entities to access global climate finance has been inadequate technical details and lapses in the application process as well as capacity challenges of the recipient entities.

Additionally, this study concludes that promoting justice in climate financing requires a systems approach that entails a need to focus on both the social and ecological aspects of climate actions and interventions. We put forward that in as much as targeting individuals to be able to adapt and mitigate

remains crucial, it becomes more effective if there are efforts to stabilize the system or macro environment as well. There should not be an attempt to delink the individual households from the general system as this will derail the particular intervention processes.

Moreover, this study makes a case for a commitment from stakeholders across the scale to demonstrate political commitment in their attempts to identify and target vulnerable people and spaces for the purpose of climate adaptation and mitigation. Without this, resources get to those who do not need it most and the disparity and vulnerability exacerbate for poor and vulnerable people (see also O'Brien et al., 2004 p.5). To address such constraint, the study argues for an equity philosophy and calls on policymakers and funders to demonstrate distributional justice and intra-generational justice, and inter-sectoral justice. Conscious efforts should be made to promote the well-being of socially disadvantaged areas and people by increasing their access to decision-making processes which will make their voices heard and concerns addressed.

Finally, the study contends that the implementation of climate actions (mitigation and adaptation interventions) requires sound technical skills deploying optimal implementation models lest well-intended policies and interventions may fail to achieve their objectives. This even calls for continuous monitoring and evaluation to access the extent to which the implementation process is going according to plan. This "follow-up" and quality assurance should be done at multiple scales to police the climate finance from the top to the local level implementation phase. We conclude that finances flowing from the rich economies to poor and vulnerable regions are only a starting point for effective climate actions, the efficacy of the process depends on the commitment to identify the real vulnerable people and areas; commitment to expend the requisite resources appropriately; the technical capacity to effectively enforce interventions followed by quality assurance measures through sound evaluation and corrective measures.

Statements and Declaration

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The authors have no conflicts of interest to declare that are relevant to the content of this article.

Consent to participate

Informed consent was obtained from all individual participants included in the study

Data availability

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request

Abbreviations

CO ₂	-	Carbon Dioxide
IPCC	-	International Panel for Climate Change
NDCs	-	Nationally Determined Contributions
NGOs	-	Non-Governmental Organizations
NSAs	-	Non-State Actors
SAVE	-	Systems Approach Verification and Equity philosophy
SDGs	-	Sustainable Development Goals
UN	-	United Nations
UNFCCC	-	United Nations Framework Convention on Climate Change

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Interpreting the Haor Eco-System through Sustainable Design: Haor (Wetland) Eco-Interpretation Center, Moulvibazar, Sylhet, Bangladesh

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Abstract- Wetlands, known as 'Haors' in Bangladesh, are vital ecosystems that provide essential ecological services and support diverse biodiversity. However, they face increasing threats due to extensive tourists visits, unawareness about environment preservation and unsustainable development practices. The "Haor Eco-Interpretation Center" in Moulvibazar, Sylhet, Bangladesh, emerges as a pioneering initiative to address these challenges by combining environmental education and sustainable design principles.

This paper provides an overview of the Haor Eco-Interpretation Center's objectives, strategies, and significance. The center serves as a unique model for interpreting the Haor ecosystem while promoting sustainability through its architectural and operational features. The key elements of this initiative include visitor education, research facilities, and eco-sensitive design principles.

Keywords: wetlands, haor ecosystems, sustainable design, environmental education, conservation.

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Abstract- Wetlands, known as 'Haors' in Bangladesh, are vital ecosystems that provide essential ecological services and support diverse biodiversity. However, they face increasing threats due to extensive tourists visits, unawareness about environment preservation and unsustainable development practices. The "Haor Eco-Interpretation Center" in Moulvibazar, Sylhet, Bangladesh, emerges as a pioneering initiative to address these challenges by combining environmental education and sustainable design principles.

This paper provides an overview of the Haor Eco-Interpretation Center's objectives, strategies, and significance. The center serves as a unique model for interpreting the Haor ecosystem while promoting sustainability through its architectural and operational features. The key elements of this initiative include visitor education, research facilities, and eco-sensitive design principles.

The Haor Eco-Interpretation Center embodies a harmonious coexistence between modern infrastructure and the fragile wetland environment. Its sustainable design incorporates green building technologies, renewable energy sources, and eco-friendly construction materials. Through this project, the center aims to educate visitors about the importance of wetlands, the challenges they face, and the critical need for their conservation. Furthermore, the center fosters research and documentation of the Haor ecosystem, providing a platform for scientists and conservationists to study and preserve these vital wetlands. By merging education, research, and sustainable design, this center serves as a model for the Haor ecosystems and wetlands worldwide, offering a blueprint for balancing human development with environmental preservation.

Keywords: wetlands, haor ecosystems, sustainable design, environmental education, conservation.

I. INTRODUCTION

Wetlands are considered as ecological valuable resources all over the world for the potential to support a wide variety of ecosystems and their significant impact on the sustainability of the environment. Haors are the native name for these

wetlands in Bangladesh, and they play an essential role to the country's economy and the survival of many people and animal species. However, the serene beauty of these watery landscapes conceals a growing and pressing concern. The sensitive equilibrium of these ecosystems is threatened by frequent travel, ignorance of environmental protection, and irresponsible development methods, threatening their important ecological functions.

In spite of these challenges, the "Haor Eco-Interpretation Center" in the beautiful area of Sylhet, Bangladesh, has emerged as a pioneering endeavor. This innovative project provides a groundbreaking example of how to comprehend and preserve Haor ecosystems by bringing together environmental education and sustainable design concepts. In the next section of the study, the many facets of this significant effort are examined, including its goals, techniques, and wider relevance in the context of wetland conservation.

The mission of the Haor Eco-Interpretation Center is to combine human progress with environmental protection. The architectural and functional components of this integration are representative of its commitment to sustainability. The importance of wetlands as ecosystems, the challenges that they confront, and the pressing need to preserve them are all emphasized as part of the tourist experience. As well as being a place where people can learn, the center is also a key research facility, helping researchers get a better knowledge of Haor ecosystems and giving them a place to share their findings and collaborate on important conservation efforts.

II. ECOSYSTEM OF HAKALUKI HAOR

Hakaluki Haor is a marsh wetland ecosystem in Bangladesh's northeast. It is one of the greatest estuary wetland resources in Bangladesh and Asia. This Haor is circumscribed to the north by the Kushiara River and a portion of the Sonai Bardal River, to the west and south by the Fenchuganj-Kulaura railway, and to the east by the Kulaura-Beanibazar road (Figure.01). Hakaluki Haor has been designated as an Ecologically Critical Area (ECA) (ECA 2010), and its surface area is 181,15 km².

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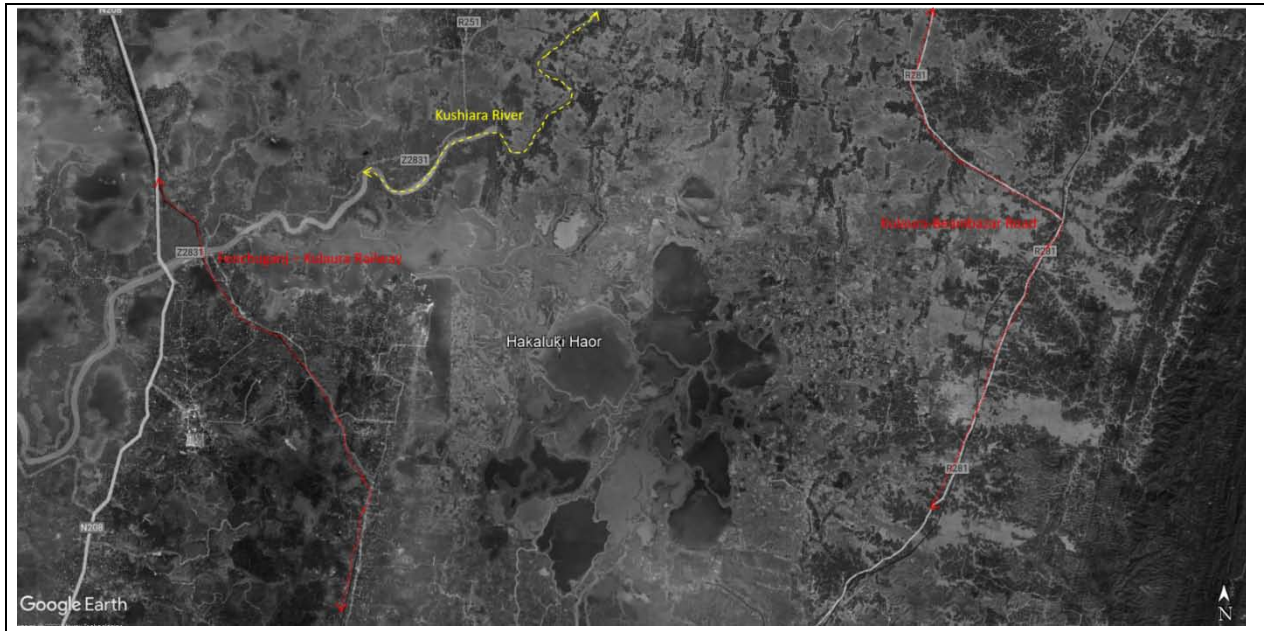
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Seasonal strong winds during the monsoon period (July to September) cause enormous swelling in the haor, which can cause significant damage to farmland. However, they all become dried out following the monsoon season. These haors are extensive stretches of verdant land during the winter.

The Total Covered area of Hakaluki Haor contains different sizes and types of water bowls. According to the typology there can be three types

basically in which different zone of this haor can be divided. Hakaluki Haor covers an area of 32,000 ha and it has a central elevation of 4m (PWD), an area of about 18,000 ha, lying below the contour of 9 m, is considered Seasonal Wetlands, and during the monsoon, the entire haor is flooded and over 60% of the area is inundated by more than 2.5 m, and the whole of the haor becomes a sheet of water (Figure. 02) (Hasan, M. et al. 2005).



(Source: Google Earth)

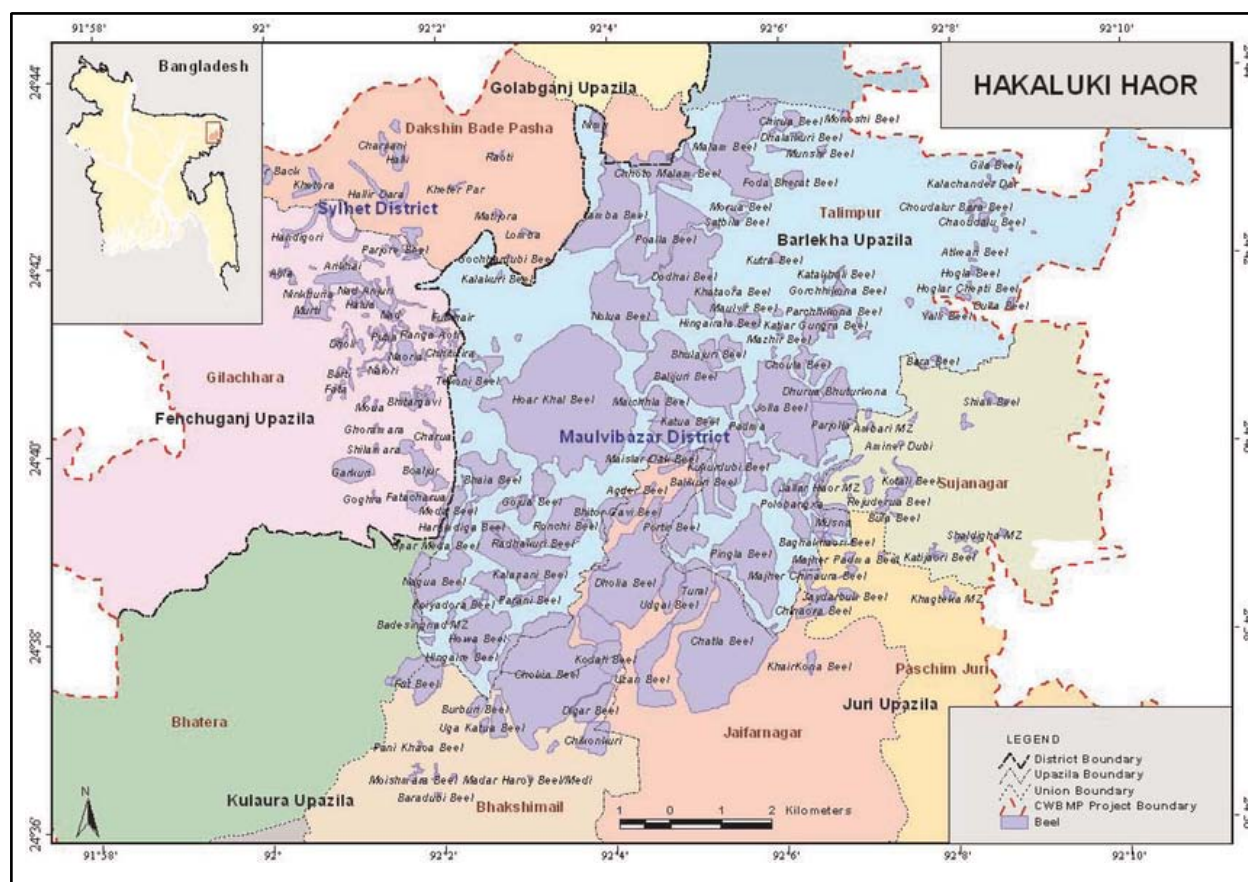
Figure 01: Surrounding of Hakaluki Haor



Figure 02: Seasonal Wetland Zone in Hakaluki Haor

But as the water level falls during the dry season, the beels become differentiated from one another. In the Hakaluki Haor, there are more than 125 interconnecting beels/ Jalmahals. The important beels are Chatla, Pinglarkona, Dulla, Sakua, Barajalla, Pioula, Balijhuri, Lamba, Tekonia, Haorkhal, Tural, Baghalkuri, Chinaura, etc. The total area of this wetland is about 18,000 ha of which 4,569 ha retain water permanently which is under Permanent Wetlands (Figure 03). The Sonai-Bardal River as well as the Juri River flowing

through the haor and some smaller hilly streams joining these rivers or discharging into some beels fall under the category of Perennial Wetlands.



Source: https://www.researchgate.net/figure/Map-of-Hakaluki-haor-of-Bangladesh_fig1_233520655

Figure 03: Permanent Wetland Zone in Hakaluki Haor

III. SITE ATTRACTIVENESS: ELEMENTS OF INTERPRETATION

There are approximately 526 plant species in the region, including 120 aquatic plants (Steemit, 2018) that not only thrive in water but also contribute to the health of fish sanctuaries. There are 417 bird species, 112 of which are migratory and 305 that are native to the area (Steemit, 2018). There are a few hamlets around the haor, nestled within the hundreds of trees that surround the area. Many thousands of birds rest in the trees at night and feed on the haor (wetland) during the day. In addition to the 200 species of uncommon winter birds, there are also 150 species of fish and 20 species of reptiles (Steemit, 2018). There are several sorts of wetland plants available, including submerged plants, free-floating plants, sedges and meadows, and reeds. The haor, or wetland, serves as a connecting link for a wide variety of species, including animals, birds, fish, and plants (Figure. 04).

During the monsoon, the entire haor becomes an ocean of water and is completely flooded and submerged. However, during the dry season, when the water level drops, the beels become distinct from one another. This same ground, when covered with mustard

in autumn, becomes dry and yellow, providing a winter resting spot for thousands of migrating birds. Colors like green, dark blue, yellow, and light blue may all be visible in the same area at the same time of year. This area is known for its sticky, adhesive soil, which makes it difficult to build on without pilings yet excellent for farming.

This location is distinguished by its vast wetland area, which is home to a wide variety of bird species, tree types, and topographical features. Water level changes further enhance the compelling seasonal change that occurs in the landscape. Landforms, wetland ecosystems, bird species, human settlements (including homes, churches, and mosques), and natural features all exist without human intervention.

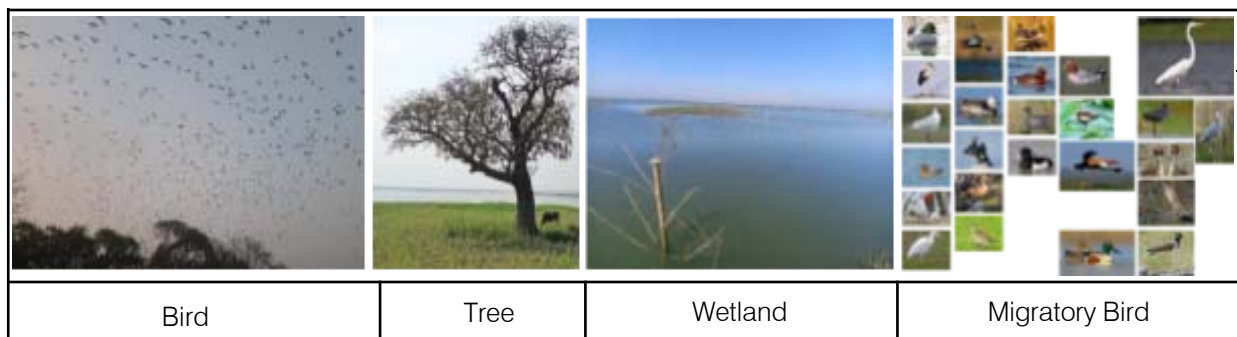


Figure 04: Elements of Interpretation of Haor

IV. SUSTAINABLE DESIGN ISSUES FOR ECO-SYSTEM INTERPRETATION

Sustainability, harmony with the environment, and practicality can only be achieved when both natural and man-made aspects are taken into account during

the construction of an Eco-System Interpretation Center (Figure 05) Following is an expansion on the most important factors that were taken into account throughout the design process:

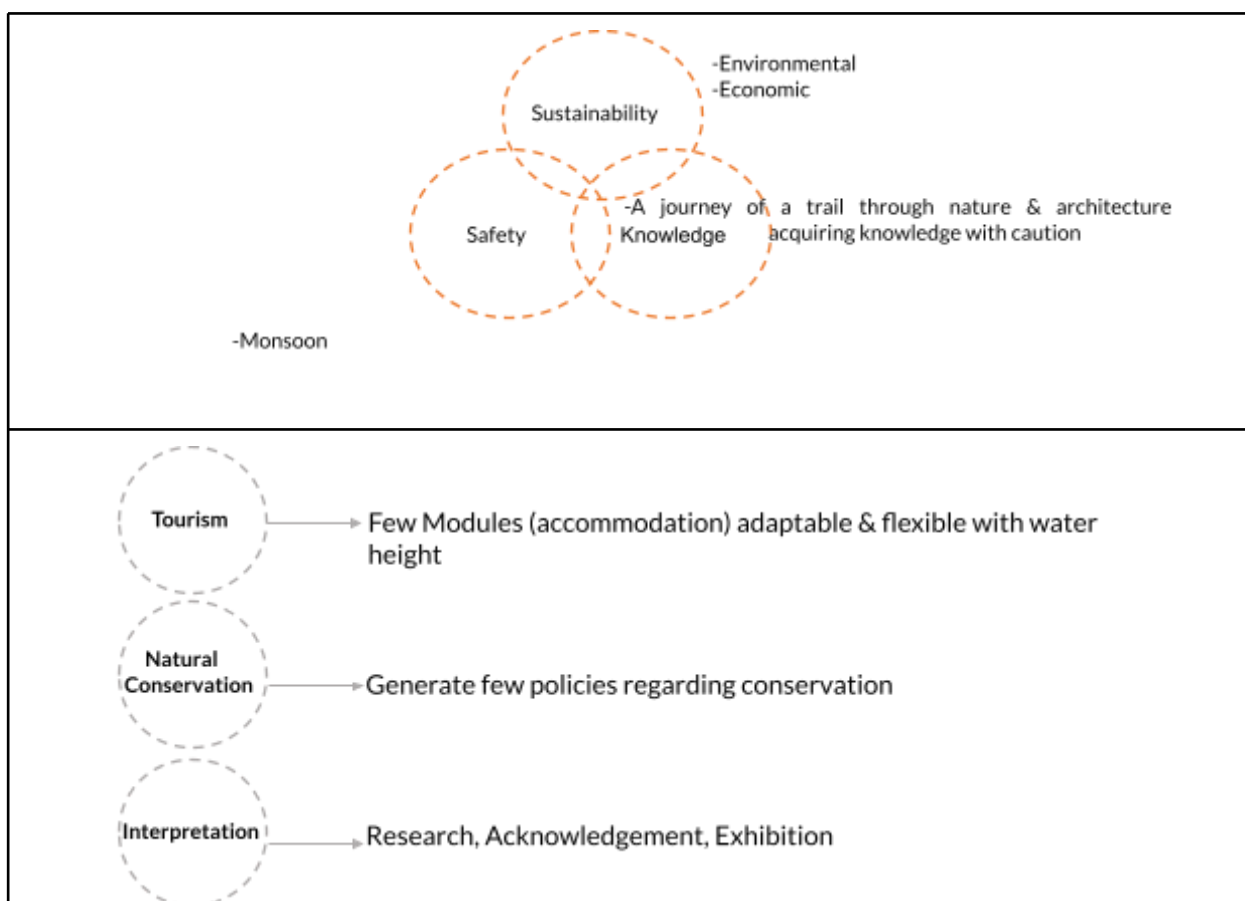


Figure 05: Sustainability Issues to Design the Center

a) Natural Factors

- **Natural Site Preservation:** The development of the facility should cause as little disturbance to the

surrounding environment as possible. This involves taking measures to protect the native plant and animal life.

- *Minimal Ground Impact:* Impact on the ground should be kept to a minimum, therefore, an elevated approach for building construction is recommended. The principle that "less is more" is adhered to by reducing the building's physical footprint, thereby minimizing disturbance to the land.
- *Substantial Plantation:* Native vegetation should be heavily prioritized for the perimeter plantings. This not only improves the site's appearance but also helps maintain its ecological balance.
- *Adaptability to Monsoon Waters:* The building design must be flexible enough to accommodate rising and falling levels of water. This ensures that the center can continue to operate without interruption during periods of high inundation (Figure 06).
- *Beyond Boundary:* The whole concept of borders has to be questioned. The center should extend beyond its conventional boundaries to merge with the local ecology, blurring distinctions between the natural and man-made worlds.

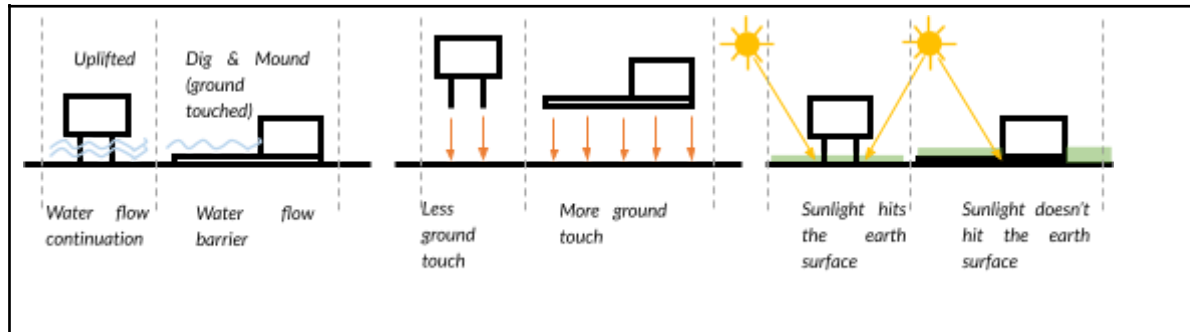


Figure 06: Natural Factors Considered in Design

b) Man-Made Factors

- The use of locally obtained materials needs to be promoted as a means to lessen the community's environmental impact and enhance the economy. Utilizing locally accessible materials contributes to the development of a sense of place.
- The center design should prioritize openness and transparency. Visitors benefit from an enhanced awareness of their natural surroundings because of the transparency of buildings that don't block their views (Figure. 07)
- The center's energy plan should prioritize sustainable practices. The carbon footprint of the facility may be reduced by using renewable energy sources like solar panels and wind turbines.
- Given the variety of uses for the area, careful zoning is essential. The division of spaces should be designed with consideration for both the private functions, like research labs and accommodation, and public zones.
- The design should emphasize the establishment of large open areas that may be used for a number of purposes, including but not limited to, walking routes, Haor (wetland) observation, and bird watching. These spaces should blend harmoniously with the natural surroundings.

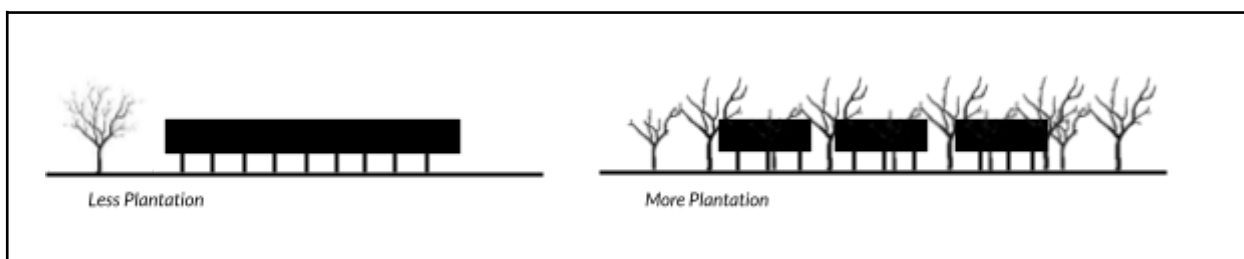


Figure 07: Man-made Factors- Trees between Structures, Structures between Trees Considered in Design

The design of an Eco-System Interpretation Center should be driven by a strong commitment to sustainability, environmental preservation, and the harmonious coexistence of man-made structures and the natural world. Taking these natural and man-made factors into account will make the center an ideal example of eco-friendly architecture and a focal point for spreading awareness about environmental issues.

V. INTERPRETING THE HAOR ECO-SYSTEM: DESIGN PROPOSAL

a) Site Selection for Interpreting the Haor Eco-System

The site analysis and selection of appropriate site for interpretation center has taken into two phases of workout (Figure 08).

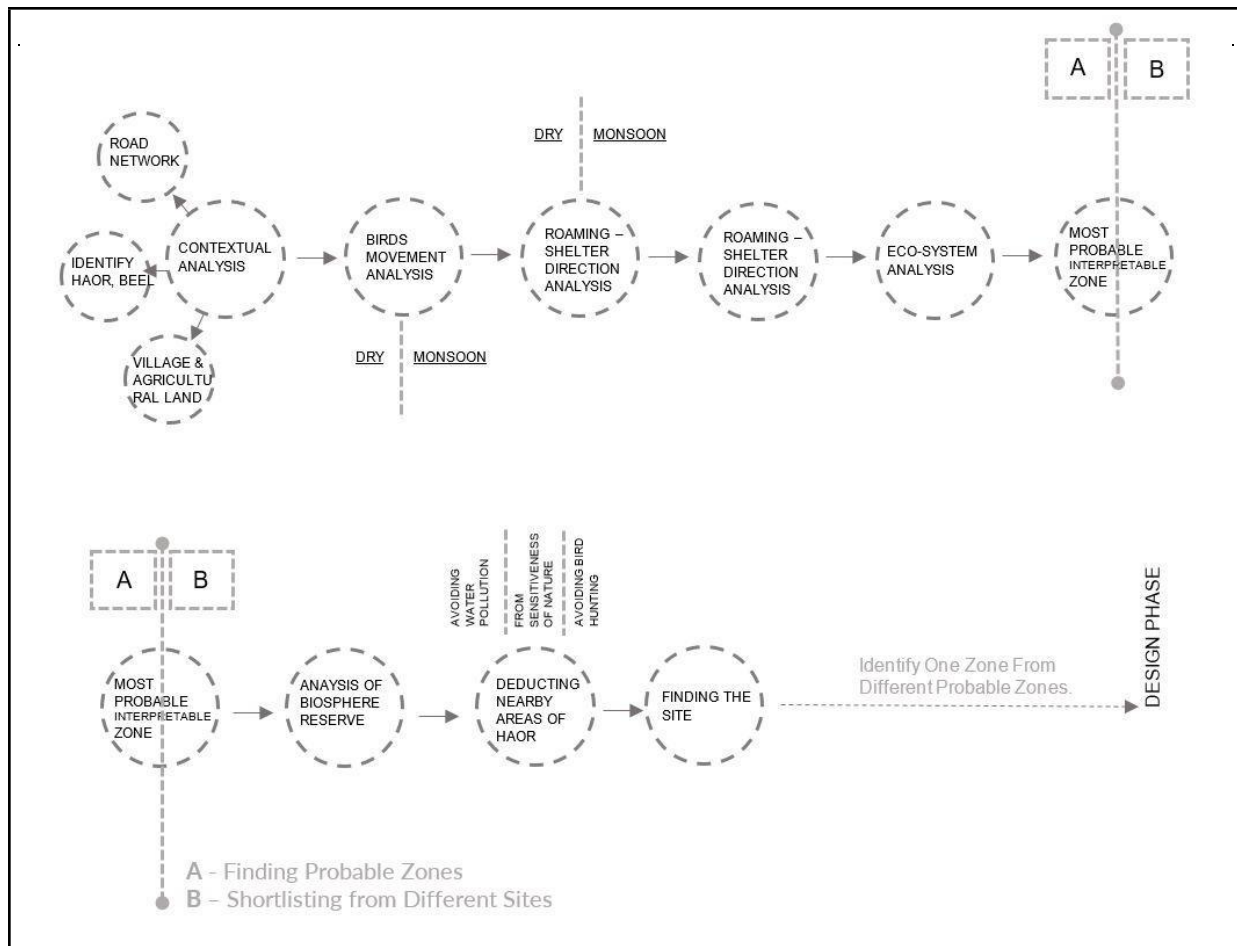


Figure 08: Site Selection Procedure for the Center

Phase A

Site selection for understanding the Haor eco-system began with a comprehensive investigation of the surrounding environment. The investigation included a wide range of topics, including road infrastructure, the location of wetlands (Haors), rivers (Beels), and human settlements (villages and towns), and the demarcation of farmland. The road system, topography, and location of settlements in relation to the Haor were all studied in detail. The study helped define areas with distinct features and characteristics.

Detailed research on the habits of birds was also accounted for alongside environmental factors. This required tracking the migration routes and flying habits of different species of birds during the dry and wet seasons. Because of this thorough study, a complete map of the Haor's ecosystem was created. This research established the existence of six separate interpretable zones (Figure. 9).

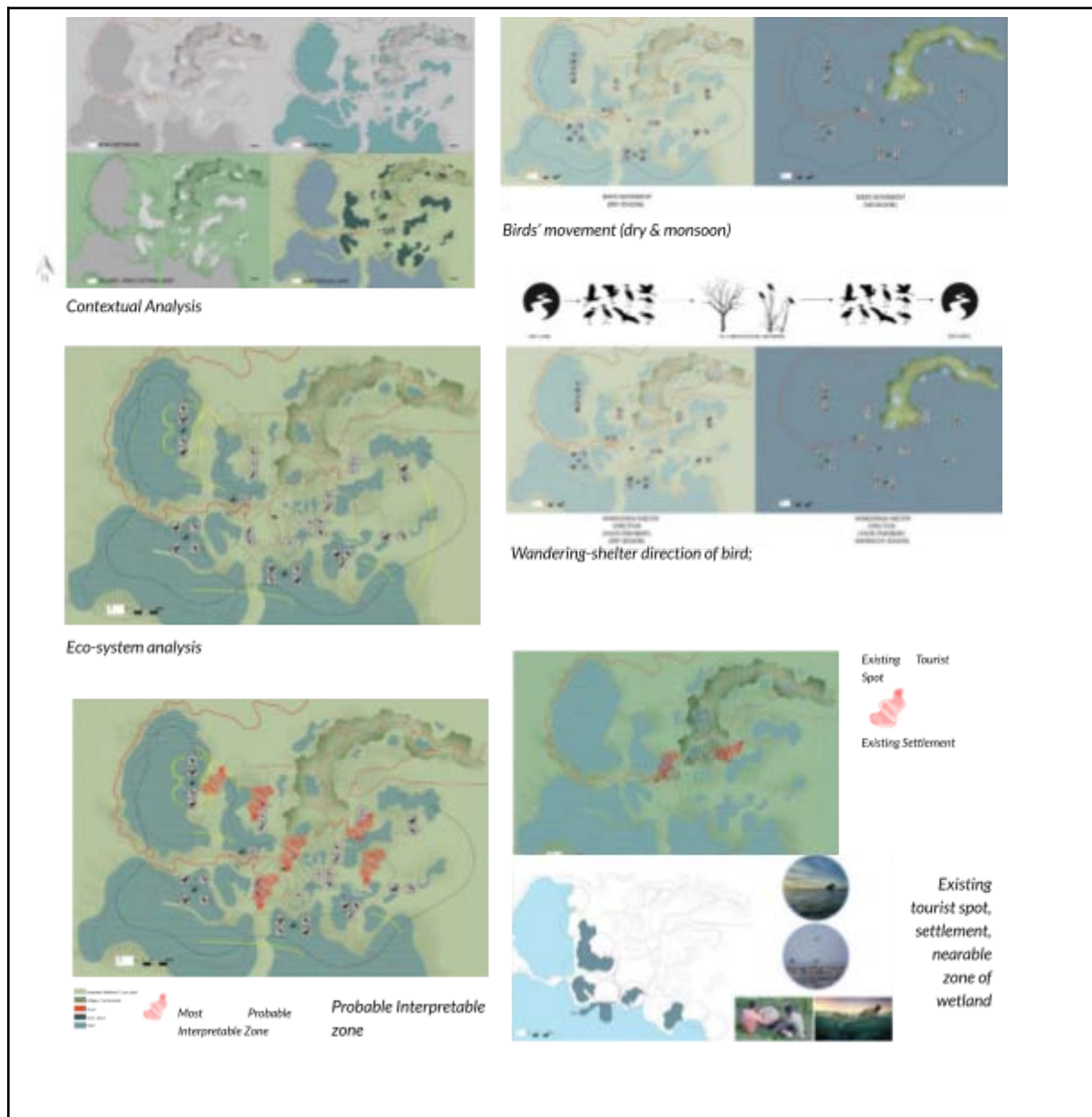


Figure 09: Phase A of Site Selection

Phase B

An intensive Biosphere Reserve (Kratzer, 2018) analysis was performed further to narrow down the choices of these six zones. In addition to this study, an examination of the road system, the location of already established tourist attractions, and the finding of communities where birds live without fear despite the presence of humans were conducted. Places that may add to pollutants or damage the wetland's natural environment were specifically avoided.

The core area, buffer zone 1, and buffer zone 2 were established based on the principles of the Biosphere Reserve concept (UNESCO 2022). For the purpose of site selection, these labels were placed on

the current location. A subset of the first six zones was removed after taking into consideration the road network and the minimal distance from the wetland. The remaining locations were reduced according to their closeness to tourist hotspots and established communities. This decision was made with the goal of minimizing impacts on the local bird population without completely cutting off access to the outdoors and the wetland. In addition to allowing new arrivals to immerse themselves in the natural environment, the selected zones also provided accommodation options alongside the existing ones, thereby minimizing disruption to the birds' habitat and ensuring harmonious coexistence (Figure 10).

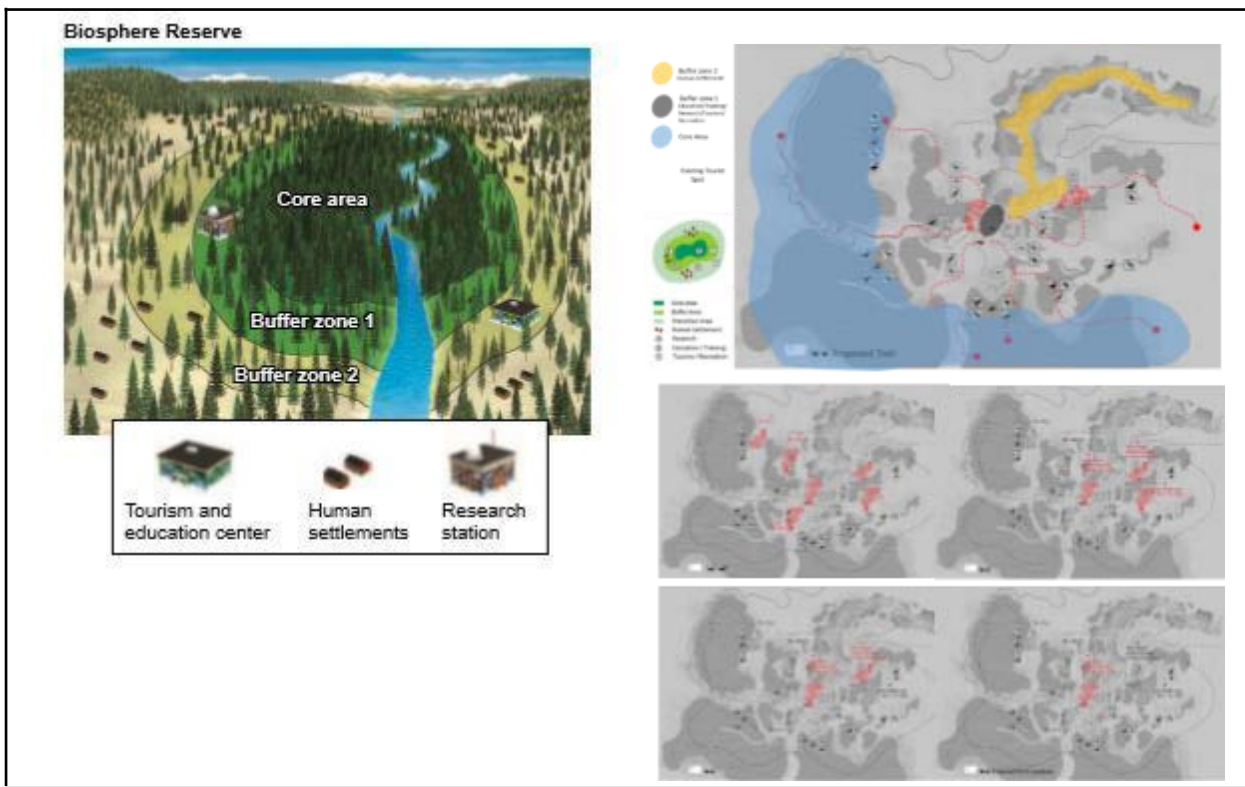


Figure 10: Phase B of Site Selection

b) Program Development

It is crucial to increase public understanding, promote biodiversity, conservation, and ecotourism by creating an eco-nature education and interpretation program for the Haor eco-system. This initiative is focused on educating people about the sensitive biological system that exists in the Haor wetlands in an effort to promote harmonious relationships with the natural world.

From an ecological perspective, tree planting has been regarded a fundamental strategy for many programs. Some trees have been found to offer birds with safe haven, despite their closeness to human dwellings in a hamlet. A large number of well-selected tree species should be planted to improve the environment and offer shelter for birds and fish during the monsoon. Aside from providing security, this reforestation project will improve the local ecosystem.

Table 1: Program Development Strategies

Goal	Target	Program
To Conserve Eco-systems for Biodiversity	Rehabilitation of Plantation	-Replanting -Enrichment planting
	Strengthening Co-management	Expansion of Eco-tourism facilities
	Wildlife	Protection and management of wildlife
Interpretation Center	Research	Modules adaptable and flexible with the context
	Acknowledgement	

The Haor Eco-System Interpretation Center's layout prioritizes two distinct areas:

- Research Lab & Office:** This zone is dedicated to the private aspects of the center's operations, primarily for scientific research and administrative functions.
- Interpretation Center:** The interpretation center is designed to facilitate public engagement and education. It encompasses several distinct zones:
 - Display Area:** The Display Area is a covered indoor place where guests may learn about the Haor

ecosystem. It includes instructional exhibitions, presentations, and interactive media.

- Natural Display Zones:** Adjacent to the interpretation center, these outdoor spaces allow visitors to get up close to nature without causing harm to the delicate ecosystem. Careful landscaping and design ensure minimal disruption.
- Education Center (Seminar Room):** This climate-controlled space is convenient for holding seminars, workshops, and other learning events because of its close proximity to the lab. It promotes a synergistic

relationship between scientific research and public education.

- *Archive*: The archive houses a collection of valuable documents, research findings, and historical records related to the Haor eco-system. It serves as a resource for researchers, students, and the public.
- *Multipurpose Area*: This adaptable area hosts events and activities for a wide range of audiences and may be used for a wide variety of purposes, including but not limited to increasing community participation and events that are in line with the center's objective.
- *Small Café*: A small café provides refreshments for visitors, offering a place to relax and reflect on their experiences while enjoying the natural surroundings.
- *Admin Area*: The administrative area supports the daily operations of the center, including staff offices and logistical functions.

By including ecological and architectural factors, the designers of this program want to provide a method to understanding the Haor ecosystem that is both comprehensive and sustainable. It aims to

educate, inspire, and protect this unique natural treasure for generations to come (Table 01).

c) Concept Derivation

The concept for the Haor (Wetland) Eco-Interpretation Center is based on three primary components. Humanity, rather than being a hindrance to the natural world, is at the heart of the project's overall philosophy. In addition, the idea is formed from a thorough examination of natural patterns with an emphasis on incorporating sustainable characteristics.

"A Refreshing Pause": The primary concept behind the initiative is to give people a chance to take a "Refreshing Pause." Visitors may take a break from their travel across the major highway via the villages and into the center, which will do them pleasant both mentally and physically. The purpose is to provide a place where people may relax while taking in new information about nature. Eventually, this pause should transform them into blessings for nature, not obstacles, by encouraging an appreciation for the natural world and preventing activities that harm it, such as pollution (Figure 11).

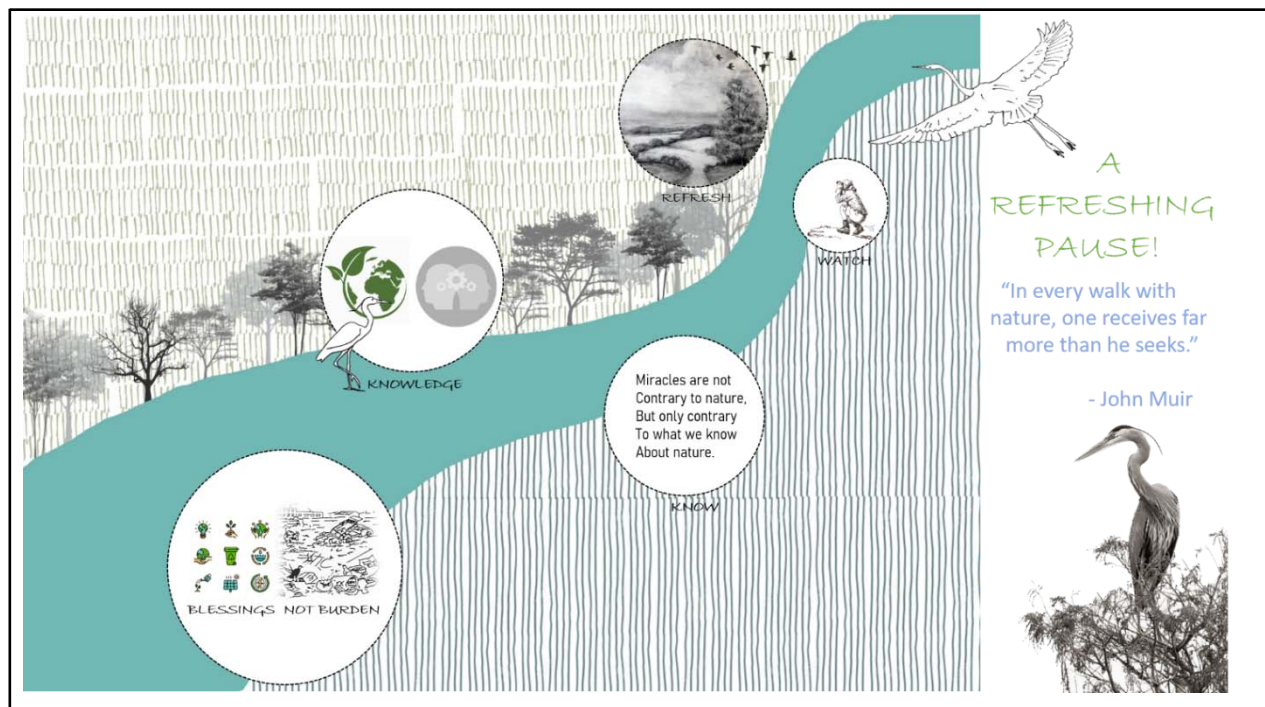


Figure 11: A Refreshing Pause – Conceptual Illustration of the Center Design

Nature's Language: Another fundamental idea is "Nature's Language." Nature has its own language, which is defined by form, function, and character. Natural land circulation is reflected in the paddy fields and islands that dot the wetland landscape. The design process ought to incorporate the language of nature to ensure that the project blends in with the surrounding environment and does not frighten the birds or disrupt the sensitive equilibrium of the wetland ecosystem. This

requires thinking about the interplay between the built environment, trees, and nature, and planting a large number of specific trees like Hijol, Korosh, and Barun to improve the habitat for birds and fish, as well as understanding and reiterating existing patterns (Figure 12).

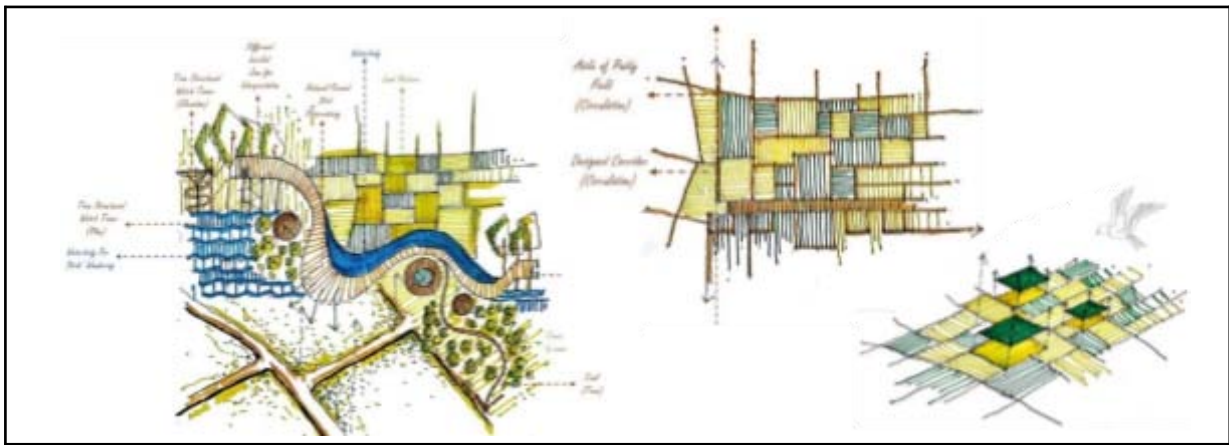
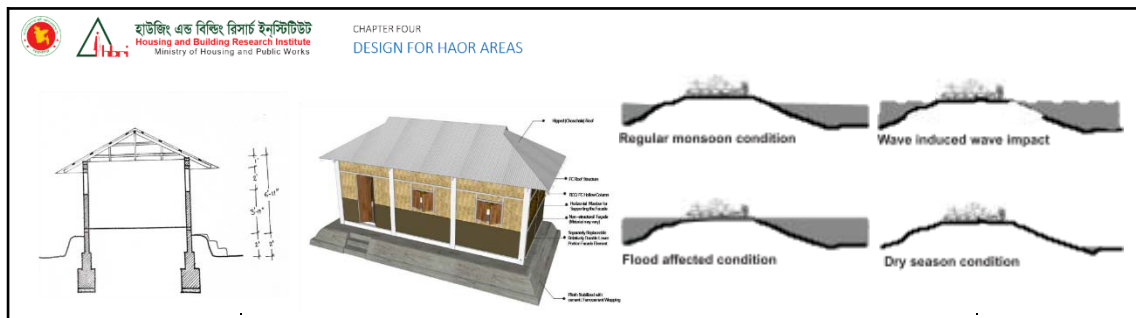


Figure 12: Nature's Language- a Component of Concept

Energy Efficiency and Eco-Friendly Practices: The project is committed to using as little energy as possible and designing eco-friendly indoor and outdoor areas. The use of solar energy, the encouragement of natural ventilation and lighting, and the use of recyclable, reusable, and low-maintenance materials all contribute to this goal. The topography of the land, the ground and surface water levels, the existing flora, and the aquatic

ecosystems are all given high priority when it comes to eco-friendly building design. To protect the sensitive ecological situation, human influences are carefully evaluated. Site selection, site planning, architectural design, material selection, and construction processes should all conform to criteria established by institutions like the Housing and Building Research Institute (HBRI) (HBRI 2018) (Figure 13).



Source: (HBRI 2018)

Figure 13: HBRI Standard for Haor Area Building Construction

d) Built Form Derivation

Haor (Wetland) Eco-Interpretation Center design and architectural form are strongly rooted in the language of nature. The shapes, patterns, and lines of nature are all its own. To achieve a design that works in concern with its surroundings, it was essential to investigate and comprehend these natural patterns. To begin, a section of the land was chosen where distinct natural lines and patterns already existed. Schematic outlines, lines, and an overall master plan were built by carefully observing and accommodating these preexisting patterns (Figure 14).

Formal lines that reflect natural geometric forms, such as rectangles and squares, describe the center's formal functions, especially the interpretation center. These forms are both structurally sound and consistent with the conventional roles of interpretation and education.

Curved lines that are more organic and relaxed characterize the more informal uses, such as the bird observatory. These lines are an attempt to capture the fluctuating patterns of a wetland's ecology. These lines' irregularity and fluidity reflect the bird observatory's informal and observant nature, giving visitors an immersive experience that blends with nature.

The Haor Eco-Interpretation Center's architecture is a literal translation of the language and patterns found in nature. Its combination of both formal and informal forms results in a design that not only blends in with its surroundings but also connects visitors to the intricate beauty of the Haor wetlands.

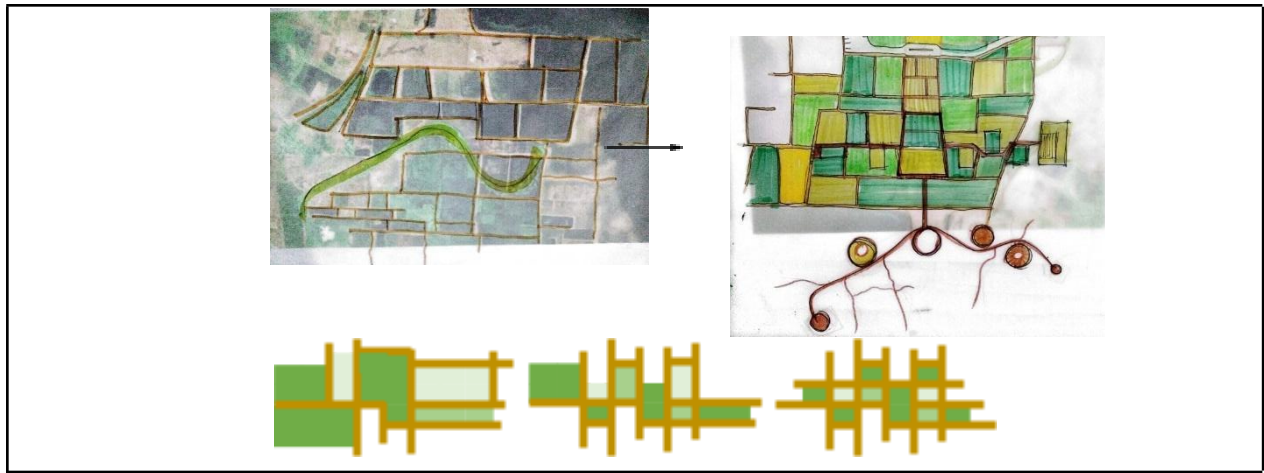


Figure 14: Built Form Derivation of the Interpretation Center

e) *Land Use Selection and Master plan Development*

The Haor (Wetland) Eco-Interpretation Center has been built according to a well-thought-out layout and land-use strategy (Figure 15). The major goal was

to create a space that could serve several purposes while still being in harmony with its natural surroundings. Three distinct zones (Figure 16) were identified based on the program requirements:



Figure 15: Masterplan of Interpretation Center with Seasonal Variation



Figure 16: Plan at 10 feet level: A-Interpretation Center, B-Bird's Observatory, C-Accommodation

i. Interpretation Center

The Interpretation Center serves as the hub for a wide variety of activities. The left side houses the more public areas including the lobby, museum, gift shop, administrative offices, multipurpose rooms, cafe, archive center, and prayer room. On the other hand, the right side of the building has more private and restricted areas such as the classrooms, laboratories, and offices (Figure 17 & 18).



Figure 17: Interpretation Center

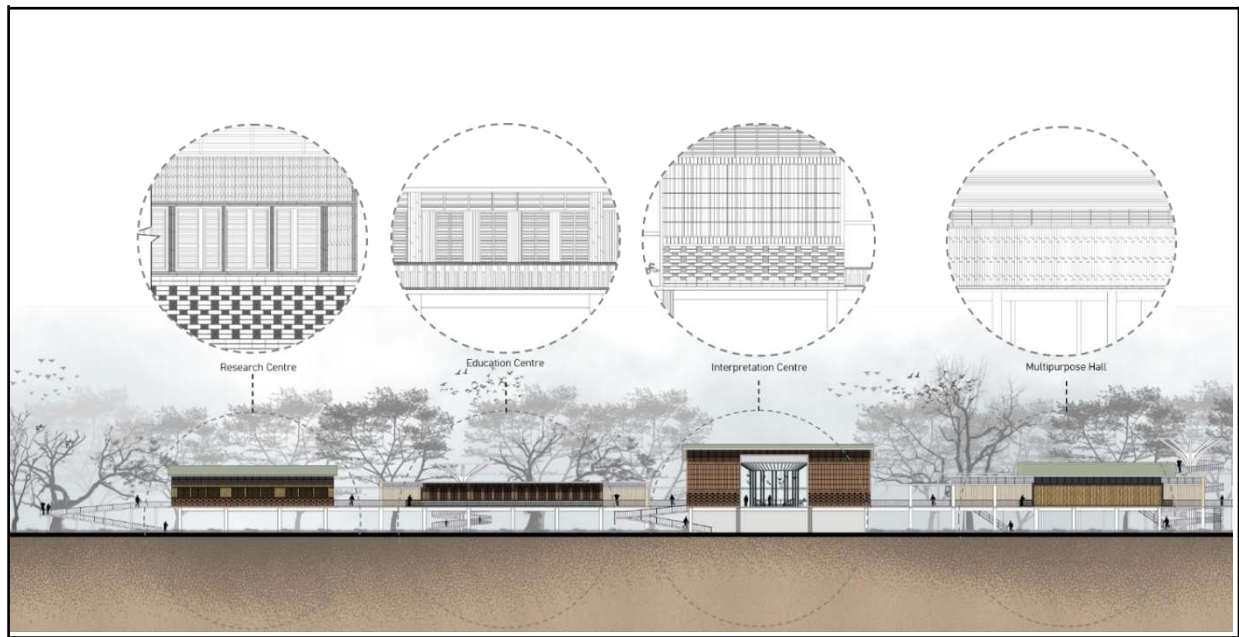


Figure 18: Elevation of Interpretation Center

ii. Bird's Observatory

This area is designed with a curved shape to facilitate bird observation. Visitors are guided through a series of progressively higher platforms from which they may get a better look at the feathered inhabitants, both at ground level and from above (Figure 19).

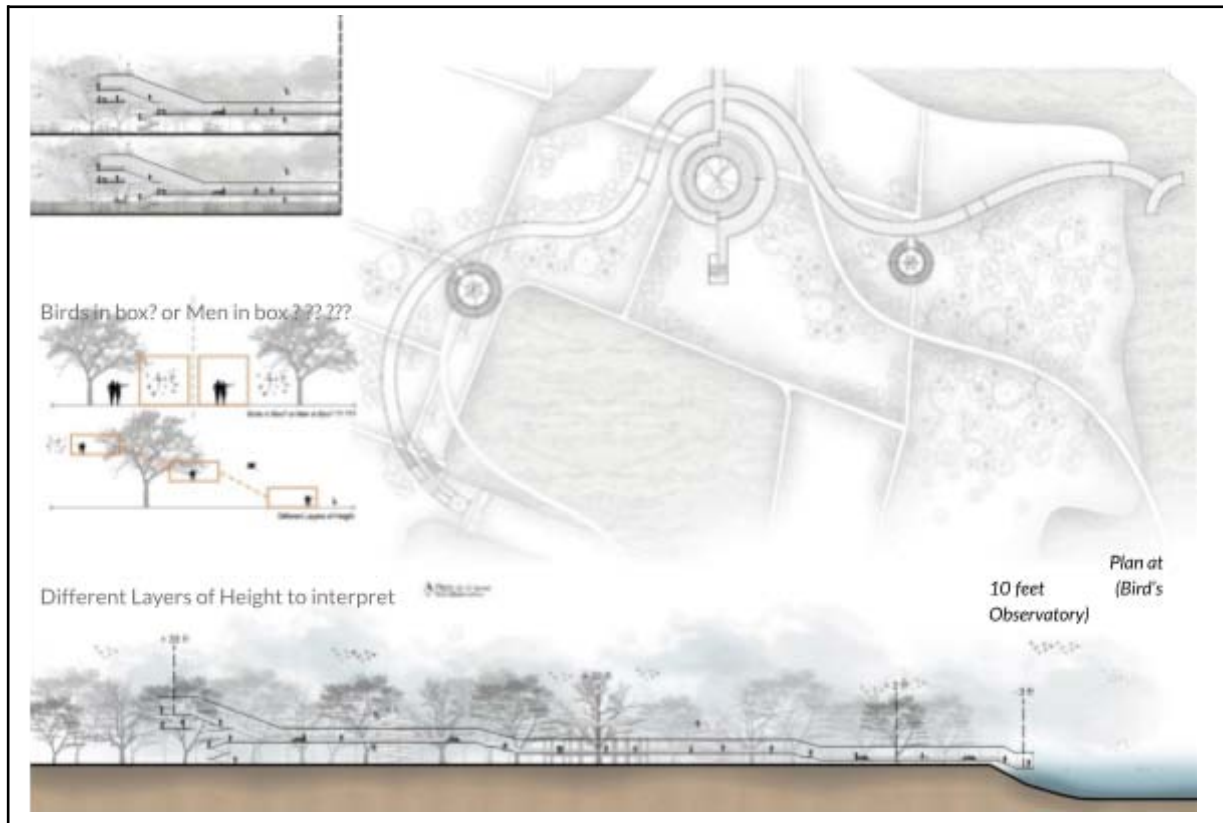


Figure 19: Bird's Observatory

iii. Accommodation

The location of the accommodation zone was carefully chosen to match the preexisting layout of settlements. This method involves constructing tiny buildings amongst hundreds of trees. This design was inspired by local buildings, which give a huge piece of land of trees and a smaller area to the house. This design protects the

ecosystem and lets birds travel and rest freely. The planned accommodation follows the "Dig & Mound" style of the existing buildings.

The master plan prioritizes a harmonious integration between the built environment and nature, minimizing the impact of the center on the wetland ecosystem. This method not only pays respect to preexisting structures but also gives visitors an interactive and eco-friendly experience (Figure 20).

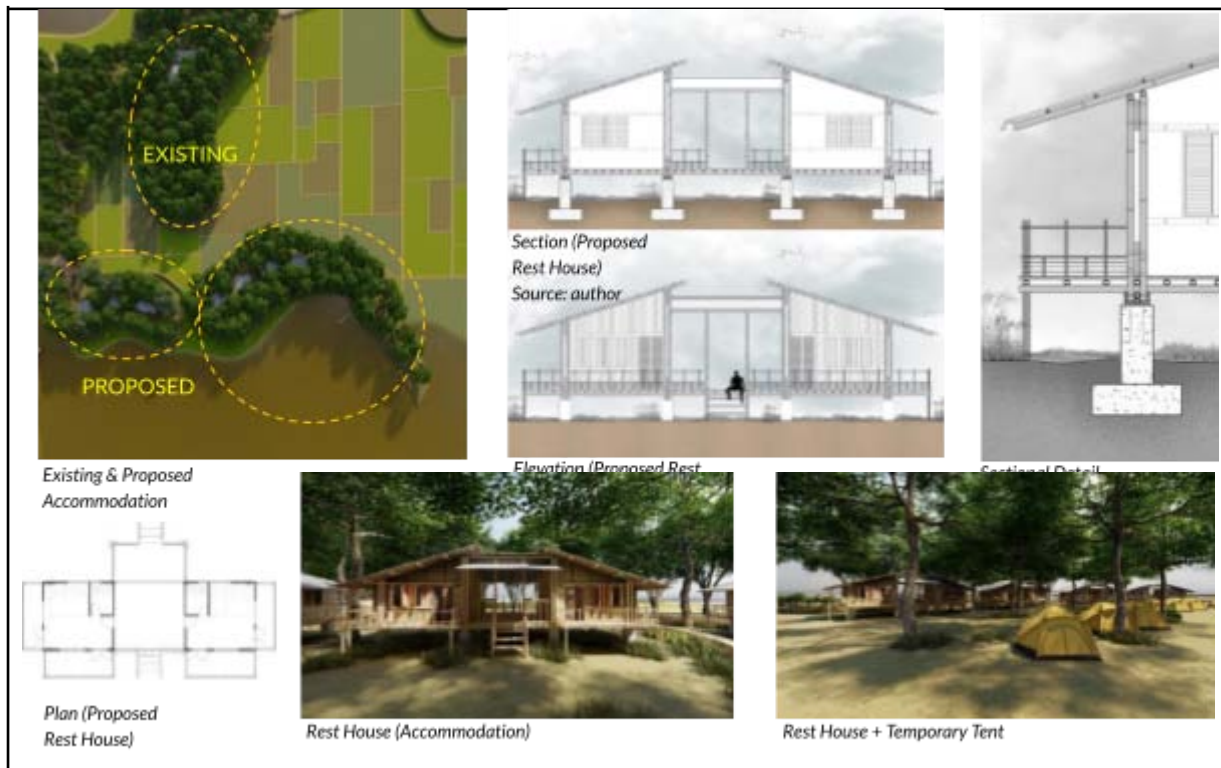


Figure 20: Accommodation

f) *Eco Sensitive and Sustainable Way of Interpretation*

The Haor (Wetland) Eco-Interpretation Center integrates the built environment with the natural environment in a way that is both sustainable and ecologically sensitive (Figure 21).



Figure 21: Eco Sensitive and Sustainable Way of Interpretation

a. *Integration of Nature:* Trees are planted in and around the structures, and open space is left between them for people and wildlife. Because of

this careful preparation, it is difficult to distinguish between manmade and natural environments. The

- design purposely blurs the line between plants and nature.
- Afforestation and Extensive Open Spaces:** The need of afforestation is emphasized, and large open areas are provided. Landscaping activities at the facility are vast, adding to the area's biodiversity and providing sanctuary for animals, notably birds and fish during the monsoon. The master plan has extensive landscaped areas, bird-watching platforms, and wetland observation paths. These parts have been thoughtfully included into the layout to provide visitors with an all-encompassing experience that is in harmony with their surroundings.
 - Adaptability to Monsoon:** The architecture is flexible and adaptive, allowing it to continue functioning even during times of high water, in consideration of the seasonal change in water levels caused by monsoon rains. Because of potential flooding, the whole building has been raised. This height not only allows for more adaptation to shifting water levels, but it also reduces the building's negative impact on the surrounding marsh.
 - Sustainability Measures:** Natural ventilation, solar panel systems, rainwater collection, the use of locally produced materials, and the installation of green roofs are just a few of the environmental measures embraced by the center. The center's impact on the environment is reduced because to these efforts (Figure 22).
 - Observation With out Disruption:** The design offers a fenced experience for visitors so they may observe from a safe distance without disturbing the natural environment. Visitors may attentively look into the surroundings without disturbing birds or destroying the natural ecosystem while traveling (Figure 23).
 - Theme - "Birds in Box? Or Man in Box?":** The decision was made to enclose people within the "box" to bring them closer to nature and allow them to observe without physical contact or harm. In contrast, the birds are left free in their natural habitat, ensuring minimal disturbance from human activity while enabling them to observe people from a safe distance (Figure 24).

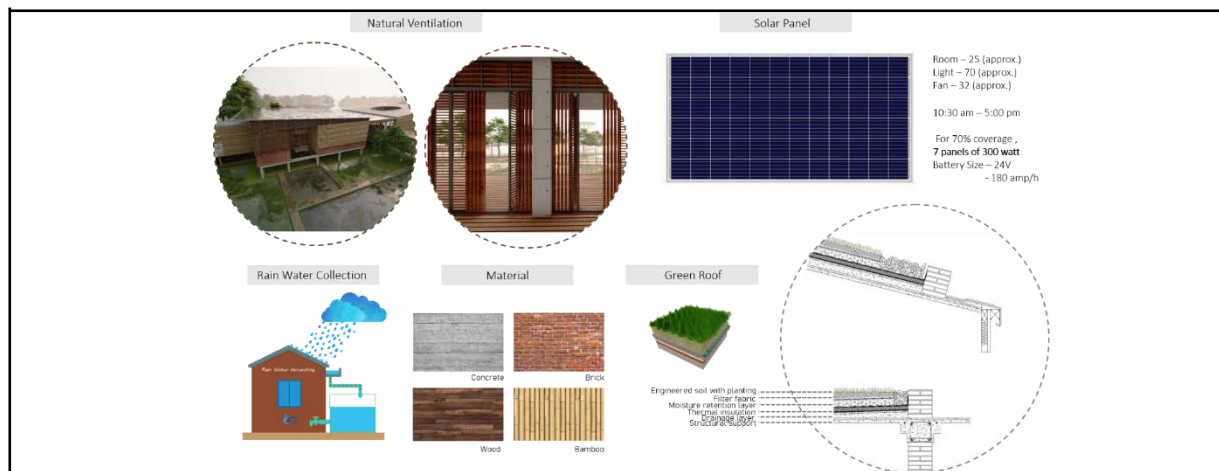


Figure 22: Sustainable Measures Taken During Design Considerations

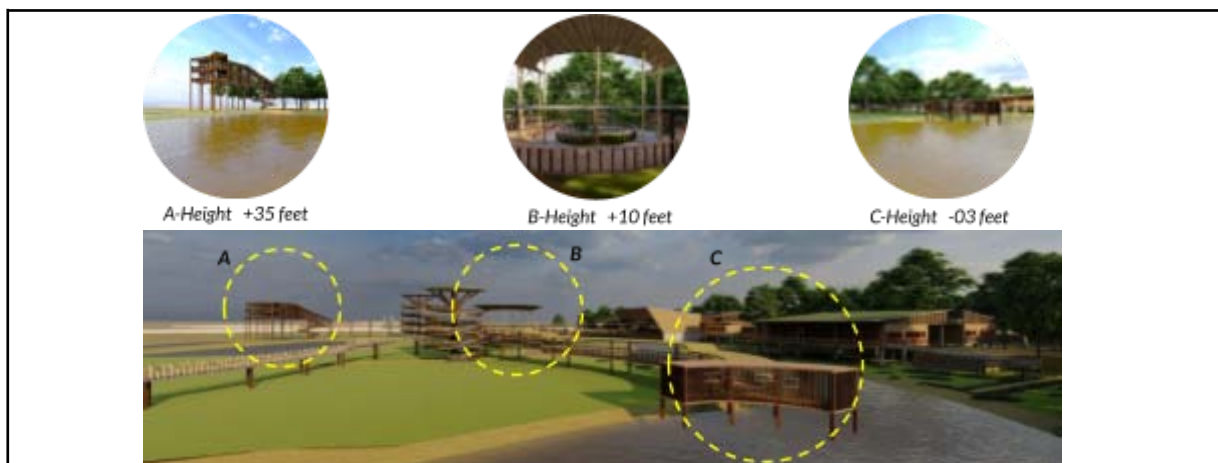


Figure 23: Observation without Disruption - Bird's Observatory

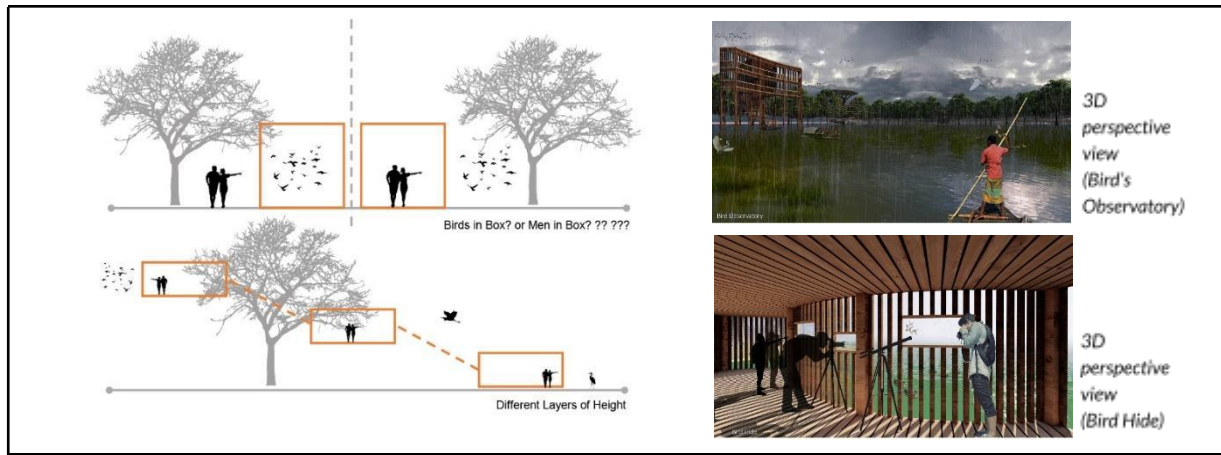


Figure 24: Man in Box-Bird's Observatory

The Haor Eco-Interpretation Center takes an approach to interpretation that places an emphasis on ecological consciousness and harmonious coexistence with nature. The birds are permitted to thrive in their natural setting, while visitors are kept safe inside a controlled atmosphere intended to safeguard the wetland's sensitive ecology.

g) Environment Friendly Materials use

The Haor Eco-Interpretation Center's materials for construction were carefully selected to minimize their environmental impact and to correspond to the standards set out by the Housing and Building Research Institute (HBRI), Ministry of Housing and Public Works, in particular Chapter 4, "Design for Haor (Wetland) Areas" (HBRI 2018).

The plinth is stabilized with cement or Ferro cement wrapping as per HBRI specifications. This type

of stabilization guarantees long-term viability and resilience in a wetland setting. FC Hollow Columns or RCC (Reinforced Concrete Columns) are used to create the building's column framework. These materials are both environmentally friendly and give structural stability. The top part of the walls is a non-structural façade, while the bottom part is meant to be individually replaceable, as per HBRI rules (HBRI 2018) (Figure 25). This kind of design makes maintenance easy and has a little ecological footprint. Perforations in the top portion of the walls, starting at a predetermined level and running all the way down to the bottom of the slab, are an innovative feature of the standard. The excessive humidity in the area is reduced due to the strategically placed perforations, making the environment more pleasant for everyone (Figure 26, 27).

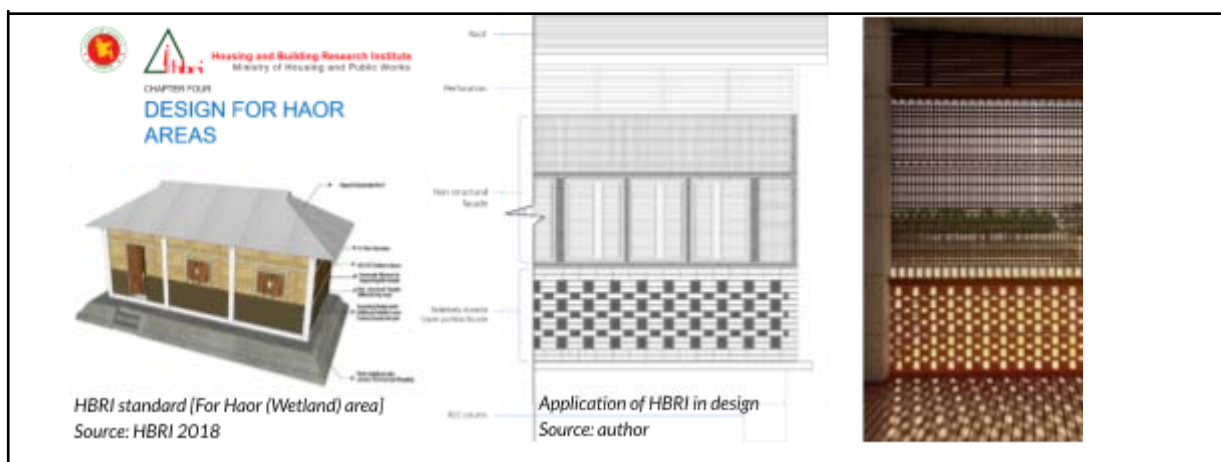


Figure 25: Application of HBRI Standard in Design

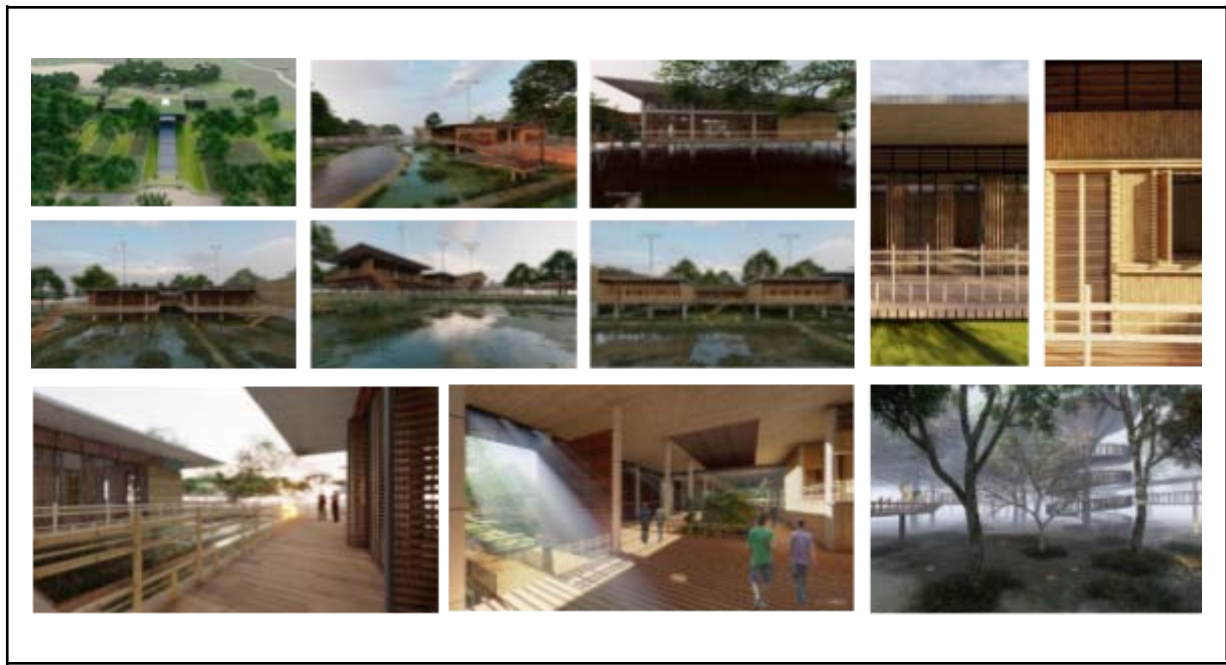


Figure 26: Use of Environment Friendly Materials

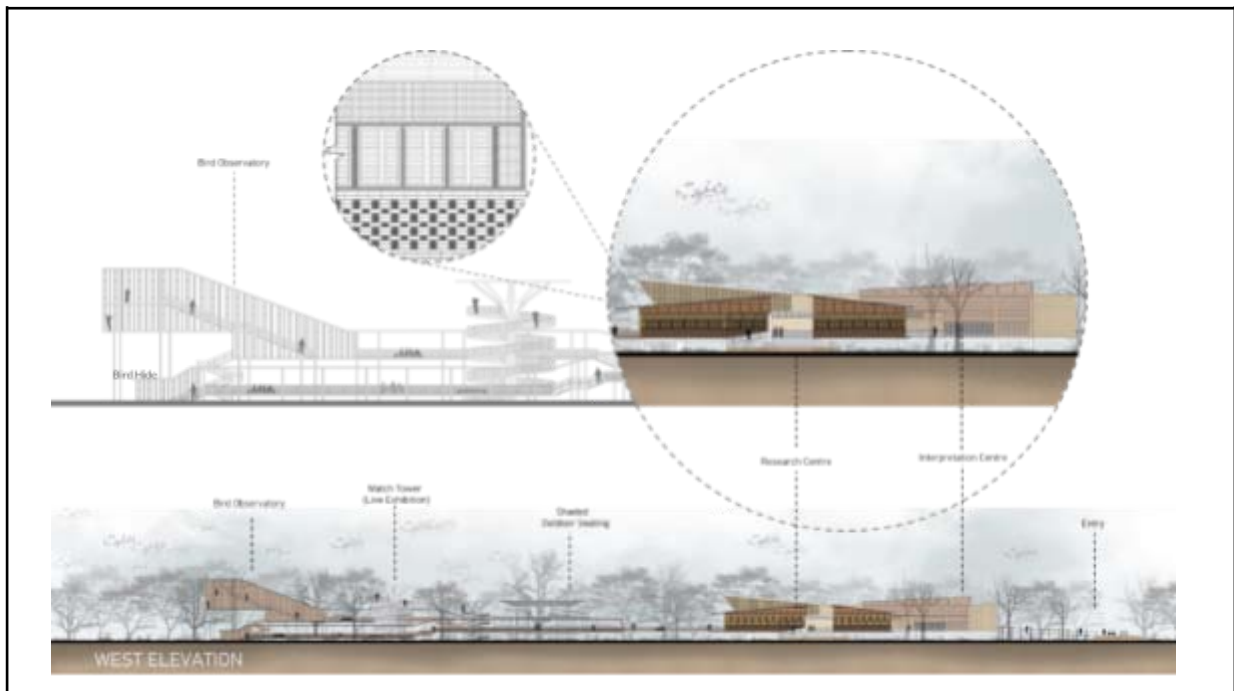


Figure 27: Use of Environment Friendly Materials

h) Experience with Seasonal Variations

The Haor (Wetland) Eco-Interpretation Center is an interesting year-round attraction because of the extensive seasonal changes that occur on-site and in the surrounding area. These seasonal variations are integral to the center's experience with conscious considerations.

The landscape becomes covered in vibrant colors of green during the pre-monsoon season (April to

May) when paddy fields shine in the summer light. There are many colors of green and yellow all around, making for a really attractive scene. The center takes on a different look during the monsoon season (June to September) due to the heavy rains. Visitors may explore the location in non-motorized boats as the architecture seems to float on the water. When water levels rise dramatically, visitors may see underwater activity

because of a section of the museum built at a lower level.

The results of the rainy season are still visible in the months after the monsoon (October-November). As a result of the previous rains, the wetland area is constantly evolving. The marsh area becomes a sanctuary for migrating birds during the winter months (November through March). These magnificent birds populate the area, providing a beautiful spectacle for tourists.

The changing seasons are a visual and sensual feast from every perspective point, whether from above or below ground or within man-made buildings. The summer's vibrant colors, the monsoon's floating structures, and the winter's birds demonstrate each provide their own unique and fascinating spectacle. Visitors to the Haor Eco-Interpretation Center may experience the genuine essence of these seasonal changes both within and outside the buildings (Figure 28, 29).

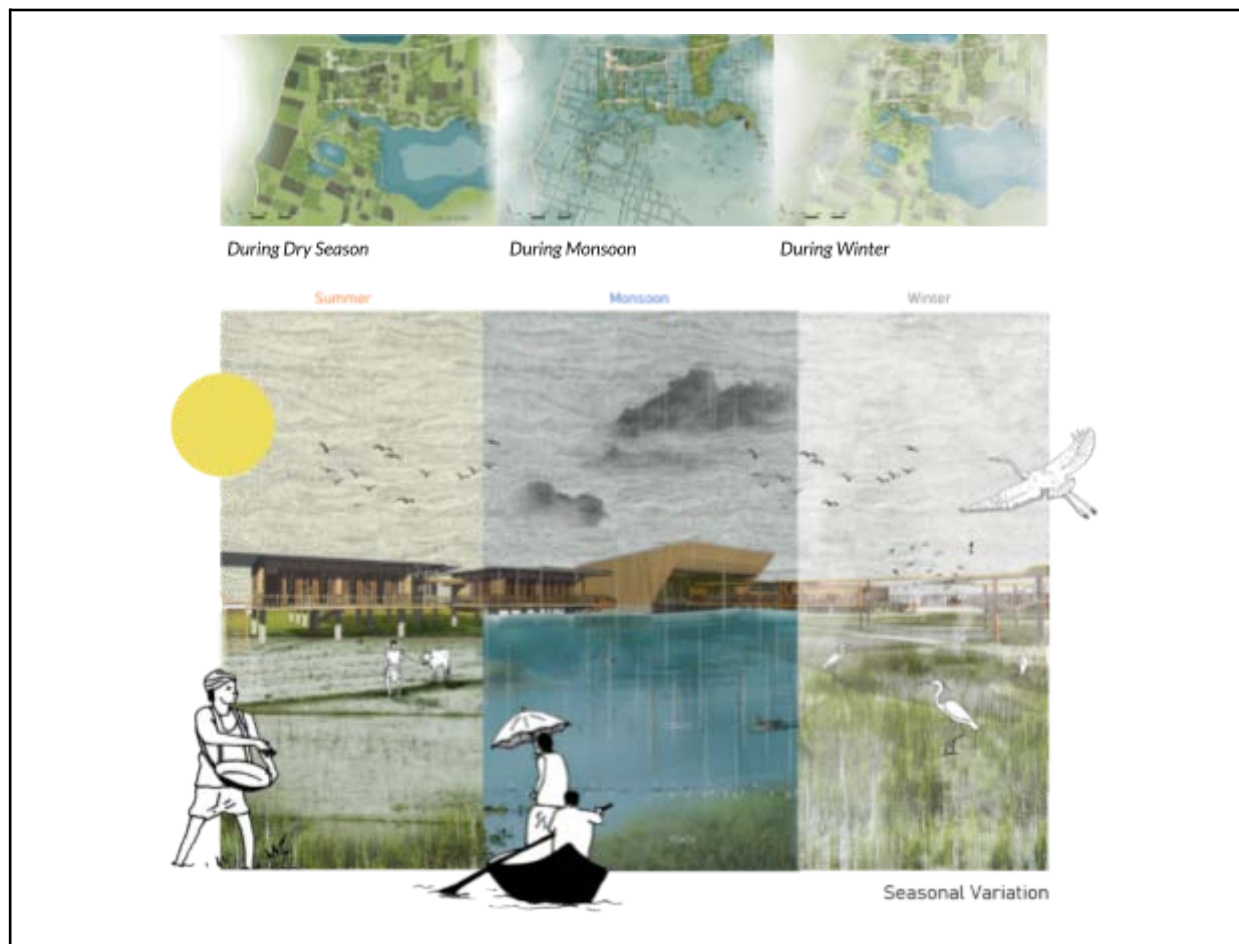


Figure 28: Seasonal Variation Incorporated into the Center Design

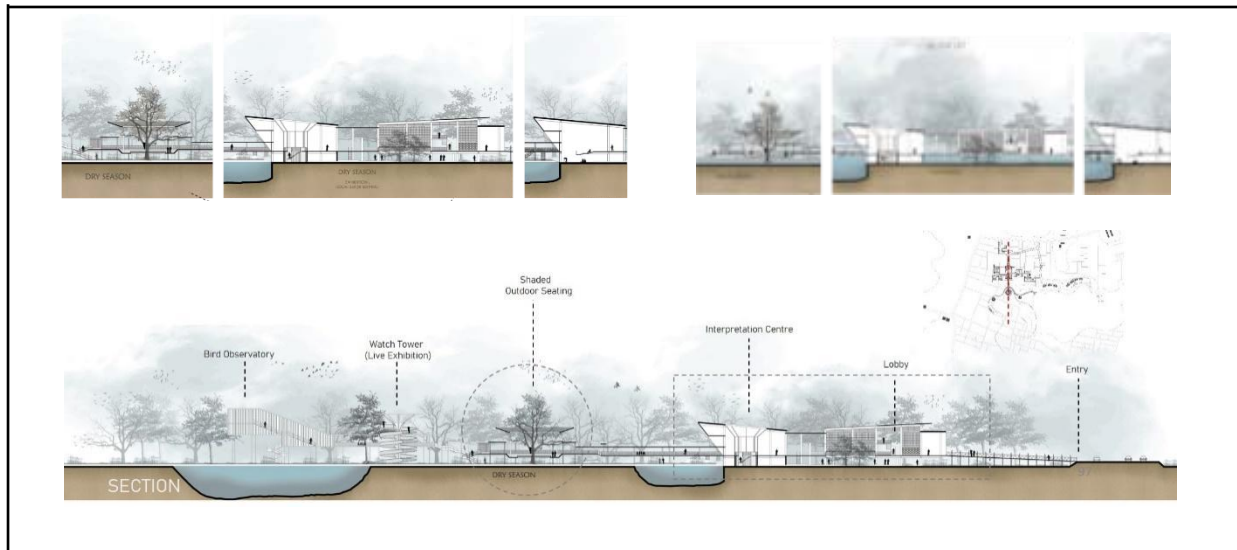


Figure 29: Adaptability to Monsoon

VI. CONCLUSION

The Haor Eco-Interpretation Center is an important step forward in the goal of raising environmental consciousness and educating locals and visitors. This endeavor is necessary for the long-term health of the adjacent wetland ecosystem, which includes the delicate equilibrium of wetlands, aquatic life, abundant flora, and diverse fauna.

Hakaluki Haor is a tapestry of tourism, research, and knowledge, embracing its ever-changing ecosystem and attractive changes in seasonal landscapes. Due to the dynamic nature of the surrounding natural fluctuations, architectural and natural features must be carefully considered throughout the design process. It stresses the need for careful site selection, no hard lines, and little disturbance of the soil.

Ecological considerations such as monsoon-induced water fluctuations, seasonal changes, avian behavior, existing site character analysis, zoning insights, humidity mitigation, local material integration, and adherence to local standards like HBRI are all addressed in this project, making it an outstanding example of eco-sensitive design. The ultimate objective is to minimize environmental impacts, harmonize the existing land pattern, and encourage extensive reforestation.

This project emphasizes the need to preserve and protect our natural habitats via careful planning, thorough planting, and skilled construction. The journey from site selection to sustainable design serves as an example of the potential of creating harmonious, eco-conscious projects that embrace both the natural world and human innovation.

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Addressing Security Risk Caused by Climate Change Across Nations: The Role of Non-State Policy Actors

By Gordon Kofi Sarfo-Adu & Henry Kwabena Kokofu

Abstract- Climate change is projected to produce a lesser amount of expectable rainfall patterns, coupled with extensive droughts intermixed with fleeting but torrential rainfall which has implications on food security risks. The paper examines the role of Non-State Actors (NSAs), specifically, Non-Governmental Organizations (NGOs) in climate change governance and how they address food security risks thereof. The study addresses this objective by placing a special emphasis on the modus operandi of NGOs in helping smallholder farmers navigate through their farming cycle successfully in the Northern belt of Ghana. The study adopts the content analysis and critical stage review of extant literature and other datasets. The study observes that NGOs help smallholder farmers to build their resilience against the ravages of climate change using a more comprehensive approach along the entire value chain of the farming cycle before, during, and after the crop planting exercises.

Keywords: *climate change; smallholder farmers; adaptation; mitigation; resilience; NSA.*

GJSFR-H Classification: LCC: QC981.8.C5



Strictly as per the compliance and regulations of:



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Gordon Kofi Sarfo-Adu ^α & Henry Kwabena Kokofu ^ο

Abstract- Climate change is projected to produce a lesser amount of expectable rainfall patterns, coupled with extensive droughts intermixed with fleeting but torrential rainfall which has implications on food security risks. The paper examines the role of Non-State Actors (NSAs), specifically, Non-Governmental Organizations (NGOs) in climate change governance and how they address food security risks thereof. The study addresses this objective by placing a special emphasis on the *modus operandi* of NGOs in helping smallholder farmers navigate through their farming cycle successfully in the Northern belt of Ghana. The study adopts the content analysis and critical stage review of extant literature and other datasets. The study observes that NGOs help smallholder farmers to build their resilience against the ravages of climate change using a more comprehensive approach along the entire value chain of the farming cycle before, during, and after the crop planting exercises. Consequently, we develop and discuss the *NSAs-holistic empowerment framework* which will contribute to policy, practice, and literature on the topic. The study contends that the impact of most NSAs in climate change is contingent on the resources available and their organizational prowess. The study argues for the need to forge a synergistic relationship and networks between the public and non-state actors to effectively play a more nuanced role in climate change efforts at all levels which will help address food insecurity in areas and regions currently experiencing drought, hunger, and under nutrition.

Keywords: climate change; smallholder farmers; adaptation; mitigation; resilience; NSA.

1. INTRODUCTION

With increased climate change trends, its effects aggravate prevailing socio-economic, and ecological threats in many contexts, which may become a source of insecurity at local and national levels (Pörtner et al, 2022; Malhi et al, 2020). The security threats that may be associated with climate change include adverse effects on food, water, and energy supplies, heightened competition over natural resources, loss of jobs, environment-related disasters, and migration and displacement (Owen, 2020).

In many contexts, protracted droughts, floods, and increases in sea levels have had exacerbated influences on socio-economic livelihoods, human well-being, environment, and related benefits, particularly in rural regions (Pörtner et al, 2022). The focus on climate actions and green economic growth has shifted over some time to giving attention to human-related crises (Lawrence et al, 2020). One particular sector which has been severely affected by climate change is the agricultural sector, especially in the developing world (Malhi et al, 2021; Mahapatra et al, 2021). What is more problematic is that the greater population especially in the rural communities has predominantly been smallholder farmers depending on favourable climate patterns (Atube et al, 2021). With the worsening climate change situation and impacts, climate change continuously affects agricultural productivity in numerous nations across West Africa unfavourably. For example, Ebele and Emodi (2016) report that the growth rates of maize, guinea corn, millet, and rice have decreased due generally to the surge in temperature in Nigeria. On their part, Badjie et al. (2019) report how late arrival and premature termination of rainfall patterns have prompted the variation of yields of cereals and cash crops per season in The Gambia. In Sierra Leone, the climate change dangers caused include bushfires, droughts, high temperatures, early rains, late rains, serious downpours, thunderstorms, landslides, and floods (Rhodes et al., 2016).

With the trend of climate change coupled with contemporary social and ecological vulnerability, it has been predicted that the Sub-Saharan region will experience the worst impacts (Ntinyari & Gweyi-Onyango, 2021; Ofori et al, 2021). Climate change is projected to produce a lesser amount of expectable rainfall patterns, coupled with extensive droughts intermixed with fleeting but torrential rainfall (World Bank, 2018). Situated along the coast of West Africa, Ghana is a typical case susceptible to climate change vulnerability, especially the rural farming communities of Northern Ghana. Essentially agricultural in outlook, northern Ghana is found in the Sudan zone; a climate zone that is found in the midpoint of semi-arid Sahel and Forest zones (Magin 2018). With its heavy dependence on natural rainfall for agriculture, subsistence farmers across the Sudan climate zone are expected to face

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increased food insecurity. This point has been observed by Hjelm and Dasori (2012) that communities in Northern Ghana have witnessed greater heights of food insecurity than the remaining communities found in those regions along the south. Consequently, households in the Northern Regions that undergo food insecurity frequently are saddled with inadequate income, malnutrition, and ill health, among others greatly caused by climate change variability. For example, Nyuor et al. (2016) report that rising temperatures in the course of the initial and late seasons have led to a decrease in the ensuing revenue that would have been obtained from a hectare of sorghum. The threats to the agricultural sector have implications on food security, socio-economic and human security threats implications since agriculture has been the source of livelihood for many households in rural communities.

This makes it more crucial for all stakeholders relevant to global climate change affairs to step up in their actions toward effective policies, interventions, and efforts aimed at stemming the tides. Traditionally, climate change governance and efforts were essentially ceded to state actors who championed these courses of action at the state and global levels. However, it has been observed that international climate change agreements continue to achieve sub-optimal commitments by states (UNEP 2013). Over time, it has become increasingly crucial that non-state actors come on board by way of collaborative governance and policy networks to effectively play a more nuanced role in climate change efforts at all levels (Abbott 2012; Bulkeley et al. 2012; Schroeder & Lovell 2012). The involvement of non-state actors in global climate governance in the last three and half decades has been a unique feature that cannot be overlooked. (Backstrand, 2013). Consequently, it has been established in the literature and climate governance regimes that climate change adaptation ought to encompass multiple actors from the public and private sectors as well as from across civil society (IPCC 2014). This point has forcefully been argued by Lemos and Agrawal (2006) that climate change involves the typical case of an intricate multi-scalar ecological problem, where mitigation and adaptation require a diversity of actors across the state-society divide.

Bäckstrand et al (2017) advance the concept of 'hybrid multilateralism' as a heuristic to demonstrate the strengthened relationship between state and non-state actors in the reviewed arena of global climate change cooperation. They conceptualize non-state actors to include civil society organizations, social movements, as well as economic actors involving, inter alia, industry and trade unions and sub-national such as local governments and cities (p 562). The increasing role and recognition of these non-state actors cannot be overestimated. For example, the Copenhagen summit

brought forth a climate regime that researchers have described as multifarious, discrete, disjointed, and polycentric (Cole 2015). In other words, the summit saw and recognized numerous actors and stakeholders from varying backgrounds. On his part, Lövbrand et al. (2017) contend that the quantum of participants at the annual Conference of Parties (COPs) has increased over the years, reaching the zenith in Paris with more than 28,000 accredited participants; with at least 8000 of these designated as non-state observers. With the inception of the Paris Agreement, the observer groups present at the annual COPs are called upon to perform a more integrated role in multilateral processes through, monitoring of national action and experimentation with local, regional, and transnational mitigation and adaptation strategies.

Conceptually, the category of NSAs may be in the form of virtually anything: organizations, global associations, investors, religious communities, social networks, industry associations, and, at last, people.

Many studies either discuss the role of non-state actors in general terms or generalize based on case studies of one non-state actor category (Fisher & Green 2004). This implies that systematic comparison of perceptions of agency across non-state actors is largely lacking (Bulkeley et al. 2012). Despite the ongoing treatise on the prospect of non-state actors contributing to mitigation and adaptation efforts by global governance scholars (Hale, 2016; Kuramochi et al., 2020), the literature has not paid greater attention to the role non-state actors might play in bringing about an appropriate response to climate change. This position has been confirmed by Baker et al. (2020) whilst the growing acceptance of hybridity in climate governance is not in doubt [one that combines public and private authority in governance], the functional participation of the non-state actors in climate governance has seen sufficient research, it appears the actual practices through which climate issues are governed towards positive socio-ecological outcomes remains under-researched. The objective of this paper was to discuss the role of non-state actors in helping smallholder farmers deal with the food and income security threats posed by climate change. Ghana's Climate Change Policy (Ministry of Environment, 2013) recognizes the dangers posed by climate change and points out that the country is especially vulnerable to climate change and variability because of its dependence on areas that are delicate to climate change, like agriculture, forestry, and energy production. In other words, farmers have become saddled with lower yields and total losses due to climate change variability, and the government appears overwhelmed. In what ways do non-state actors in the form of NGOs intervene to help these farmers? The paper discusses the role of non-state actors [with particular emphasis on international NGOs] in addressing the food security threats posed by climate

change in the Northern parts of Ghana. In other words, as climate change continues to pose threats to the agricultural activities of farmers which have rendered most of them jobless and others migrated to the urban south, the study discusses efforts by NSAs in ensuring the resultant farmers adapt and mitigate the threats by climate change. The paper is organized into five main sections. The first section is an introduction that provides background to the study as well as elicits the problem statement. The second section provides a brief literature review and theoretical framework which frames and puts the study in context. Section three of the study provides an overview of the methodology employed for the study whilst section four provides analysis and findings which have been presented in themes. The final section provides conclusions and policy implications.

II. THEORETICAL OVERVIEW

a) *Climate Change and Food Security Risks*

A major challenge associated with climate change is food security risks. Among the key issues that are germane to the discussion of food security involve, *inter alia*: (1) *Availability* (the extent to which a community or section can make available or be given or achieve adequate food) (2) *Access* (the extent to which a people or community can obtain the food produced or available), (3) *Utilization* (the extent to which a people or community can make the most of food's benefits), and (4) *Stability* (the extent to which a people or community can ensure availability and access to food consistently) (FAO 2006; Barrett 2010).

Across Sub-Saharan Africa, the number and level of undernourished individuals have increased beginning of 2014 (FAO, IFAD, UNICEF, WFP, and WHO 2017). Consistent with this pattern, food insecurity is predominant all over the Northern Areas of Ghana (Hjelm & Dasori 2012). Estimating levels of food insecurity is challenging, given contrasts in scale, the meaning of terms, and data collection protocols. Nonetheless, household-level information can give further understanding of whom within a nation is at the highest risk of food insecurity, and can assist with illuminating more vigorous policy (Hussein, 2002; Barrett, 2010).

A household study undertaken by Quaye (2008) found subsistence farmers in the Northern part experienced food insecurity from four to six months out of the year, contingent on the crop. Farmers frequently depleted the millet supply in April, and could not replenish their stocks until September harvests. Other significant crops, including sorghum and maize, were lacking from June to October. As climate change advances and forces expanded desertification in the Sudanian savanna zone that traverses Northern Ghana, means subsistence farmers will probably encounter more prominent declines in yields of staple crops

(Armah et al. 2011). Wossen and Berger (2015) found that climate change and the fluctuation of food costs were closely connected, bringing about higher food costs for poor families in Ghana. Be that as it may, subsistence farmers who are unable to produce surplus products cannot take part in the market, as they lack the funding and capital to do as such. In such cases, families that basically depend on subsistence farming become more defenseless against food insecurity. (Armah et al. 2011; Wossen & Berger 2015)

b) *Concept of Non-State Actors*

The concept of non-state actors involves an array of stakeholders or actors who do not hold the sovereign powers of nation-states yet remain crucial in climate governance architecture. This point has been corroborated by Allan (2020) who contends that the array of NSAs entails cities, multinational establishments, international organizations, and private individuals who assist in varied ways to respond to climate governance.

On his part, Bevir (2009) brings the argument closer home by maintaining that the set of non-state actors responds to climate change by serving as promoters of particular policies, setting standards, and making a clarion call for efforts with or short of the cooperation of states (p.87). This suggests that non-state actors tend to operate as entities on their own or in concert with the state in driving home their activities. According to Hoffman (2011), NSAs mostly advocate and advance their case for actions and efforts towards climate adaptation and mitigation which may include, *inter alia*, energy efficiency, carbon markets, local adaptation, and revolution of the built environment as well as transportation systems (p. 5).

They are a varied group, full of different motivations, capacities of action, and routes took – and have different types of presence at different levels of governance (Allan, 2020). There are different forms of NSAs in the context of climate change. These are actors who are not negotiating parties within the UNFCCC' given some recognition (Duggan, 2019).

Essentially, the United Nations Framework Convention on Climate Change (UNFCCC) classifies NSAs into these distinct forms: *business and industry non-governmental organizations (BINGOs)*, *environmental non-governmental organizations (ENGOS)*, *indigenous peoples' organizations (IPOs)*, *local government and municipal authorities (LGMAs)*, *research and independent non-governmental organizations (RINGOs)*, *trade unions non-governmental organizations (TUNGOS)*, *farmers and agricultural NGOs, women, and gender, and youth (YOUNGO)*. 2 All these have observer status or serve as observer organizations.

Bevir (2009) discusses key ways that non-state actors respond to climate change by serving or acting as promoters of particular policies or courses of action,

providing standards, and schemes, and coming out with campaigns for buy-ins and attention to these. This, they may tend to act in concert with the public sector or act alone (p.87). This suggests that non-state actors tend to operate as entities on their own or in concert with the state in driving home their activities. According to Hoffman (2011), NSAs mostly advocate and advance their case for actions and efforts towards climate adaptation and mitigation which may include, inter alia, energy efficiency, carbon markets, local adaptation, and revolution of the built environment as well as transportation systems (p. 5).

They are a varied group, full of different motivations, capacities of action, and routes taken – and have different types of presence at different levels of governance (Allan, 2020).

c) *Theoretical Framework*

i. *Hybrid Multilateralism, Roles and Modus Operandi of NSAs*

The concept of 'hybrid multilateralism' has been discussed to denote the new landscape of international climate cooperation which became popular during the period after the Copenhagen Summit which has become well established via the Paris Agreement.

The concept was coined by Bäckstrand et al/ (2017) to mean the various forces and actors including state and non-state actors involved and recognized in climate change governance. It suggests a bottom-up climate policy architecture that combines voluntary pledging by states with an international transparency framework for periodic review and ratcheting-up of ambition, in which non-state actors play important roles as implementers, experts, and watchdogs. Additionally, hybrid multilateralism refers to an increasingly dynamic interplay between multilateral and transnational climate action, where the UNFCCC Secretariat has taken a role as facilitator, or orchestrator, of a multitude of non-state climate initiatives and actions.

Non-state actors tend to strappingly support climate change mitigation over people's adaptation. For example, in an empirical study that sampled sixty (60), non-state actors, to assess their activities, it was observed that seventy-five percent (75%) of these NSAs mainly concentrated on mitigation alone, with twenty-two percent (22%) concentrating on both mitigation and adaptation, with 3% paying attention exclusively to adaptation (Bulkeley et al. (2014).

As non-state actors neither do have sovereign powers nor command coercive powers as states, those NSAs who command a few resources and with no regulatory power resort to some subtle ways of influencing climate actions. Their main climate action activities essentially entail lobbying relevant stakeholders, orchestrating some actions, and consensus-building with parties.

On the role of the NSA in climate governance, NSA participation can be grouped into two broad categories. First, there are instrumental claims, which hold that CSO participation in public governance provides knowledge to enhance problem-solving capacity, which in turn leads to more effective and efficient policy implementation (Baker & Chapin 2018).

The second group of arguments is normative in appeal, based on claims that participation supports democratic values by fostering a more inclusive and deliberative form of public policy decision-making. This in turn can enhance public support for policy and reduce policy conflict. For instance, non-state actors can give voice to under-represented groups, thereby legitimizing and validating policy decisions and improving the democratic quality of a polity (Bäckstrand & Kuyper 2017).

Engagement can also promote governance transparency, thus mitigating the risk of governments catering primarily to influential domestic interest groups (Dombrowski 2010). By pushing for monitoring and stakeholder consultation mechanisms, CSOs can also help foster the creation of formal accountability mechanisms in the system of governance, particularly within public administration (for further discussion, see Bernauer & Gampfer 2013). CSOs participate with the state as actors in international climate change negotiations (Lane & Morrison 2006, United Nations 1992), being recognized as an essential component of good governance (Banks et al. 2015). CSOs also participate as key agents in the implementation, monitoring, and evaluation of climate change policy (Haris et al. 2020).

III. METHOD

This paper synthesizes from extant theoretical and empirical readings, predominantly sorted from peer-reviewed journal sources and pertinent scholarly books intending to examine the role of non-state actors in addressing the security risk challenges associated with climate change. Whilst NSAs connote a broader concept, the scope of the study was on the role of NGOs in helping smallholder farmers deal with the food security risk which often comes as a result of unpredictable climate patterns caused by climate change. From the extant empirical literature, the study uses the experience of four international NGOs who operate in the Northern Regions of Ghana with a particular emphasis on how they help farmers navigate through the contours of mitigating and adapting to the challenges of climate change. This involves taking cues from the work of Yakubu et al. (2019) which discussed how international NGOs help farmers adapt to climate change adaptation. The literature search covered all terms and concepts related to non-state actors and climate change. The study combined words and

expressions related to climate change security risks and NGOs intervention; NGOs and smallholder farmer adaptation to climate change.

The varying combination of words and concepts of NSA in addressing climate change challenges and food security risks were combined variously which made it possible to obtain a pool of more relevant literature on the study. The study resorted to three main search engines which were essentially deployed due to their germaneness to the study and availability to the author: *Science Direct*, *T and Fonline*, and *Google Scholar*. We derived a greater pool of articles from the sources and needed to do an initial skimming and scanning of their synopsis to sort for relevance to the thesis of the paper. After the initial sorting process, all abstracts were independently reviewed by each of the co-authors. Finally, authors convened to jettison duplicated materials and mapped out a narrow down of abstracts that were scheduled for comprehensive and systematic assessment. The distinct arguments and cases discussed in each paper had to be synthesized in different phases to generate the discussions and conclusions.

IV. DATA ANALYSIS

a) *Post-Copenhagen Accord and Nature of Global Climate Governance: Focus on NSAs*

Although NSAs have been involved in climate action and governance processes, the period after the Copenhagen Accord at the 15th Session of the Conference of Parties (COP 15) in 2009 saw an intensification of NSA actions and varying efforts involving conventional and non-conventional modes of participation in order to drum home issues related to climate justice and climate action. Since the Copenhagen Summit, climate governance and diplomacy have been instrumental in improving access and ensuring inclusivity and representation of NSAs through an array of considered and participatory mechanisms (Bernstein, 2012).

Ever since UN negotiations on the global climate were initiated in the early 1990s, NGOs, businesses and local governments have been present as activists, experts, and diplomats (Newell 2000, Betsill & Corell 2001, Betsill 2015). It should be highlighted that at the global level, transnational climate governance may take different forms, involving, *inter alia*, private carbon reporting, labeling, offsetting and trading schemes, transnational city networks, and local grassroots mobilization for low carbon lifestyles (Bulkeley et al. 2014). Following Copenhagen, the range of roles available to non-state observers expanded, along with their ability to exercise authority in the international climate regime (Green 2014). However, different non-state actor groups play different roles in multilateral climate diplomacy. Treating 'non-state

actors' as a homogeneous category can be useful for heuristic purposes, but in practice, heterogeneity prevails (Nasiritousi et al. 2016).

From the extant literature on advocacy and roles of NSAs, it has been observed that whilst some NSAs tend to seek insider status, others tend to seek radical, and systemic change (Hadden 2015). This point has been advanced by Fisher (2000) that the intensification of the climate justice movement ignited climate activism which has since witnessed fresher energy and intensification whose actors involve an array of new social groups and networks in global climate politics. The mobilization of non-state actors for climate governance (climate justice) remained crucial on the agenda of the Copenhagen meeting, whose aftermath has been several climate protests, demonstrations, and marches across the countries in the North and South in the run-up to the Paris Conference. From the foregoing, one observes that a very important landmark in the post-Copenhagen climate summit and governance regime has been the progressive coordination between the UNFCCC system and non-state actors in climate governance and efforts (Betsill et al. 2015, Chan et al. 2016, Hale 2016).

In the year 2012 at the COP 18 held in Doha, states decided to explore a wide range of actions that could help to promote climate action and targets set out. The importance of civil society and private sector contributions was particularly highlighted in relation to developing country activities, such as finance and negative consequences resulting from climate change. In the ensuing year, the COP held in Warsaw, the UNFCCC inaugurated a website that would provide up-to-date data on those collaborative climate actions happening around the globe on multiple scales by governments, international organizations, civil society, and businesses. This suggests a growing recognition of the activities and relevance of NSAs in climate change efforts and interventions. The portal has proven to be very effective and relevant in climate change issues and initiatives (Widerberg 2017)

b) *Paris Agreement and Non-State Actors in Global Climate Governance*

A careful assessment of the Paris Accord of 2015 mostly brings attention to the increasing role of local climate action in the contemporary climate governance sphere (Bang et al. 2016, Falkner 2016). The National Determined Contributions tendered in by nation-states in 2015 signify the primary instrument of the Agreement which also provides the basis from which international adaptation and mitigation efforts towards a less than 2°C mean global warming or emissions. These are voluntary contributions and pledges by states yet it recognized the relevant roles played by non-state actors in ensuring these NDCs are carried out.

The Paris Agreement formally acknowledges 'the importance of the engagements of all levels of government, and various actors' (UNFCCC 2015). The accompanying COP decision details the role of 'non-party stakeholders, especially in enhancing (UNFCCC 2015) and calls for the 'scaling up and introduction of new or strengthened voluntary efforts and initiatives' (UNFCCC *ibid*). Formally, the Paris Agreement opens up for the engagement of non-state actors in three processes: the 5-year cycles of a global stocktake of NDCs preceded by the 'facilitative dialogue' in 2018; the transparency framework reviewing mitigation and adaptation actions; and the implementation and compliance mechanism (van Asselt 2016, p. 7).

c) *Resources of Non-State Actors*

While non-state actors mostly do not possess the conventional forms of political authority and sovereignty, they nonetheless have some influence and alternative sources of power. According to Gulbrandsen and Andresen (2004), the essential skills and resources that non-state actors have may emanate from their intellectual, membership, political, and financial bases (p. 58). This point has been given support by other scholars who contend that knowledge and information remain crucial (see Betsill & Corell 2008); the economic resources and locus in the bigger society or international community (Falkner 2010); the organizational prowess and capacity, world-wide connections and its capability to mobilize (Falkner 2010); as well as its legitimacy (Gough & Shackley 2001). This point concerning the capacity of NSAs has essentially been summarized to entail:

1. Ability to invoke moral claims
2. Knowledge, expertise
3. Access to networks
4. Access to key agents and decision-making processes
5. Access to resources and position in the global economy (see Keck & Sikkink, 1999; Boström & Tamm Hallström, 2010).

d) *Role of Non-Governmental Organizations (Ngos) in Climate Change Discourse*

The United Nations through its UNFCCC categorizes accredited NSAs into nine clusters which involve those representing: *business and industry non-governmental organizations (BINGOs)*, *environmental non-governmental organizations (ENGOS)*, *indigenous peoples' organizations (IPOs)*, *local government and municipal authorities (LGMAs)*, *research and independent non-governmental organizations (RINGOs)*, *trade unions non-governmental organizations (TUNGOS)*, *farmers and agricultural NGOs*, *women, and gender, and youth (YOUNGO)* (UNFCCC, 2020).

This section pays particular attention to the role of NSAs with particular emphasis on NGOs in helping

the course of climate change interventions. The theoretical analysis is complemented by two empirical cases on how NSAs help in addressing security threats that are associated with climate change.

e) *Role in Agenda Setting and Climate Change Policy Implementation*

NGOs play a significant role in agenda setting and help to push some functional policies and laws which will help mitigate climate change impacts. For example, NGOs such as industry associations and research institution do engage in lobbying and agenda-setting; what remains outstanding is that they follow through to see the eventual implementation of such policies by the government, and continues to monitor the effectiveness of the process (Gupta, 2010).

Despite the fact, climate negotiations at the global level nonetheless operate by color-coding the participants with respect to their institutional affiliation, the 2015 Paris Agreement¹ and later advances have additionally reinforced the role of NSAs in looking over ambitions set out, enforcement by member states, as well as compliance with emission-reduction targets (Asselt, 2016). The literature on environmental governance refers to the growing participation of Non-state actors within the UNFCCC system as 'hybrid multilateralism' which has been the theoretical framework underpinning this paper. As explained, the concept denotes the 'intensified interplay between state and non-state actors in the new landscape of international climate cooperation' (Bäckstrand et al, 2017).

¹ Paris Agreement (adopted 12 December 2015, entered into force 4 November 2016) (2016) 55 ILM 740

Table 1: Role of NGOs in Adapting to Climate Change Impact in Northern Ghana

The second case study sought to assess the role and contribution of non-state actors in addressing security threats posed by climate change with a special emphasis on how NGOs address food security threats in Northern Ghana. An analysis of the empirical literature suggests that non-state actors in the form of NGOs have been influential in helping farmers to mitigate and adapt to the nuances of climate change impacts. The various activities of the NGOs have been presented in themes below:

Addressing maturity issues

A major challenge posed by climate change has been the variable rainfall pattern which in recent times appears unpredictable. In other words, farmers find it difficult to determine when exactly the rains may set in and when they will cease dropping. Sometimes the rains cease at a premature period and crops which are yet to mature may suffer destruction and farmer losses whilst an eventual food crisis may occur. How do we get this challenge resolved? Non-state actors in the form of NGOs operating in Northern Ghana have been responding to this challenge by providing crops with shorter maturity periods to farmers so that even if the rains cease to flow prematurely, the crops would have reached harvest season by that time. These crops have early gestation times to be adopted to cope with the change in rainfall pattern.

Farmer Education, sensitization, and extension services to farmers

Knowledge is power and the provision of relevant climate information services to farmers goes a long way to help them understand the key issues, and occurrences, and how to navigate them. Smallholder farmers have held on to traditional or indigenous knowledge and procedures of farming for a longer period; in the wake of climate change impacts, there at times is the need to adapt by altering farm practices and farming methods that can withstand the new conditions of the time. Consequently, the relevant NGOs tend to provide farmers with new and drought-resistant methods of farming that can stand climate change conditions. These have been beneficial to smallholder farmers.

Product marketing

A major challenge faced by smallholder farmers has been post-harvest losses which have been exacerbated by climate change where the life span of many crops tends to reduce. Access to the ready market, therefore, has become an important aspect in the value chain without which there will be serious food security threats exacerbated by climate change. What the NGOs do is facilitate access to wider markets so that smallholder farmers can easily local consumers for their products. In many cases also motivate farmers to identify potential markets and entities that will demand their products ahead of farming.

Value addition and income-generating activities

The NGOs tend to inspire smallholder farmers to add value to their raw farm products by processing raw materials such as cassava into 'gari' and rice into 'parboiled' rice. Processing the crops reduces their vulnerability to side effects of climate change and their susceptibility to becoming unwholesome. The processed products also tend to have higher price value which will augment the social and economic side of farmers.

Provision of Insurance Package

Due to the uncertainty that may surround crop planting and their survival due to the unpredictable nature of rainfall, smallholder farmers mostly tend to run at a loss when the unfortunate happens. Many people tend to be discouraged or even if they would, may not put in their all because of this possibility. To address this challenge, NGOs have introduced farmers to and encouraged them to adopt the practice of "crop insurance". It must be noted that this technique has not been very popular or on a wider scale due to the fact that it is coupled with some key complexities such as requiring farmers to painfully record rainfall patterns in their farmlands to get enough proof to substantiate their claim that their crops did not yield better because of poor rains and drought which will be the basis to get the claims from their insurers. More challenging the gadget to help farmers keep records of rainfall that their farmlands receive is not readily available to them.

Better water management

In view of the erratic rainfall pattern, it has become imperative for farmers to be educated and encouraged to make bunding or barricades in the farmlands to retain water for some time after rains. The retained water in the farmlands could improve the amount of water in the soil. The adaptation measure was rated high among all the International NGOs that were included in the study.

Access to water for farming

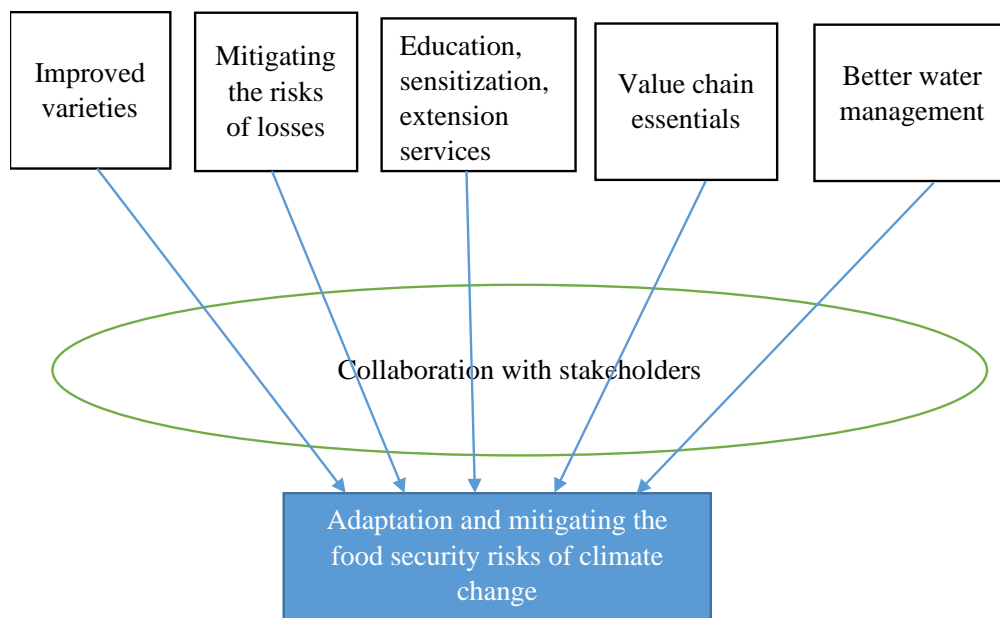
A crucial role played by NGOs in addressing climate change food security threats has been water issues and making sure crops have access to water for reasonable farming. On some occasions, they educate and train farmers on how to deploy barricades to store water in the farms when during the rainy season which will be put to use when the rains cease prematurely. Another way by which they help in water provisioning has been the

development of irrigation projects or facilities. The Northern part of Ghana mostly experiences six months of rain and another six months of the dry season which means that finding ways to get a regular water supply in the ensuing six months of dry season is critical. NGOs in the study have been instrumental in the provision and facilitation of irrigation facilities for farmers.

(Adapted from Yabubu et al, 2019)

V. DISCUSSION

From the case above, this analysis discovers that non-state actors have been instrumental in contributing to climate change risk reduction and smallholder farmers' adaptation. In other words, NSAs help in building the resilience of stakeholders in order to effectively help deal with climate change impacts. From the data deduced from the extant literature, the following themes have been deduced which have been used to construct figure 1 below.



Source: Developed by author from extant literature

Figure 1: NSAs-Holistic Empowerment Framework

As illustrated in figure 1 above, the study reveals that due to the variability of climate elements such as rainfall and temperature, non-state actors, specifically, NGOs assist farmers with improved varieties of crops that mature earlier before the 'bad times' set in by which time they crops are already matured. Additionally, drought-resistant crops which can withstand the long period of drought have been introduced and encouraged the farmers to use which have been ways of reducing the adverse effects of climate change on food security in these farming communities

Even after introducing these drought-resistant and early gestation plants, the study highlights how NGOs go the extra mile to mitigate any unforeseen consequence which might be caused by failure of the rains to set in or unpredictably failure to 'honour its obligations' on the expected times. Consequently, NGOs encourage and assist farmers to insure their farms against any of such losses provided the latter will

be able to prove that the crop failure was a result of the rains failing to come at the appropriate time with recorded evidence. Irrespective of the demands of this effort, it nonetheless remains an important intervention that meticulous farmers do incorporate to ensure certainty in their farming activities.

More importantly, knowledge is power and the ability to engage in one activity or the other involves one's knowledge and know-how of the entity. Consequently, NGOs sensitize farmers, and educate them on relevant issues regarding climate change and how to cope with same. They provide extension services to monitor and through hands-on activities encourage farmers to adopt best practices that are tried and tested. They assist in the varieties of crops and their advantages, which farming methods are conducive to the times, and other agro-related issues on marketing among others. As part of the sensitization process, farmers are introduced to ways to conserve water and deploy it to use during the dry seasons or when the

rains cut summarily. These are ways that do help to reduce some of the vulnerabilities caused by climate change impacts which unattended to could have dire consequences on food security. It was gathered that local farmers do trust the information they receive from these NSA; this observation supports an argument by Haas (1992) that NGOs have functioned as epistemic communities, forming critical bridges that serve as conduits for information flow. Over time, the NGOs have put together firm and credulous associations with local communities, governmental agencies, state, and municipal governments, playing an essential role in the capacity building of an array of key actors (ibid).

Additionally, the study discovers that NGOs assist in value chain essentials by ensuring that farmers are educated on marketing trends and how to secure ready markets for their farm produce. By also encouraging farmers to add value to their products, it helps in reducing post-harvest losses whilst increasing the returns or income that will emanate from subsequent sales of the processed farm produce. Marketing and value addition are two important activities that help in reducing food security risks associated with climate change whilst they help to reduce the poverty and vulnerability of smallholder farmers to further impoverishment.

The study has brought to the fore that NGOs have been influential in the provision of climate services defined to mean “the generation, provision, and contextualization of information and knowledge derived from climate research for decision-making at all levels of society” (Vaughan & Dessai, 2014, p.1). The utility of climate information for driving farm management practices and decision-making in relation to when and what crops to plant in relation to climate change and variability cannot be over-emphasized (Vaughan et al., 2019; Singh et al., 2017).

Mainstreaming CIS into development planning and agricultural systems requires that stakeholders especially smallholder farmers have a full understanding and appreciation of the issues involved in climate change adaptation (UNDP, 2012). Various studies (Ayers et al., 2014; Ellis et al., 2013; Pilato et al., 2018) have highlighted the need to build awareness of climate change issues amongst stakeholders in order to mainstream climate change issues. Lack of awareness or trusted information about uncertainties, risks, opportunities, and trade-offs presents challenges to policymakers (Pilato et al., 2018). Ideally, the measures as illustrated in the framework ought to be the function of the state and its actors yet due to resource constraints and/or inadequate commitment and political will, some of these roles are not properly executed by the government on behalf of the state. Neumayer (2003) observes and argues that developing countries tend to be mostly saddled with many other crucial socio-economic demands than their attention on climate

change issues which in many cases the quest for short-term socio-economic gains and political expediency over long-term environmental gains including building climate resilience and reducing security risks associated with same (see Pilato et al., 2018).

Filling such a vacuum created by the state or government is usually filled by non-state actors who in most cases have to complement the efforts of state actors by acting as a crossing point between local people and the state or policymakers (see Cash et al., 2003). From the Ghanaian case, it was observed that NGOs help in addressing food security risks posed by climate change by assisting smallholder farmers navigate through their farming activities. The set of climate activities is multi-faceted which cumulate to equip farmers on how to effectively adapt to and mitigate the risks. This observation synch well with the existing literature which contends that climate services develop and involve the provision of climate-relevant information (Brasseur & Gallardo, 2016) and remain quintessential in plummeting climate vulnerability thereby enhancing resilience (Carr & Onzere, 2018) and helping reduce various losses and risks which would have occurred. This point has forcefully been argued by Singh et al. (2017) that climate information services that are provided by external actors remain very useful in building on indigenous knowledge to reorient and reshape the understanding of climate risks and direct or inform decision-making across scales.

The study observes a non-state actor collaboration with state agencies in order to drum home the agenda of climate change resilience and mitigating the security risks associated thereof. In both the Ghanaian case study. The ability of NSAs to effectively coordinate and collaborate with other NSAs or the state remains determines their relevance and impact in communities. From the extant literature, a study by Deason et al (2022) observed that the NSA made an impact by collaborating with the state agencies which helped in strengthening the protection of natural sources against climate hazards. In figure 1 above, this sort of coordination of efforts is denoted by “*Collaboration with stakeholders*”. For NGOs to be very impactful, they need to align their efforts and activities to synch with other interested parties, including the local government, other NGOs, and civil societies. The NGO collaboration with the local government other related state agencies as well as local farmers to achieve a task finds a place in the instrumental claims of NGO participation in public governance which according to Baker and Chapin (2018) involves the former providing relevant knowledge to help solve real societal problems which would lead to effective and efficient outcomes. On the other hand, their activities also find a proper place within the normative sense based on claims that participation supports democratic values by fostering a

more inclusive and deliberative form of public policy decision-making (Bäckstrand & Kuyper, 2017).

VI. CONCLUSION AND POLICY IMPLICATIONS

The activities of NSAs have become more pronounced and nuanced in the period after Copenhagen Conference and reinforced by the Paris Conference. The importance of civil society and private sector contributions have particularly been highlighted in relation to developing country activities, such as finance and the negative consequences resulting from climate change. With the Paris Conference where states are obliged to submit Nationally Determined Contributions (NDCs), it can be realized these NDCs can only be fully realized with the state acting in concert with non-state actors.

The study concludes that NSAs vary in size, influence, and ability to make a meaningful impacts in terms of reducing the security risks posed by climate change. Based on their resource availability and organizational prowess, they are able to make an impact in the lives of smallholder farmers to help reduce losses incurred by climate change.

The study argues that the ability of NGOs to make an impact in the lives of smallholder farmers requires a holistic and more comprehensive approach that addresses the multifarious forces that militate against food security and climate change. In this study, it was observed that the NGO addressed the issues across the varying value chain starting with educating the mindset, helping with the variety of crops to plant, how to plant well and store water, how to insure against a foreseeable loss of crops due to climate change, post-harvest issues including value addition and marketing.

The study recommends deeper collaboration between state actors as well as local governments and non-state actors with the goal of maximizing the impact they all make in the lives of smallholder farmers in their quest to adapt to climate change. Since these entities have a common goal of ensuring the welfare of local people in building their resilience towards climate change impacts, their efforts will be meaningful if there is a coordination of efforts.

Statements and Declaration

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Consent to Participate

Informed consent was obtained from all individual participants included in the study.

Abbreviations

BINGOs	- Business and Industry Non-Governmental Organizations
COP	- Conference of Parties
CSO	- Civil Society Organization
ENGOS	- Environmental Non - Governmental Organizations
FAO	- Food and Agriculture Organization
IFAD	- International Fund for Agricultural Development
IPCC	- International Panel for Climate Change
IPOs	- Indigenous Peoples' Organizations
LGMA	- Local Government and Municipal Authorities
NGOs	- Non-Governmental Organizations
NSAs	- Non-State Actors
RINGOs	- Research and Independent Non - Governmental Organizations
TUNGOS	- Trade Unions Non - Governmental Organizations
UNEP	- United Nations Environment Program
UNFCCC	- United Nations Framework Convention on Climate Change
UNICEF	- United Nations Children's Fund
WFP	- World Food Program
WHO	- World Health Organization
YOUNGO	- Constituency of Youth Non-Governmental Organizations

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Acknowledgments

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The following is the official style and template developed for publication of a research paper. Authors are not required to follow this style during the submission of the paper. It is just for reference purposes.



Manuscript Style Instruction (Optional)

- Microsoft Word Document Setting Instructions.
- Font type of all text should be Swis721 Lt BT.
- Page size: 8.27" x 11", left margin: 0.65, right margin: 0.65, bottom margin: 0.75.
- Paper title should be in one column of font size 24.
- Author name in font size of 11 in one column.
- Abstract: font size 9 with the word "Abstract" in bold italics.
- Main text: font size 10 with two justified columns.
- Two columns with equal column width of 3.38 and spacing of 0.2.
- First character must be three lines drop-capped.
- The paragraph before spacing of 1 pt and after of 0 pt.
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- Large images must be in one column.
- The names of first main headings (Heading 1) must be in Roman font, capital letters, and font size of 10.
- The names of second main headings (Heading 2) must not include numbers and must be in italics with a font size of 10.

Structure and Format of Manuscript

The recommended size of an original research paper is under 15,000 words and review papers under 7,000 words. Research articles should be less than 10,000 words. Research papers are usually longer than review papers. Review papers are reports of significant research (typically less than 7,000 words, including tables, figures, and references)

A research paper must include:

- a) A title which should be relevant to the theme of the paper.
- b) A summary, known as an abstract (less than 150 words), containing the major results and conclusions.
- c) Up to 10 keywords that precisely identify the paper's subject, purpose, and focus.
- d) An introduction, giving fundamental background objectives.
- e) Resources and techniques with sufficient complete experimental details (wherever possible by reference) to permit repetition, sources of information must be given, and numerical methods must be specified by reference.
- f) Results which should be presented concisely by well-designed tables and figures.
- g) Suitable statistical data should also be given.
- h) All data must have been gathered with attention to numerical detail in the planning stage.

Design has been recognized to be essential to experiments for a considerable time, and the editor has decided that any paper that appears not to have adequate numerical treatments of the data will be returned unrefereed.

- i) Discussion should cover implications and consequences and not just recapitulate the results; conclusions should also be summarized.
- j) There should be brief acknowledgments.
- k) There ought to be references in the conventional format. Global Journals recommends APA format.

Authors should carefully consider the preparation of papers to ensure that they communicate effectively. Papers are much more likely to be accepted if they are carefully designed and laid out, contain few or no errors, are summarizing, and follow instructions. They will also be published with much fewer delays than those that require much technical and editorial correction.

The Editorial Board reserves the right to make literary corrections and suggestions to improve brevity.



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It is necessary that authors take care in submitting a manuscript that is written in simple language and adheres to published guidelines.

All manuscripts submitted to Global Journals should include:

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The title page must carry an informative title that reflects the content, a running title (less than 45 characters together with spaces), names of the authors and co-authors, and the place(s) where the work was carried out.

Author details

The full postal address of any related author(s) must be specified.

Abstract

The abstract is the foundation of the research paper. It should be clear and concise and must contain the objective of the paper and inferences drawn. It is advised to not include big mathematical equations or complicated jargon.

Many researchers searching for information online will use search engines such as Google, Yahoo or others. By optimizing your paper for search engines, you will amplify the chance of someone finding it. In turn, this will make it more likely to be viewed and cited in further works. Global Journals has compiled these guidelines to facilitate you to maximize the web-friendliness of the most public part of your paper.

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A major lynchpin of research work for the writing of research papers is the keyword search, which one will employ to find both library and internet resources. Up to eleven keywords or very brief phrases have to be given to help data retrieval, mining, and indexing.

One must be persistent and creative in using keywords. An effective keyword search requires a strategy: planning of a list of possible keywords and phrases to try.

Choice of the main keywords is the first tool of writing a research paper. Research paper writing is an art. Keyword search should be as strategic as possible.

One should start brainstorming lists of potential keywords before even beginning searching. Think about the most important concepts related to research work. Ask, "What words would a source have to include to be truly valuable in a research paper?" Then consider synonyms for the important words.

It may take the discovery of only one important paper to steer in the right keyword direction because, in most databases, the keywords under which a research paper is abstracted are listed with the paper.

Numerical Methods

Numerical methods used should be transparent and, where appropriate, supported by references.

Abbreviations

Authors must list all the abbreviations used in the paper at the end of the paper or in a separate table before using them.

Formulas and equations

Authors are advised to submit any mathematical equation using either MathJax, KaTeX, or LaTeX, or in a very high-quality image.

Tables, Figures, and Figure Legends

Tables: Tables should be cautiously designed, uncrowned, and include only essential data. Each must have an Arabic number, e.g., Table 4, a self-explanatory caption, and be on a separate sheet. Authors must submit tables in an editable format and not as images. References to these tables (if any) must be mentioned accurately.



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Figures are supposed to be submitted as separate files. Always include a citation in the text for each figure using Arabic numbers, e.g., Fig. 4. Artwork must be submitted online in vector electronic form or by emailing it.

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For scanned images, the scanning resolution at final image size ought to be as follows to ensure good reproduction: line art: >650 dpi; halftones (including gel photographs): >350 dpi; figures containing both halftone and line images: >650 dpi.

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TIPS FOR WRITING A GOOD QUALITY SCIENCE FRONTIER RESEARCH PAPER

Techniques for writing a good quality Science Frontier Research paper:

1. Choosing the topic: In most cases, the topic is selected by the interests of the author, but it can also be suggested by the guides. You can have several topics, and then judge which you are most comfortable with. This may be done by asking several questions of yourself, like "Will I be able to carry out a search in this area? Will I find all necessary resources to accomplish the search? Will I be able to find all information in this field area?" If the answer to this type of question is "yes," then you ought to choose that topic. In most cases, you may have to conduct surveys and visit several places. Also, you might have to do a lot of work to find all the rises and falls of the various data on that subject. Sometimes, detailed information plays a vital role, instead of short information. Evaluators are human: The first thing to remember is that evaluators are also human beings. They are not only meant for rejecting a paper. They are here to evaluate your paper. So present your best aspect.

2. Think like evaluators: If you are in confusion or getting demotivated because your paper may not be accepted by the evaluators, then think, and try to evaluate your paper like an evaluator. Try to understand what an evaluator wants in your research paper, and you will automatically have your answer. Make blueprints of paper: The outline is the plan or framework that will help you to arrange your thoughts. It will make your paper logical. But remember that all points of your outline must be related to the topic you have chosen.

3. Ask your guides: If you are having any difficulty with your research, then do not hesitate to share your difficulty with your guide (if you have one). They will surely help you out and resolve your doubts. If you can't clarify what exactly you require for your work, then ask your supervisor to help you with an alternative. He or she might also provide you with a list of essential readings.

4. Use of computer is recommended: As you are doing research in the field of science frontier then this point is quite obvious. Use right software: Always use good quality software packages. If you are not capable of judging good software, then you can lose the quality of your paper unknowingly. There are various programs available to help you which you can get through the internet.

5. Use the internet for help: An excellent start for your paper is using Google. It is a wondrous search engine, where you can have your doubts resolved. You may also read some answers for the frequent question of how to write your research paper or find a model research paper. You can download books from the internet. If you have all the required books, place importance on reading, selecting, and analyzing the specified information. Then sketch out your research paper. Use big pictures: You may use encyclopedias like Wikipedia to get pictures with the best resolution. At Global Journals, you should strictly follow here.



6. Bookmarks are useful: When you read any book or magazine, you generally use bookmarks, right? It is a good habit which helps to not lose your continuity. You should always use bookmarks while searching on the internet also, which will make your search easier.

7. Revise what you wrote: When you write anything, always read it, summarize it, and then finalize it.

8. Make every effort: Make every effort to mention what you are going to write in your paper. That means always have a good start. Try to mention everything in the introduction—what is the need for a particular research paper. Polish your work with good writing skills and always give an evaluator what he wants. Make backups: When you are going to do any important thing like making a research paper, you should always have backup copies of it either on your computer or on paper. This protects you from losing any portion of your important data.

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11. Pick a good study spot: Always try to pick a spot for your research which is quiet. Not every spot is good for studying.

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Verbs have to be in agreement with their subjects. In a research paper, do not start sentences with conjunctions or finish them with prepositions. When writing formally, it is advisable to never split an infinitive because someone will (wrongly) complain. Avoid clichés like a disease. Always shun irritating alliteration. Use language which is simple and straightforward. Put together a neat summary.

14. Arrangement of information: Each section of the main body should start with an opening sentence, and there should be a changeover at the end of the section. Give only valid and powerful arguments for your topic. You may also maintain your arguments with records.

15. Never start at the last minute: Always allow enough time for research work. Leaving everything to the last minute will degrade your paper and spoil your work.

16. Multitasking in research is not good: Doing several things at the same time is a bad habit in the case of research activity. Research is an area where everything has a particular time slot. Divide your research work into parts, and do a particular part in a particular time slot.

17. Never copy others' work: Never copy others' work and give it your name because if the evaluator has seen it anywhere, you will be in trouble. Take proper rest and food: No matter how many hours you spend on your research activity, if you are not taking care of your health, then all your efforts will have been in vain. For quality research, take proper rest and food.

18. Go to seminars: Attend seminars if the topic is relevant to your research area. Utilize all your resources.

19. Refresh your mind after intervals: Try to give your mind a rest by listening to soft music or sleeping in intervals. This will also improve your memory. Acquire colleagues: Always try to acquire colleagues. No matter how sharp you are, if you acquire colleagues, they can give you ideas which will be helpful to your research.



20. Think technically: Always think technically. If anything happens, search for its reasons, benefits, and demerits. Think and then print: When you go to print your paper, check that tables are not split, headings are not detached from their descriptions, and page sequence is maintained.

21. Adding unnecessary information: Do not add unnecessary information like "I have used MS Excel to draw graphs." Irrelevant and inappropriate material is superfluous. Foreign terminology and phrases are not apropos. One should never take a broad view. Analogy is like feathers on a snake. Use words properly, regardless of how others use them. Remove quotations. Puns are for kids, not grunt readers. Never oversimplify: When adding material to your research paper, never go for oversimplification; this will definitely irritate the evaluator. Be specific. Never use rhythmic redundancies. Contractions shouldn't be used in a research paper. Comparisons are as terrible as clichés. Give up ampersands, abbreviations, and so on. Remove commas that are not necessary. Parenthetical words should be between brackets or commas. Understatement is always the best way to put forward earth-shaking thoughts. Give a detailed literary review.

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23. Upon conclusion: Once you have concluded your research, the next most important step is to present your findings. Presentation is extremely important as it is the definite medium through which your research is going to be in print for the rest of the crowd. Care should be taken to categorize your thoughts well and present them in a logical and neat manner. A good quality research paper format is essential because it serves to highlight your research paper and bring to light all necessary aspects of your research.

INFORMAL GUIDELINES OF RESEARCH PAPER WRITING

Key points to remember:

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- Write your paper in the form which is presented in the guidelines using the template.
- Please note the criteria peer reviewers will use for grading the final paper.

Final points:

One purpose of organizing a research paper is to let people interpret your efforts selectively. The journal requires the following sections, submitted in the order listed, with each section starting on a new page:

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The discussion section:

This will provide understanding of the data and projections as to the implications of the results. The use of good quality references throughout the paper will give the effort trustworthiness by representing an alertness to prior workings.

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- Submitting a manuscript with pages out of sequence.
- In every section of your document, use standard writing style, including articles ("a" and "the").
- Keep paying attention to the topic of the paper.
- Use paragraphs to split each significant point (excluding the abstract).
- Align the primary line of each section.
- Present your points in sound order.
- Use present tense to report well-accepted matters.
- Use past tense to describe specific results.
- Do not use familiar wording; don't address the reviewer directly. Don't use slang or superlatives.
- Avoid use of extra pictures—include only those figures essential to presenting results.

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Choose a revealing title. It should be short and include the name(s) and address(es) of all authors. It should not have acronyms or abbreviations or exceed two printed lines.

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An abstract is a brief, distinct paragraph summary of finished work or work in development. In a minute or less, a reviewer can be taught the foundation behind the study, common approaches to the problem, relevant results, and significant conclusions or new questions.

Write your summary when your paper is completed because how can you write the summary of anything which is not yet written? Wealth of terminology is very essential in abstract. Use comprehensive sentences, and do not sacrifice readability for brevity; you can maintain it succinctly by phrasing sentences so that they provide more than a lone rationale. The author can at this moment go straight to shortening the outcome. Sum up the study with the subsequent elements in any summary. Try to limit the initial two items to no more than one line each.

Reason for writing the article—theory, overall issue, purpose.

- Fundamental goal.
- To-the-point depiction of the research.
- Consequences, including definite statistics—if the consequences are quantitative in nature, account for this; results of any numerical analysis should be reported. Significant conclusions or questions that emerge from the research.

Approach:

- Single section and succinct.
- An outline of the job done is always written in past tense.
- Concentrate on shortening results—limit background information to a verdict or two.
- Exact spelling, clarity of sentences and phrases, and appropriate reporting of quantities (proper units, important statistics) are just as significant in an abstract as they are anywhere else.

Introduction:

The introduction should "introduce" the manuscript. The reviewer should be presented with sufficient background information to be capable of comprehending and calculating the purpose of your study without having to refer to other works. The basis for the study should be offered. Give the most important references, but avoid making a comprehensive appraisal of the topic. Describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will give no attention to your results. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here.



The following approach can create a valuable beginning:

- Explain the value (significance) of the study.
- Defend the model—why did you employ this particular system or method? What is its compensation? Remark upon its appropriateness from an abstract point of view as well as pointing out sensible reasons for using it.
- Present a justification. State your particular theory(-ies) or aim(s), and describe the logic that led you to choose them.
- Briefly explain the study's tentative purpose and how it meets the declared objectives.

Approach:

Use past tense except for when referring to recognized facts. After all, the manuscript will be submitted after the entire job is done. Sort out your thoughts; manufacture one key point for every section. If you make the four points listed above, you will need at least four paragraphs. Present surrounding information only when it is necessary to support a situation. The reviewer does not desire to read everything you know about a topic. Shape the theory specifically—do not take a broad view.

As always, give awareness to spelling, simplicity, and correctness of sentences and phrases.

Procedures (methods and materials):

This part is supposed to be the easiest to carve if you have good skills. A soundly written procedures segment allows a capable scientist to replicate your results. Present precise information about your supplies. The suppliers and clarity of reagents can be helpful bits of information. Present methods in sequential order, but linked methodologies can be grouped as a segment. Be concise when relating the protocols. Attempt to give the least amount of information that would permit another capable scientist to replicate your outcome, but be cautious that vital information is integrated. The use of subheadings is suggested and ought to be synchronized with the results section.

When a technique is used that has been well-described in another section, mention the specific item describing the way, but draw the basic principle while stating the situation. The purpose is to show all particular resources and broad procedures so that another person may use some or all of the methods in one more study or referee the scientific value of your work. It is not to be a step-by-step report of the whole thing you did, nor is a methods section a set of orders.

Materials:

Materials may be reported in part of a section or else they may be recognized along with your measures.

Methods:

- Report the method and not the particulars of each process that engaged the same methodology.
- Describe the method entirely.
- To be succinct, present methods under headings dedicated to specific dealings or groups of measures.
- Simplify—detail how procedures were completed, not how they were performed on a particular day.
- If well-known procedures were used, account for the procedure by name, possibly with a reference, and that's all.

Approach:

It is embarrassing to use vigorous voice when documenting methods without using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result, when writing up the methods, most authors use third person passive voice.

Use standard style in this and every other part of the paper—avoid familiar lists, and use full sentences.

What to keep away from:

- Resources and methods are not a set of information.
- Skip all descriptive information and surroundings—save it for the argument.
- Leave out information that is immaterial to a third party.



Results:

The principle of a results segment is to present and demonstrate your conclusion. Create this part as entirely objective details of the outcome, and save all understanding for the discussion.

The page length of this segment is set by the sum and types of data to be reported. Use statistics and tables, if suitable, to present consequences most efficiently.

You must clearly differentiate material which would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matters should not be submitted at all except if requested by the instructor.

Content:

- Sum up your conclusions in text and demonstrate them, if suitable, with figures and tables.
- In the manuscript, explain each of your consequences, and point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation of an exacting study.
- Explain results of control experiments and give remarks that are not accessible in a prescribed figure or table, if appropriate.
- Examine your data, then prepare the analyzed (transformed) data in the form of a figure (graph), table, or manuscript.

What to stay away from:

- Do not discuss or infer your outcome, report surrounding information, or try to explain anything.
- Do not include raw data or intermediate calculations in a research manuscript.
- Do not present similar data more than once.
- A manuscript should complement any figures or tables, not duplicate information.
- Never confuse figures with tables—there is a difference.

Approach:

As always, use past tense when you submit your results, and put the whole thing in a reasonable order.

Put figures and tables, appropriately numbered, in order at the end of the report.

If you desire, you may place your figures and tables properly within the text of your results section.

Figures and tables:

If you put figures and tables at the end of some details, make certain that they are visibly distinguished from any attached appendix materials, such as raw facts. Whatever the position, each table must be titled, numbered one after the other, and include a heading. All figures and tables must be divided from the text.

Discussion:

The discussion is expected to be the trickiest segment to write. A lot of papers submitted to the journal are discarded based on problems with the discussion. There is no rule for how long an argument should be.

Position your understanding of the outcome visibly to lead the reviewer through your conclusions, and then finish the paper with a summing up of the implications of the study. The purpose here is to offer an understanding of your results and support all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of results should be fully described.

Infer your data in the conversation in suitable depth. This means that when you clarify an observable fact, you must explain mechanisms that may account for the observation. If your results vary from your prospect, make clear why that may have happened. If your results agree, then explain the theory that the proof supported. It is never suitable to just state that the data approved the prospect, and let it drop at that. Make a decision as to whether each premise is supported or discarded or if you cannot make a conclusion with assurance. Do not just dismiss a study or part of a study as "uncertain."



Research papers are not acknowledged if the work is imperfect. Draw what conclusions you can based upon the results that you have, and take care of the study as a finished work.

- You may propose future guidelines, such as how an experiment might be personalized to accomplish a new idea.
- Give details of all of your remarks as much as possible, focusing on mechanisms.
- Make a decision as to whether the tentative design sufficiently addressed the theory and whether or not it was correctly restricted. Try to present substitute explanations if they are sensible alternatives.
- One piece of research will not counter an overall question, so maintain the large picture in mind. Where do you go next? The best studies unlock new avenues of study. What questions remain?
- Recommendations for detailed papers will offer supplementary suggestions.

Approach:

When you refer to information, differentiate data generated by your own studies from other available information. Present work done by specific persons (including you) in past tense.

Describe generally acknowledged facts and main beliefs in present tense.

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Methods and Procedures	Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads	Difficult to comprehend with embarrassed text, too much explanation but completed	Incorrect and unorganized structure with hazy meaning
Result	Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake	Complete and embarrassed text, difficult to comprehend	Irregular format with wrong facts and figures
Discussion	Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited	Wordy, unclear conclusion, spurious	Conclusion is not cited, unorganized, difficult to comprehend
References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring



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