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Nature-based solutions: An analysis of approaches and case studies from the countries in the East and the West

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Abstract- English

Climate is changing rapidly, and the earth is getting warmer. Until now, there has been no planet B. We need urgent actions and need to come up with steps to prevent the disastrous effects of climate change. Climate change mitigation and adaptation measures are a few ways. Nature-based solutions (NBS) are one of those measures we can put in the category of mitigation as well as adaptation. IUCN defines NBS as actions to conserve, sustainably manage, and restore natural and modified ecosystems that handle societal concerns effectively, benefiting both people and the environment simultaneously. More research on NBS is conducted in developed countries, while the research is comparatively less in other countries. Developing countries use many innovative techniques that are not considered NBS due to limited research.

This thesis discusses Nature-Based Solutions and studies from Asian and European countries. By analysing different case studies, it explores if the NBS in Asian countries are more or less effective than in European countries. It uses a mixed methodology approach adapted from the IUCN Global Standard for NBS and the Think Nature handbook (its development was funded by EU Horizon 2020).

An essential aspect of NBS is the participation of different stakeholders. To better understand public participation, with the help of the Start Park approach, a workshop was conducted with the students of Politecnico di Torino. As a result, students devised different solutions for the given problems and the role of power in decision-making was understood.

There is no precise answer to the research question, but many informative results came up. Developed countries can invest more money in climate change-related practices than others. However, some countries use innovative NBS, which are cost-effective, and which will significantly benefit other places if used. In different continents, solutions perform differently to fulfil the Sustainable Development Goals (SDGs) and solve societal problems compared to the solutions when observed in the same continent. This difference depends on the country's primary goal - to prevent climate change or poverty.

Keywords- Climate change, Nature-based solutions, IUCN, ThinkNature, Start Park, Sustainable Development Goals, Societal problems, Asian countries, European countries

Abstract- Italian

Il clima sta cambiando rapidamente e la temperatura terrestre sta aumentando. Fino ad oggi, non è stata trovata alcuna soluzione per un pianeta B. C'è bisogno di azioni urgenti per prevenire gradualmente i disastrosi effetti del cambiamento climatico. Le misure di mitigazione ed adattamento al cambiamento climatico sono diverse. Le soluzioni naturali (NBS) sono una delle possibili misure che possono essere inserite in entrambe le categorie. La IUCN definisce le NBS come azioni volte a conservare, gestire in maniera sostenibile e ricostruire ecosistemi naturali ed antropizzati e che maneggino in modo efficace problematiche sociali, portando benefici sia alle popolazioni che all'ambiente. La ricerca sulle NBS è condotta principalmente nei Paesi sviluppati, mentre è minore negli altri Paesi. Gli Stati in via di sviluppo usano diverse tecnologie innovative che non sono considerate NBS per la scarsa ricerca condotta su di esse.

Questa tesi discute le NBS e studi da Paesi asiatici ed Europei. Analizzando diversi casi studio, ricerca se le NBS nei Paesi asiatici sono più o meno efficienti che in quelli europei. Viene usata una metodologia mista adattata dagli standard globali dell'IUCN e dal manuale "ThinkNature" (finanziato da EU Horizon 2020).

Un aspetto essenziale delle NBS è la partecipazione di diversi stakeholder. Per capire meglio la partecipazione pubblica, con l'aiuto dell'approccio Start Park, è stato fatto un laboratorio con gli studenti del Politecnico di Torino. Gli studenti hanno analizzato diverse soluzioni per i problemi definiti a priori e sono stati compresi gli equilibri di potere nella decisione politica.

Non c'è una risposta precisa alla domanda di partenza, ma diverse informazioni sono emerse. I Paesi sviluppati possono investire più denaro nelle pratiche relative al cambiamento climatico. Ciononostante, alcuni Stati usano NBS innovative, economicamente vantaggiose e che possono portare benefici significativi anche in altri posti. In diversi continenti, le soluzioni hanno diverse ricadute sul raggiungimento degli Obiettivi per lo Sviluppo Sostenibili e sull'efficacia nel risolvere problemi sociali. Questa osservazione dipende dall'obiettivo primario di un Paese - prevenire il cambiamento climatico o la povertà.

List of Abbreviation

NBS- Nature-based solutions

IUCN- International Union for Conservation of Nature

SDG- Sustainable Development Goal

CRZBNF - Climate Resilient Zero Budget Natural Farming

WHO- World Health Organisation

UN- United nations

UNFCC-United Nations Framework Convention on Climate Change

WWF-World Wide Fund for Nature

FAO- Food and Agriculture Organization of the United Nations

IPCC-Intergovernmental Panel on Climate Change

IPBES-Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services

ADB-Asian Development Bank

EC- European Commission

EU- European Union

GI- Green Infrastructure

GBI- Green Building Infrastructure

ANR- Assisted Natural Regeneration

NITI- National Institution for Transforming India

GNI- Gross National Income

GVNML- Gram Vikas Navyuvak Mandal Laporiya

ENCA- Enabling a Natural Capital Approach

AP- Andhra Pradesh (a state in India)

GIZ- Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (It is an international enterprise owned by the German Federal Government)

RySS- Rythu Sadhikara Samstha (A non-profit company by Andhra government in India)

AEMET- *Agencia Estatal de Meteorología* (State Meteorological Agency of Spain)

CET- Central England Temperature

1

Introduction

1.1 Background and Problem statement

Climate change is not fiction but a fact. Climate is changing rapidly. Countries are breaking records each summer and winter. Quoting some famous newspaper headlines here from this year(2022)- heading from The Guardian, **"Weather tracker: record-breaking heat continues to scorch western Europe"**(Flowle, 2022), here the author talks about the rising temperature in various European countries and that the central England temperature (CET) which records the temperature dating back to 1772, in 2022 recorded the highest ever daily average temperature of 28.1C, which is an increase of 2.8^{o} C above the previous recorded highest temperature. Another heading from CNN is **"European cities set all-time temperature records amid unrelenting heat wave"**(Orie et al., 2022). It states that, on 12th July 2022, the city of 'Ourense' in northwest Spain broke the record high temperature of 43.2^{o} Celsius, according to Spain's meteorological agency AEMET. An article from India titled "**Heatwave breaks monthly records in India and continues to build"** stated that parts of Delhi recorded the second hottest April in the last 72 years, with an average monthly temperature of 40.2^{o}C. The situation is getting griever, and countries are trying to come up with solutions.

Everybody knows about climate change and global warming. While not many work for the measures related to climate mitigation and climate adaptation. United Nations talks about climate change and global warming in several briefings. It states that the linear 100-year warming trend was 0.74°C (1906–2005), with most of the warming occurring in the last 50 years. The expected rate of warming over the next 20 years is 0.2°C each decade(United Nations Framework Convention on Climate Change, 2011).

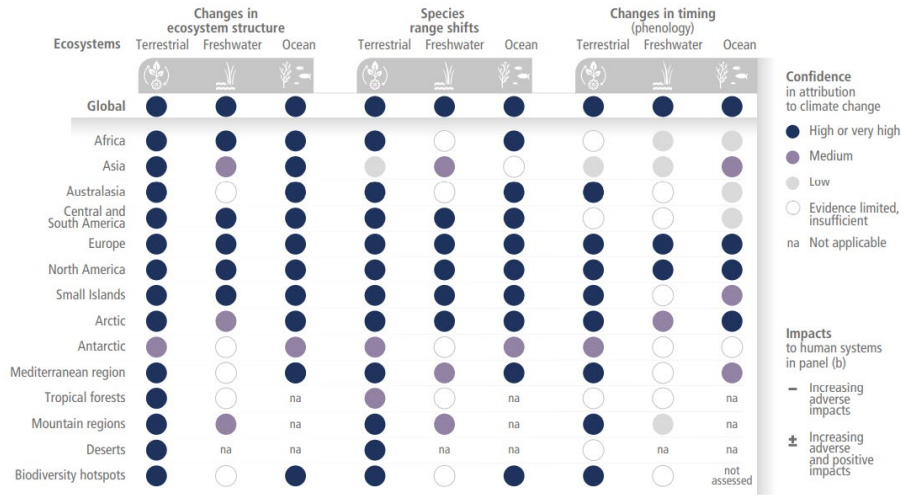


Figure 1 Effects of Climate change in Various countries- Changes in ecosystem, Species, phenology(IPCC, 2022)

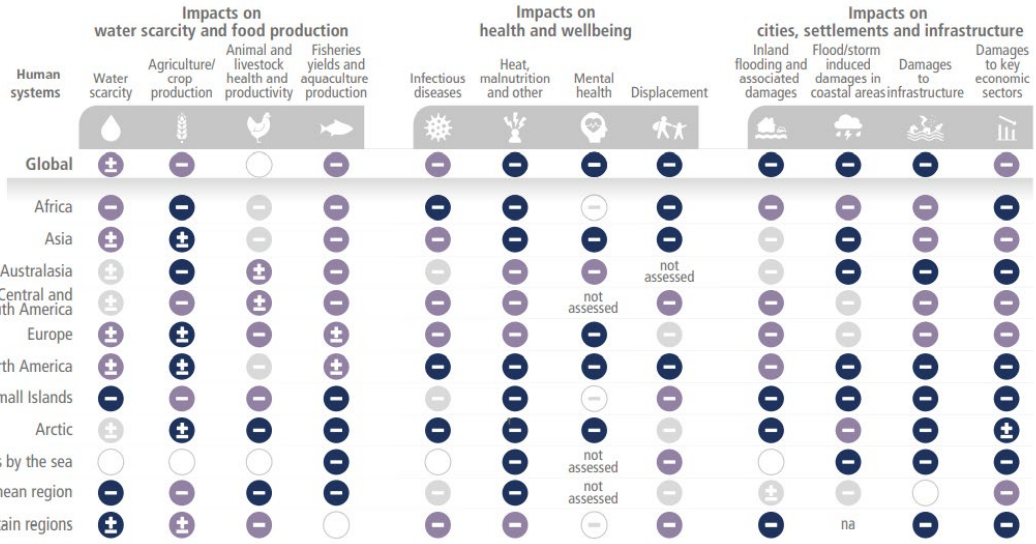


Figure 2 Effects of Climate change in various countries- Impacts on water, food, health and cities(IPCC, 2022)

Under all possible emission scenarios, the global surface temperature will continue to rise through at least the middle of the century. Unless carbon dioxide and other greenhouse gas emissions are drastically reduced in the upcoming decades, the 1.5°C and 2°C global warming thresholds will be exceeded throughout the twenty-first century(IPCC, 2022).

It is the present-day's need to protect our environment; otherwise, the temperature may rise to extreme levels, and it will not be bearable on Earth for us. There are many ways by which we can try to protect our climate, one being Nature-based solutions.

The 2015 Paris climate accord seeks to keep the increase in the average global temperature this century well below 2 °C but with a goal of 1.5 °C. According to the IPCC and many other national and international organisations, the best way is to reduce the machines that emit GHGS, especially CO_2. According to research by Girardin et al., (2021), nature-based solutions can be used to limit warming. These "natural climate solutions" seek to lower atmospheric greenhouse gas concentrations in three different approaches. One is to reduce carbon release by safeguarding ecosystems and preventing emissions, which includes limiting deforestation. The second is restoring habitats, including wetlands, as they are an option to help trap carbon. The third is to enhance land management for grazing, crops, and wood in order to absorb carbon and lower carbon, methane, and nitrous oxide emissions. So, nature-based solutions are a good way of mitigating and adapting to climate change and simultaneously benefitting people and nature.

The NBS approach is presently being used widely across Europe(Lechner et al., 2020), and their numerous NBS research and demonstration projects demonstrate the benefits of the NBS strategy for tackling urbanisation and other concerns, including climate change adaptation. However, there is not as much literature on the use of NBS and ecosystem services in Southeast Asia as there is for different parts of the world(Lechner et al., 2020). The same goes for South Asia and East Asia (found during the research process).

These limits range from environmental to planning or legal inflexibilities that provide minimal room for novel approaches(Lechner et al., 2020). Significant cultural disparities also exist, and as preferences and expectations are influenced by culture, these variances affect what individuals anticipate from their city(Home et al., 2010).

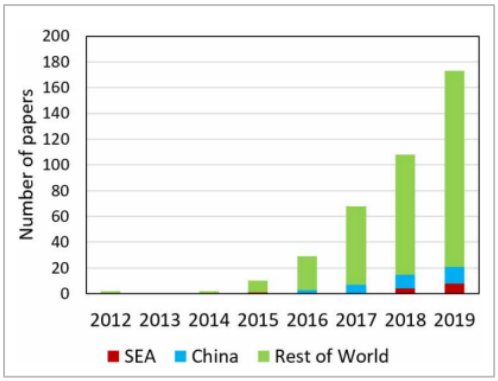


Figure 3 Graph showing researches [(Source- (Lechner et al., 2020)]

According to the keyword research done by (Lechner et al., 2020), the graph on left was developed. From it, we can see that most of the research papers were from the "Rest of the world" category, which increased drastically from 2014 to 2019. They searched 560 papers; only 16 were from South Asia and 45 from East Asia(all from China). It was also concluded that the reason might be due to money available for research.

So, this thesis tries to analyse the Nature-based solutions in Asia and European countries after working out a methodology which can be applied in the given(limited) time frame and try to analyse which kind of solutions are better (if any) or maybe both are equally good. We will sometimes refer to European countries as the "West" and Asian countries as the "East".

1.2 Research Question

The research question of the thesis is – **"If the Nature-based Solutions in Asian countries(East) are more or less effective than in European countries (West)?**

The world was divided according in many different frameworks. Firstly, the first, second and third-world countries. A French demographer named Alfred Sauvy published an essay in the French journal L'Observateur in 1952 that concluded by drawing comparisons between the Third World and the Third Estate(Karakır, 2012).

- First World- The term "First World" refers to what is known as developed, capitalist, industrialised nations. Roughly speaking, this group includes North America, Western Europe, Japan, and Australia—after World War II, all nations that partnered with the United States and shared a number of political and economic interests (Karakır, 2012).
- Second World- The term "Second World" denotes the former communist-socialist industrial states (previously called the Eastern Bloc, which was the realm of the effect of the Union of Soviet Socialists Republic, USSR) of today, including China, Russia, Eastern Europe (including Poland), some Turk States, (also comprising of Kazakhstan) (Karakır, 2012).
- Third World- The term "Third World" is now frequently used to broadly refer to the developing nations of Latin America, Asia, and Africa (Karakır, 2012). The term "Third World" encompasses both capitalist (like Venezuela) and communist (like North Korea) nations, as well as highly wealthy (like Saudi Arabia) and very impoverished nations (like Mali).

While there is another way of classifying the countries-

- West- The West might be considered a civilisation that is global in scope. One hears of a West today that encompasses not only countries with a European majority but also non-Western countries that have adopted Western institutions, methods, and to some extent, ideals. Take Japan as an example(McNeill, 1997).
- East- While the countries which have not adopted the concept of Western institutions are called the East.

For this research-

This research will consider the East as the developing countries of Asia, namely Indonesia, India, Thailand, Nepal, Bangladesh and Vietnam, while the West as the developed countries of Europe, namely- the Netherlands, Belgium, Germany, Spain, Sweden and Denmark. In today's time, these words have become obsolete, and it is not advised to use the words like East and West. But just for research purposes, we will use them.

1.3 Research Objectives

Research objectives which will help in getting a solution to the research question are -

1.3.1 Analysis of different solutions available in European and Asian countries.

The thesis aims firstly to understand NBS, its advantages and definitions used in various world organisations. Then, go through different methodologies which are available to assess the NBS. Further to it, to choose one of the methodologies and adapt it according to the data and time available. Finally, apply it to the solutions available in different countries. Also, a comparison of studies between Europe and Asia.

1.3.2 Understanding the Participatory approach in Nature-based solutions.

An essential aspect of NBS is participation by the locals or the citizens. NBS, according to many definitions, is not just the use of nature and similar techniques; it also needs the involvement of society and solving its problems. Without this, the solution cannot be called NBS. Different participatory approaches are available. One of them was chosen, and a game was played with the students of the Master's in Science program in Territorial, Urban, Environmental and Landscape Planning (Academic Year 2021-2022), Decision Making for Sustainable Development Goals course, with the help of this approach (here we used Start Park approach, which follows Design thinking methodology).

1.4 Thesis structure

The Thesis is divided into five (5) chapters, and all contain information through which the objectives are attained and a solution to the problem is achieved.

1. Introduction

This part is further divided into - 1. Background and Problem statement, 2. Research question, 3. Research Objectives, and 4. Thesis Structure

This is a theoretical part, and it introduces the research question. Starting from the background of why this topic was chosen to the objectives followed in achieving the solutions. It lays the foundation for upcoming parts.

2. Literature Review

This part is a theoretical understanding of different topics related to NBS. It is an integral part as it was needed to go ahead to make the methodology for finding the solution to the research question. It includes the desktop study. Firstly, it consists of the different definitions of NBS in various organisations worldwide. This was done to understand if there are similarities or differences between them. Though some international organisations also help countries with NBS techniques, still the definitions could be different, and it needed an understanding. Then it moves on to the methods of classification and different assessment techniques. It also

includes the relationships between the SDGs and NBS. If the considered solution is able to solve the SDG, then it is more helpful. This part also focuses on the participatory approach and its importance in NBS. Different participatory approaches are studied, and finally, the Start Park approach is focused on.

3. Methodology

It involves how the research was carried out. To understand which assessment techniques can be used to assess a solution, then study different solutions and check which are better, if any. And a comparison of European and Asian solutions is made.

It also considers the participatory approach. It talks about the importance of participation in NBS and how one of the different approaches studied was applied in a workshop conducted with the students of Politecnico di Torino to understand better what people might think during decision-making discussions(realistic).

4. Results

This part discusses the case studies. The methodology which was formulated after the literature review is utilised here. The cases are described in different countries and classified along with various benefits, and an assessment is carried out. It also talks about solutions within a country and then compares the solutions in Europe and Asia. Furthermore, it includes the results of the participatory approach workshop observations and results.

5. Conclusions and Final Recommendations

The final part includes what we understood after the comparison between the European and Asian countries. And most importantly, it tries to solve the problem statement, "*If the Nature-based Solutions in the Asian countries (East) are more or less effective than in the European countries (West)?"* along with some other details like if some solution can be applied in other countries or not.

And for future research, some recommendations are given to take the research further. As Geeta Iyenger said, "Knowledge has a beginning but no end".

2

Literature Review

2.1 Definitions of Nature Based Solutions

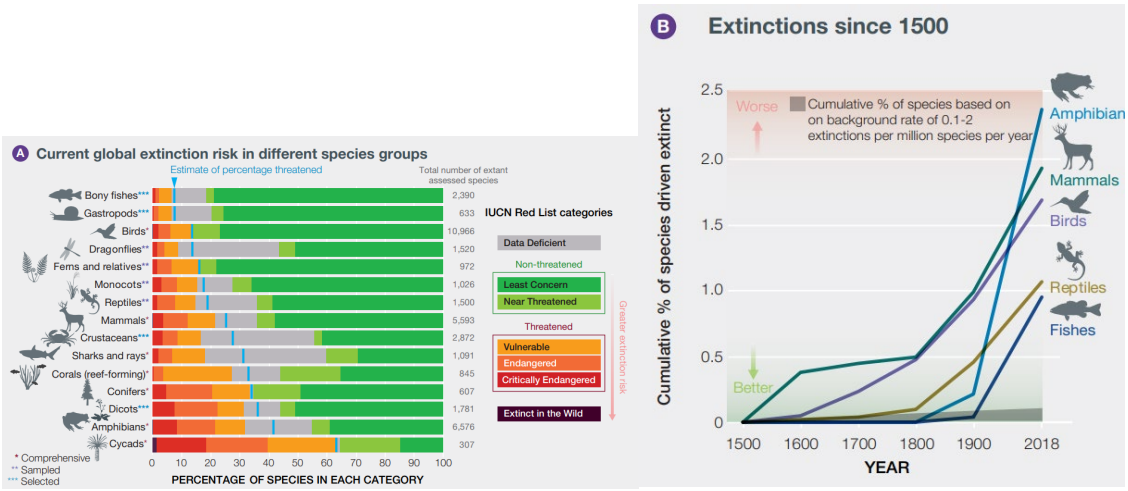


Figure 4 Species in extinction risk and Extinctions since 1500(Source- IPBES report; (Brondizio et al., 2019))

The species assessed during the research by IPBES are threatened with extinction, and rates of extinction are increasing. Earth faces many challenges, including biodiversity loss and climate change, which results in other harmful consequences. There are around 1 million species threatened with extinction(Brondizio et al., 2019). For a means of climate mitigation and adaptation, NBS can be used. They have varied definitions as follows-

Definitions *(Quoted with citation to better understand the exact definitions) -*

- **IUCN-** "Nature-based Solutions are actions to protect, sustainably manage, and restore natural and modified ecosystems that address societal challenges effectively and adaptively, simultaneously benefiting people and nature" (IUCN, 2020).
  "Nature-based Solutions address societal challenges through the protection, sustainable management and restoration of both natural and modified ecosystems, benefiting both biodiversity and human well-being"(IUCN, 2020).

- **European Commission-** "Solutions that are inspired and supported by nature, which are cost-effective, simultaneously **provide environmental, social and economic benefits and help build resilience.** Such solutions bring more and more diverse nature and natural features and processes into cities, landscapes and seascapes through locally adapted, resource-efficient and systemic interventions. Nature-based solutions must benefit biodiversity and support the delivery of a range of ecosystem services" (EC, 2020; Faivre et al., 2017).

- **World Wide Fund for Nature-** "Ecosystem conservation, management and/or restoration interventions intentionally planned to deliver measurable positive climate adaptation and /or mitigation benefits that have human development and biodiversity co-benefits managing anticipated climate risks to nature that can undermine their long-term effectiveness"(WWF, 2020).

- **World Bank-** Nature-based solutions (NBS) is an umbrella term referring to "actions to protect, sustainably manage, and restore natural or modified ecosystems that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits." (Cohen-Shacham et al. 2016.). Since 2012, the World Bank's portfolio of NBS investment projects contributing to climate resilience is worth nearly 5 billion USD. For instance, a common issue is flooding in coastal areas that happens due to storms and coastal erosion. This issue which was usually tackled with manmade or grey infrastructure, e.g., dikes, can also be tackled by solutions that also provide ecosystem services such as tree planting.

- **Asian Development Bank-** Uses the exact definition as IUCN.

- **Food and agricultural organisation of United Nations(FAO)- "**Nature-based solutions (NBS) are defined as techniques or actions which protect, manage sustainably and restore natural or modified ecosystems, and they address societal challenges effectively and adaptively, concurrently providing benefits for human well-being as well as biodiversity. In agriculture (which, as defined by FAO, includes the crop, livestock, fisheries, apiculture, aquaculture and forest sectors), NBS mimic natural processes relying on ecosystem functioning to ensure security of the livelihood and food, more inclusive rural economies and healthier diets"(FAO, n.d) -Taken from FAO website.

There are some approaches related to NBS which can be categorised as follows(will be discussed in detail later):

- Ecosystem approach (EA) and ecosystem-based approaches (EbAp);
- Ecosystem protection and restoration approach: sustainable forest management (SFM), sustainable management (SM), ecosystem-based management (EbM);
- Infrastructure-related approaches: green infrastructure (GI), blue-green infrastructure (BGI);
- Issue-specific ecosystem-related approaches:
  – climate change adaptation: ecosystem-based adaptation (EbA);
  – flooding: natural water retention measures (NWRM);
  – disaster risk reduction: ecosystem-based disaster risk reduction (Eco-DRR)
  – climate mitigation: sustainable climate actions (SCA), natural climate solutions (NCS)

2.2 What is the difference between conservation and nature-based solutions?

Conservation is the safeguarding of the natural resources and biological variety of the planet to ensure their continued existence. It involves defending against threats to plant and animal

species, habitats, ecosystems, and crucial ecological services. Setting aside parks and preserves, ensuring that species have the habitat they need to exist, or enacting legislation to protect threatened or endangered species are all examples of conservation.(Brown, 2022).

On the other hand, **nature-based solutions** are for solving social issues and cover a wide range of strategies, such as habitat restoration, water resource management, catastrophe risk reduction, and green infrastructure. Nature-based solutions are centred on the idea that when ecosystems are healthy and well-managed, they offer vital benefits and services to humans, such as lowering greenhouse gas emissions, securing clean water supplies, improving the air quality we breathe, and increasing food security. (*Guidance for Using the IUCN Global Standard for Nature-Based Solutions: First Editions*, 2020).

2.3 Do nature-based solutions help fight climate change? And can it be used for resilience?

According to estimates carried out in the IPBES research, nature-based solutions can provide **37% of the mitigation** required until 2030 to accomplish the targets of the Paris Agreement (IPBES, 2019). Basic examples through which it can be done are planting trees, urban agriculture, decreasing deforestation, etc., which can help in reducing carbon from nature, and giving habitat for different plants and animals. Another option to reap from nature-based solutions is to reduce deforestation. For instance, paying farmers not to clear the forest maintains ecosystem services like carbon sequestration, provision of clean drinking water, and decrease in downstream river sedimentation. NBS can also help in achieving urban resilience, like preventing landslides, fighting droughts, etc. As discussed above, NBS can be used for climate-related approaches.

- Natural infrastructure and green infrastructure are phrases that describe approaches that rely on nature. They are sometimes used synonymously with "nature-based solutions," while other times, they are referred to as more precise ideas that fit within the broad category of "nature-based solutions." Additionally, they lack common definitions. (Luedke, 2019).

2.4 International Union for Conservation of Nature (IUCN) and NBS

Most Asian countries use the IUCN definitions, so I will discuss them in more detail.

IUCN divides its Nature-based solutions into three parts-

1 **Nature-derived solutions-** Wind, wave and solar energy. These solutions help to fulfil our low-carbon energy needs.

2 **Nature Based-** Solutions based on nature (definitions discussed above)

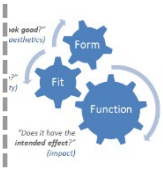
3 **Nature Inspired-** Involves innovative design and production of materials, structures. Best example is biomimicry.

2.4.1. What is Biomimicry?

Janine Benyus, coined the term biomimicry and gave nine principles, namely-

Nature runs on sunlight

Nature uses only the energy it needs



Nature fits form to function

Nature recycles everything

Nature banks on diversity

Nature rewards cooperation

Nature demands local expertise

Nature curbs excesses from within

Nature taps the power of limits

2.5 Green Infrastructure

"A planned network of natural and semi-natural areas with supplemental environmental features is known as "green infrastructure," and it is created and managed to provide a variety of ecosystem services, including water purification, air quality, recreational space, and climate mitigation and adaptation." (Euopean Commission, n.d.). The Green and blue infrastructure have positive effects on human health and life as this improves environmental conditions. This also supports the green economy and creates job opportunities.

When we go into detail, we find that according to European Commission "it provides **environmental, economic and social benefits through natural solutions" (which are also the main aims of the definition of Nature Based Solutions)**. By using GI, countries can reduce the dependency on grey infrastructure, which is mainly considered a means of hampering the environment and is far from traditional techniques.

2.5.1 What is Green Economy?

United Nations Environment Programme defines Green Economy as "a low-carbon, resource-efficient and socially inclusive". Growth in employment and income in a green economy is fuelled by public and private investment in the economic activities, infrastructure, and resources that make carbon emissions lower and pollution lesser, better energy and resource efficiency, and the preservation of biodiversity and ecosystem services.

2.5.2 NBS and GI- Two words with similar meanings

The NBS and the GI both follow the same principles, concepts and approaches. They can be considered as a part of each other. They include the same ideas.

The concept of green infrastructure (GI) and nature-based solutions play a crucial role in **addressing the climate and nature crisis while bringing other benefits to people.**

Green infrastructure (GI) is a network of (semi-)natural areas which are protected and enhanced to deliver ecosystem services while also benefiting biodiversity and society more widely (Biodiversity Information System For Europe, n.d.).

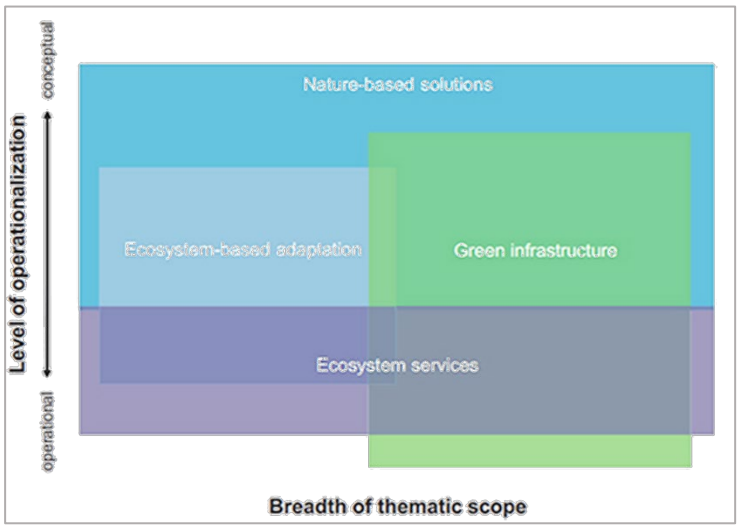


Figure 5 Similarities and differences between different words- (Huthoff, Brinke, Schielen, Daggenvoorde, & Wegman, 2018)

There are differences as well. According to Dorst et al. (2019:4), NBS focuses on delivering immediate "solutions" to sustainability problems. For Mell and Clement (2019), they suggest that the NBS approach "mainly focuses on 'nature' in its fullest sense and promotes its ecological value as being of equal importance to socio-economic benefits". Here "nature" is at the centre of every aspect.

Overall, Pauleit et al. (2017) say that NBS is an "umbrella" term that includes (Dorst et al., 2019) GBI, ES, and EBA. This can be seen in figure (3).

Sometimes, Green Infrastructure is referred to as Nature Based Solutions in Asian Countries. So, this thesis will also consider Green Infrastructure practices in the Asian scenario.

2.6 Green and Grey Solutions

For a number of politicians around the globe, grey solutions are considered better as they yield results quickly, and the results are also readily visible to all (UNEP, 2014). These types of solutions start giving benefits just after their construction, so they are felt to be more appealing by the public and the politicians. Politics play an essential role because sometimes the grey solutions would not yield results, but they are still used as they show visible effects which persuade the local people that something good is happening. On the opposite, it takes time for the NBS to give benefits, and they need more research and background work.

On the darker side, these grey solutions have several adverse effects. There is a need for capital (human or resources) to construct and maintain them while they lead to disruption of the existing ecosystem.

So, we find that NBS has nature in its name, and its definitions also consider it thus, NBS will necessarily focus on the environment. Also, NBS are flexible, can be adapted according to needs, and may sometimes give better than what is needed. As quoted by (Huthoff, Brinke, Schielen, Daggenvoorde, & Wegman, 2018), considering the research carried out by Wesselink et al. (2015) there is a more possibility of "lock-in", meaning hard to bring changes in the grey solutions after construction. From the above discussion, it is also clear that NBS has many co-benefits, like societal and economical along with many environmental benefits.

Finally, it can be concluded that though NBS is slow to show its effects, the positives supersede the negatives.

2.7 Planning and Evaluation of Nature-Based Solutions

2.7.1 EKLPISE

EKLPISE was established in 2016 in order to enable governments, organizations, companies, and NGOs in Europe to make more informed decisions on biodiversity and ecosystem services. The Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES) supports scientific policy at the worldwide level, while EKLIPSE addresses a critical leftover vacuum at the European level by concentrating on the unique knowledge requirements and concerns of European decision-makers.

EKLIPSE had developed "An effect evaluation framework to aid in the development and assessment of projects utilising nature-based solutions"(Raymond et al., 2017).

The European Commission requested *EKLIPSE* to develop an evidence and knowledge base on the advantages and disadvantages of applying NBS. Accordingly, EKLIPSE prepared a tool (Raymond et al., 2017):

1. To create an effective evaluation methodology and a set of criteria for measuring how well the NBS handles issues linked to climate resilience in urban places.
2. To develop an application guide for evaluating how NBS initiatives perform in delivering environmental, economic, and social benefits against the defined metrics.;
3. To provide guidance on how to better evaluate the performance of NBS initiatives, including identifying knowledge gaps in accordance with the standards set out in the impact evaluation framework.

There are particular challenges which the world is facing, and NBS are focused on those challenges; these challenges have objectives and actions. Each action has a set of impacts related to them. For these impacts, certain indicators are needed, which can be assessed by certain methods.

This evaluation framework is mainly for the urban areas but could be altered for rural settings, but it would need a lot of time and money to achieve.

2.7.2 ENCA

ENCA is an acronym for "Enabling a Natural Capital Approach" and is a comprehensive manual which gives information about natural capital and how to apply it. It is produced by the United Kingdom Department for Environment, Food & Rural Affairs. It has the following contents (Department for Environment Food and Rural Affairs, n.d.)-

1. ENCA guidance

2. ENCA assessment template
3. ENCA services data book
4. ENCA assets data book
5. ENCA featured tools
6. ENCA case studies

The Guide defines natural capital as: "Natural capital refers to specific stocks of the elements of nature that are valuable to the population, including biodiversity, lands, minerals, fisheries, forests, rivers, and fisheries. Both the living and non-living components of ecosystems are considered natural capital."

This approach covers the following-

1. Natural capital
2. Monetary values for environmental effects
3. How ENCA can support policy priorities
4. Understanding whether my proposal will affect the nature
5. Experience with natural capital approaches (Case Studies)

This approach does not tell how stakeholders would be integrated into different processes. According to Pakeman, Waylen, & Wilkinson, (2021), "this is not a very flexible framework that would need a lot of input to make comprehensive in its coverage of co-benefits and stakeholder engagement".

2.7.3 Interreg Building with Nature

According to the "Evaluating Nature: Based Solutions Best practices, frameworks and guidelines", this framework was developed for water-related objectives and challenges, mainly floods and droughts (Huthoff, Brinke, Schielen, Daggenvoorde, & Wegman, 2018). It considers ecological degradation and pollution (mostly water). This framework was made to apply in the North Sea region of Europe. The outcomes, the benefits and different trade-offs needed a way for evaluation; thus, this framework was formed.

With an easy and simple approach to scoring NBS, and the possibility of scoring with or combining with engineering solutions yet it lacks some aspects. Primarily, focusing just on water-related hazards makes it less usable. Also, it excludes NBS distributional disparities.

2.7.4 IUCN Global Standard for Nature-based Solutions

The aim of the standards is to be a simple tool for the user to design and implement as well as to enhance the techniques which are being followed. According to IUCN, these standards are developed to deal with a wide variety of contexts to give a better result which is feasible environmentally, socially and economically. It has eight criteria which are subdivided into 28 indicators. These help the user to assess the NBS and define how suitable it is to be called an NBS- 'strong, adequate, partial and insufficient. Also, to develop a proper design through NBS so that it can fulfil the eight criteria in a better way.

There are some other approaches which fall under the "umbrella" of the NBS-

- Natural Solutions (the protected areas which help in fighting climate change)
- Ecosystem-based Disaster Risk Reduction (Eco-DRR)

- Ecosystem-based Adaptation (EbA)
- Natural Infrastructure (for sustainable Integrated Water Resource Management)
- Green Infrastructure (for economic growth and investments in the urban context)
- Holistic or Regenerative Landscape management.

These approaches, or maybe a combination, are important as they help execute NBS. Further, as we will move forward, we will also see the simplification of these approaches in the ThinkNature Handbook.

According to IUCN global standards, a solution **can be considered an NBS if it solves one of the following major societal problems** (otherwise, it can be regarded as just a regular conservation action)-

- Climate change mitigation and adaptation
- Disaster risk reduction
- Economic and social development
- Human health
- Food security
- Water security
- Other societal challenges may be added in future.

NBS, with respect to the biodiversity crisis

The 2019 Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) "Global Assessment Report on Biodiversity and Ecosystem Services" (IPBES, 2019a) reports that biodiversity is in a very threatening condition and many plants and animal species are threatened or extinct. Due to the loss of biodiversity, ecosystem services are not being provided properly to humans. IPES also suggests that these adverse effects may have worse effects on indigenous and poor people compared to others. Therefore, it is also necessary for an action to benefit both humans and biodiversity to be treated as NBS.

NBS, with respect to the climate crisis

It may be catastrophic if Paris Agreement is not followed and if the temperatures are not kept below 2^{o} C considering preindustrial levels. So it is urgent to have some measures along with a move towards using renewable resources like sunlight, wind, etc.

NBS plays a vital role in solving this problem. According to IUCN global standards as quoted by the IPCC's special report, the IPCC Climate Change and Land Report (IPCC, 2019) and the IPBES Global Biodiversity Assessment Report (IPBES, 2019a) that NBS has the ability to achieve different climate-change related agreements and to address the societal and ecological challenges.

Climate change has a direct link to people. For instance, a coastal cyclone will lead to the deaths of people living on the coast, and it will uproot the trees, flowers and other crop-related plants. IUCN connects nature and people here and writes about how these two are linked. The IPCC report also observes that 'climate change' will be the foremost cause of biodiversity loss following the year 2020 (IPCC, 2019). We can conclude from here that climate change, humans and nature are interlinked and have effects on each other. Proper implementation of NBS with proper knowledge is necessary; otherwise, it might lead to adverse outcomes or no benefits.

NBS with respect to the inclusivity crisis

According to IUCN global standards, an action can be called NBS only if it includes different kinds of people like "indigenous, local communities, women and youth" (IUCN, 2020). E.g., In the case of India, which will be explained in the coming chapters, local practices and communities solved the water shortage and were also made sufficient economically.

Involvement of all people, be it poor, women, lower class, different religions, educated or not, colour, caste, etc., is essential for implementing and maintaining the NBS and also to be classified as NBS.

According to these standards, indigenous people and their knowledge play a vital role in the implementation of NBS techniques because they are considered to be the original owners of the land, and just as the owner would know better as how to use a particular thing, similarly indigenous people would be more professional in taking care of this planet. Even IPCC assessment also discusses this in Chapter 14 "Indigenous knowledge and science are resources for understanding climate change impacts and adaptive strategies (very high confidence)" (pp. 14–20).

According to World Bank, around 6% of the world's population (476 million roughly) comprises indigenous people and around 15 % of them are extremely poor. This population is divided into 90 countries, and it represents about 5000 cultures and about 6700 of the world's languages. They own around 20% of the world's territory and safeguard 80 % of the remaining biodiversity on this planet (World Bank, 2008). Their knowledge is vital, and their expertise is needed for the adaptation and mitigation measures of climate change, or we can also say to protect this planet from catastrophe. They integrate environmental sustainability as a spiritual practice (as some consider forests as forms of God), duty and responsibility (because they understand the importance of the environment), and obligation to the current and future betterment of the planet and the coming generations. An instance is visible in Canada, where Indigenous Peoples and Local Communities (IPLC) are playing a vital role in making innovative opportunities for the central problem of environment protection, conservation, and management. Here co-benefits from NBS to the environment and people can be seen (Vogel, Yumagulova, McBean, & Norris, 2022). Thus, from this discussion, we understand the importance of their knowledge.

Women, children, and youth also need to get involved as they focus on long-term impacts rather than just short-term benefits.

Target audience and its use

The standards are designed to be used by everyone, be it landscape architects, project managers, etc. It functions in two ways- to develop an action which qualifies as an NBS and to verify the action/design if it's an NBS or not.

Criteria and Indicators (Important for assessing the Solutions)(IUCN, 2020)

There are eight criteria and twenty-eight indicators in this standard. *(The names of the indicators and criteria are copied as it is, this is done after permission from IUCN and credit is given to IUCN)*

1. Criterion 1: NBS effectively address societal challenges

As discussed before, NBS addresses the societal challenges (primarily those above, but they are adding more). The action should also maintain ecosystem functions. It focuses on the importance of all the people who are directly (or indirectly) involved.

a) Indicator 1.1. The most pressing societal challenge(s) for rights-holders and beneficiaries are prioritised

The NBS action must clearly address the problems and challenges which impact society. At least one societal challenge should be solved. This challenge can be found through proper consultation between different stakeholders. Sometimes the challenges are interlinked, so solving one instinctively solves other problem(s). For instance, planting trees for food security may also solve the problem of human health, climate change, disaster risk and water security.

b) Indicator 1.2 The societal challenge(s) addressed are clearly understood and documented

It is important that the challenges addressed should be properly addressed and documented, keeping in account future accountability and optimising the strategies for human betterment. Additional benefits which the NBS yields should also be recorded. Some NBS aim to solve a challenge that gives more than one benefit, while sometimes some conservation measures also solve the societal challenge, so it is not necessary for those measures to be an NBS; instead, it would need assessment by these IUCN standards.

c) Indicator 1.3 Human well-being outcomes arising from the NBS are identified, benchmarked and periodically assessed

Effects on humans should be "specific, measurable, attainable, and realistic (SMART)" (IUCN, 2020). There should be a way through which these benefits could be measured as they are essential for the accountability of the action. It could also be possible to have specific targets or milestones, and after crossing, it would mean that NBS can prove its worth.

2. Criterion 2: Design of NBS is informed by scale

The scale does not imply just the geographical viewpoint but also the effect on the economic systems, policy structures and cultural prospects. NBS can have different effects on different ecosystems and different effects at different scales, as several ecosystems can be found in a specific given area. NBS should be considered within a land/seascape because ecosystems are affected and have effects on the larger land/seascape in which they are set in.

a) Indicator 2.1 The design of the NBS recognises and responds to interactions between the economy, society and ecosystems

The quality of the NBS is not the only thing which is necessary for the NSB to be effective. It also needs good interaction and understanding between people, the economy, and the ecosystem. Different stakeholders are involved, and how their values are considered. This is necessary as NBS practitioners integrate different sectoral plans, policies and programmes and use traditional practices into one spatial context. These land/seascape scale actions include multiple stakeholders at various sites within a given area.

A basic qualitative model generated through a participative method may be used to construct NBS designs since interactions between humans and nature are complicated and ambiguous. This usually entails identifying the critical relationships between the various stakeholder groups and their land uses, the land or seascape itself, and the jurisdictional policy and regulatory frameworks, such as national laws and regulations. It is better to have an integrated approach as it helps in reducing the adverse effects and facilitates mainstreaming the NBS into policies and different sectors. It is better to seek synergies between different sectors like forestry, health, water, etc., as it contributes to the betterment of the NBS, and also helps in improving the quality of the environment.

b) Indicator 2.2 The design of the NBS is integrated with other complementary interventions and seeks synergies across sectors

It is possible to implement NBS alone, but it can also be implemented in an integrated way with other types of solutions together addressing societal challenges, which is the ultimate goal of the NBS. These solutions can be engineering solutions, other conservation solutions, etc.

c) Indicator 2.3 The design of the NBS incorporates risk identification and risk management beyond the intervention site

The effect of social and ecological processes, the possibility of unfavourable system changes as a result of an external event (such as a natural hazard), and how this may affect the desired outcome of intervention must all be evaluated as part of the design process. This is especially necessary for the negative impacts which are outside the intervention area of the NBS. This assessment of the risk will also consider the stakeholders who could be more vulnerable due to the NBS effect. Risk assessment, be it environmental or other, is necessary for a better design.

Some questions which should be asked-

- Is there a possibility that there are land practices which could have adverse effects on the NBS?
- Can the NBS sustain and withstand “economic, demographic and climate-related changes?”
- Is there a possibility that other national or local policies may reduce the NBS management objectives?
- Is there a possibility that NBS produces some risks or adds pressure?

3. Criterion 3: NBS result in a net gain to biodiversity and ecosystem integrity

As already discussed before, NBS helps in the betterment of biodiversity; thus to be a good NBS, the action should not hamper in the prosperity of biodiversity but help in its prosperity. This will also yield long-term effects. Whichever societal challenge is being focussed, the NBS should help in the prosperity of the biodiversity.

Simplification of ecosystem is not a virtuous aspect; for instance having just eucalyptus trees on a patch of land for the economic betterment, instead this will be monetarily better, but it will not be suitable for the ecosystem as it will reduce essential nutrients from the soil, and soil will become useless over time. Thus, NBS should avoid the simplification of the ecosystem.

It is necessary for the developers of NBS to consider the integrity of the ecosystem over the long term. These people should check for any adverse effects in the ecosystem where the new

NBS is applied as well as the neighbourhood ecosystems. “An evidence-based review” is a necessity in the NBS operational plan. Also, before the implementation of the NBS, the “baseline” condition should be considered as this helps in finding if there are adverse effects of the NBS or not if it accomplishes its targets properly.

a) Indicator 3.1 The NBS actions directly respond to evidence-based assessment of the current state of the ecosystem and prevailing drivers of degradation and loss

Having a baseline for the implementation is essential to understand the changes in the ecosystem. In addition, this helps in analysing the changes over time.

b) Indicator 3.2 Clear and measurable biodiversity conservation outcomes are identified, benchmarked and periodically assessed

Proper monitoring and assessment of the effects of the NBS are necessary to provide its worth. Some actions may lead to the removal of degradation, which would return areas to their original or better condition. At the same time, some may focus on the diversification of species (a part of the ecosystem). The targets should be taken before the implementation.

The action should include the following (IUCN, 2020) –

- Specific measurable variable(s) associated with the management target (e.g. number of species / ha, % canopy cover)
- Action (e.g., increase, decrease, maintain)
- Quantity (e.g., 50%)
- Time-period (e.g., 5 years)

c) Indicator 3.3 Monitoring includes periodic assessments of unintended adverse consequences on nature arising from the NBS

As explained before, ecosystems are complex and should be left as it is. Thus, a certain NBS might have different effects on different ecosystems. Monitoring and assessments are a necessity for the development of an NBS. Hence, a monitoring programme to determine the efficiency of the NBS should be made and put into place from the time the NBS is implemented.

d) Indicator 3.4 Opportunities to enhance ecosystem integrity and connectivity are identified and incorporated into the NBS strategy

According to the Oxford dictionary, ‘Connectivity’ means- “the state of being connected; the degree to which two things are connected”. Similar is the case here, ecosystem connectivity means “the two-way flow of biotic components which should separate otherwise” (IUCN, 2020). An excellent example of a conservation measure which helps in ecosystem connectivity is the ‘wildlife crossing.’ Another can be the small pockets of protected forests outside the main forests or a corridor between two protected forests.

4. Criterion 4: NBS are economically viable

The NBS should be economically viable across all stages of its life. To work better against the grey solutions, which provide benefits in a short span of time, NBS need to balance the costs of investment with the long-term benefits it will provide. If the economic benefits are not worth it, the NBS could become a short-term project.

Many NBS stopped working after their project lifelines as a proper financial plan was not considered, and since they don't provide benefits, they were stopped being used. Some approaches like cost-effectiveness and cost-benefit assessments can be incorporated into understanding the financial feasibility. Cost-effectiveness does not need a common currency or monetisation; it can work with non-monetary benefits also. Cost-benefit assessments can be used to understand the monetary gains that the NBS is producing or will produce in future.

a) Indicator 4.1 The direct and indirect benefits and costs associated with the NBS, who pays and who benefits, are identified and documented

It has been discussed already that NBS may focus on more than one societal challenge and have co-benefits which can be there in the ecosystem where the NBS is applied to the neighbouring ecosystems as well. Thus, to evaluate an NBS, all the benefits, direct or indirect, over a time should be analysed. The benefits may be both monetary and non-monetary.

b) Indicator 4.2 A cost-effectiveness study is provided to support the choice of NBS including the likely impact of any relevant regulations and subsidies

A cost-effectiveness study is important to prevent investment without any good results. It involves investment costs, maintenance costs, other ancillary costs, and the benefits the NBS will receive over time.

c) Indicator 4.3 The effectiveness of the NBS design is justified against available alternative solutions, taking into account any associated externalities

It is necessary to check if the NBS is better than other available NBS, grey solution or a mixture of NBS and grey solution. The NBS should solve a societal problem and be economically feasible and efficient.

d) Indicator 4.4 NBS design considers a portfolio of resourcing options such as market-based, public sector, voluntary commitments and actions to support regulatory compliance

Resource management is an important aspect of NBS management. As different stakeholders are involved, it may be hard to maintain a balance between all. Often conflicts arise between private and public parties. Thus, resourcing options are a necessity for the NBS. A range of options to finance is a better choice, which can be mixed or individual, like circular economy, tax schemes, etc.

5. Criterion 5: NBS are based on inclusive, transparent and empowering governance processes

In this, the NBS need to cover the concerns of different stakeholders. It is necessary for the NBS to adhere to the existing legal provisions and be transparent in its approach aspects. To achieve short-term and long-term benefits, the NBS needs to have an inclusive approach and should recognise existing cultural practices, be it of indigenous or local people. People and environment will gain simultaneously from equitable involvement, power sharing, acknowledgement and security of rights, and clarity of obligations in the short- and long-term.

The stakeholders involved are also necessary for the NBS, to divide the benefits to all and prevent future problems with the people involved. Transparency is also an important aspect which should be taken care of so that the benefits and investments are appropriately shared and agreed upon by different stakeholders. "Using the Natural Resource Governance Framework (NRGF) can fulfil Criterion 5 because they are intended to guide the design and implementation of projects considering inclusion, rights and equity" (IUCN, 2020).

a) Indicator 5.1 A defined and fully agreed upon feedback and grievance resolution mechanism is available to all stakeholders before an NBS intervention is initiated

Feedback on the implemented NBS is important for the positive and negative effects of the NBS on the stakeholders. This would help manage the NBS well and incorporate changes in it or in other similar NBS to be applied elsewhere. It can be an informal or legal system of grievance resolution.

b) Indicator 5.2 Participation is based on mutual respect and equality, regardless of gender, age or social status, and upholds the right of Indigenous Peoples to Free, Prior and Informed Consent (FPIC)

Participation of different categories of people is needed. Traditionally excluded groups, be they poor or indigenous, should have equal and fair participation. This will help in taking inputs from the vast knowledge of people from different fields of life. Also, full and active participation is needed for the fulfilment of the NBS, passive participation may not be enough and may result in negative effects. If indigenous people are involved, then the principles of Free, Prior and Informed consent (FPIC) must be incorporated in the design and implementation, which will also help other stakeholders.

c) Indicator 5.3 Stakeholders who are directly and indirectly affected by the NBS have been identified and involved in all processes of the NBS intervention

Stakeholder mapping is an important aspect. All the people who are directly and indirectly impacted by positive or negative effects on them should be analysed. This helps in their participation as well.

d) Indicator 5.4 Decision-making processes document and respond to the rights and interests of all participating and affected stakeholders

Transparency is a critical aspect which is needed for NBS decision-making procedures. It helps in proper accountability and a way to resolve disputes. In instances where all decision makers are not on the same level, there should be taken care that the inequalities are reduced.

e) Indicator 5.5 Where the scale of the NBS extends beyond jurisdictional boundaries, mechanisms are established to enable joint decision-making of the stakeholders in the affected jurisdictions

Ecosystems do not follow any given political boundaries. For instance, the Ganga-Brahmaputra delta lies between India and Bangladesh and boasts of being the largest continuous mangrove forest in the world. Therefore, transboundary relations between countries, inter-district and interregional agreements should be made to utilise the ecosystem and the NBS in a better way.

6. Criterion 6: NBS equitably balance trade-offs between achievement of their primary goal(s) and the continued provision of multiple benefits

Trying to maximise the benefit from NBS might risk a reduction in another key ecosystem benefit. Wanting for a thing leads to the reduction of another thing. For instance, forests for wooden furniture are preferred over clean air. Some stakeholders might be benefitted more than others and vice versa. Sometimes the ecosystems may also disappear if the wrong choices are repeated.

A solution can be found by proper consultation among all stakeholders, and a mechanism to reimburse the negative effects of the trade-offs is a positive process of NBS.

a) Indicator 6.1 The potential costs and benefits of associated trade-offs of the NBS intervention are explicitly acknowledged and inform safeguards and any appropriate corrective actions

The costs and benefits of the NBS should be carefully noted and studied. Trade-offs have a spatial, temporal and reversibility dimension" (IUCN, 2020). Spatial means over a certain area or different neighbouring areas, temporal means if the effects happen quickly or over a certain period of time, and reversibility means if the degraded/disruptive ecosystem can be brought back.

b) Indicator 6.2 The rights, usage of and access to land and resources, along with the responsibilities of different stakeholders, are acknowledged and respected

The usage rights of the people and marginalised groups should be taken care of. Tools like stakeholders' analysis and mapping can be used to make the work more effective. If indigenous people are involved, then "Indigenous peoples and local communities, free, prior and informed consent (FPIC)" should be utilised. The trade-offs should be balanced.

c) Indicator 6.3 The established safeguards are periodically reviewed to ensure that mutually agreed trade-off limits are respected and do not destabilise the entire NBS

Safeguards are important to prevent unavoidable risks, and these need to be reviewed so that they can be updated (if the need arises), as the trade-offs may change over time. This helps in proper reaping benefits from the NBS and equally to all.

7. Criterion 7: NBS are managed adaptively, based on evidence

NBS actions might have different kinds of effects on the ecosystem. There may be some negative and unintended effects as well. NBS attempts to influence an ecosystem to change, so that societal needs are met. NBS is based on the "theory of change" and can be adapted on the basis of proof.

Adaptive management should be added to the NBS implementation process. According to the IUCN global standards, adaptive management is "a structured, iterative process of … decision-making in the time of uncertainty, with a focus to reduce ambiguity over time" (IUCN, 2020).

a) Indicator 7.1 A NBS strategy is established and used as a basis for regular monitoring and evaluation of the intervention

"Theory of change" is not static but dynamic. Different assumptions which are thought for the theory needs to be reviewed regularly and altered if required. Other positive and negatives proofs which can enhance the benefits or reduce the risks to the NBS should also considered.

b) Indicator 7.2 A monitoring and evaluation plan is developed and implemented throughout the intervention lifecycle

Along with the previous requirements, having a monitoring and evaluation plan is a crucial element for the NBS to be of good quality. It is necessary that the monitoring and evaluation plan considers different scales as well. Also, it is considered better if the plan is participatory and incorporates the stakeholders, so that the people involved can check if the NBS is doing its job well.

c) Indicator 7.3 A framework for iterative learning that enables adaptive management is applied throughout the intervention lifecycle

"Iterative learning" means learning from repetitions or previous applications to gain better control or make something better. The evaluation and feedback can be incorporated into the learning process and, when mixed with scientific methods, helps understand how the NBS can be improved.

8. Criterion 8: NBS are sustainable and mainstreamed within an appropriate jurisdictional context

To last long, the NBS should work with different governmental policies and sectors. The developers of NBS need to also take into account that NBS last beyond the timeline, which can be several decades.

a) Indicator 8.1 The NBS design, implementation and lessons learnt are shared to trigger transformative change

Replicating the best NBS at various places and scaling up the NBS is important for the world and the places facing crises and problems. For this to happen, proper knowledge, lessons, positives, and negatives should be made available for everyone readily or on demand. For the areas and people who cannot access electronically, the information can be made accessible through international organisations like UNEP or through NGOs, etc.

b) Indicator 8.2 The NBS informs and enhances facilitating policy and regulation frameworks to support its uptake and mainstreaming

Sometimes the existing governmental policy may lead to limited development of the NBS. Thus the NBS developers should be aware of the policies, and they should work with national and local leaders so that all of them can together come up with a solution so that if a policy hinders the NBS, it can be worked upon.

c) Indicator 8.3 Where relevant, the NBS contributes to national and global targets for human well-being, climate change, biodiversity and human rights, including the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP)

As already discussed, NBS focuses on one or more societal challenges and the ecosystem and nature. Also, NBS can help fulfil national and international targets of climate change, human rights and development, biodiversity and other related aspects.

Using the IUCN global standard

A self-assessment tool is developed by IUCN for using the standard (which is in its initial phases). Though the guidance says that the self-assessment tool is downloadable from the given pdf, but it was not (maybe due to some technical error). A form, which is available on the website of IUCN, can be filled out by stating the personal details and the need for the tool, and IUCN would send the self-assessment tool (which is in the form of an excel file) via email.

	Key (%)		Output
	≥75	Strong	Intervention adheres to the IUCN Global Standard for NbS.
	≥50 & <75	Adequate	
	≥25 & <50	Partial	
	<25	Insufficient	Intervention does not adhere to the IUCN Global Standard for NbS.

Figure 6 Categorisation of result after the assessment- (IUCN, 2020)

The above table is the result of the assessment. An action which scores points less than 25 is considered insufficient, and that would not be considered an NBS. IUCN also states that the standard is just a part, and to assess and monitor each step, it is also advised to use other standards (IUCN, 2020).

2.7.5. Think Nature

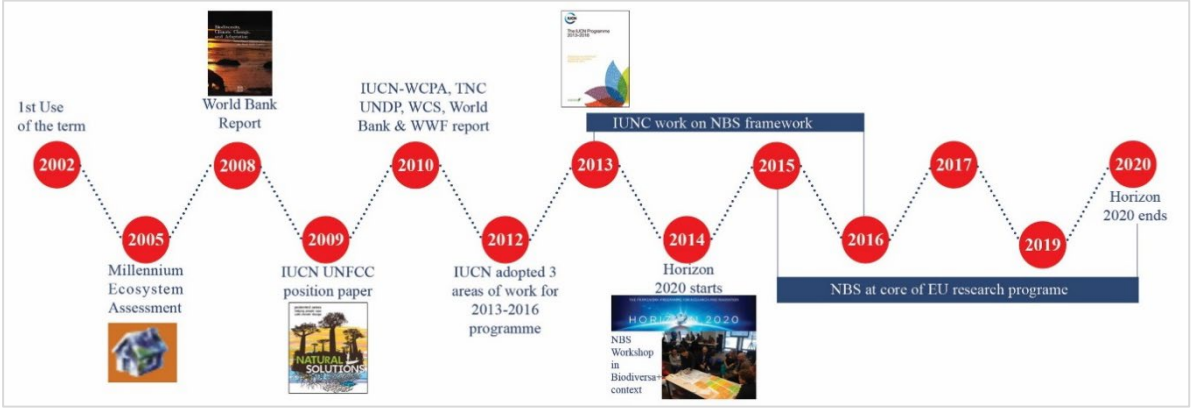


Figure 7 Timeline of NBS - (IUCN, 2020) & (Liu et al., 2021)

According to ThinkNature website, "A multi-stakeholder communication platform supporting the understanding and promotion of Nature-based Solutions (NBS)" (ThinkNature, n.d.). According to ThinkNature, each part of NBS is properly studied, from the start of the project to the end, along with changes which happen to the project, and it is showcased in a comprehensive way so that it is properly understandable (Somarakis, Stagakis, Chrysoulakis, 2019).

It is a comprehensive guidebook which covers numerous aspects of NBS. There are ways to cover the benefits and disbenefits of NBS, but it does not talk about different currencies and how to bring them together. It mainly focuses on biophysical aspects. It is relevant to be used as it considers a number of important topics which help in the implementation of the NBS, using them and earning the support of the locals (Somarakis, Stagakis, Chrysoulakis, 2019).

Classification of NBS by Think nature

The adapted classification scheme was a result of a synthesis conducted from a literature review and stakeholder consultation/discussion on the Think Nature platform. Each NBS type can be classified following four distinct approaches that all together identify the uniqueness and usefulness of the NBS(Somarakis et al., 2019). The four approaches are:

- Approach 1 (A1) - It is based on the NBS typology developed by Eggermont et al. (2015), considering the level and the type of engineering or management applied to biodiversity and ecosystems along with the number of ecosystem services delivered and the stakeholder groups involved.
- Approach 2 (A2) - The NBS approach classification(explained later)- ecosystem-based approaches, community-based approaches, ecological engineering approaches, etc.

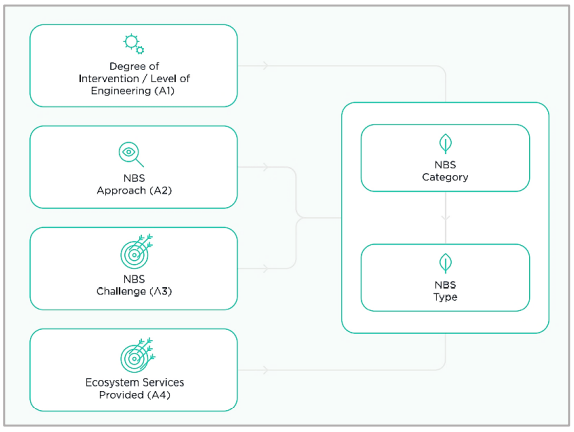


Figure 8 NBS types and approaches (Source- ThinkNature)

- Approach 3 (A3) - The NBS challenge that it is expected to solve. These NBS challenges are also related to the United Nation's Sustainable Development Goals (SDG).
- Approach 4 (A4) - The ecosystem services it delivers (EC, 2015).

The above-mentioned classification of NBS is indicative of the open nature of the term, a fact that poses certain difficulties but also favours wider uptake. The **challenge lies in defining "nature"** and **what is considered as "natural".** With many actions involving different levels and types of interventions, not all approaches can be classified as NBS. For example, the creation of vegetated roofs or walls in order to mitigate the Urban Heat Island cannot be considered as an NBS, if specific aspects such as biodiversity and sustainability are ignored (Eggermont et al., 2015).

NBS Typology (Approach 1, A1)-

There are three types of NBS typology, according to ThinkNature(Somarakis et al., 2019), which are simplified versions of IUCN approaches. These help us aggregate shared solutions to better study and explore them.

1. Type 1- Better use of protected/natural ecosystems - These solutions make a better use of the existing ecosystems. E.g., measures to prevent the cropland from pests by natural means, etc.

2. Type 2 – NBS for sustainability and multifunctionality of managed ecosystems- These solutions develop protocols, and different procedures for managed/restored ecosystems. E.g., traditional agroforestry or aquaculture practices, etc.

3. Type 3 – Design and management of new ecosystems- As the name suggests, these create new ecosystems. These are very often seen in cities and towns, for e.g., green wall, roof gardens, urban parks, etc.

NBS Approaches (Approach 2, A2)-

The approaches according to the ThinkNature handbook(Somarakis et al., 2019) are as follows-

1. **Ecological Restoration (ER)-** It is a practice in which the ecosystems are restored, and the biodiversity is safeguarded while taking care of the habitats and species. E.g., the restoration of the basin of the polluted river; and (ii) the restoration of a forest area which was ruined by gold mining.

2. **Ecological engineering (EE)-** It can be considered as a branch of both ecology and engineering (Schulze, 1996). This and ecological restoration have a lot of similarities. According to Mitsch & Jørgensen (2004) and Barot et al., (2012), this mainly focuses on environmental issues like wastewater treatment, recycling and pollution problems. E.g., the self-design of tidal creeks, in which a special plant species is introduced for the restoration of salt marsh (Teal & Weinstein, 2002), and the use of species that helps in trapping the sediment for coastal protection of sandy shores (Borsje et al., 2011).

3. **Ecosystem-based adaptation (EbA)-** The was created to use ecosystem services in managing the climate impacts on the people (Staudinger et al., 2012; Locatelli et al., 2011). According to Convention on Biological Diversity, EbA is defined as “Ecosystem conservation, restoration, and sustainable management as a component of a comprehensive adaptation plan that considers the numerous social, economic, and cultural advantages for neighbouring populations” (CBD, 2010). EbA also includes community engagement, where awareness is raised for the protection of natural resources and to help in supporting the restoration and sustainable management activities. E.g., the restoration of rivers or canals to mitigate flooding or the afforestation of forests with more future climate-tolerant species so that they may better adapt to climate change (Doswald & Osti, 2011).

4. **Ecosystem-based mitigation (EbM)-** It is often combined with EbA approach. It is a framework which focuses directly on the sources of greenhouse gases and reduces them. Also, it enhances the greenhouse gas sinks (Staudinger et al, 2012; Locatelli et al., 2011). Its main aim is to reduce the causes of climate change and long-term impacts

of climate change (Locatelli et al., 2011). This kind of solution emphasizes the importance of the forests, which can be afforestation, reduced deforestation, etc. E.g., the use of the forest as a place to trap atmospheric carbon; another example is the restoration of coastal and marine ecosystems so that the blue carbon can be stocked and not released into the atmosphere.

5. **Climate adaptation approaches (CAA)-** This is sometimes used as a synonym with the EbA concept, but it covers wider areas compared with EbA. It also covers ecological mechanisms and has features which help the adaptation of ecosystems (Lavorel et al., 2015). This points to the benefits of healthy ecosystems as it helps them cope with climate change impacts. Also, it stresses on the services which are not considered important for the human well-being (Colloff et al., 2016).

6. **Ecosystem-based disaster risk reduction (Eco-DRR)-** These types of solutions make people's capacities able to manage the hazards in a better way, thus reducing their severe impacts. It is not necessarily that these events be due to climate change related problems (Renaud et al., 2013). E.g., the restoration of large marshlands to protect from flooding due to hurricanes (Temmerman et al., 2013), and the using the protected areas in order to reduce disaster risk in the coastal areas (Murti & Buyck, 2014).

7. **Infrastructure related approaches (IR)-** According to Merriam Webster dictionary, infrastructure is defined as "the resources which can be personnel, buildings, or equipment, etc. required for an activity". The Natural Infrastructure is a way of delivering ecosystem services by restoring ecosystems, while Green Infrastructure is a way in which enhancement of the ecosystems happens to give better ecosystem services. Both these approaches use a hybrid approach, meaning that they use hard infrastructure with ecosystem-based infrastructure.

8. **Ecosystem-based management (EbMgt)-** It is transdisciplinary in nature which takes into account the whole ecosystem (also humans), in contrast to other planning management, which focuses on smaller spatial scales. It is also sometimes used with ecological and environmental management approaches.

9. **Natural Resource Management (NRMgt)-** The resources which are taken from nature are natural resources. They provide fundamental support to life and economic processes. Proper management of natural resources is needed to maintain and enhance the quality of life of the increasing population of the world and help in sustainable growth. According to World Bank report, consumption of natural resources such as land, water, air, forests, fisheries, minerals, and wild flora and fauna is called Natural Resource Management. This should make the utilisation of natural resources in sustainable manner to enhance human welfare (Muralikrishna & Manickam, 2017).

10. **Community-based adaptation (CbA)-** This is a form in which the local community is at the centre of the initiative. This involves the community in participatory learning and problem-solving with creative approaches. These can be derived from age-old practices being followed in the area or modern techniques with older practices. These incorporate information and examples of climate change measures which are location-specific and community-managed (UNDP, n.d.).

11. **Sustainable agriculture/agro-forestry/ aquaculture (SA)**- According to *Food and Agriculture Organization of the United Nations (FAO),* "sustainable agriculture means that agriculture should meet the needs of the present as well as the future generations, while taking care of profitability, environmental health, and social and economic equity" (Food and Agriculture Organization of the United Nations, n.d.)

    According to the *Food and Agriculture Organization of the United Nations (FAO),* agroforestry is defined as a nature resource management system, where trees or woody perennials are grown on agricultural fields. This helps in the social, economic and environmental benefits for the landowners (Food and Agriculture Organization of the United Nations, n.d.)

    According to the US department of agriculture, Aquaculture is the cultivation of aquatic organisms in controlled environments. This way future food needs can be satisfied and the burden on the existing natural resources can be reduced(USDA, n.d.).

    These practices have a number of benefits like supporting the production and resilience of various products, mitigating climate change, and enhancing nature and biodiversity

Challenges which can be solved by NBS (Approach 3 , A3)--
According to ThinkNature the challenges which NBS solve are the following-

- Climate mitigation and adaptation
- Water management
- Coastal resilience
- Green space management
- Air quality
- Urban regeneration
- Participatory planning and governance
- Social justice and social cohesion
- Public health and well-being
- Potential of economic opportunities and green jobs

These are the parts and targets of the Sustainable Development Goals. ***So, this thesis will be using the SDGs because they are vast and contain all the given challenges which are to be solved.***

According to United Nations, "The Sustainable Development Goals were adopted in 2015 as a joint call to action to end poverty, protect the planet, and ensure that by 2030 all people enjoy peace and prosperity"(UN, 2022). The SDGs are interconnected, as an effect in one of them will affect the other(s) as well. They aim for a development that focuses on social, economic and environmental sustainability. There are 17 SDGs, which are branched into 169 targets(United Nations, n.d.; United Nations Development Programme, n.d.). The SDGs are as follows-

- Goal 1: No poverty
- Goal 2: Zero hunger
- Goal 3: Good health and well-being
- Goal 4: Quality education
- Goal 5: Gender equality

- Goal 6: Clean water and sanitation
- Goal 7: Affordable and clean energy
- Goal 8: Decent work and economic growth
- Goal 9: Industry, Innovation and Infrastructure
- Goal 10: Reduced inequality
- Goal 11: Sustainable cities and communities
- Goal 12: Responsible consumption and production
- Goal 13: Climate action
- Goal 14: Life below water
- Goal 15: Life on land
- Goal 16: Peace, justice and strong institutions
- Goal 17: Partnership for the goals

2.8. Participatory Approach

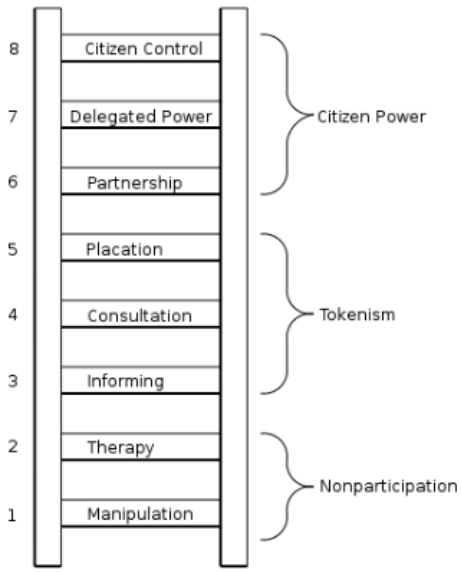
Community-based adaptation is used as an approach in the different steps of NBS. Even the IUCN global standards focus on the importance of the involvement of different stakeholders from various fields of life, irrespective of gender, religion, caste, income, and tribe.

As discussed in the previous part, according to IUCN global standards, an action can be called NBS only if it includes different kinds of people like "indigenous, local communities, women and youth" (IUCN, 2020). IUCN states in its global standards that an NBS should have an inclusive approach, meaning it should include people from all backgrounds(IUCN, 2020). It should respect the existing cultural practices and land uses wherever needed. The stakeholders involved may be diverse, so it is important that the participation is transparent, irrespective of gender, age or social, economic or cultural backdrop. Also, the decision-making is transparent and involves safeguarding the people and the culture. IUCN states that this participation is needed for the NBS to give more benefits and achieve its full potential. Therefore, it is essential to follow the NBS approach, which enables the stakeholders (not ignoring the poor, less influential or marginalised categories) with positive capacity enrichment and sharing of knowledge.

Participatory methods (PMs) cover a wide range of activities with one thing in common: allowing regular people to have an active and significant role in choices that have an impact on their lives. This implies that individuals are both heard and listened to, and their voices have an impact on results. The main objective is to view the power level from the bottom to the top. But even some participatory approaches do not achieve their goal of retaining community engagement once the project is over (Raynor et al., 2017). This has to be taken care of.

There are different kinds of participative approaches which can be used depending on the need and data needed. More than one approach can also be utilised for better results.

The ladder of citizen participation



From bottom to top, **the steps explain the level of citizen participation** and how much power citizens actually have to understand the process and outcomes. Arnstein divides the ladder into the following(Arnstein, 1969; The citizen's Handbook, n.d.)-

1 Manipulation and 2 Therapy. Bottom two levels are non-participative. The aim is to cure or educate the participants. In this, real participation is substituted by people in power for different roles. The power holders "educate" and "cure" the local citizens.

3 Informing. An initiation of legitimate participation. But commonly, the emphasis is on a one-way flow of information. There is no channel for feedback from the people's side.

4 Consultation. Surveys of attitudes, neighbourhood gatherings, and public inquiries are all valid steps here. Arnstein, though, continues to believe that this is just to show to the real world and inside its hollow.

5 Placation. Citizens are free to plan or offer advice, but those in positions of authority are still free to determine whether or not the advice is valid or practical.

6 Partnership. From here, the citizen power starts. Here, the power is redistributed via negotiations between citizens and those in positions of authority. Joint committees are one way that planning and decision-making duties are shared.

7 Delegation. Clear majority of seats with decision-making authority are held by citizens. The public may now ensure that the programme is accountable to them.

8 Citizen Control. Without any middlemen standing between the have-nots(people) and the source of funding, they handle all aspects of programme planning, policy creation, and management, such as neighbourhood corporations.

The limitations of the ladder of citizen participation-

Arnstein (1969) says that the ladder of participation has limitations. The powerless citizens are juxtaposed with the powerful to highlight the division between them. In reality, the have-nots and the powerful, are not homogenous, they have divergent views, different and competing interests. This criterion does not include the most substantial barriers to achieve actual levels of participation. On the side of the powerholders, they include racism, paternalism, and opposition to power sharing. On the side of the have-nots, they include the inadequate political, socio-economic infrastructure and knowledge base of the impoverished community, as well as the challenges in forming a representative and accountable citizens' group due to uselessness, estrangement, and mistrust(Arnstein, 1969).

2.8.1 Storytelling/ Narrative-Building

Storytelling is the oldest form of communication and was used long before written or visual communication. It was the primary form of historical information transferred from generation to generation.

Storytelling is, in essence, a collection of tales about individuals who are linked by a shared issue as solvers (heroes), perpetrators (villains), or wounded (victims) along a chronological trajectory (plot), leading to a resolution in a specific location or environment. An audience's shared aim, reason, or vision is developed during the course of a tale, which often begins in the past and progresses into the future.

Every (good) plan has a narrative, and planners always make stories to communicate their ideas, whether intentionally or not. Planners must always begin their tales of the future from a "contestable normative stance," but they must also modify them to fit the various local interests, social groupings, and geographical perceptions.

Advantages of Storytelling

- By crafting fictional tales and stories, you may broaden the viewpoints of various stakeholder groups.
- Before moving on to other citizen engagement components in the planning process, it may be helpful to gain additional insights by adopting a different perspective.
- Narratives may also highlight potential discrepancies between expectations and actual societal needs. Activities may also strengthen the communal agency of citizens.

Example-

Silence Speaks- They encourage the sharing of tales that frequently go untold and unheard by using participatory media, popular education, and testimonial techniques.

https://www.storycenter.org/silence-speaks/- Stories about Covid, daily lives, etc.

Case of Argentina- Rosario Habitat

Groups of 6 or 7 people were formed from the crowd. They received photo cards that served as a reminder of the issues in their neighbourhoods, such as unequal lot sizes, hazardous walkways, malfunctioning streetlights, and a lack of video monitoring. They were then asked for the remedies, while others were questioned on their agreement with the problems and the proposed solutions. While it was quite easy for some, it was hard for others. They were also instructed to write issues, answers, and whether or not everyone agreed on them on the board or not. They were invited to portray these issues and their solutions via plays and other artistic mediums.

2.8.2 World Cafe

It is a simple technique for building a collaborative living network around issues important to real-world life.

“People already possess the creativity and intelligence necessary to handle even the most challenging problems; the solutions we want are accessible, and we are wiser together than we are alone.”- *World Café Reference Guide*(The World Café Community Foundation Creative Commons Attribution, 2015).

According to “The World Café Community Foundation Creative Commons Attribution”, the following principles are involved-

1 Set the Context
2 Create Hospitable Space
3 Explore Questions that Matter
4 Encourage Everyone’s Contribution
5 Connect Diverse Perspectives
6 Listen Together for Patterns & Insights
7 Share Collective Discoveries

There can be 4 to 5 people at maximum, sitting on round coffee tables. There are at least three rounds of conversations for a better resolution. After one round, one person remains seated, and others go to other tables. The person who remains seated tells the discussion to new people who take the seats, while the people who come to new table also carry new ideas. Different questions may be asked or same questions can be asked in different rounds. Finally, discussions happen among all participants and they decide if they can come to a conclusion or not. It needs a host, who takes care of properly following the principles and if any problem occurs between people.

2.8.3 Design Thinking

Design thinking is a solution-based approach that encourages collaboration and creativity in problem resolution. Design thinking is more than just a simple method. It introduces a completely new way of thinking and provides a variety of practical techniques to aid in the application of the new way of thinking. It :

- Revolves around a deep curiosity to understand the people for whom we design products (things) and services.
- Enables us to observe and cultivate empathy for the intended audience
- Strengthens our capacity for inquiry: design thinking encourages us to probe the implications and assumptions of the problem.
- Is incredibly helpful for tackling situations that are vague or unidentified.
- Involves continual experimenting with new thoughts and ideas through sketching, prototypes, testing, and trials.

Advantages of Design thinking-

- There are small steps involved rather than big and complex steps.
- It places citizens at the heart of the process. For instance, it involves organising household surveys, population interviews.
- It is an iterative process that motivates teams to transition between problem-defining, ideating, prototyping, and testing (feedback from the user).
- It involves creating and testing prototypes. It allows the end-users to participate in the process of any project (be it NBS) right from the initial phases.
- It is an approach in which people from all walks of life can get involved, like farmers, planners, architects, politicians, and civilians, in one room(Guevara et al., 2016).

Steps involved in Design Thinking (Murtell, 2021)**-**

1 **Empathize-** It is a kind of interviews and listening to stories from people to understand what they want. It should be done with people experiencing the same problem. It is only through an understanding of customer demands, obstacles, attitudes, and ambitions that novel solutions and emerging possibilities can be unlocked. This makes use of going closer to the consumers.

2 **Defining the Problem-** Reviewing the interviews and finding the common problems they have. Maybe there could be a hidden problem which is not directly shown in the interviews. The secret to finding the best ideas and achieving consensus along the path is that a strong creative brief (problem) is developed with both strategic emphasis and creativity.

3 **Ideate -** This phase is where creativity is set free on the intellect. Ideas come up to solve the problem. It is also necessary to come up with many ideas and not just one. This creative and important phase may be fuelled by brainstorming, mind mapping, landscape mapping, and Post-it Notes, among other techniques, to make the work better.

4 **Prototype-** The solutions are to be put to test in this part. Through a succession of evaluations and criticisms by a large team, suggested solutions may be enhanced, altered, or discarded throughout this stage. This quick iteration approach has several positives.

5 **Test-**Test it with actual users (the consumers) if they like or not. Go back if any change is needed and adjust it so that it becomes better and is suitable for the consumers with good benefits.

Design thinking is one of the methods which seek feedback from the citizens after the plan is prepared. It helps in the refinement of the plan.

2.8.4 Start Park Approach

Start Park is a design concept that came during Climathon 2017, which was held in Florence in 2017 at Impact HUB and was organised as a result of the partnership between **Green Apes** and **Codesign Toscana**. Two multidisciplinary teams comprised of professionals, municipal technicians, individual citizens, and students were given 24 hours to devise solutions to lessen the effects of climate change on extreme weather events that Florence will experience in future.

It focuses on the ways in which people can be stimulated to become aware of climate change and transform this into resilient actions. The second event was held in January 2019, in which necessary data was gathered to build the Green Blue Infrastructure (GBI).

The previous top-down approach which was adopted by the municipalities, was not worth and did not solve the problems of Climate change correctly. An essential aspect of CC is that people should be made aware of it, and they should be involved in different decision-making processes. In contrast, Start Park aims to make the people involved in co-designing the Green-Blue Infrastructure (GBI) through a bottom-up approach.

The design methodology we wish to use is participatory, which calls for the participation of all concerned parties in the decision-making processes as well as citizens during the design phases, with a focus on children and elders. We'll employ a unique participative design. It had already done a project in Prato where Start Park has used its methodology.

Start Park Game *(This is the description of Start Park. The methodology we used will be altered according to the workshop, which will be explained in Chapter 4 and 5 of this thesis)*

Here the actual rules of the game by the Start Park are being described. They were changed according to the time available for the workshop (the rules used for the workshop are described in Chapter 3, Methodology).

Character Cards-

They are filled by the hosts containing the information about the stakeholders. These include their profiles- Name, sex, profession, etc. Then a short bio or profile and description of their profiles. Then they contain limits of the stakeholder and problems faced, along with their capacity

Main Cards-

- GBI cards (Green Blue infrastructure)
- Furniture cards
- Activities cards
- Vision cards.

GBI cards

The GBI card consists of construction costs, maintenance costs, card numbers, and its effectiveness (benefits given).

1) The effectiveness data are as follows-

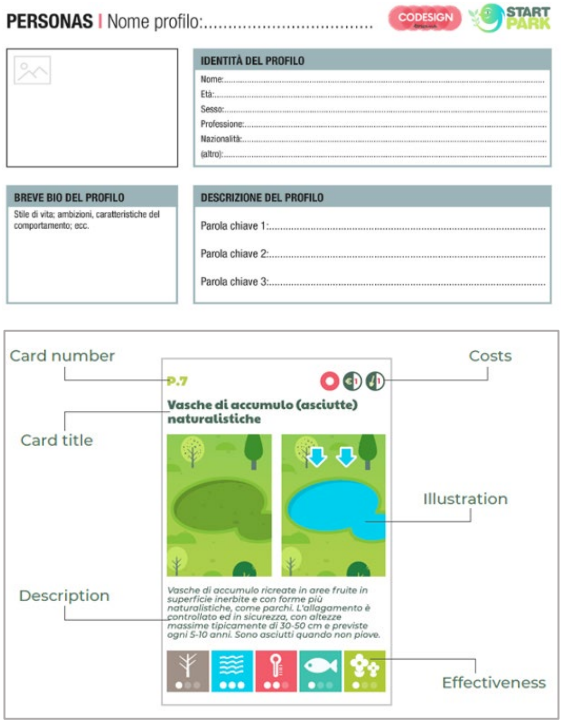
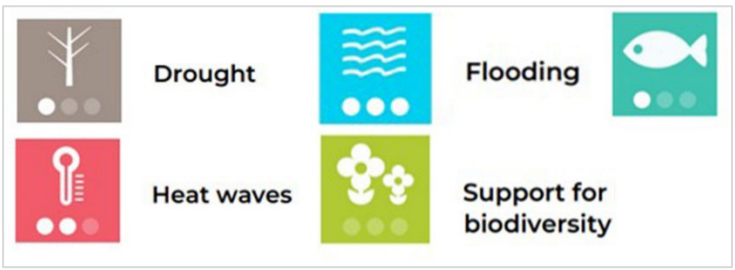
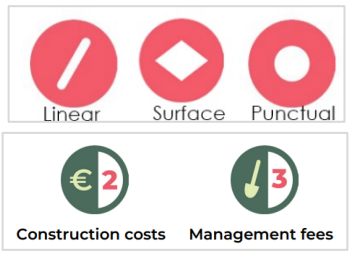


Figure 9 Character cards and GBI card description- below the effectiveness and types (Source -StartPark)





The effectiveness of the above card is *more for flooding* and less for support for biodiversity.

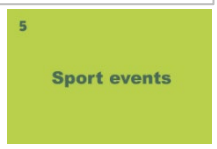
2) Then there are construction and maintenance costs as well. The construction and maintenance costs in the above card are 1 Euro.
3) The symbols- If a card is Linear, it implies that it is used to transport or transfer water from one point to another (e.g., a pipe or a channel); if a card is Punctual, it means that it is a solution that the player or co-designer may envisage in a specific location of the Plan (e.g., a tank or an infiltration region). If the point is close to the source of water created (such as near the building from which we collect rainwater from rooftops), the Punctual card can also be played alone. If this is not the case, it is required to combine this card with another card. In contrast, surface cards are used to manage water from large areas before they can be brought to punctual or linear cards.

Furniture Cards

In order to make the park come to life and stimulate the development of a lively neighbourhood surrounding it, these cards are used. They include streetlights, trash cans, tables, etc.

Figure 10 An example of furniture card

Activity Cards



In contrast to the furniture cards, these activities can be done on the given site. It includes training events, sports events, treasure hunts, etc.

Figure 11An example of activity card

Vision Cards

The furniture and activity cards must be used to create something that aims to achieve the vision cards that the participants will hold in their hands.

Site Plan

A simplified plan, which is understandable by all, is printed and used as a background for different ideas and pasted on the boards or walls.

How the game is played-

1. **First Round -** 10+20 minutes

The players or the co-designers are divided into groups of 2 each. Each group decides which character/stakeholder they choose to play. Then, they discuss and fill the plan with 2 furnishing cards, 1 Activity card and maximum of 2 GBI Punctual cards and 1 GBI Linear card.

2. **Second Round-** 45 minutes

This is the round in which the vision card is played. A vision card is picked from the deck and is held upside down in the right spot on the Plan. It is not yet time to find out what it contains. The group will collaborate on the overall site plan, with the aim of choosing jointly the GBI cards to construct a shared plan from the minor ideas put forth by the subgroups during the previous round.

3. **Third Round-** 60 minutes

Then a second Vision card is picked, which is turned along with the first to reveal its information. The objectives during this co-design phase are represented by these Vision cards and the Super-Goal. As a group, activities and furniture are picked while considering the requirements of the characters, which are being played in pairs in round 1. Use the large plan that was previously drawn upon with the GBI solutions, and then write or draw the specified Furniture and Activity cards.

There are three levels which can be used during the play-

	Climate Change Adaptation	Construction costs	Management fees
Easy level	10	6	6
Medium level	15	5	5
Difficult level	20	4	4

3

Methodology

After the literature review and analysing of different approaches. IUCN global standards and ThinkNature Handbook were chosen and adapted according to data and time available.

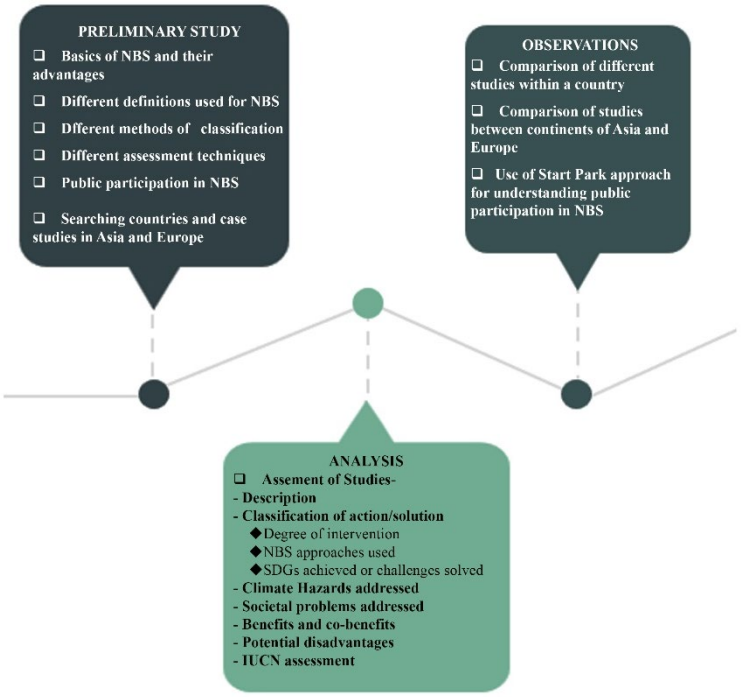


Figure 12 Methodology diagram (By author)

3.1 Preliminary Study

Firstly, a detailed study on the basic and better understanding of the Nature Based Solution was carried out. What NBS is for a layman was understood, and then the advantages and disadvantages of the NBS were studied. Secondary resources were used, like websites, journal articles and reports by IUCN, UNDP, UNEP, WHO, WWF, etc.

To understand further, different definitions of NBS used by various worldwide organisations were studied. Definitions used by IUCN, European Commission, Asian Development Bank (ADB) and WWF were reviewed. Also, Green Infrastructure, which is referred to as a synonym of NBS in some Asian countries, was researched. There are different words which can symbolise NBS, namely Green Infrastructure, Ecosystem-based adaptation, inspired by nature, ecosystem-based mitigation, sustainable solutions, mitigation solutions, adaptation solutions, and a few others, so they were studied as well.

Then, different methods of classification for the NBS were studied. This was done so that we can understand in which category the NBS falls. And if one NBS falls into more than one category, if so, then there is a possibility that it gives more benefits and could be used at a more significant number of places.

Further, to assess different solutions, which will be evaluated later, various assessment techniques (IUCN, EKLIPSE, etc) for the NBS were researched. IUCN global standards were chosen (with a bit of alteration, just the drop-down menus were used) due to their possible use in all countries, fixed time, and available data.

Since NBS and public participation go hand in hand (Discussed in the definitions above that for NBS, participation of all kinds of people is necessary). So, participation and its different approaches were researched. And Start Park approach, which follows the design thinking ideology, was chosen.

3.2. Analysis

The study is focused on the countries in Europe and Asia (the so-called East and the West). Some countries were chosen, and then the case studies were selected in those countries. The case study might be just a standalone solution or a mix of different solutions. This is done considering the data and time available for research and whether that country is famous for NBS. For instance, Nepal was chosen as it is not renowned, while Denmark was chosen as it is famous for its climate change adaptation techniques. This is done to understand better whether the countries hyped about climate adaptation techniques have some excellent solutions or not. The case studies may be referred to as cases, studies or solutions.

Table 1 Table of case studies (to be discussed later in Chapter 4)

S.no	Case Study	Place	Country
A.	**Asian Studies**		
1	Subak	Bali	Indonesia
2	Associated Mangrove Aquaculture	Demak	Indonesia
3	Sumatra Merang Peatland Project	Sumatra	Indonesia
4	Chauka System, Lapodia village	Jaipur district	India
5	Climate Resilient Zero Budget Natural Farming (CRZBNF)	Andhra Pradesh state	India
6	Dhara Vikas: Water security through spring-shed development	Sikkim State	India
7	Living weir construction-Ecosystem-based drought and flood management in river basins	Khon Kaen Province	Thailand
8	Community-Based Ecological Mangrove Restoration (CBEMR)	Trang	Thailand

9	Kaem Ling or the 'Monkey Cheeks'	Ayutthaya Province	Thailand
10	Floating Agriculture Garden (Dhap in local language)	Provinces of Gopalganj, Barisal and Pirojpur	Bangladesh
11	Soil Restoration with Biochar (Cookstoves)	Dhaka, and other places	Bangladesh
12	Jholmal, Bio-fertilizer	Kavre Palanchowk District	Nepal
13	Improved terracing for enhancing soil fertility on sloping land, Kubinde Village	Kavrepalanchok District	Nepal
14	Local knowledge for better water availability and Bio-engineering	Panchase and Makwanpur District	Nepal
15	Flood-based agriculture in the Upper Mekong Delta	Dong Thap, Province	Vietnam
B	**European Studies**		
16	Salt marshes for flood defence in the Dutch Wadden Sea	Wadden sea	Netherlands
17	Room for the River	Rivers Rhine, Meuse, Waal, and Ijssel delta	Netherlands
18	NBS for building a waterproof city	Rotterdam	Netherlands
19	Social urban gardens of "Pla Buits" (Vacant Lots Plan),	Barcelona	Spain
20	A Coruña: An Urban Gardens Green Network	Coruña	Spain
21	The edible forest of Alcalá de Henares	Alcalá de Henares	Spain
22	Urban farming	Högdalen	Sweden
23	Storm water management and urban regeneration	Malmö	Sweden
24	Water park treats	Laduviken	Sweden

25	Green corridors: Network of Ventilation corridors	Stuttgart	Germany
26	Green-blue climate corridor	Kamen	Germany
27	Hamburg green roof strategy	Hamburg	Germany
28	Climate adaptation	Risvangen	Denmark
29	Restoration of Lille Vildmose	Storvorde town	Denmark
30	Community Garden Biodroom	Antwerp	Belgium

The cases were assessed by using the following method (adapted from IUCN global standards and Think Nature handbook as discussed in part 2.7) -

i. **Description-** Firstly, the case study is introduced and described as what it is and where it is located. Then a brief (or sometimes detailed) description is written about the study with some graphical representation in photos or diagrams. This makes the reader understand the study and what is being talked about.

ii. **Classification of action/solution**- In this step, the study is classified in various ways. This helps to differentiate between different solutions which the studies represent.

   i. Degree of intervention {One (or more) of the following type is chosen}
      - TYPE 1 – Better use of protected/ natural ecosystems
      - TYPE 2 – NBS for sustainability and multifunctionality of managed ecosystems
      - TYPE 3 - Design and management of new ecosystems

   ii. NBS approaches used (One (or more) of the following approaches is chosen)
      - Climate adaptation approaches
      - Community-based Adaptation
      - Ecosystem-Based Adaptation
      - Ecosystem-Based Management
      - Ecosystem-Based Mitigation
      - Ecosystem-Based disaster risk reduction
      - Ecological Restoration
      - Ecological Engineering
      - Infrastructure related approaches
      - Natural resources management
      - Sustainable Agriculture/agro-forestry/aquaculture

   iii. NBS challenge to be solved/SDGs (Chosen from the below)-
      - SDG 1
      - SDG 2.....
      - .....(Until) SDG 17

iii. **Climate Hazards addressed** (Chosen from the below)-

Heat	Floods				Water		Others
	River	Surface Water	Coastal	Landslide	Scarcity	Quality	

Other columns can be filled if needed.

iv. **Societal problems addressed** (Chosen from the below, necessity for IUCN)-
   a) Climate change
   b) Disaster risk
   c) Water Security
   d) Food security
   e) Human health
   f) Economic and social development

v. **Benefits and co-benefits** (Ecosystem services) provided (adapted from (Petsinaris et al., 2020)) -

Environmental	Social/Cultural	Economic
Temperature regulation	Health and quality of life	Food provision
River flood mitigation	Recreation, education & gathering	Water provision
Surface water flood mitigation	Regeneration of degraded areas	Energy savings
Coastal flood mitigation	Spiritual, religious &artistic values	Income generation
Water quality	Amenity value	Increased value of land/property
Regulation of the water cycle	Employment	Increased tourism
Groundwater recharge		
Soil quality & erosion prevention		
Air quality		
Noise mitigation		
Biodiversity		
Pollination		
Carbon storage		

vi. **Potential disadvantages / negative impacts of the solutions-** This part is to be written with the help of an understanding of the NBS or the sources.

vii. **IUCN assessment-** The table containing the eight criteria and the spider chart is put in this part to understand how good the solution is and if the case studied is an NBS or not. IUCN asks for a lot of requirements for the assessment of standards, but due to limited time and data, this is relaxed, and if the criteria seem to be fulfilled, then it is

accepted. Just either of the four options (strong, adequate, partial and insufficient) is selected from the drop-down menu on the tool after studying the NBS.

3.3 Observations

To understand what is happening inside a particular country, the research also checks how the different criteria behave within a specific country (we had seen in 3.2 how they would behave for a single case study). So firstly, the case studies (which were discussed individually in 3.2) were assessed together(combined) within a single country. For instance, Indonesia has three studies, so those three were combined, and observations were written.

Then, the studies combined together for Europe and for Asia respectively were compared between the two continents. And the observations were noted. Here all studies (combined) in Europe were compared with all studies (combined) in Asia.

A workshop was conducted with the students of the Master's in Science program in Territorial, Urban, Environmental and Landscape Planning (Academic Year 2021-2022), Decision Making for Sustainable Development Goals course, with the help of the Start Park approach, discussed below (Described in detail in Start Park approach in Chapter 3.3.1).

3.3.1 Start Park Approach- Approach used for Workshop conducted

Rules of the Start Park approach- used in the game played in the classroom

After the method of the game was introduced to the students, they were presented with the case in which they had to work (which will be discussed in Chapter 4 of this thesis). In this, they were told about the site, different problems faced and what the stakeholders wanted.

The students picked up a STAKEHOLDER CARD. The following were the stakeholder's cards-

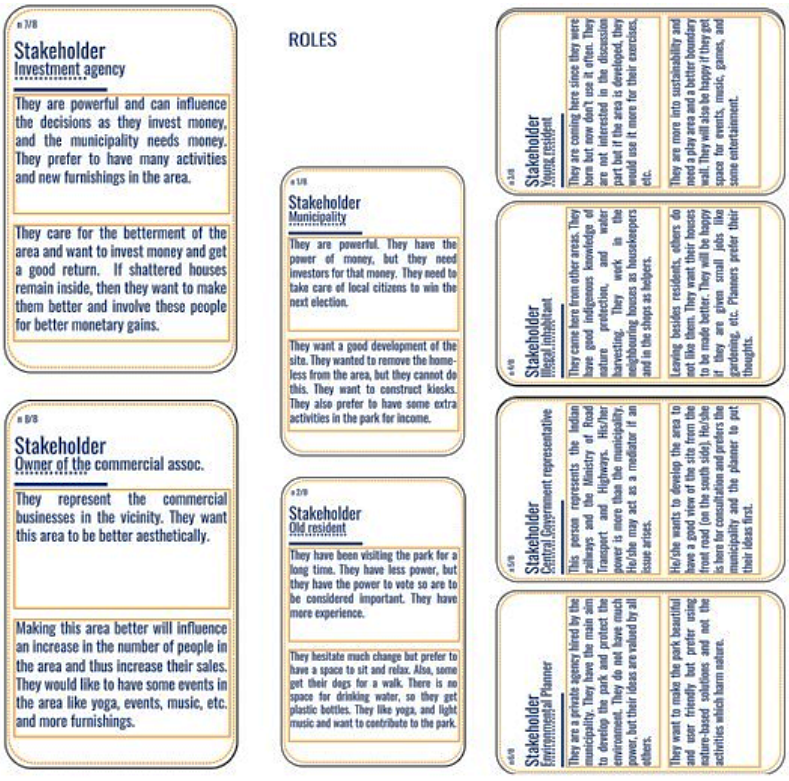


Figure 13 Stakeholders card- adapted from StartPark (source- https://www.startpark.org/)

On the board (containing the problem and the case), there were 3 problems and 3 pack of cards with the solutions. 3 rounds were played with the students, and each focused on different problems. After each round, the students decided where they had to put each solution and how. They also had to write down some notes about the reasons why they chose that particular solution only.

1. **First Round:** Problem 1 - 40 minutes were given for this round

This round was played by **green building infrastructure or GBI cards**. Students had to choose a maximum of two GBI Punctual cards (pond, rain garden, etc.), one GBI Linear card (paths, bioswale, etc.) and one surface card (paving, etc.). Students were asked to solve the first problem faced by the site. For that, they had to use GBI cards.

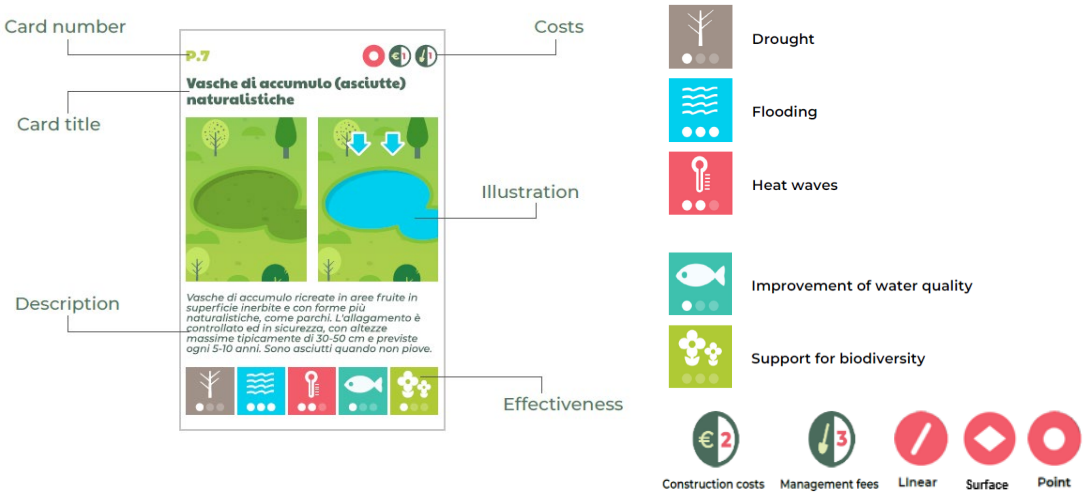


Figure 14 The description of card (on left) with its details on the right- effectiveness, costs, type of card. (Source- https://www.startpark.org/)

The following cards were there in the GBI pack of cards-

Point (P)	Linear(L)	Surface(S)
Rainwater treatment with technological solutions	Tube+Storm drain	Intensive green roofs
Underground storage tanks	Filter drains	Extensive green roofs
Filter Trench	Dry Canals	Permeable pavements- porous blocks
Rain garden	Wet canals	Rainwater treatment with technological solutions
Tree lined filtering box		Permeable pavements- green concrete grating
Surface dry storage tanks/ponds		Plastic grassed gratings
Naturalistic dry storage tanks		

Pond/Water tank		
Naturalistic pond		
Technological solutions for treatment of grey water		
Phyto-depuration of rainwater treatment		
Green walls for rainwater treatment		
Tube+ storm drain		

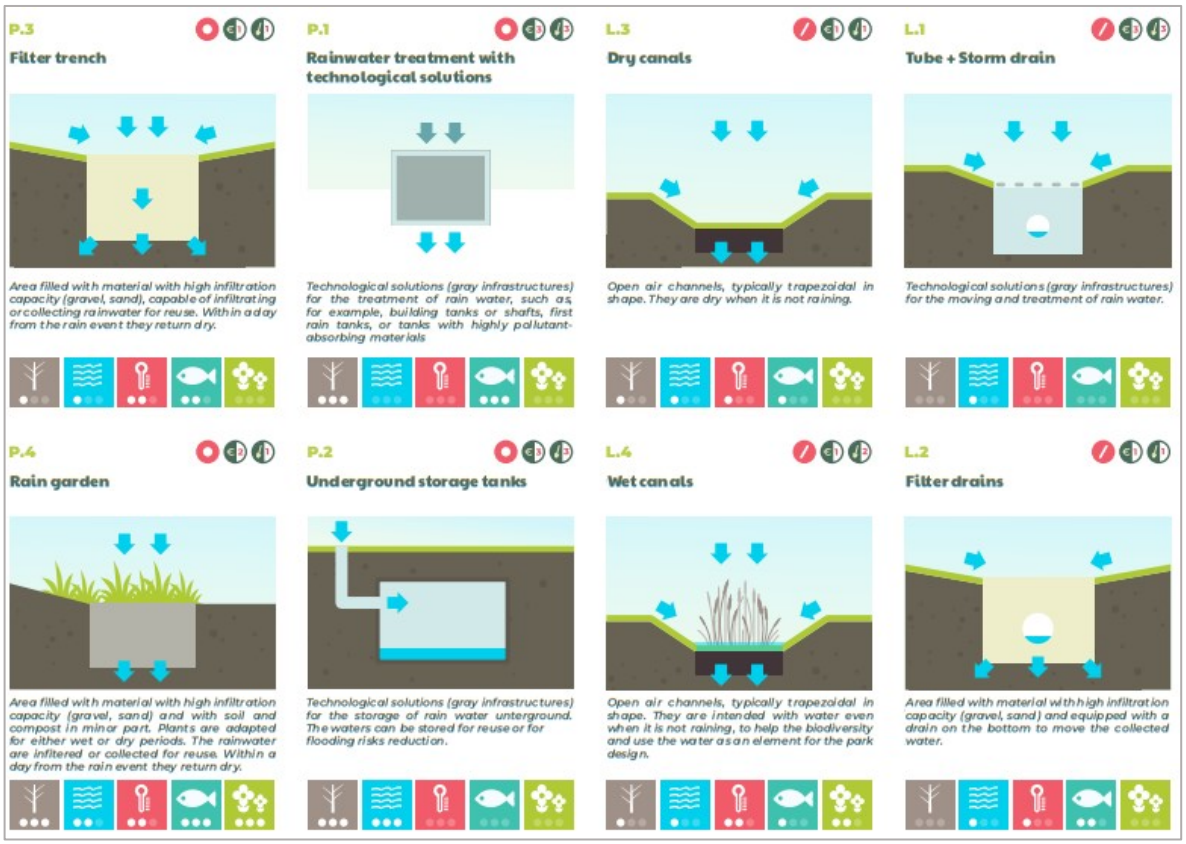


Figure 15 GBI cards- Translated in English from Italian-Set 1- (source- https://www.startpark.org/)

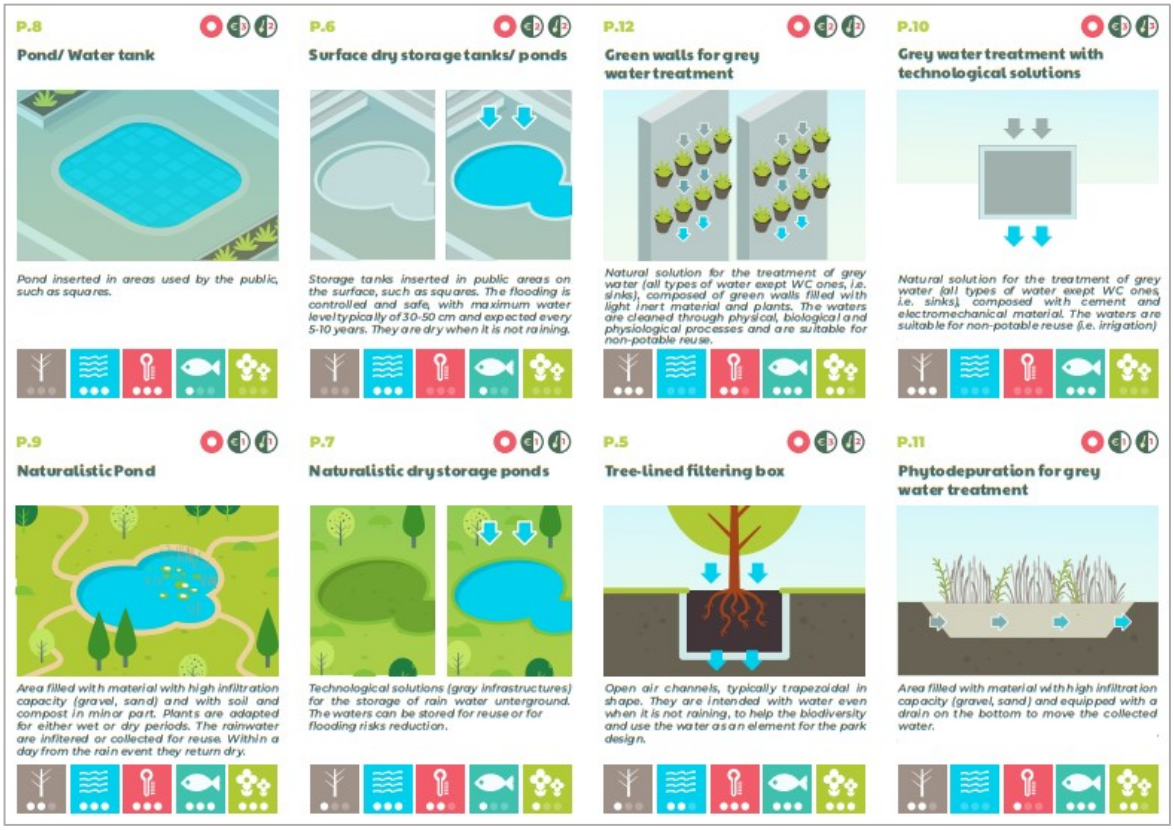


Figure 16 GBI cards- Translated in English from Italian-Set 2- (source- https://www.startpark.org/)

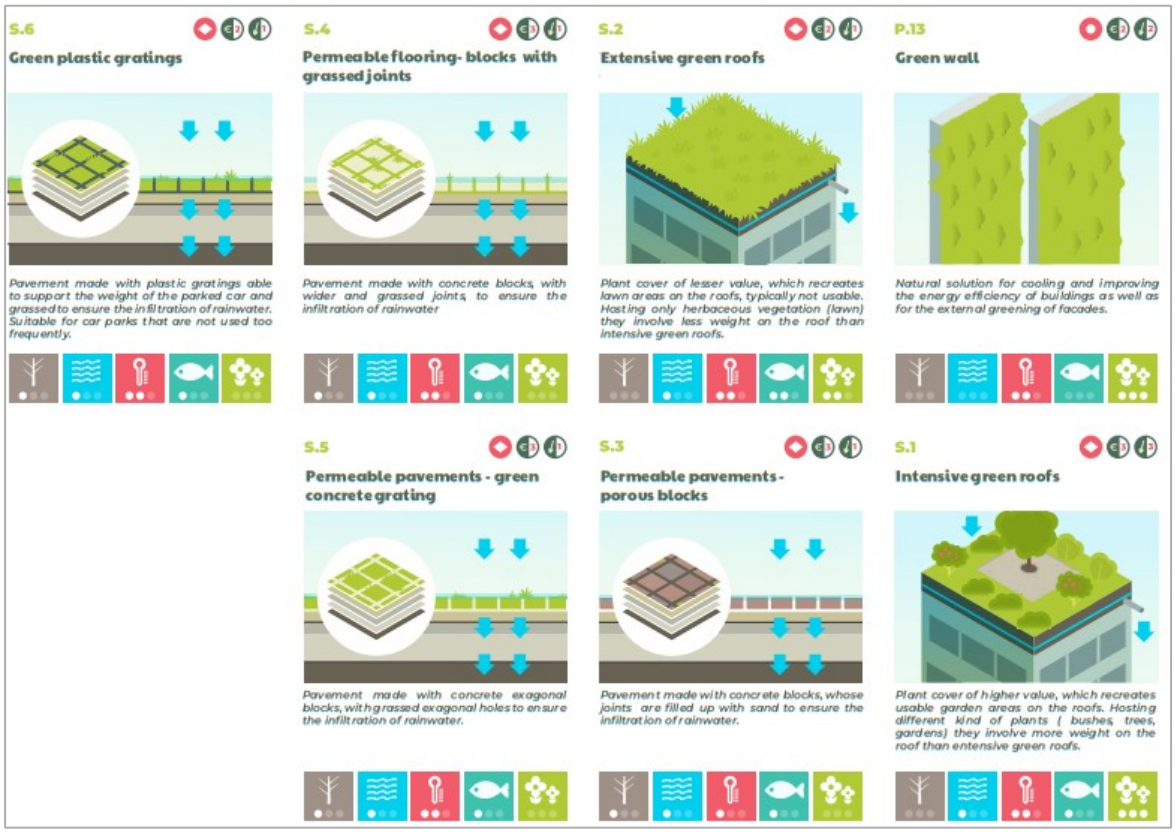


Figure 17 GBI cards- Translated in English from Italian-Set 3- (source- https://www.startpark.org/)

2 **Second Round:** Problem 2- 30 minutes were given for this round

This round was played with **furniture cards (seats, trees).** Students had to choose a maximum of 3 Furniture cards. Following cards were available in the pack of Furniture cards.

Figure 18 Furniture cards- Translated in English from Italian-Set 1- (source- https://www.startpark.org/)

Figure 19 Furniture cards- Translated in English from Italian-Set 2- (source- https://www.startpark.org/)

3 **Third Round:** Problem 3 - 30 minutes were given for this round

This round was played with **activity cards.** Students had to choose maximum of 2 Activities.

During each round, students had to work on their boards with “sketches” and “Post-Its” to present to their colleagues and professors at the end of the game. The following cards were available in the pack of activity cards.

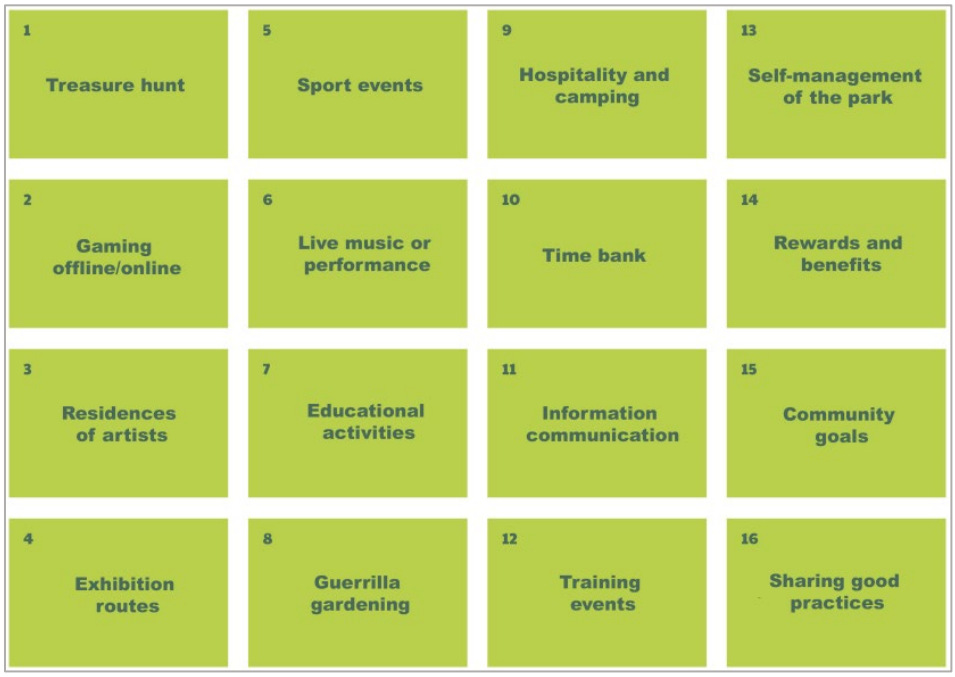


Figure 20 Activity cards- Translated in English from Italian-Just 1 set- (source- https://www.startpark.org/)

4

Results

Here the thesis will firstly discuss the countries and their case studies (solutions) and then compare the solution among countries and continents.

4.1 Case studies in Asia

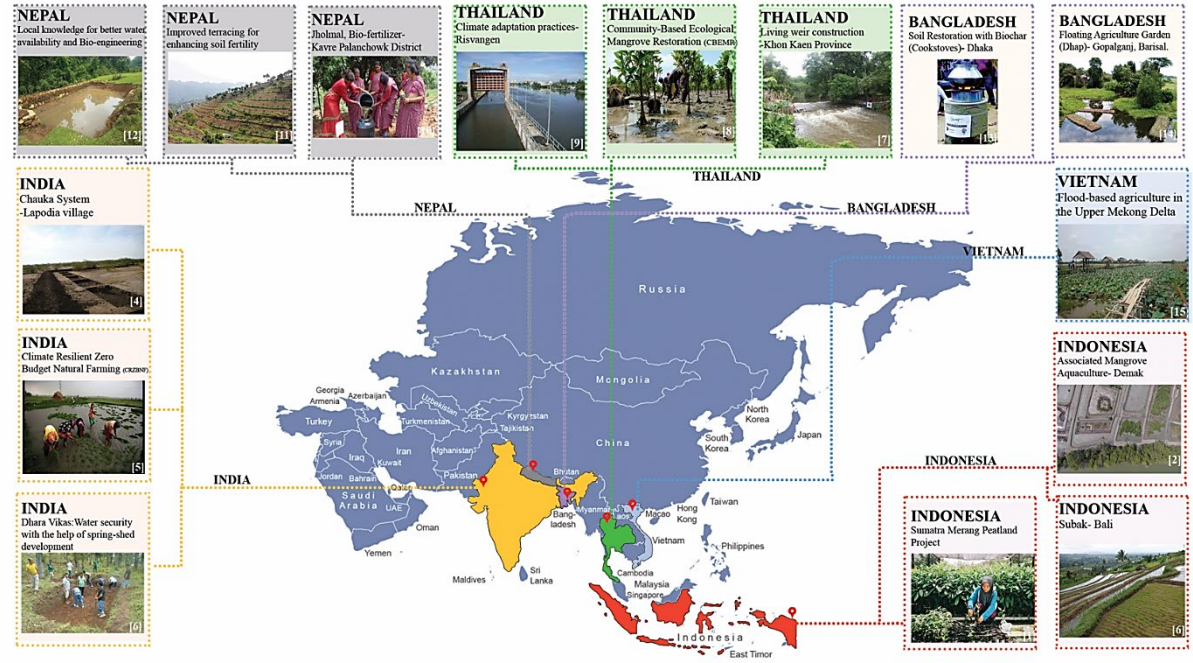


Figure 21 Case studies done in Asia (Source- written after each photo later, and designed by author)

One of the most distinctive geographical areas in the globe is Asia, which is either seen as a separate continent or as a subcontinent of Eurasia, which shares the continent of Afro-Eurasia with Africa. Asia makes up 8.7% of the planet's surface area and nearly 30% of its land area(AEDA, 2013). Many of the first civilizations were located on this continent, which has long been the place where the bulk of people lives. Around 60% of the world's population, or 4.7 billion people, live here(Worldometer, 2022).

Figure 22 Asia map showing different countries (Source- https://gisgeography.com/asia-map/)

4.1.1 Indonesia

It is a developing country located in Southeast Asia between the Indian and Pacific oceans, UN had kept it in Lower-middle-income countries based on "Economies by per capita GNI in June 2018" (United Nations, 2019). It is also the hosting country for G20 (2022). It has a population of approximately 276,361,788 (World Bank, 2021). It faces many natural disasters like drought, water scarcity, floods, food production problems, coastal floods and soil erosion, vector-borne diseases, earthquakes and tsunamis (Statista, 2022) .

Figure 23 Location of Indonesia in Asia (Source- https://commons.wikimedia.org/wiki/)

1. Case Study 1 *(Overall Study – 1)*

Subak, Bali

i. Description

Figure 24 Subak- (Source- George Steven, www.ourplaceworldheritage.com)

Subak is the water management (irrigation) system for the paddy fields on Bali Island in Indonesia. It was developed in the 9th century (Risna, Herry, Buchori, & Pribadi, 2022). Sometimes *Subak* is also considered as a mechanism used by indigenous people. It has been a UNESCO World Heritage Culture since 2012 thus, it also has worldwide interests. This shows the local culture of the people of that area. According to UNESCO, *Subak* is a part of a unique landscape network, and it reflects the interaction between humans and nature. The governance of these areas also incorporates the stakeholders, which are part of the outstanding values. The Subak system is an area of "19,500 ha and 1,454.8 ha of buffer zones" (UNESCO World Heritage Convention, 2012). *Subak* follows 'Tri-Hita Karana' philosophy which consists- '*parhyangan, palemahan, and pawongan principles*.' Where *parhyangan* are rituals which are followed from starting to the end of agricultural practices. In *Palemahan,* paddy fields are made without disturbing the contours, while in *pawongan,* Subak fundamental structures are developed, and regulations are made which make the work on this process smoother and better for all stakeholders. It is clear here that the ideology of *Tri Hita Karana* (THK) is for sustainable development. Even according to the regional regulation, the "*awig-awig*"(policies and laws) of "*Subak*" need "a go-ahead" from the village head, and the regulations come under Decree of the Regent of Regional head.

ii. Classification of action/solution-

a) Degree of intervention

TYPE2 - NBS for sustainability and multifunctionality of managed ecosystems

b) NBS approaches used

- Community-based Adaptation
- Ecosystem Based Adaptation
- Ecosystem Based Management
- Ecosystem based disaster risk reduction
- Ecological Restoration
- Sustainable Agriculture

c) NBS challenge to be solved/SDGs

The following SDGs are covered by this action/solution-

- Goal 3: Good Health and Well-being
- Goal 8: Decent work and economic growth
- Goal 10: Reduced inequality
- Goal 12: Responsible consumption and production
- Goal 13: Climate action
- Goal 15: Life on land
- Goal 16: Peace, justice and strong institutions

iii. Climate Hazards addressed- Protects from landslides, floods (cloudbursts), water scarcity, soil protection, and safety from pest attacks (no invasive species as well).

Heat	Floods				Water		Others
	River	Surface Water	Coastal	Landslide	Scarcity	Quality	Pests
							Solved

iv. Societal problems addressed: Water Security, Food security, Human health, and Economic and social development.

v. Benefits and co-benefits (Eco system services) provided-

Environmental	Social/Cultural	Economic
Temperature regulation	Health and quality of life (C)	Food provision
Surface water flood mitigation	Spiritual, religious &artistic values	Water provision (C)
Water quality (C)	Amenity value	Increased tourism (C)
Biodiversity (C)		
Regulation of the water cycle(C)		

Groundwater recharge		

vi. Potential disadvantages / negative impacts-

Bali is known as one of the most important tourism destinations in the world. It recorded 66.35% of total growth (Regional Development Planning Agency of Bali Province, 2012). On the contrary side, tourism is a significant trouble for *Subak*. According to Budiasa, Setiawan, Kato, Sekino, & Kubota (2015), tourism has led to land use changes. Many agricultural land areas are now converted to different land use for the construction of resorts, hotels, spas, etc. The increase in tourism in Bali is also leading to a change of practices by farmers, and it causes neglect towards the ancient practice of *Subak*.

vii. IUCN assessment-

Table 2 NBS self-assessment for Case 1 - Indonesia- (Source- IUCN 2020, adapted)

Criterion	Your Criterion Score	Maximum Criterion Score	Normalised criterion	FINAL OUTPUT Your Criterion %age
1. Societal challenges	8	9	0.89	89%
2. Design at scale	5	9	0.56	56%
3. Biodiversity net-gain	8	12	0.67	67%
4. Economic feasibility	7	12	0.58	58%
5. Inclusive governance	13	15	0.87	87%
6. Balance trade-offs	3	9	0.33	33%
7. Adaptive management	3	9	0.33	33%
8. Sustainability and mainstreaming	7	9	0.78	78%
Total Percentage match				63%
Is this in adherance with the IUCN Global Standard for NbS?			In adherance	

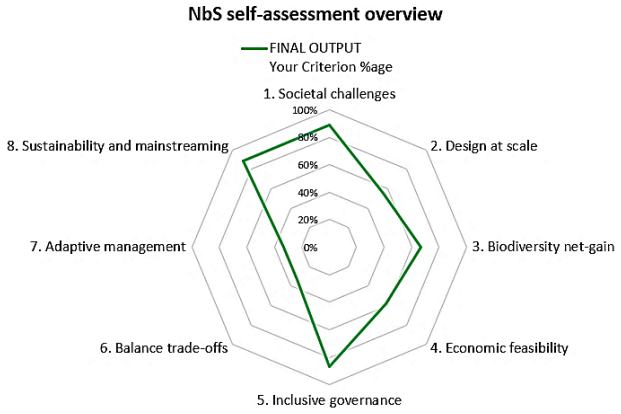


Figure 25 Spider Chart for self-assessment for Case 1 -Indonesia- (Source- IUCN 2020, adapted)

2. **Case Study 2** *(Overall Study – 2)*

Associated Mangrove Aquaculture, Demak

i. Description

Figure 26 Associated Mangrove Aquaculture- (Source- Blue forests- https://panorama.solutions/en/solution/associated-mangrove-aquaculture)

"Aquaculture is a process of breeding, harvesting fish, shellfish and aquatic plants"(National Oceanic and Atmospheric Administration, n.d.). 'Associated Mangrove Aquaculture' is a concept where aquaculture is combined with forestry by providing a greenbelt of mangroves along the shorelines. This process helps protect the shorelines and protects the fishponds from seawater. Sometimes AMA is also referred to as silvo-aquaculture or mixed-mangrove-aquaculture. But contrary to the original silvo-aquaculture where the mangroves are planted in the ponds, in AMS the mangroves are planted outside. This procedure requires maintenance as shadows from trees may negatively affect pond animals, but there are positive effects on animals too. The program has three main aims (EcoShape, n.d.) are-

1. Revival of mangrove shoreline for the protection of the coast
2. Revival of ponds for aquaculture
3. Classes/training for locals/farmers for better use of mangroves and more production

This project was part of the 'Building with Nature project in Demak'. The financial investment came from the AMA, through the Bio-rights mechanism, which links poverty removal and environmental conservation. In the Bio-rights mechanism, people receive funds when they complete conservation and restoration work. There were community groups created in 9 villages, who got training and help in the management of the mangroves and their pond(Bosma et al., 2020). There are 'Stakeholder Innovation Platforms (SIP) and Saving Clubs', which help the farmers to gain more information and help in resolving their current and future issues. They can then access government funding as well if needed.

ii. Classification of action/solution-

a) Degree of intervention

TYPE 2 - NBS for sustainability and multifunctionality of managed ecosystems

b) NBS approaches used

- Climate Adaptation Approaches
- Community Adaptation Approaches
- Ecosystem Based Adaptation
- Ecosystem Based Mitigation
- Ecosystem based disaster risk reduction
- Ecological Restoration
- Sustainable Agriculture

c) NBS challenge to be solved/SDGs

The following SDGs are covered by this action/solution-

- Goal 1: No poverty
- Goal 2: Zero hunger
- Goal 3: Good Health and Well-being
- Goal 8: Decent work and economic growth
- Goal 11: Sustainable cities and communities
- Goal 12: Responsible consumption and production
- Goal 13: Climate action
- Goal 14: Life below water

iii. Climate Hazards addressed- Protects from coastal floods, soil erosion protection, mangrove belt act as a biofilter and reduce toxic materials.

Heat	Floods				Water		Others
	River	Surface Water	Coastal	Landslide	Scarcity	Quality	Toxins in soil
							Solved

iv. Societal problems addressed: Climate change, Disaster risk, Food security, and Economic and social development.

v. Benefits and co-benefits (Eco system services) provided-

Environmental	Social/Cultural	Economic
Temperature regulation (C)	Health and quality of life (C)	Food provision
Coastal flood mitigation	Recreation, education & gathering (C)	Income generation
Soil quality and erosion prevention	Regeneration of degraded areas	
Biodiversity (C)	Employment	
Carbon storage(C)		

vi. Potential disadvantages / negative impacts-

It was hard to persuade the farmers to make them understand the benefits of this method. Though their pond areas are reduced but they get more aquatic animals, thus more income.

vii. IUCN assessment-

Table 3 NBS self-assessment for Case 2 - Indonesia- (Source- IUCN 2020, adapted)

Criterion	Your Criterion Score	Maximum Criterion Score	Normalised criterion	FINAL OUTPUT Your Criterion %age
1. Societal challenges	9	9	1.00	100%
2. Design at scale	8	9	0.89	89%
3. Biodiversity net-gain	10	12	0.83	83%
4. Economic feasibility	10	12	0.83	83%
5. Inclusive governance	10	15	0.67	67%
6. Balance trade-offs	6	9	0.67	67%
7. Adaptive management	7	9	0.78	78%
8. Sustainability and mainstreaming	9	9	1.00	100%
Total Percentage match				83%
Is this in adherance with the IUCN Global Standard for NbS?			In adherance	

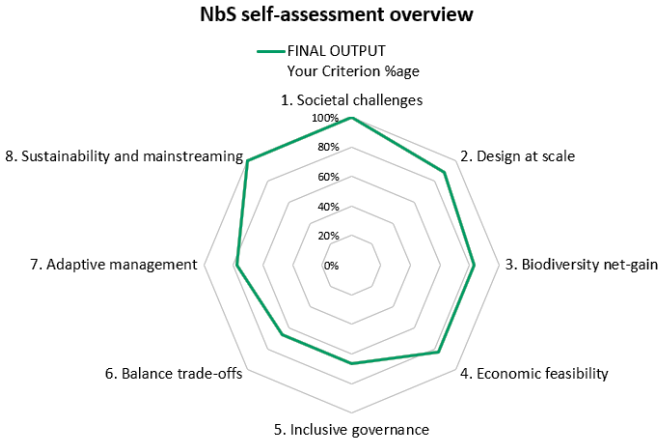


Figure 27 Spider Chart for self-assessment for Case 2 - Indonesia- (Source- IUCN 2020, adapted)

3. Case Study 3 *(Overall Study– 3)*

Sumatra Merang Peatland Project

i. Description

Figure 28 Sumatra Meran Peatland Project- A girl sowing plants- (Source- https://ecosphere.plus/sumatra-merang-peatland/)

The project aims to restore 22,922 hectares of peatland (Ecosphere+, n.d.). The project focuses on the 'Merang biodiversity zone' in Sumatra. It is a complex project which includes prevention of emissions, protection of endangered species (including Sumatra Tiger) and protection of peatland (which is the main aim). Local communities are an integral part, and this project tries to increase their jobs and income and improve their livelihood.

According to IUCN, peatlands are kind of wetlands which are crucial for mitigating the effects of climate change(IUCN, 2021). They have numerous benefits to humans and environment like, they are world's largest natural carbon store, they reduce flood risk, provide safe water, and they preserve biodiversity. Their protection is needed for the

betterment of this planet. The peatlands that get damaged are the source of 5% of CO2 (anthropogenic) emissions which is not good.

Assisted Natural Regeneration (ANR) helps in the fast-growing of seedlings and assists in the natural regeneration of trees rather than using any artificial mechanism. It includes-

- Rejuvenation and regrowth of existing trees- By using native species.
- Prevention of fire- Construction of around 180 dams for proper drainage of water so that the water table rises and trees do not remain dry.
- Monitoring of the forest- By teams to check the health of the area and prevent illegal activities.

Locals are an essential part of this project. They are incorporated into the process, and initiatives like health campaigns, water infrastructure, etc., are started for them. Crops for their betterment and their increase in livelihood are grown. Women are also involved, and around 28% of people are them(Ecosphere+, n.d.). Rewetting the peatlands again by locals helps in peatland protection as well as an increase in fishes.

ii. Classification of action/solution-

a) Degree of intervention

TYPE 1 – Better use of protected/ natural ecosystems

b) NBS approaches used

- Climate adaptation approaches
- Community-Based Adaptation
- Ecosystem Based Management
- Ecosystem Based Mitigation
- Ecosystem based disaster risk reduction
- Ecological Restoration
- Infrastructure related approaches
- Natural resources management
- Sustainable Agriculture

c) NBS challenge to be solved/SDGs

The following SDGs are covered by this action/solution-

- Goal 1: No poverty
- Goal 2: Zero hunger
- Goal 5: Gender equality
- Goal 8: Decent work and economic growth
- Goal 9: Industry, Innovation and Infrastructure
- Goal 10: Reduced inequality
- Goal 12: Responsible consumption and production
- Goal 13: Climate action
- Goal 15: Life on land
- Goal 16: Peace, justice and strong institutions
- Goal 17: Partnership for the goals

iii. **Climate Hazards addressed-** Prevented extinction of species and peatland restoration.

Heat	Floods				Water		Others
	River	Surface Water	Coastal	Landslide	Scarcity	Quality	Extinction of species
							Solved

iv. **Societal problems addressed:** Climate change, water security, human health, and economic and social development.

v. **Benefits and co-benefits (Eco-system services) provided-**

Environmental	Social/Cultural	Economic
Temperature regulation (C)	Health and quality of life (C)	Water provision
Surface water flood mitigation	Regeneration of degraded areas	Income generation (C)
Water quality	Employment(C)	
Biodiversity (C)		
Regulation of the water cycle		
Carbon Storage		
Soil quality & erosion prevention		

vi. **Potential disadvantages / negative impacts-**

Previously for the last 30 years, it was a hard time for the peatlands as it was harmed by deforestation activities and an increase in commercial agriculture, which created problems for the hydrology of these peatlands, and caused them peat to dry, and they became vulnerable to fires. But now, there are possibly no negative impacts because many international organisations are working together with the locals for the betterment of the livelihoods of the people as well as helping in ecosystem rejuvenation.

vii. IUCN assessment-

Table 4 NBS self-assessment for Case 3 - Indonesia- (Source- IUCN 2020, adapted)

Criterion	Your Criterion Score	Maximum Criterion Score	Normalised criterion	FINAL OUTPUT Your Criterion %age
1. Societal challenges	7	9	0.78	78%
2. Design at scale	6	9	0.67	67%
3. Biodiversity net-gain	12	12	1.00	100%
4. Economic feasibility	6	12	0.50	50%
5. Inclusive governance	5	15	0.33	33%
6. Balance trade-offs	5	9	0.56	56%
7. Adaptive management	9	9	1.00	100%
8. Sustainability and mainstreaming	9	9	1.00	100%
Total Percentage match				73%
Is this in adherance with the IUCN Global Standard for NbS?			In adherance	

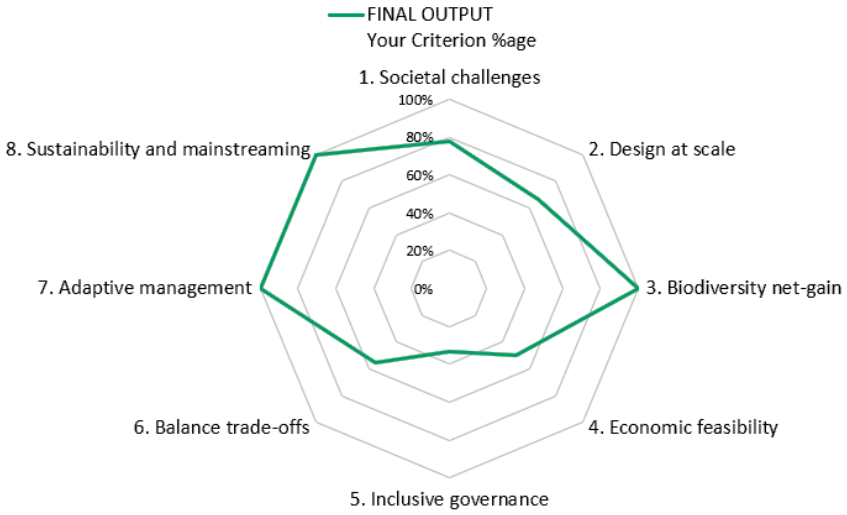


Figure 29 Spider Chart for self-assessment for Case 3 - Indonesia- (Source- IUCN 2020, adapted)

4.1.2 India

It is a developing country in South Asia bounded by the Indian Ocean, Bay of Bengal and Andaman Sea. UN had kept it in Lower-middle-income countries on the basis of "Economies by per capita GNI in June 2018" (United Nations, 2019). It is the worlds second most populous country with a population of approximately 1,393,409 people (World Bank, 2021). It will supersede China in 2023 (Hegarty Stephanie, 2022). It is facing many natural disasters like drought, water scarcity, floods, food production problems, coastal floods and soil erosion, vector-borne diseases, earthquakes and Tsunami, malnutrition, air pollution, storms, cloudburst and landslides (Government of India, 2009; Ministry of Health & Family Welfare Government of India, 2018).

Figure 30 Location of India in Asia (Source- https://upload.wikimedia.org/wikipedia/commons/thumb/a/a8/.svg.png)

1. Case Study 1 *(Overall Study – 4)*

Chauka System, Lapodia (Laporiya) Village, Jaipur district

i. Description

Figure 31 Small depression in the earth- (Source- GVNML)

Rajasthan is the western state of India, with a majority of the area being part of the Thar desert. It has numerous dry spells, but life comes to its form during monsoons, but due to change in climate this has also changed. As the water falls on the ground, it evaporates, and the water table does not recharges.

Chauka system is a process to enhance the soil moisture in grasslands. Until 1970s, *Lapodia* village was like any other village situated at a distance of approximately 90 km from the capital of the state of Rajasthan, known for its massive forts and desert. Then due to some people's mutual understanding, the village was converted into a place with water availability for the whole year.

'Chauka' comes from the Hindi word 'four' or 'square'. It is a rainwater harvesting technique used in arid areas of India. Square shallow depressions are made on the ground, and a small wall (embankment) is made on three sides and is left open on one side. This helps retain rainwater as one *chauka* fills and overflows and the next is filled. This method is used in *Lapodia* with some changes. Around three to four kilometres of canals were built to bring the water to the ponds. Also, 3 water bodies, of which 2 were for ground water retention and one for irrigation, were also built (or existing spaces were used). The region is famous for its dry spells and sometimes excess rain in a short time; thus, pastureland was used as it was better than other crops and uses less water for irrigation. When the cattle graze on these plants, their dung acts as a natural manure and helps in planting crops which can be sold in the market and is healthy for humans as well because it is grown with natural fertilizers (Karelia, 2019). It is an excellent example of humans, nature and animals who coexist and help each other.

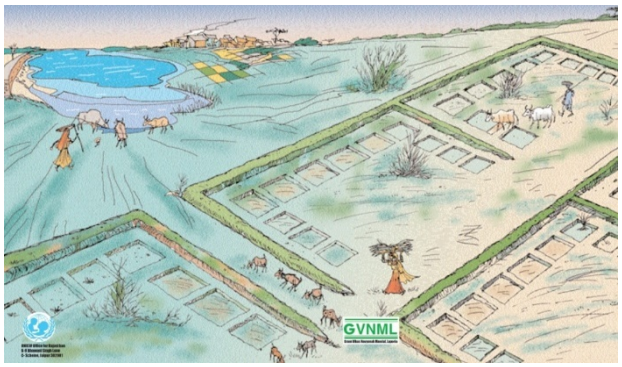


Figure 32 Shallow depressions with embankments made (Source- GVNMNL)

This whole process involved everyone from the village. For *chauka* design, a participatory approach is essential. Along with this system, Community-led inclusive natural resource management is also being utilised in this and other neighbouring villages. An NGO called Gram Vikas Navyuwak Mandal is taking steps to make the villages sustainable and self-reliable; it also manages the processes and acts as a link between government and people. Invasive species like Gandababool (*juliflora*) are removed, and native species like Desi *babool* are planted. A Village Development Committee (VDC) was made, which helps the people to govern and take care of the natural resources, but it is not recognised by the state. A village plan was also made with locals' input to better organise the action's implementation process. Now Laporiya has evolved and sells water to neighbouring villages (Everard & West, 2021).

ii. Classification of action/solution-

a) Degree of intervention

TYPE2 - NBS for sustainability and multifunctionality of managed ecosystems

TYPE 3 - Design and management of new ecosystems

b) NBS approaches used

- Community-Based Adaptation
- Ecosystem Based Adaptation
- Ecosystem Based Management
- Ecosystem based disaster risk reduction
- Ecological Restoration
- Sustainable Agriculture
- Climate Adaptation Approaches
- Natural Resource Management

c) NBS challenge to be solved/SDGs

The following SDGs are covered by this action/solution-

- Goal 2: Zero hunger
- Goal 3: Good Health and Well-being
- Goal 5: Gender equality
- Goal 6: Clean water and sanitation
- Goal 8: Decent work and economic growth
- Goal 10: Reduced inequality
- Goal 12: Responsible consumption and production
- Goal 13: Climate action
- Goal 15: Life on land

iii. Climate Hazards addressed- Protects from droughts, retains water runoff, and recharges the underground water table before evaporation, helps in regeneration of flora and even fauna (as vegetation attracts the animals and insects).

Heat	Floods				Water		Others
	River	Surface Water	Coastal	Landslide	Scarcity	Quality	Vegetation regeneration
							Solved

iv. Societal problems addressed: Climate change, Disaster risk, Water Security, Food security, Human health, and Economic and social development.

v. Benefits and co-benefits (Eco system services) provided-

Environmental	Social/Cultural	Economic
Temperature regulation (C)	Health and quality of life (C)	Food provision
Regulation of the water cycle	Spiritual, religious &artistic values (C)	Water provision
Water quality	Amenity value (C)	Energy savings (C)
Soil quality & erosion prevention (C)	Regeneration of degraded areas	
Biodiversity (C)	Recreation, education & gathering (C)	
Groundwater recharge		

vi. Potential disadvantages / negative impacts-

This system of *chaukas* is better in semi-arid and arid areas. And it needs less slope (0.5-2%), so the water is retained in these *chaukas*.

vii. IUCN assessment-

Table 5 NBS self-assessment for Case 1 -India- (Source- IUCN 2020, adapted)

Criterion	Your Criterion Score	Maximum Criterion Score	Normalised criterion	FINAL OUTPUT Your Criterion %age
1. Societal challenges	9	9	1.00	100%
2. Design at scale	4	9	0.44	44%
3. Biodiversity net-gain	8	12	0.67	67%
4. Economic feasibility	4	12	0.33	33%
5. Inclusive governance	12	15	0.80	80%
6. Balance trade-offs	4	9	0.44	44%
7. Adaptive management	7	9	0.78	78%
8. Sustainability and mainstreaming	7	9	0.78	78%
Total Percentage match				66%
Is this in adherance with the IUCN Global Standard for NbS?			In adherance	

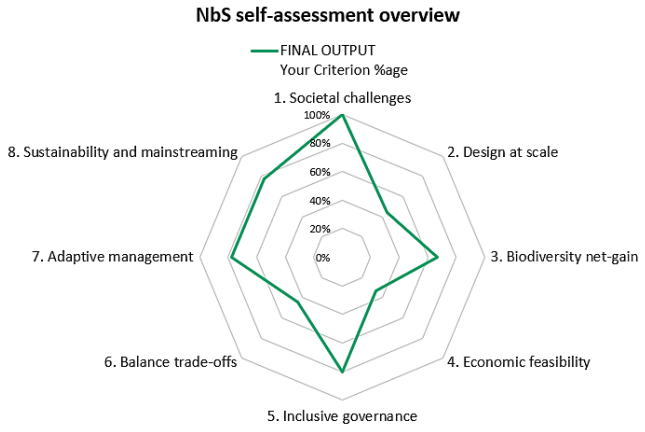


Figure 33 Spider Chart for self-assessment for Case 1 - India- (Source- IUCN 2020, adapted)

2. Case Study 2 *(Overall study – 5)*

Climate Resilient Zero Budget Natural Farming (CRZBNF), Andhra Pradesh

Figure 34 CRZBNF in Andhra Pradesh (Source- https://www.theweek.in/news/biz-tech/2019/07/13/Is-Zero-Budget-Natural-Farming-the-way-ahead.html)

i. Description

Andhra Pradesh (will be called AP in further text) is an Indian state situated in the southern part towards the Bay of Bengal. It is prone to many cyclonic disturbances and was hit by the 2004 Tsunami.

CRZBNF is a way of farming which believes in growing crops naturally without the need for artificial fertilisers or any other artificial element for the help of growth of plants, the growth should be through natural means. The word 'Zero Budget' means without spending almost anything by the farmers as the inputs used are locally available, like cow dung for fertilizers. "RySS - Farmer's Empowerment Corporation" is a not-for-profit company which was formed by the government to take care of the farming practices and shift to CRZBNF. This approach has become famous, and even the central government is promoting it in other parts of the country. It also fulfils many SDGs as it asks to move to natural farming from genetically engineered. This incorporates many organisations like UNEP, ICRAF, BNP Paribas, AP government and SIFF (Sustainable India Finance Facility).

Around 100,000 farmers are already using this technique, and about 500,000 will be moving towards it in the near future (Saldanha, 2018). It is said in the research by Saldanha (2018) that it is impossible to increase production by other methods, and cow is the way forward.

Before this mechanism, AP used the Community Managed Sustainable Agriculture (CMSA), which paved the way for CRZBNF. Four main changes happened (Saldanha, 2018) -

- Approach for both men and women instead of just women.
- Approach which covers the whole gram panchayat.
- The project is owned by Agriculture Department, and making sure it happens
- Full commitment of the government is also essential.

The 4 wheel or the *chakaras* on which this type of farming depends in AP are (Saldanha, 2018)

1. Jeevamrutham- It is a microbial culture that comes from the dung and urine of the cow, jaggery, pulse flour and soil (which is uncontaminated).
2. Beejamrutham- It is the coating of seeds, which is based on cow dung, urine and lime
3. Acchadana- Mulching- This is a process in which the soil is covered by cover top and crop residues.
4. Whaphasa- This is the soil aeration process which takes place due to first and the third processes. And it represents the changes which happen in water management.

According to government officials, fertilizer use has fallen in AP and nitrous oxide and other GHGs have also reduced, but there is no solid evidence. Also, water requirements have been reduced by 25% and farmers are able to withstand the monsoon rains as well.

To increase production, vertical harvesting of sunlight (creeper-type plants) is also being assessed, and many farmers have also utilised it as well. It incorporates livestock as well. Cows are an integral part of this process. But using native cows is better than foreign cows. Self-help groups of farmers are formed who help each other during need, and the master farmers who

are trained by RySS help these farmers if the need arises. Most importantly, the CRZBNF is authenticated by state acts and national laws, but some points are unclear.

ii. Classification of action/solution-

a) Degree of intervention

TYPE 2 - NBS for sustainability and multifunctionality of managed ecosystems

b) NBS approaches used

- Climate Adaptation Approaches
- Community-Based Adaptation
- Ecosystem Based Mitigation
- Ecosystem Based Management
- Ecosystem based disaster risk reduction
- Ecological Restoration
- Natural resources management
- Sustainable Agriculture

c) NBS challenge to be solved/SDGs

The following SDGs are covered by this action/solution-

- Goal 1: No Poverty
- Goal 2: Zero hunger
- Goal 3: Good Health and Well-being
- Goal 5: Gender equality
- Goal 10: Reduced inequality
- Goal 12: Responsible consumption and production
- Goal 13: Climate action
- Goal 15: Life on land

iii. Climate Hazards addressed- Rejuvenation of soil nutrients, helps in regeneration of flora and even fauna.

Heat	Floods				Water		Others
	River	Surface Water	Coastal	Landslide	Scarcity	Quality	Vegetation regeneration
							Solved

iv. Societal problems addressed: Disaster risk, Water Security, Food security, Human Health, and Economic and social development.

v. Benefits and co-benefits (Ecosystem services) provided-

Environmental	Social/Cultural	Economic
Surface water flood mitigation	Health and quality of life (C)	Food provision
Regulation of the water cycle (C)	Spiritual, religious & artistic values	Water provision (C)
Water quality	Amenity value (C)	Energy savings (C)
Soil quality & erosion prevention	Employment (C)	Income generation
Biodiversity (C)		
Air quality (C)		

vi. Potential disadvantages / negative impacts-

This concept of CRZBNF is quite helpful for farming as it focuses on zero expenditure. But it needs farmers to get trained properly; for this, experts or other already trained farmers are asked to help. This might create problems. Also, some farmers prefer using the old techniques, and it would take time to shift to this practice.

vii. IUCN assessment-

Table 6 NBS self-assessment for Case 2 - India- (Source- IUCN 2020, adapted)

Criterion	Your Criterion Score	Maximum Criterion Score	Normalised criterion	FINAL OUTPUT Your Criterion %age
1. Societal challenges	7	9	0.78	78%
2. Design at scale	8	9	0.89	89%
3. Biodiversity net-gain	7	12	0.58	58%
4. Economic feasibility	11	12	0.92	92%
5. Inclusive governance	5	15	0.33	33%
6. Balance trade-offs	4	9	0.44	44%
7. Adaptive management	6	9	0.67	67%
8. Sustainability and mainstreaming	8	9	0.89	89%
Total Percentage match				69%
Is this in adherance with the IUCN Global Standard for NbS?			In adherance	

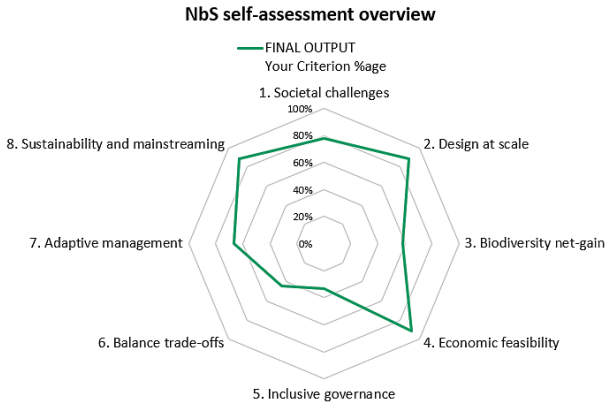


Figure 35 Spider Chart for self-assessment for Case 2 - India- (Source- IUCN 2020, adapted)

3. Case Study 3 *(Overall Study – 6)*

Dhara Vikas: Creating water security with the help of spring-shed development, Sikkim

i. Description

Figure 36 People digging holes for pond (Source- (Rural Management and Development Department Government of Sikkim, 2017)

Not only do deserts bear the brunt of climate change, but also the mountains bear the effects of it. Glaciers are melting at a faster rate, the continuous construction which is happening in the Himalayas is leading to many ill effects on the natural ecosystem. It has been quoted in number of newspaper articles and also by the High Court of Nainital (Judicial capital of Uttarakhand which is situated on the Himalayas), that the Nainital lake is dying because of unlawful construction, debris from it, solid wastes in the lake, siltation and encroachments of the drains which leads the water to the lake (Santoshi, 2018) and (Rautela, 2017). According to research quoted by NITI Aayog, (2018), functional springs have fallen from a massive 360 to 60 over the previous 150 years. The natural springs are obstructed, and thus it is hard for people to drink natural (mineral water). Springs and rivers have many cultural and traditional activities across them, and many people pray to them if any mishap (drought) happens.

Figure 37 A water pond between the greenery (Source- (Rural Management and Development Department Government of Sikkim, 2017)

Women are most affected because, in a majority of traditional households, they still take care of the house and go to refill water. However, due to the obstruction of spring water, the gravitational force cannot bring the water to their homes (through pipes), so they have to go uphill to fill the containers with water and bright them back to their homes.

Traditionally some practices were followed by the people, like the use of plants like *dhokrey phul, and dhobi phul (Brugmansia suaveolens , Mussaenda glabrata)* above the spring and were fenced. These plants helped in infiltrating water, but the situation is worse now and need extra steps. So nowadays, to increase the capacity of the land to infiltrate more water, spaces are dug out, like trenches and ponds and trees are planted on the hilltop. Also, lakes are revived so that they act as natural recharge areas, terrace lands, paddy fields as they store water, natural sinkholes for water seeping in, etc. (Rural Management and Development Department Government of Sikkim, 2017). This process incorporates traditional and scientific knowledge, and the rural government department helps the locals in the implementation and management of this system. This also incorporates now, water supply development, sanitation and catchment area protection with its goal.

Firstly, a comprehensive analysis is carried out before using this method incorporating traditional knowledge. The discharge of the spring which needs help is measured as it is the

most important step and the measurement is carried for further 2-3 years. Many trenches are made for better collection of water, and they are made on natural depressions on the land.

ii. Classification of action/solution-

a) Degree of intervention

TYPE2 - NBS for sustainability and multifunctionality of managed ecosystems

b) NBS approaches used

- Climate Adaptation Approaches
- Community-Based Adaptation
- Ecosystem Based Adaptation
- Ecosystem Based Management
- Ecosystem based disaster risk reduction
- Ecological Restoration
- Natural Resource Management

c) NBS challenge to be solved/SDGs

The following SDGs are covered by this action/solution-

- Goal 3: Good Health and Well-being
- Goal 5: Gender equality
- Goal 6: Clean water and sanitation
- Goal 10: Reduced inequality
- Goal 12: Responsible consumption and production
- Goal 13: Climate action
- Goal 15: Life on land

iii. Climate Hazards addressed- Protects from droughts, retains water runoff, and recharges the underground water table, helps in the regeneration of flora and even fauna (as vegetation attracts the animals and insects).

Heat	Floods				Water		Others
	River	Surface Water	Coastal	Landslide	Scarcity	Quality	Vegetation regeneration
							Solved

iv. Societal problems addressed: Climate change, Disaster risk, Water Security, Food security (C).

v. Benefits and co-benefits (Ecosystem services) provided-

Environmental	Social/Cultural	Economic
Water quality	Health and quality of life (C)	Food provision (C)

Regulation of the water cycle	Spiritual, religious &artistic values	Water provision
Biodiversity (C)	Amenity value (C)	
Groundwater recharge	Regeneration of degraded areas	

vi. Potential disadvantages / negative impacts-

It has no disadvantages, but the places which will be used as a recharge pit cannot be used for other purposes. If there is a steep slope, they cannot use this method as it will be hard to make a recharge space for the water to infiltrate the groundwater table.

vii. IUCN assessment-

Table 7 NBS self-assessment for Case 3 -(Source- IUCN 2020, adapted)

Criterion	Your Criterion Score	Maximum Criterion Score	Normalised criterion	FINAL OUTPUT Your Criterion %age
1. Societal challenges	9	9	1.00	100%
2. Design at scale	8	9	0.89	89%
3. Biodiversity net-gain	10	12	0.83	83%
4. Economic feasibility	11	12	0.92	92%
5. Inclusive governance	12	15	0.80	80%
6. Balance trade-offs	6	9	0.67	67%
7. Adaptive management	8	9	0.89	89%
8. Sustainability and mainstreaming	9	9	1.00	100%
Total Percentage match				87%
Is this in adherance with the IUCN Global Standard for NbS?			In adherance	

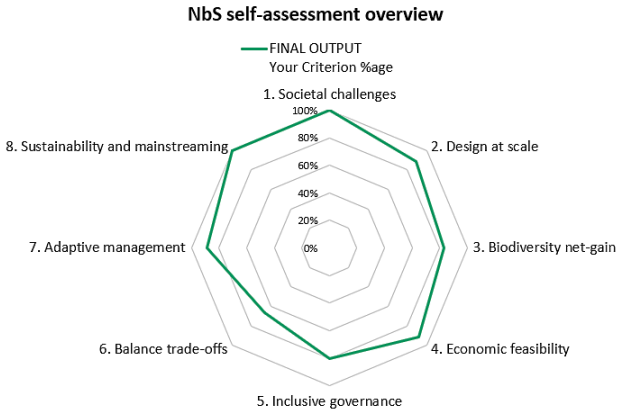


Figure 38 Spider Chart for self-assessment for Case 3 - India- (Source- IUCN 2020, adapted)

4.1.3. Thailand

It is a developing country located in Southeast Asia and is situated in the Indochinese Peninsula. UN had kept it in Upper-middle-income countries based on Economies by per capita GNI in June 2018 (United Nations, 2019). It has a population of approximately 69,950,844 people (World Bank, 2021). It faces many natural disasters like drought, water scarcity, floods, food production problems, epidemics, vector-borne diseases, earthquakes, heatwaves, storms, cloudbursts, landslides and Tsunami(Climate Change Knowledge Portal, 2022)

Figure 39 Location of Thailand in Asia (Source- https://upload. wikimedia .org /wikipedia/ commons/thumb/

1. Case Study 1 *(Overall Study – 7)*

Living weir construction - Ecosystem-based drought and flood management in river basins, Thailand

i. <u>Description</u>

The living weir raises the water level to a specific level and allows it to flow over the weir crest or penetrate through to the bottom at all times. This an invention which had resulted from thought processes and local expertise over a period of time. This creates circulation and fills the river with air, making the water flow as naturally as possible. In contrast, the concrete weir or common weir, the water inside rots. Animals that live in water can also cross the living weir.

Figure 40 Living weir- (Source-GIZ Thailand, 2015)

The water flow that sweeps different nutrients leads to open ecological restoration. These factors contribute to the abundance of living organisms, including fish, shrimp, shellfish, crabs, and different aquatic plants. This ecological restoration and harmonious relationship between humans and nature allow the river ecology to once again sustain the flow of life.

Nowadays, it is not uncommon for a place to witness drought and flood within a certain period of time. Farmers in Southern Thailand have to face issue of water scarcity. During the rainy and the following season, it is easy for them to grow crops but later on, they have to tap water and divert it to their fields. To tap the river, the best solution is small dams made up of concrete (grey solution), but it does not fulfil the need of the farmers and is damaged over time and needs a replacement. So, farmers thought of shifting to natural materials like bamboo, trees and shrubs, which are not easily destroyed in the river and are also stabilized on riverbeds. They also use bags of sand (made of biodegradable material) to slow the flow of water. So these small dams are called 'living weirs' and help in preventing floods and slow the river as well. The fertile soil is not washed away. Samplings are also planted on the edge of the dam, and when they grow, they will be providing extra support to the dam. Locals participate in this

process, and thus, all of them are happy that they have managed to solve their problems. This solution also incorporates innovative solutions to better utilise the NBS. The solution has other benefits as well, like it helps in increasing the production of crops. The aim is 'Nature can regenerate itself if it's in harmony with humans.'

ii. Classification of action/solution-

a) Degree of intervention

TYPE 2: NBS for sustainability and multifunctionality of managed ecosystems

b) NBS approaches used

- Climate adaptation approaches
- Community-Based Adaptation
- Ecosystem Based Management
- Ecosystem Based Mitigation
- Ecosystem based disaster risk reduction
- Ecological Restoration

c) NBS challenge to be solved/SDGs

The following SDGs are covered by this action/solution-

- Goal 1: No poverty
- Goal 2: Zero hunger
- Goal 6: Clean water and sanitation
- Goal 8: Decent work and economic growth
- Goal 12: Responsible consumption and production
- Goal 15: Life on land
- Goal 16: Life below water

iii. Climate Hazards addressed- Prevents from drought and floods, better fertility of soil.

Heat	Floods				Water		Others
	River	Surface Water	Coastal	Landslide	Scarcity	Quality	Extinction of species
							Solved

iv. Societal problems addressed: Climate change (C), water security, food security, and economic and social development.

v. Benefits and co-benefits (Eco system services) provided-

Environmental	Social/Cultural	Economic
River water flood mitigation	Health and quality of life (C)	Water provision
Groundwater recharge	Regeneration of degraded areas	Income generation (C)
Biodiversity (C)	Employment(C)	Increased value of land/property (C)
Regulation of the water cycle (C)		
Droughts		

vi. Potential disadvantages / negative impacts-

If the river flows slowly due to these weirs, there may be more mosquitoes which is a problem for the farmers. But this will also lead to more fish as they will feed on the larvae of the mosquitoes. More research is needed on this aspect, as how much slower the river should flow, and GIZ and other experts are working on this aspect.

vii. IUCN assessment-

Table 8 NBS self-assessment for Case 1 – Thailand- (Source- IUCN 2020, adapted)

Criterion	Your Criterion Score	Maximum Criterion Score	Normalised criterion	FINAL OUTPUT Your Criterion %age
1. Societal challenges	8	9	0.89	89%
2. Design at scale	5	9	0.56	56%
3. Biodiversity net-gain	3	12	0.25	25%
4. Economic feasibility	7	12	0.58	58%
5. Inclusive governance	7	15	0.47	47%
6. Balance trade-offs	2	9	0.22	22%
7. Adaptive management	3	9	0.33	33%
8. Sustainability and mainstreaming	7	9	0.78	78%
Total Percentage match				51%
Is this in adherance with the IUCN Global Standard for NbS?			Not in adherance	

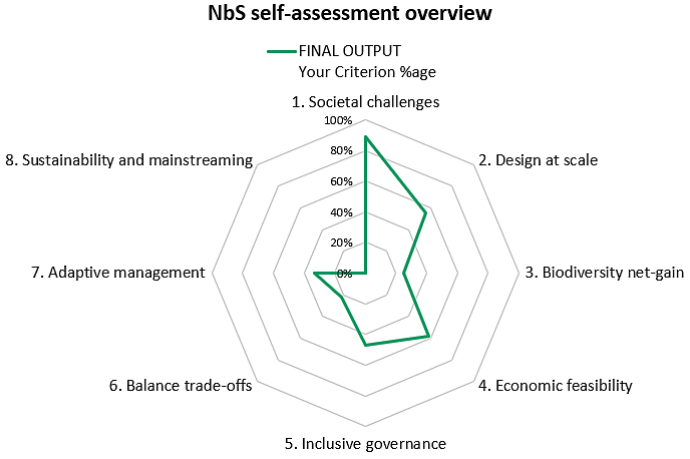


Figure 41 Spider Chart for self-assessment for Case -1- Thailand- (Source- IUCN 2020, adapted)

2. Case Study 2 *(Overall Study – 8)*

Community-Based Ecological Mangrove Restoration (CBEMR), Trang

i. Description

In this solution, with the help of community participation, the abandoned ponds once used for shrimps, fishes and other areas of degraded mangroves are rejuvenated with traditional knowledge and scientific methods. This has many benefits, as healthy mangroves protect the communities from floods, soil erosion, and other disasters. There are at present 13 sites where this practice is used, especially in the Trang Krabi provinces of Thailand.

Figure 42 Taking care of mangroves plants (Source- https://mangroveactionproject.org/mangrove-restoration/)

The first step is finding the relevant sites, these are found with the help of using scientific data like aerial imagery, maps (historic and present), reproductive capacity of the mangroves, proportion of healthy mangroves, etc. The degraded areas are assessed if the rejuvenation will be essential to humans and nature or not. The ones with more benefits are chosen. These sites are then compared with the nearby healthy sites of mangroves to understand the reasons why the mangroves are not naturally regenerating. Then different kinds of works are agreed upon between the villagers who would help in the regeneration of mangroves like improving the area's hydrology, community rules and other social agreements, etc.

Figure 43 Adjusting hydrology – by digging channels to improve water flow (Source- https://mangroveactionproject.org/mangrove-restoration/)

The villagers are trained in restoration activities, and they are taken to some other projects which are successful. On seeing the increase in the animal and plants in those areas, the villagers are persuaded to use the process on the degraded site as well.

Contrary to many planting initiatives, CBEMR mimics natural processes to restore damaged mangroves while working with nature and considering mangrove biology. The benefit of natural regeneration is that it not only results in a more biodiverse mangrove, increasing its resistance to climate change but may also be more cost-effective because it eliminates the expenses of nursery and planting (Mangrove Action Project, n.d.). This technique needs a lot of discussion between the different stakeholders like the farmers, the trainers, etc. Also, it helps in increasing biodiversity and the resilience of coastlines and has more long-lasting efforts.

ii. Classification of action/solution-

a) Degree of intervention

TYPE 1 – Better use of protected/ natural ecosystems

b) NBS approaches used

- Climate adaptation approaches

- Community-Based Adaptation
- Ecosystem Based Mitigation
- Ecosystem based disaster risk reduction
- Ecological Restoration
- Infrastructure related approaches
- Natural resource management

c) NBS challenge to be solved/SDGs

The following SDGs are covered by this action/solution-

- Goal 4: Quality education
- Goal 8: Decent work and economic growth
- Goal 13: Climate action
- Goal 15: Life on land
- Goal 16: Life below water

iii. Climate Hazards addressed- Prevention from coastal floods, from soil erosion, mangrove belt act as a biofilter and reduce materials which are toxic.

Heat	**Floods**				**Water**		**Others**
	River	**Surface Water**	**Coastal**	**Landslide**	**Scarcity**	**Quality**	**Regeneration of biodiversity**
							Solved

iv. Societal problems addressed: Climate change (C), disaster risk, water security, and economic and social development.

v. Benefits and co-benefits (Ecosystem services) provided-

Environmental	Social/Cultural	Economic
Coastal water flood mitigation	Health and quality of life (C)	Income generation (C)
Soil quality & erosion prevention	Regeneration of degraded areas	
Biodiversity (C)		
Carbon storage		

vi. Potential disadvantages / negative impacts-

The starting point incorporates trainers from different places within the country and abroad. Thus cooperation between them and the villagers is necessary because, in one instance, when the money was not given to the villagers, they did not finish the work. Also, a valid motive for the villagers is essential; otherwise, many would not prefer to help or be a part of the group.

vii. IUCN assessment-

Table 9 NBS self-assessment for Case 2 – Thailand- (Source- IUCN 2020, adapted)

Criterion	Your Criterion Score	Maximum Criterion Score	Normalised criterion	FINAL OUTPUT Your Criterion %age
1. Societal challenges	5	9	0.56	56%
2. Design at scale	4	9	0.44	44%
3. Biodiversity net-gain	10	12	0.83	83%
4. Economic feasibility	10	12	0.83	83%
5. Inclusive governance	9	15	0.60	60%
6. Balance trade-offs	4	9	0.44	44%
7. Adaptive management	6	9	0.67	67%
8. Sustainability and mainstreaming	8	9	0.89	89%
Total Percentage match				66%
Is this in adherance with the IUCN Global Standard for NbS?			In adherance	

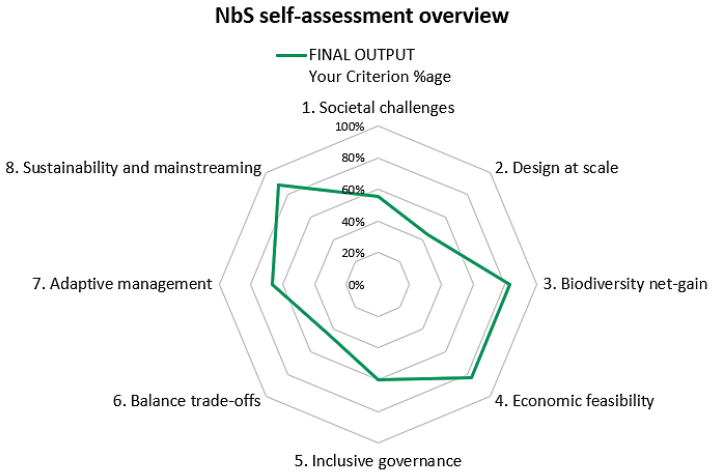


Figure 44 Spider Chart for self-assessment for Case -2 Thailand- (Source- IUCN 2020, adapted)

3. Case Study 3 *(Overall Study – 9)*

The 'Monkey Cheeks' or Kaem Ling, Ayutthaya Province

i. Description

Thailand (just like other South-East and South Asian) countries is prone to both floods and droughts. This country needs good coordination between nature and humans, and integration between grey and nature-based solutions for faster results. There is a move towards "soft" measures for flood management(Trakuldit & Faysse, 2019) . These measures do not need many investments, heavy infrastructure, etc. An example of these measures is

Figure 45 Kaem Ling (Source- Bangkok post)

controlled flooding areas to prevent the downstream areas. Most importantly, public participation is needed for these methods.

The name "Monkey Cheeks" refers to when a monkey puts a lot of food in its cheek and gradually chews it later and swallows it. Similarly, the farms and other areas are used to store flood water upstream and as the flood recedes, the water is released. This is done to protect the areas (of importance) downstream. The water is sometimes transferred to canals, and from there, it moves to the sea. This became popular in 1995 during the reign of King Bhumibol Adulyadej.

In Ayutthaya province, the people themselves made the reservoirs in a rice field which was temporarily converted, and another land was excavated. These places store water during flood season. There are laws and policies which help people in making these spaces. They got help from some experts, but the locals did the process. The areas are planted with paddy(rice). After the harvest of the crops, the water is diverted here from Chao Phraya River and the Noi River as a flood prevention measure to control floods in these rivers (Pongpao, 2017). It has many benefits like the need for pesticides, and weedicides is removed, and soil also gets its nutrients.

ii. Classification of action/solution-

a) Degree of intervention

TYPE 3 – Design and management of new ecosystems –

b) NBS approaches used

- Climate adaptation approaches
- Community-Based Adaptation
- Infrastructure related approaches

c) NBS challenge to be solved/SDGs

The following SDGs are covered by this action/solution-

- Goal 8: Decent work and economic growth
- Goal 13: Climate action
- Goal 15: Life on land

iii. Climate Hazards addressed- Prevention from coastal floods, from soil erosion. Mangrove belts act as a biofilter and reduce materials which are toxic.

Heat	Floods				Water		Others
	River	Surface Water	Coastal	Landslide	Scarcity	Quality	
							None

iv. Societal problems addressed: Disaster risk

v. Benefits and co-benefits (Eco system services) provided-

Environmental	Social/Cultural	Economic
River water flood mitigation	Health and quality of life (C)- Not directly related, as floods leads to loss of life	Income generation (C) – Not directly related, as floods leads to expenditure to repair and reconstruct
Soil quality & erosion prevention		
Biodiversity (C)		

vi. Potential disadvantages / negative impacts-

Not any disadvantage as such. The most important reason for this to qualify for an NBS is to incorporate public participation. Otherwise, it has significantly fewer direct benefits and solves only one societal challenge; thus, it may not be treated as an NBS but just a flood protection measure.

vii. IUCN assessment-

Table 10 NBS self-assessment for Case 3 - Thailand- (Source- IUCN 2020, adapted)

Criterion	Your Criterion Score	Maximum Criterion Score	Normalised criterion	FINAL OUTPUT Your Criterion %age
1. Societal challenges	7	9	0.78	78%
2. Design at scale	5	9	0.56	56%
3. Biodiversity net-gain	7	12	0.58	58%
4. Economic feasibility	9	12	0.75	75%
5. Inclusive governance	5	15	0.33	33%
6. Balance trade-offs	3	9	0.33	33%
7. Adaptive management	6	9	0.67	67%
8. Sustainability and mainstreaming	6	9	0.67	67%
Total Percentage match				58%
Is this in adherance with the IUCN Global Standard for NbS?			In adherance	

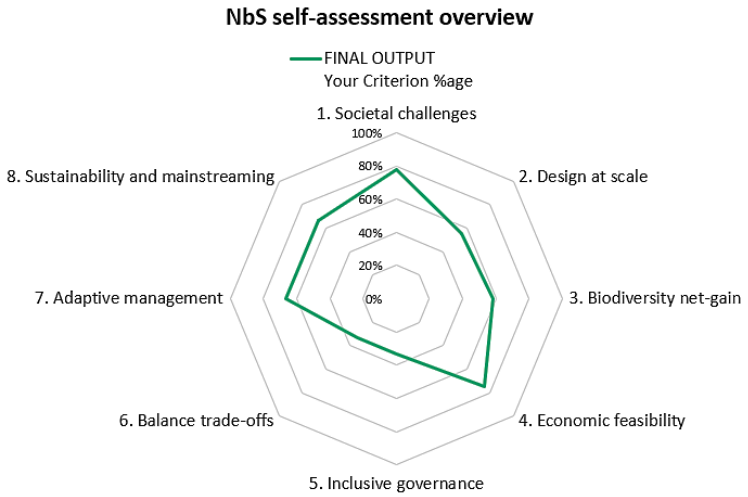


Figure 46 Spider Chart for self-assessment for Case -3 Thailand- (Source- IUCN 2020, adapted)

4.1.4 Nepal

It is a developing country located in South Asia, surrounded by India and China. It is situated in the Himalayas. UN kept it in Low-income countries according to Economies by per capita GNI in June 2018 (United Nations, 2019). It has a population of approximately 29,674,920 (World Bank, 2021). Worlds largest peak, Mount Everest, is situated here. It faces many natural disasters like drought, water scarcity, floods, epidemics, vector-borne diseases, earthquakes, storms, cloudbursts, and landslides (Climate Change Knowledge Portal, 2022)

Figure 47 Location of Nepal in Asia (Source- https:// upload.wikimedia .org/wikipedia/commons/thumb/

1. Case Study 1 *(Overall Study – 10)*

***Jholmal*, Bio-fertilizer, Kavre Palanchowk District**

i. <u>Description</u>

Nepal is a small country nested in the heart of the Himalayas. Major occupation of the people is agriculture, and some are involved in helping the trekkers during their treks. According to Ministry of Agriculture, 65.6% of the population is engaged in agriculture or related activities (MoAD, 2014). The country is prone to many disaster-like earthquakes, landslides, cloudbursts, floods, droughts, forest fires, etc. It has a strong base of traditional knowledge that people use for agricultural practices and to protect from natural disasters. Bio-fertilizers are one of the kinds.

Figure 48 Ladies preparing Jholmal- (Source- Roshan Subedi, https://www.icimod.org/jholmal-a-chemical-free-solution-for-farmers-in-kavre/)

Bio-fertilizers are made of local materials, and researchers like (Bhalshakar, 2020) have found that bio-fertilizers help in crop yields and change the soil biologically, physically, and chemically which helps in improving the nutrient content(access) of the soil. They have living microbes which help in nitrogen fixation, roots expansion. These fertilisers are easy to produce, less energy intensive and are less harmful to both environment and humans(P. Dhakal et al., 2018).

Figure 49 Ladies micing dry plants to make jholmal (Source- Shilu Manandhar, GPJ Nepal)

Jholmal is a type of bio-fertilizer and bio-pesticide made at home by local farmers (especially women). It is made by mixing animal urine, manure from farmlands, microorganisms, plants, water in a specified ratio(International Centre for Integrated Mountain Development (ICIMOD), 2016). It has numerous benefits like, it acts as a pesticide and fungicide by stopping pests and vector-borne diseases as well. It is easy to make, and all the materials are readily available on the farms or at the farmers' houses. Depending

on the type of *Jholmal* the ingredients can be changed. For instance, for type 1, cow dung is added, while for type 2, no solid component is added. After the preparation it is then diluted with water and is either added to the soil or sprayed on the leaves or stems (depending on the type). After the application, farmers saw better productivity and thought it to be a fairy tale and better than chemical fertilisers.

According to an interview which was part of research by Subedi, (2016), many farmers have seen their expenses reduced by up to 50%. Due to less use of chemical fertilisers, the demand has decreased, and thus carbon emission in the area has also decreased. The random scattering of cattle dung is reduced, and the cattle sheds have become more cleaner, which in turn reduced the carbon emission. This has also educated the famers and made them grow healthy and organic food, thus getting more profits. The farmers can sell the *Jholmal* and have a second income as well.

ii. Classification of action/solution-

a) Degree of intervention

TYPE 2 - NBS for sustainability and multifunctionality of managed ecosystems

b) NBS approaches used

- Climate adaptation Approaches
- Community Adaptation Approaches
- Ecosystem Based Adaptation
- Ecological Restoration
- Natural resources Management
- Sustainable Agriculture

c) NBS challenge to be solved/SDGs

The following SDGs are covered by this action/solution-

- Goal 1: No poverty
- Goal 2: Zero hunger
- Goal 3: Good Health and Well-being
- Goal 5: Gender Equality
- Goal 7: Affordable and clean energy
- Goal 8: Decent work and economic growth
- Goal 10: Reduced Inequalities
- Goal 11: Sustainable cities and communities
- Goal 12: Responsible consumption and production

iii. Climate Hazards addressed- Soil fertility, pests and vector borne diseases.

Heat	Floods				Water		Others
	River	Surface Water	Coastal	Landslide	Scarcity	Quality	Soil fertility
							Solved

iv. Societal problems addressed: Disaster risk, Food security, and Economic and social development, human health, water security.

v. Benefits and co-benefits (Ecosystem services) provided-

Environmental	Social/Cultural	Economic
Water Quality (C)	Health and quality of life (C)	Food provision
Soil quality and erosion prevention	Recreation, education & gathering (C)	Income generation
Biodiversity (C)	Regeneration of degraded areas	Energy savings
	Employment (C)	Increased value of land/property

vi. Potential disadvantages / negative impacts-

The raw materials used for making Jholmal are different for different crops and for getting different benefits. Thus it needs proper training for the farmers to properly utilise the method. Initial implementation needs a small investment which is being provided by some companies and NGOs still more is required, for instance, for the construction of better sheds for cattle so urine can be easily collected. But overall, it is a good solution, with the positives superseding the negatives.

vii. IUCN assessment-

Table 11 NBS self-assessment for Case 1 - Nepal- (Source- IUCN 2020, adapted)

Criterion	Your Criterion Score	Maximum Criterion Score	Normalised criterion	FINAL OUTPUT Your Criterion %age
1. Societal challenges	6	9	0.67	67%
2. Design at scale	6	9	0.67	67%
3. Biodiversity net-gain	4	12	0.33	33%
4. Economic feasibility	6	12	0.50	50%
5. Inclusive governance	5	15	0.33	33%
6. Balance trade-offs	2	9	0.22	22%
7. Adaptive management	4	9	0.44	44%
8. Sustainability and mainstreaming	6	9	0.67	67%
Total Percentage match				48%
Is this in adherance with the IUCN Global Standard for NbS?			Not in adherance	

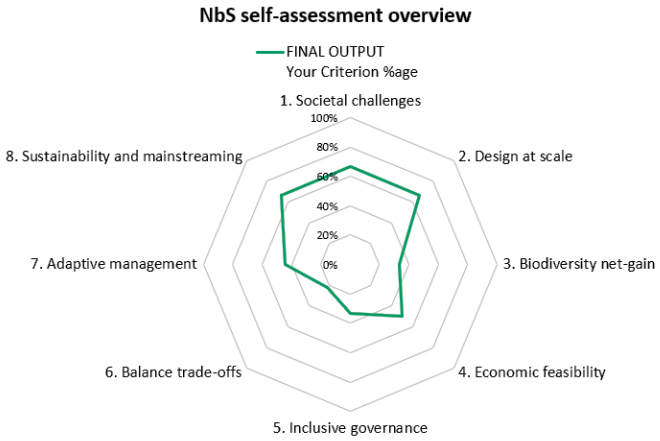


Figure 50 Spider Chart for self-assessment for Case -1- Nepal- (Source- IUCN 2020, adapted)

2. Case Study 2 *(Overall Study – 11)*

Improved terracing for enhancing soil fertility on sloping land, Kubinde Village of Kavrepalanchok District

i. Description

As discussed before that, Nepal is a beautiful country with mighty Himalayas. This has some negative effects, like the majority of agriculture is practised on hill slopes. The crops are grown on sloped, usually fed by monsoon or rain. Due to pre-monsoon showers, the important nutrients are washed off the soil thus, the harvest is not good. This also hampers the working of the hill ecosystem(Lamichhane, 2013). The farming production in Nepal is comparatively low. Thus, it becomes hard to meet the needs of the growing population of Nepal (Sharma et al., 2010). The runoff of water is more than the infiltration, which results in lower soil fertility. Also, snow, sleet, and landslides harm the crops on the slopes of the hills.

Figure 51 Improved terrace practice- (Source- Chuki Wangmo- https://blog.worldagroforestry.org/index.php/2018/04/11/bhutan-and-nepal-learn-more-about-agroforestry-in-vietnam/

Terracing is a method adopted to improve slopes and help avoid the above problems. A committee was formed which was called “Terrace Improvement Committee”; it incorporated farmers, trained executives of soil and water and other committee members. Although this process has been used for centuries, but the current method is innovated using scientific inputs and local knowledge. The terraces are created, and bags (empty cement or wheat bags mostly) containing soil and stones are put on the edges constructing walls. Sometimes more natural method of bamboo clumps is used. The soil is excavated from the upper slopes, and is used in making the wall at lower parts. Then, some grasses and hedgerows are also grown on outer parts of these walls. There maybe be more than one row of these hedgerows, this depends on the method used and the benefits needed. The terrace risers are sliced once or twice a year and the hedges are maintained at 50cm(M. P. Dhakal, n.d.). The waste of these hedges can be used as manure, which is an added benefit of this method. The method is adapted form of Sloping Agricultural Land Technology (SALT), which is a method of soil preservation and enhancement of crops. According to FAO, Nitrogen-fixing trees and shrubs (NFTS) should

also be used to make the soil nitrogen sufficient. The process can be made better by growing crops with trees to better conserve the soil and preserve the nutrients.

This has many benefits like soil erosion is reduced, and soil fertility is increased due to reduction of water and soil runoff during rains. The fodder along the margins is used by the cattle. According to ICIMOD, due to this method there was an increase in crop (potato, maize, and beans) production by around 100 percent. The price of land also increased, which was beneficial for both farmers and the government. This SALT method was incorporated in the Tenth Plan (National Planning Commission 2003–2007)

According to research conducted in Nepal by (Lamichhane, 2013), it was found that SALT systems were efficient in conserving both soil and water runoffs, enriching the soil, stabilizing slopes and thus giving a better output in farming. It also helped in increasing the organic and nutrient contents in soil and if added with organic manure and legume type crops they were more beneficial.

ii. Classification of action/solution-

a) Degree of intervention

TYPE 2 - NBS for sustainability and multifunctionality of managed ecosystems

b) NBS approaches used

- Climate adaptation Approaches
- Community Adaptation Approaches
- Ecosystem Based Adaptation
- Ecosystem Based Management
- Ecological Restoration
- Natural resources Management

c) NBS challenge to be solved/SDGs

The following SDGs are covered by this action/solution-

- Goal 1: No poverty
- Goal 2: Zero hunger
- Goal 5: Gender Equality
- Goal 7: Affordable and clean energy
- Goal 8: Decent work and economic growth
- Goal 13: Climate action
- Goal 15: Life on land

iii. Climate Hazards addressed- Landsides, water runoff, floods, Soil fertility.

Heat	Floods				Water		Others
	River	Surface Water	Coastal	Landslide	Scarcity	Quality	Soil fertility
							Solved

iv. Societal problems addressed: Disaster risk, Food security, and Economic and social development, water security.

v. Benefits and co-benefits (Eco system services) provided-

Environmental	Social/Cultural	Economic
Groundwater recharge	Spiritual, religious &artistic values (C)	Food provision
Regulation of the water cycle (C)	Regeneration of degraded areas	Income generation
Soil quality and erosion prevention	Employment (C)	Water provision
Biodiversity (C)		Increased value of land/property (C)

vi. Potential disadvantages / negative impacts-

There are some negative effects of this method. The terraces, if not appropriately made, may lead to negative effects like change of water flow from natural springs and streams(Deng et al., 2021). The initial education and training are complex and need good guidance, although some farmers have been practising this process for centuries. Improper terraces may lead to collapses, which would also lead to destruction in downhill areas.

vii. IUCN assessment-

Table 12 NBS self-assessment for Case 2 - Nepal- (Source- IUCN 2020, adapted)

Criterion	Your Criterion Score	Maximum Criterion Score	Normalised criterion	FINAL OUTPUT Your Criterion %age
1. Societal challenges	8	9	0.89	89%
2. Design at scale	7	9	0.78	78%
3. Biodiversity net-gain	8	12	0.67	67%
4. Economic feasibility	8	12	0.67	67%
5. Inclusive governance	7	15	0.47	47%
6. Balance trade-offs	4	9	0.44	44%
7. Adaptive management	4	9	0.44	44%
8. Sustainability and mainstreaming	7	9	0.78	78%
Total Percentage match				64%
Is this in adherance with the IUCN Global Standard for NbS?			In adherance	

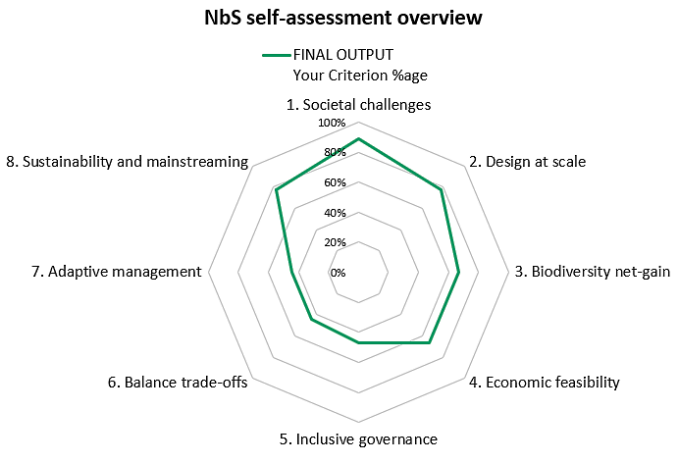


Figure 52 Spider Chart for self-assessment for Case -2- Nepal- (Source- IUCN 2020, adapted)

3. Case Study 3 *(Overall Study – 12)*

Local knowledge for better water availability and Bio-engineering (Panchase and Makwanpur District)

i. Description

From the previous study we understood the need to stop water runoff, as during the rains the water is enough but otherwise, due to improper use of natural resources and irregular construction, the natural streams and ponds have dried up.

Figure 53 A natural pond constructed by people to capture water- Source -Anu Adhikari

With some local materials which are readily available, like mud, slate, and stones, locals have tried to fortify the streambanks and the reservoirs of water (*Pokhari)*. Also, they have removed the extra vegetative growth (unwanted) and the unessential things lying in the ponds or reservoirs to elongate their use. Also, some local species of vegetation were planted, which can store better water and soil. People are constructing seating/resting places near these water places. Traditionally *Peepal* tree *(Ficus religiosa)* was planted at the reservoir, which was very sacred.

Bioengineering is a method of using living plants or their materials for constructing structures that can perform engineering function of stabilizing the slope and making the area safe. Broom grass and bamboo are planted to mitigate landslides. These are also planted on degraded lands. They help in stabilizing the slopes, slows soil erosion and help in better functioning of the ecosystem. These can be later used for brooms, fuel and paper(Dhital et al., 2013).

ii. Classification of action/solution-

a) Degree of intervention

TYPE 2 - NBS for sustainability and multifunctionality of managed ecosystems

TYPE 3 – Design and management of new ecosystems

b) NBS approaches used

- Climate adaptation Approaches
- Community Adaptation Approaches
- Ecosystem Based Adaptation
- Ecosystem Based Management
- Ecosystem based disaster risk reduction
- Ecological Restoration
- Natural resources Management

c) NBS challenge to be solved/SDGs

The following SDGs are covered by this action/solution-

- Goal 1: No poverty
- Goal 2: Zero hunger
- Goal 3: Good Health and Well-being
- Goal 5: Gender Equality
- Goal 6: Clean water and sanitation
- Goal 7: Affordable and clean energy
- Goal 8: Decent work and economic growth
- Goal 10: Reduced Inequalities
- Goal 11: Sustainable cities and communities
- Goal 13: Climate action
- Goal 15: Life on land

iii. Climate Hazards addressed- Landsides, water runoff, water scarcity, Soil fertility.

Heat	Floods				Water		Others
	River	Surface Water	Coastal	Landslide	Scarcity	Quality	Soil fertility
							Solved

iv. Societal problems addressed: Disaster risk, water security, and Economic and social development, climate action, human health.

v. Benefits and co-benefits (Ecosystem services) provided-

Environmental	Social/Cultural	Economic
Groundwater recharge	Spiritual, religious &artistic values	Water provision

Regulation of the water cycle (C)	Regeneration of degraded areas	Increased value of land/property (C)
Soil quality and erosion prevention	Health and quality of life (C)	
Biodiversity (C)		

vi. Potential disadvantages / negative impacts-

The stakeholders do not usually have the same goals thus, sometimes there may be conflicts which need experts or older people to resolve. Therefore, strong coordination between the experts and the government with the locals is needed; otherwise, the aim is not achieved.

vii. IUCN assessment-

Table 13 NBS self-assessment for Case 3 - Nepal- (Source- IUCN 2020, adapted)

Criterion	Your Criterion Score	Maximum Criterion Score	Normalised criterion	FINAL OUTPUT Your Criterion %age
1. Societal challenges	7	9	0.78	78%
2. Design at scale	5	9	0.56	56%
3. Biodiversity net-gain	3	12	0.25	25%
4. Economic feasibility	5	12	0.42	42%
5. Inclusive governance	3	15	0.20	20%
6. Balance trade-offs	2	9	0.22	22%
7. Adaptive management	2	9	0.22	22%
8. Sustainability and mainstreaming	5	9	0.56	56%
Total Percentage match				40%
Is this in adherance with the IUCN Global Standard for NbS?			Not in adherance	

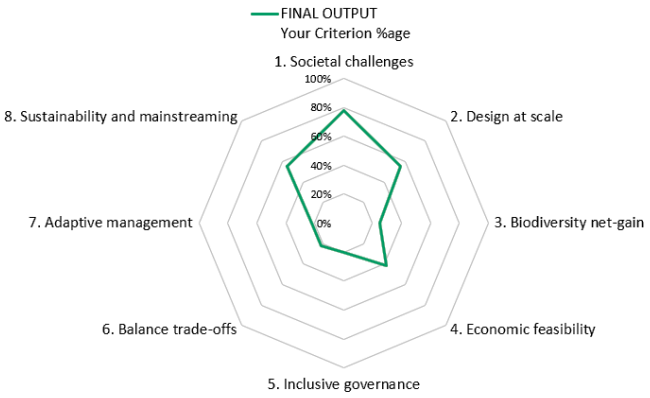


Figure 54 Spider Chart for self-assessment for Case -3 Nepal- (Source- IUCN 2020, adapted)

4.1.5 Bangladesh

It is a developing country located in South Asia, surrounded by India and Bay of Bengal. UN had kept it in Low-middle income countries based on Economies by per capita GNI in June 2018 (United Nations, 2019). It has a population of approximately 166,303,494 people (World Bank, 2021). It faces many natural disasters like drought, floods, earthquakes, storms, cloudbursts, riverbank erosion, and landslides (Climate Change Knowledge Portal, 2022)

Figure 55 Location of Bangladesh in Asia (Source- https:// wikimedia.org/

1. Case Study 1 *(Overall Study – 13)*

Floating Agriculture Garden *(Dhap),* provinces of Gopalganj, Barisal and Pirojpur

i. Description

Figure 56 A practice for those who lose their land- (Source- Fahmida Akter)

Bangladesh is prone to a number of disasters; the most important ones are floods and cyclones. It is situated on the flood plains of two giant rivers, namely Ganga and Brahmaputra. Two third of the country is covered with wetlands(Sunder, 2020). While many parts of the country are under the water for around 8 months of the year. The country has many poor people, and around 48% of the population is without land. According to an FAO report, 100,000 women, men and children have to leave their villages due to floods and new livelihoods. But compared to its neighbour India, its GDP per capita is more.

People are leaving the practice of agriculture and moving on to other works in the secondary and tertiary sectors. To overcome this, many farmers are shifting from the normal crops of rice to the age of "floating vegetable gardens" techniques, which is a form of hydroponics and is a practice that their forefathers practiced for the last 300-400 years. This practice is used in the "coastal freshwater wetlands, northern riverine floodplains, and north-eastern wetlands (called ***haor***)"(Nature Based Solutions Bangladesh, n.d.).

Figure 57 Small balls of seedlings - germinated before they are put in the floating garden beds (Source- Fahmida Akter)

Firstly, the farmers collect water hyacinth and overlay it with bamboo poles and a kind of raft is constructed which is the base layer. If needed, several water hyacinths are layered and woven so that the raft keeps floating. The raft is about 20ft (6m) long but can even be 180ft (55m). After a week or so, "mulch" is added over this raft and then soil, and compost like cow dung, azola, etc are added, and around 25 cm of layer is made of these materials. To make the seeds improve in development, they are covered with round balls of decomposed water hyacinth in addition to organic fertiliser. Finally, the seedlings(seeds) are sown on the raft. These rafts can be used more than once but not indefinitely. But these can be broken in their final stage (winter season) and can be used as compost and for making further rafts. Summer crops like gourd, eggplant (also called brinjal in the area), pumpkin, onions, Indian spinach, cucumber, wax gourd, etc. can be grown. Winter crops, namely cabbage, turnip, cauliflower, tomato, etc., can be grown. Along with these, spices like chilli, turmeric, etc can also be grown on these floating rafts.

Making these gardens is inexpensive and does not need investment considering seeds, fertilizers, pesticides, weedicide, etc., since the raft is full of important nutrients like nitrogen, potassium and phosphorus (Ministry of Agriculture, People's Republic of Bangladesh, 2017).

Sometimes they are so stiff that they can be accessed by the farmers. Many females work on farms, and with the men, they are also educated regarding this technique, thus showing gender equality. Although an old technique but proper use is taught by some NGOs and some farmers who know it better than others. Another important aspect is that the land of the farmers, which is flooded, can be used for fisheries. It is quite ironic to say, "planting crops on water and having fisheries on land". Some people incorporate this technique due to their community's culture and wisdom.

This is an excellent example of natural resource management and enhancement of biodiversity. Also, perfect way to adapt to climate change. With less investment and by growing organic vegetables, farmers (can)sell them in the markets and get good profits which can help sustain their families. "Huge biodiversity depends on these wetlands like 300 plant species and some 400 vertebrate species, and 260 species of fin fishes and 25 shellfish are dependent on this region(Ministry of Agriculture People's Republic of Bangladesh, 2017)".

Typically water hyacinths are invasive species and are considered bad as they do not allow the sunlight to go below, and the aquatic plants and animals cannot survive below them. But through this process of cultivation, this negative effect is removed. Also, they absorb eutrophication nutrients like nitrogen and phosphorus(compounds) from water, but it is reversed as the plants which grow on these rafts, absorb these nutrients from the hyacinths. According to Kabir et al. (2019) as cited by Ministry of Agriculture People's Republic of Bangladesh (2017) the Benefit-Cost ratio (BCR) in Pirojpur district is 1.43, while according to Pavel et al. (2014) as cited by Ministry of Agriculture People's, Republic of Bangladesh (2017) in Haor region it is 2.7.

Countries like India, Thailand, and Vietnam can utilise this cultivation technique as they are prone to floods and rising seawater.

ii. Classification of action/solution-

a) Degree of intervention

TYPE 2: NBS for sustainability and multifunctionality of managed ecosystems

b) NBS approaches used

- Climate adaptation approaches
- Community-Based Adaptation
- Ecosystem Based Management
- Ecosystem based disaster risk reduction
- Ecological Restoration
- Infrastructure related approaches
- Natural resources Management
- Sustainable agriculture

c) NBS challenge to be solved/SDGs

The following SDGs are covered by this action/solution-

- Goal 1: No poverty
- Goal 2: Zero hunger

- Goal 4: Quality education
- Goal 5: Gender Equality
- Goal 8: Decent work and economic growth
- Goal 10: Reduced Inequalities
- Goal 12: Responsible consumption and production
- Goal 13: Climate Action
- Goal 15: Life on land
- Goal 16: Life below water

iii. **Climate Hazards addressed-** Growing crops even during floods, reduction of pests and insects (mosquitoes).

Heat	**Floods**				**Water**		**Others**
	River	**Surface Water**	**Coastal**	**Landslide**	**Scarcity**	**Quality**	**Food**
							Solved

iv. **Societal problems addressed:** Climate change (C), food security, and economic and social development, disaster risk, human health.

v. **Benefits and co-benefits (Ecosystem services) provided-**

Environmental	**Social/Cultural**	**Economic**
Biodiversity	Health and quality of life (C)	Energy savings (C)
Coastal flood adaptation	Regeneration of degraded areas	Income generation
	Employment	Increased value of land/property
	Spiritual, religious &artistic values (C)	Increased tourism (C)
	Amenity value	
	Employment	

vi. Potential disadvantages / negative impacts-

The expenditure on these techniques is relatively less, but it needs space for cultivation. A farmer who does not has that space cannot use it. It is impossible to use in areas where a lot of tide changes.

vii. IUCN assessment-

Table 14 NBS self-assessment for Case 1 - Bangladesh- (Source- IUCN 2020, adapted)

Criterion	Your Criterion Score	Maximum Criterion Score	Normalised criterion	FINAL OUTPUT Your Criterion %age
1. Societal challenges	9	9	1.00	100%
2. Design at scale	8	9	0.89	89%
3. Biodiversity net-gain	10	12	0.83	83%
4. Economic feasibility	11	12	0.92	92%
5. Inclusive governance	11	15	0.73	73%
6. Balance trade-offs	8	9	0.89	89%
7. Adaptive management	7	9	0.78	78%
8. Sustainability and mainstreaming	9	9	1.00	100%
Total Percentage match				88%
Is this in adherance with the IUCN Global Standard for NbS?			In adherance	

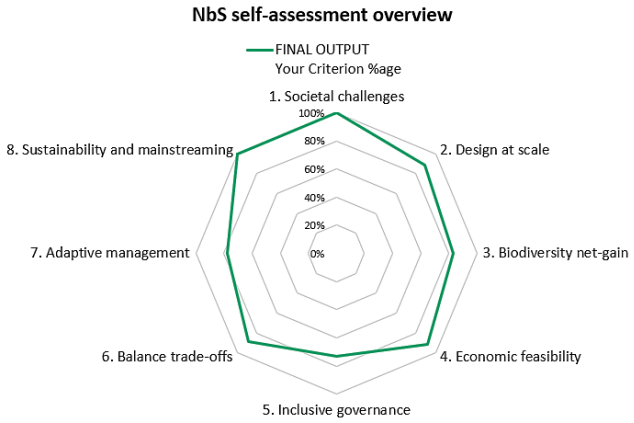


Figure 58 Spider Chart for self-assessment for Case -1- Bangladesh- (Source- IUCN 2020, adapted)

2. Case Study 2 *(Overall Study – 14)*

Soil Restoration with Biochar (Cookstoves), Bangladesh

i. Description

As already discussed Bangladesh has scarce land for cultivation of crops (apart from floating agriculture). Locals and scientists are trying their best to find solutions and actions through which they can grow more crops. The Ganga-Brahmaputra basin is one of the world's most alluvial patches of land but not enough. Elements like manures and composts have limited life, and putting them in the soil has not satisfied many scientists, though they are good if used organically (Baquy et al., 2022).

Figure 59 Stoves for biochar and cooking- (Source- https://thedailynewnation.com/news/95600/biochar-producing-through-rural-households-in-bangladesh.html)

Biochar is a substance which looks like charcoal and is produced from plant materials like leftover of agriculture and plants, grass, which are decomposed at high temperatures(Jahromi et al., n.d.). The chemical properties of the plants and related materials

changes, and they become more porous, rich in carbon and stable. This material is useful in agriculture as it improves the properties of soil physically, biologically and chemically. It is sometimes referred to as "Black-gold". According to Domingues et al., 2017; Khan et al., 2016a; Laghari et al., 2015 as cited by Baquy et al., (2022) , it helps in retaining nutrients like K, P, N and Ca, depending on which material the biochar is made. It also reduces acidity and leaching, thus making the soil more fertile. It helps in reducing the heavy and toxic metals (or compounds) in soil (Yuan et al., 2019). Overall, we see that biochar has many essential benefits and helps in the growth of crops, but mostly in degraded soil or with soil having fewer nutrients compared to the already healthy soil(Hussain et al., 2017) Two essential components in this technique are women at home and the farmers in the farms.

The equipment used in Bangladesh is called *Akha,* which is a Top-tilt Updraft Gasifier (TLUD). It is a kind of canister (*Akha* is handmade) with a fuel bed and few openings from which the air enters. The fuel bed is soaked in kerosene and is lit. The gases which come from the fuel are combustible and get burnt. As the process goes on, the fuel is burnt and snuffed. Then as the process ends, the char is removed from the canister. Interesting to know that the ladies can use the top part of the stove for cooking purposes. The stove is "Agri and women-friendly" and was developed by different researches of universities and knowledge of locals. According to research by Rahman et al., (2020) which incorporated several other researches (about *Akha*), *Akha* is inexpensive (open patent), produces less smoke and produces less CO2 in the air. The leftover from agriculture production (rice straw, rice straw, sawdust, sugarcane bagasse, etc.) animal and poultry waste, forest waste can be utilised for making biochar. Researches have shown that different materials used for biochar have varying effects on different crops.

"Akha" and the product produced by it – "Biochar" has many benefits. Firstly, as stated, it is suitable for women as the traditional stoves produce a lot of smoke. Then the biochar can be used in the farms for better soil fertility, ultimately, for better growth of crops. It creates women's equality and empowerment. Biochar can be sold and used as a side income.

ii. Classification of action/solution-

a) Degree of intervention

TYPE 2 – NBS for sustainability and multifunctionality of managed ecosystems

b) NBS approaches used

- Climate adaptation approaches
- Community-Based Adaptation
- Ecosystem Based Management
- Ecosystem based disaster risk reduction
- Ecological Restoration
- Natural resource management
- Sustainable agriculture

c) NBS challenge to be solved/SDGs

The following SDGs are covered by this action/solution-

- Goal 1: No poverty
- Goal 2: Zero hunger

- Goal 3: Good health and well-being
- Goal 4: Quality education
- Goal 5: Gender equality
- Goal 7: Affordable and clean energy
- Goal 8: Decent work and economic growth
- Goal 8: Climate action
- Goal 10: Reduced inequalities
- Goal 12: Responsible consumption and production
- Goal 13: Climate action
- Goal 15: Life on land

iii. Climate Hazards addressed- Soil fertility, preservation of soil nutrients.

Heat	**Floods**				**Water**		**Others**
	River	**Surface Water**	**Coastal**	**Landslide**	**Scarcity**	**Quality**	**Regeneration of soil fertility**
							Solved

iv. Societal problems addressed: Food security, human health, economic and social development, disaster risk.

v. Benefits and co-benefits (Ecosystem services) provided-

Environmental	**Social/Cultural**	**Economic**
Biodiversity	Health and quality of life	Income generation
Soil quality & erosion prevention	Regeneration of degraded areas	Energy savings
	Amenity value (C)	Food provision
	Employment	

vi. Potential disadvantages / negative impacts-

Using *Akha* is a little complicated. Women need to be trained to use them, although after a small training, they can use them easily and train others. The stove creates issues in burning wet fuel. The size of fuel should be compact and small, otherwise it hampers the burning and

takes time. But a better version of *Akha* can be built after taking suggestions from local research which is going on. Also, using this at a large scale will be hard to utilise its full potential. It needs more research and more training for people to use it properly.

vii. IUCN assessment-

Table 15 NBS self-assessment for Case 2 - Bangladesh- (Source- IUCN 2020, adapted)

Criterion	Your Criterion Score	Maximum Criterion Score	Normalised criterion	FINAL OUTPUT Your Criterion %age
1. Societal challenges	8	9	0.89	89%
2. Design at scale	9	9	1.00	100%
3. Biodiversity net-gain	6	12	0.50	50%
4. Economic feasibility	11	12	0.92	92%
5. Inclusive governance	10	15	0.67	67%
6. Balance trade-offs	6	9	0.67	67%
7. Adaptive management	6	9	0.67	67%
8. Sustainability and mainstreaming	8	9	0.89	89%
Total Percentage match				77%
Is this in adherance with the IUCN Global Standard for NbS?			In adherance	

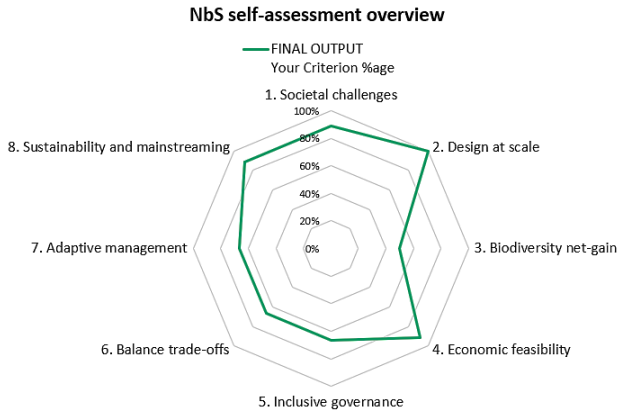


Figure 60 Spider Chart for self-assessment for Case -2- Bangladesh- (Source- IUCN 2020, adapted)

4.1.6 Vietnam

It is a developing country located in Southeast Asia situated in the Indochinese Peninsula. UN had kept it in Lower-middle-income countries based on Economies by per capita GNI in June 2018 (United Nations, 2019). It is the world's fifth most populous country, with a population of approximately 98,168,829 (World Bank, 2021). It faces many natural disasters like drought, water scarcity, floods, food production problems, coastal erosion, vector-borne diseases, earthquakes, heatwaves, storms, and landslides (Climate Change Knowledge Portal, 2022)

Figure 61 Location of Vietnam in Asia (Source- https://upload.wikimedia. org/ wikipedia/commons/thumb /4/42/Vietnam_in_Asia.svg/1024px-Vietnam_in_Asia.svg.png)

1. Case Study 1 *(Overall Study– 15)*

Flood-based agriculture in the Upper Mekong Delta

i. Description

Vietnam is another country which is very prone to floods. Many practices are being carried out to adapt to the harmful effects of climate change. Their economy is dependent on agriculture and related activities. 14.85% of the country's GDP in 2020 was from agriculture, forestry and fishing, and architecture which employed 33.06%of the people (Viet Nam General Statistics Office (GSO), 2021).

Flood-based agriculture is one technique which can be used and helps people is earning money during times of flood as well. It involves three kinds of systems- lotus farming, floating rice and rice aquaculture systems. Even hybrid systems are being researched and tried to use so that in case of drought, they can be used in place of just water intensive approach.

Figure 62 Lotus farming in flood retention area- (Source IUCN Vietnam)

Commonly two rice crops were grown in the upper delta flood zones, and in the flood season, it was used as a floodplain for the water to come. But to grow more crops (3 crops per year) dykes were made taller so it displaces the floods and crops can be grown even in the flood season. This practice has led to profits in the upstream but damages due to floods in the downstream areas. According to IUCN, the city of *Cần Thơ*, situated downstream, got an additional flood damage of 3 to 11 million USD in flood damages in 2011 due to high dykes constructed upstream (Wyatt, 2016).

The primary goal of this project was to shift from rice intensive approach by bringing in political consensus on its negative effects because it was bad for the land and led to a loss of biodiversity and loss of deltas(Wyatt, 2016). The secondary goal was to make the farmers also get profits, so the three crop systems were proposed, which were accepted by many farmers due to better gains. Rather than getting scared of the floods, now the farms are used for holding and absorbing floodwater as a natural floodplain and in return, the crops are grown on it (as explained above). These crops are giving more profit to the farmers; thus, farmers shift to these approaches. To better use these methods, one-meter dykes are made so that they can hold the onset of floods and slow the recession so that flood-time crops can be matured.

Some farmers have said that the lotus model can hold more flood water than the rice field and can also adapt to climate. Due to the promotion of Dong Thap Province as a "lotus region of the delta" also helped promote lotus crops(Vo et al., 2021). For the officials, lotus farming is a symbol of cultural identity and also implementation of national policy of restructuring of agricultural policies.

The fields have more fish and water birds. These approaches are good for areas with huge flood effects and help in biodiversity conservation.

ii. Classification of action/solution-

a) Degree of intervention

TYPE 2 – NBS for sustainability and multifunctionality of managed ecosystems

TYPE 3 – Design and management of new ecosystems –

b) NBS approaches used

- Climate adaptation approaches
- Community-Based Adaptation
- Ecosystem based adaptation
- Ecosystem based management
- Ecosystem based disaster risk reduction
- Ecological restoration
- Natural resource management
- Sustainable agriculture

c) NBS challenge to be solved/SDGs

The following SDGs are covered by this action/solution-

- Goal 1: No Poverty
- Goal 3: Good health and well-being
- Goal 8: Decent work and economic growth
- Goal 8: Climate action
- Goal 13: Climate action
- Goal 14: Life below water
- Goal 15: Life on land

iii. Climate Hazards addressed- Prevention floods, from soil erosion.

Heat	Floods				Water		Others
	River	Surface Water	Coastal	Landslide	Scarcity	Quality	
							None

iv. Societal problems addressed: Disaster risk, food security, economic and social development.

v. Benefits and co-benefits (Ecosystem services) provided-

Environmental	Social/Cultural	Economic
River water flood mitigation	Regeneration of degraded areas	Food provision

Soil quality & erosion prevention	Amenity value (C)	Income generation
Biodiversity (C)		Increased tourism (C) (for seeing lotus plantations)

vi. Potential disadvantages / negative impacts-

No disadvantage as such. The important problem is to persuade all the farmers to shift to this type of this agriculture practice and help in flood mitigation. It will be hard for the government to persuade all farmers, but coordination is needed.

vii. IUCN assessment-

Table 16 NBS self-assessment for Case 1 - Vietnam- (Source- IUCN 2020, adapted)

Criterion	Your Criterion Score	Maximum Criterion Score	Normalised criterion	FINAL OUTPUT Your Criterion %age
1. Societal challenges	9	9	1.00	100%
2. Design at scale	8	9	0.89	89%
3. Biodiversity net-gain	10	12	0.83	83%
4. Economic feasibility	11	12	0.92	92%
5. Inclusive governance	12	15	0.80	80%
6. Balance trade-offs	8	9	0.89	89%
7. Adaptive management	6	9	0.67	67%
8. Sustainability and mainstreaming	9	9	1.00	100%
Total Percentage match				87%
Is this in adherance with the IUCN Global Standard for NbS?			In adherance	

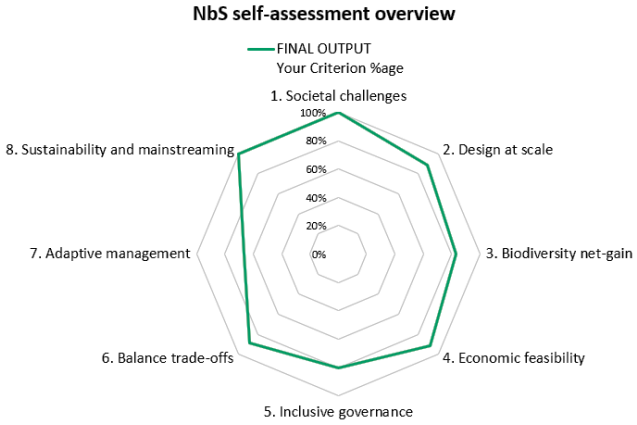


Figure 63 Spider Chart for self-assessment for Case -1- Vietnam- (Source- IUCN 2020, adapted)

4.2 Case studies in Europe

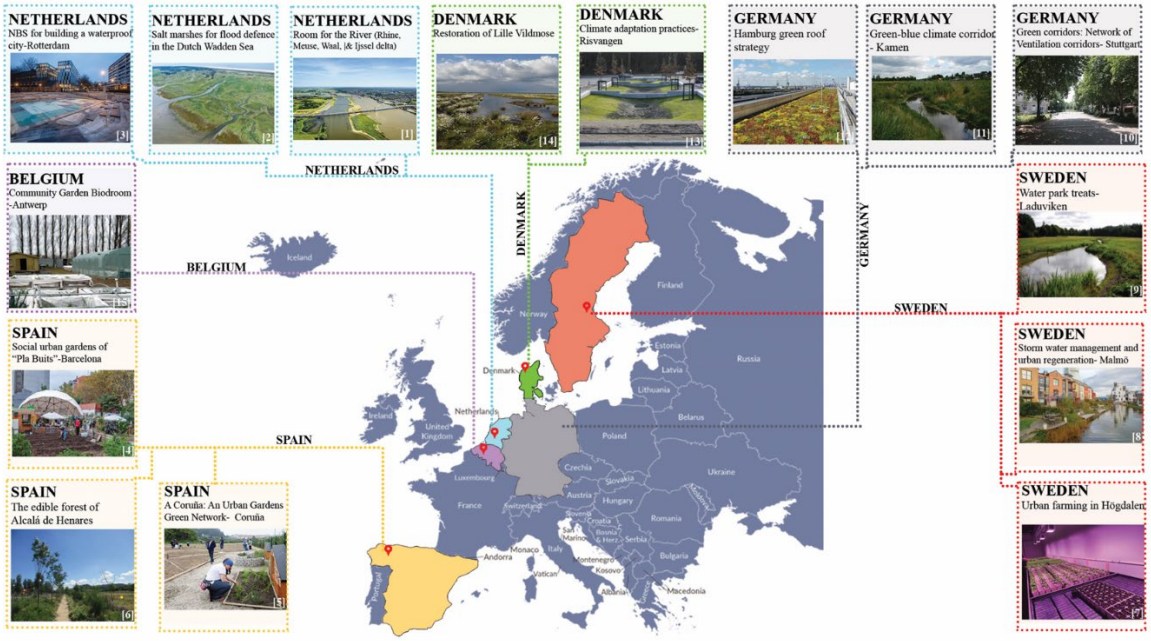


Figure 64 Case studies done in Europe (Source- written after each photo later, and designed by author)

It is famous for its history and customs. Europe is the second-smallest continent, comprising around 10.18 million km² (3.93 million sq mi), about 2% of the Earth's surface (6.8% of land area (using the seven-continent model)(Nations Online Project, n.d.). Western civilization, which may be traced to ancient Greece and Rome, is founded on European culture. In 2021, there were 745 million people living in Europe, or nearly 10% of the world's population.(World Bank, 2021).

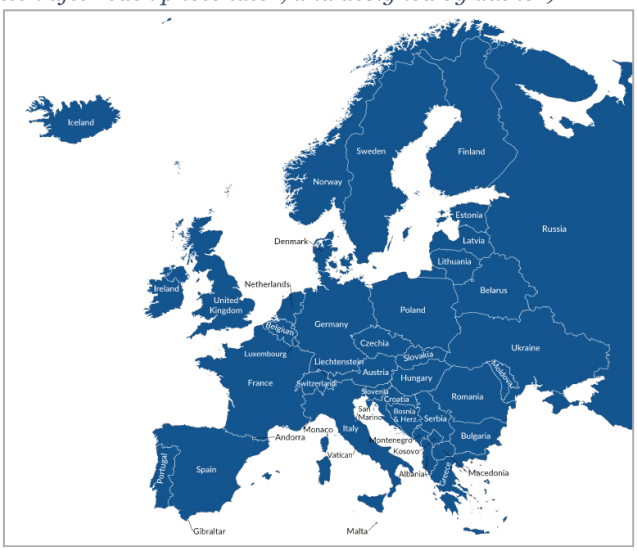


Figure 65 Europe with its countries marked- (Source- https://gisgeography.com/europe-map/)

4.2.1 Netherlands

It is a developed country located in North-western Europe. UN kept it in High-income countries based on Economies by per capita GNI in June 2018 (United Nations, 2019). It borders Germany to the east, Belgium to the south, with North Sea as coastline. It has a population of approximately 17,533,405 people (World Bank, 2021) and faces many natural disasters like drought, extreme temperature, floods, coastal erosion, earthquakes and storms (World bank, 2022) .

Figure 66 Location of Netherlands in Europe- (Source- https://en.m.wikipedia.org/wiki/File:Netherlands_in_Europe.svg)

1. Case Study 1 *(Overall Study – 16)*

Salt marshes for flood defence in the Dutch Wadden Sea

i. <u>Description</u>

Figure 67 Wadden Sea project (https://www.waddensea-secretariat.org/news/new-interreg-coastal-management-project-approved-wadden-sea-core)

Climate change and rising sea levels directly impact the coastal towns and their habitants. Various countries are taking measures to adapt to the harmful effects. The Netherlands is taking a lot of actions for the protection of its cities from floods and making available freshwater for future generations. To meet the resolution of fighting climate change and protecting the Netherlands from flood, a programme called the Delta programme was launched in 2010. Its aim was to focus on the northern provinces and to develop a long-term strategy to adapt a long term strategy for adaptation to climate change, simultaneously helping in the beneficing Waden's natural and landscape values (Delta Commissioner 2010). The salt marshes in the adaptation map was made by studying various aspects and case studies, also incorporating the locals. Although some did not accept the proposal but finally it was accepted.

Wadden Sesa, situated in the Waden region, is one of the world's largest intertidal areas and is well-known worldwide for its sand and mudflats (De Jong et al. 1999). It acts as a natural barrier and protects the main Dutch land from coastal flooding. It has a row of islands, banks and salt marshes which dampen the capacity of the waves. Around 227 km of dikes protect the mainland and about 32 km of dikes also join the provinces of Fryslân and North Holland(van Loon-Steensma, 2015). Another Phd research carried out by van Loon-Steensma, (2014), points out the importance of proper policy formation for salt marshes. The dampening of wave depends on different characteristics like the width and height of the salt marsh, and the type and height of vegetation growing on it. The marshes with vegetation could reduce around 60% of the wave(Möller, 2006).

Due to climate change, flood defences have to be altered according to needs. The bad effects of climate change could be undermining the existence of barrier islands and intertidal areas. To adapt to these effects, a proper sediment supply is needed; otherwise, the tidal flats, and salt marshes can drown, which leads to increased water action on the dikes on the mainland. A 25 km of man-made salt marshes were constructed along the dike. According to a cost-effective evaluation by (Vuik et al., 2019b) the salt marsh construction was better than dike heightening (with some clauses). It was found out that it was better to construct earthen breakwaters within the salt marsh over the area where the natural accumulation of the salt marshes happens. Salt marsh construction is cheaper than dike heightening, but salt marshes cannot sometimes hold due to sediment accumulation(Vuik et al., 2019b). They did another study by taking bamboo and brushwood dams for sediment accumulation, and they had positive effects, but they neglected them due to poor long-term benefits.

It is important to have good stable marshes or flats, and better to have vegetated ones (Leonardi et al., 2016). The degraded marshes do not protect better from stronger winds (hurricanes)(Cahoon, 2006). These salt marshes are home to numerous biodiversity, including

migratory birds. Due to its importance, it has also earned the title of "UNESCO World Heritage Site" and is protected by European Union's (EU) Natura 2000(van Loon-Steensma, 2015). The developed adaptation strategy involves many stakeholders for better knowledge exchange and decision-making.

Some of the marshes are owned by the local public, but with an agreement with the Dutch Department of Public Works, they can graze their cattle with improved conditions, and the government help conserves these marshes.

Some trade-offs also occur, like the benefit of salt marshes, mainly during extreme events, which have different requirements than biodiversity conservation (van Loon-Steensma & Vellinga, 2013). One of them is that the salt marshes need to be higher for flood protection to work better, but for biodiversity, that is not the case. The top of the marshes may be rarely flooded, thus reducing the growth of biodiversity. Another aspect is that a stable salt marsh is better suited to provide flood protection. Hard engineering methods are often more dependable than soft methods and are also useful in unfavourable wind-wave circumstances. However, if geomorphological processes are impeded, salt marshes lose some of their naturalness. Additionally, erosion control may restrict the salt marsh's ability to extend seaward. In order to increase biodiversity, it is often preferred to promote natural processes. However, employing the "building with nature" method does not always result in increased biodiversity values(van Loon-Steensma & Vellinga, 2013). Another one is sediments are reducing, and more sediments can be added from elsewhere, but the effects are not known for large spaces and may create damage in the place from where these sediments are excavated.

ii. Classification of action/solution-

a) Degree of intervention

TYPE 2 – NBS for sustainability and multifunctionality of managed ecosystems

TYPE 3 – Design and management of new ecosystems

b) NBS approaches used

- Climate adaptation approaches
- Ecosystem based adaptation
- Ecosystem based management
- Ecosystem based disaster risk reduction
- Infrastructure related approaches

c) NBS challenge to be solved/SDGs

The following SDGs are covered by this action/solution-

- Goal 3: Good health and well-being
- Goal 8: Decent work and economic growth
- Goal 13: Climate action
- Goal 14: Life below water
- Goal 15: Life on land

iii. Climate Hazards addressed- Prevention of coastal floods, protection of biodiversity.

Heat	Floods				Water		Others
	River	Surface Water	Coastal	Landslide	Scarcity	Quality	
							None

iv. Societal problems addressed: Disaster risk, climate change.

v. Benefits and co-benefits (Eco system services) provided-

Environmental	Social/Cultural	Economic
Coastal water flood mitigation	Regeneration of degraded areas	Income generation (C) - Prevention from reconstruction after flood damage
Soil quality & erosion prevention	Amenity value (C)	
Biodiversity		

vi. Potential disadvantages / negative impacts-

There are some trade-offs which are discussed above. However, they do not have any severe effects. But still, options have been thought by the delta programme to better fight those trade-offs.

vii. IUCN assessment-

Table 17 NBS self-assessment for Case 1 – Netherlands - (Source- IUCN 2020, adapted)

Criterion	Your Criterion Score	Maximum Criterion Score	Normalised criterion	FINAL OUTPUT Your Criterion %age
1. Societal challenges	9	9	1.00	100%
2. Design at scale	9	9	1.00	100%
3. Biodiversity net-gain	12	12	1.00	100%
4. Economic feasibility	12	12	1.00	100%
5. Inclusive governance	14	15	0.93	93%
6. Balance trade-offs	9	9	1.00	100%
7. Adaptive management	9	9	1.00	100%
8. Sustainability and mainstreaming	9	9	1.00	100%
Total Percentage match				99%
Is this in adherance with the IUCN Global Standard for NbS?			In adherance	

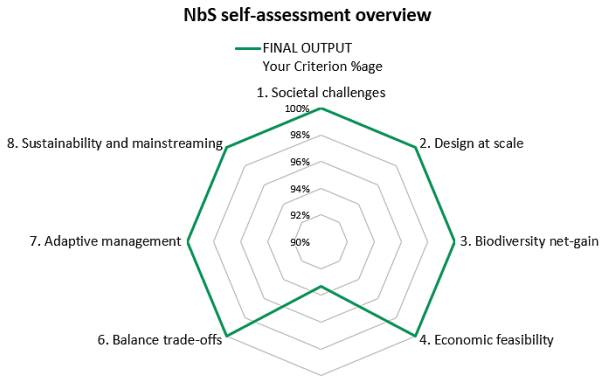


Figure 68 Spider Chart for self-assessment for Case -1- Netherlands - (Source- IUCN 2020, adapted)

2. Case Study 2 *(Overall Study – 17)*

Room for the River

i. Description

Figure 69 At more than 30 locations measures are being taken- (Source- https://worldlandscapearchitect.com/room-for-the-river-nijmegen-the-netherlands-hns-landscape-architects/)

The Netherlands is prone to flood. And it has taken many steps to protect the city and its citizens to protect itself from devastating floods. The flood plains which were once used to protect from high levels of water are decreasing. The most recent example was in 2021, when some parts of the Netherlands faced severe floods and damages(Reuters, 2021).

After learning from the drastic events of the 1990s floods, in 2007, the Dutch Government started the "Room for River" programme, which became an approach for flood protection in the rivers. The main objective of it was to handle more river water levels by lowering the floodplain levels, providing water buffers, moving levees, deepening side channels, and building flood bypasses. Over 30 projects were included in the programme, most of which have been finished. In 2022, the entire programme is anticipated to be completed.

To decrease river water levels, they expanded river space at 30 places around the Netherlands. For instance, they built high-water canals and moved dykes farther inland. Additionally, in certain areas, they lowered the floodplains. Then, at times of high water, these regions will get submerged, temporarily expanding the river's space and relieving strain on the dikes(Rijkswaterstaat, n.d.).

The programme had twin goals - (1) enhancing flood safety in the riverine areas of the Rhine, Meuse, Waal, IJssel, and Lek, by accommodating a discharge of 16,000 m^3/s, and (2) enhancing the spatial quality of the riverine area. The Room for the River initiative has embraced a new (multi-level) governance strategy in which government agencies actively collaborate across several fields (such as water safety, planning, agriculture, and environment). A central programme office has been established by the national government to oversee and track development, assess the quality of designs, and support regional projects through

guidelines, the provision of expert knowledge, community building, and, when necessary, the application of political pressure(Rijke et al., 2012). According to the concerned stakeholders, one of the pillars of Room for the River is communal leadership. “The four factors namely, leadership, capacity building and demonstration, public engagement and research) are facilitating a cohesive approach through cooperative leadership and promoting multi-level governance approaches which are required for integrated water management”(Rijke et al., 2012).

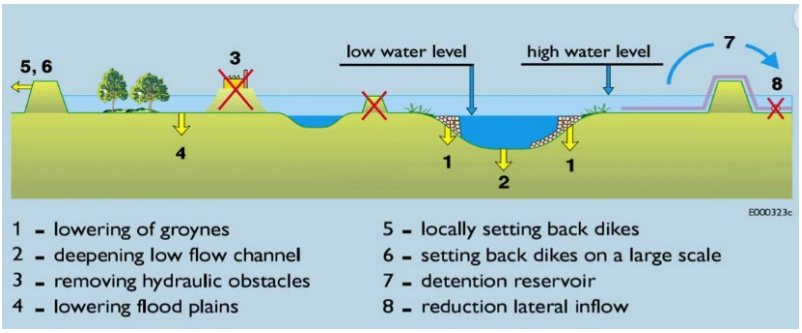


Figure 70 Eight different Room for the River measures(Silva et al., 2001)

Land use planning within the floodplain helps in preventing floods in the future. The Room for the River program's goals were to increase the spatial quality in the river basin while accommodating a 16.000 m^3/s discharge volume in the Rhine's branches by 2015.

To understand better, cost-effectiveness and cost-benefit analysis were carried out in the Netherlands. The cost-effectiveness of the water level reduction was calculated as mm/million euros or m^2/m Euros. This made it possible to choose the best economical solution for each river branch or river stretch. Most researchers concluded that shifting embankments, building bypasses, lowering groynes, and levelling floodplains produced the greatest design water level effects per million euros invested. Lowering floodplains and removing hydraulic barriers were the most expensive solutions (Silva et al., 2001). Additionally, it was determined that it was economically feasible to invest more than 2 billion euros to improve flood protection in Dutch rivers (Centraal PlanBureau (CPB), 2005).

Depending on the type of measure, these impacts can be advantageous. For instance, there are several ways to reduce floodplains, such as through the growth of nature, switching from a dry and humid environment to a wet nature, or controlling vegetation. These variations will all result in various advantages (Klijn et al., 2012). In addition, the location has a significant impact on the advantages of the measures.

ii. Classification of action/solution-

a) Degree of intervention

TYPE 3 - Design and management of new ecosystems

b) NBS approaches used

- Climate adaptation Approaches
- Community-Based Adaptation
- Ecosystem Based Adaptation
- Ecosystem Based Management
- Ecosystem Based Mitigation

- Ecosystem Based Disaster risk reduction
- Ecological Engineering
- Infrastructure related approaches

c) NBS challenge to be solved/SDGs

The following SDGs are covered by this action/solution-

- Goal 3: Good Health and Well-being
- Goal 11: Sustainable Cities and Communities
- Goal 13: Climate action
- Goal 14: Life below water
- Goal 15: Life on land

iii. Climate Hazards addressed- Protection from floods and enhancing the biodiversity of the area.

Heat	Floods				Water		Others
	River	Surface Water	Coastal	Landslide	Scarcity	Quality	
							None

iv. Societal problems addressed: Climate change, disaster risk, human health.

v. Benefits and co-benefits (Eco system services) provided-

Environmental	Social/Cultural	Economic
Biodiversity	Amenity value	
River flood mitigation	Health and quality of life (C)	

vi. Potential disadvantages / negative impacts-

Diverting or narrowing the river has costs, including increased flood danger and a reduction in the river's natural carrying capacity. More room for the river naturally equates to less space or opportunity for other activities that are valued by society (such as housing, commercial space, and other regions) (Warner et al, 2013). The advantages of having space for the river are more challenging to quantify. Room for the river measures may benefit flood protection, the environment, and enjoyment, but it may be detrimental to agriculture and shipping. It is challenging to quantify and much harder to evaluate its effects on recreation and the environment. It needs more research.

vii. IUCN assessment-

Table 18 NBS self-assessment for Case 2 – Netherlands - (Source- IUCN 2020, adapted)

Criterion	Your Criterion Score	Maximum Criterion Score	Normalised criterion	FINAL OUTPUT Your Criterion %age
1. Societal challenges	9	9	1.00	100%
2. Design at scale	8	9	0.89	89%
3. Biodiversity net-gain	12	12	1.00	100%
4. Economic feasibility	12	12	1.00	100%
5. Inclusive governance	14	15	0.93	93%
6. Balance trade-offs	8	9	0.89	89%
7. Adaptive management	8	9	0.89	89%
8. Sustainability and mainstreaming	9	9	1.00	100%
Total Percentage match				95%
Is this in adherance with the IUCN Global Standard for NbS?			In adherance	

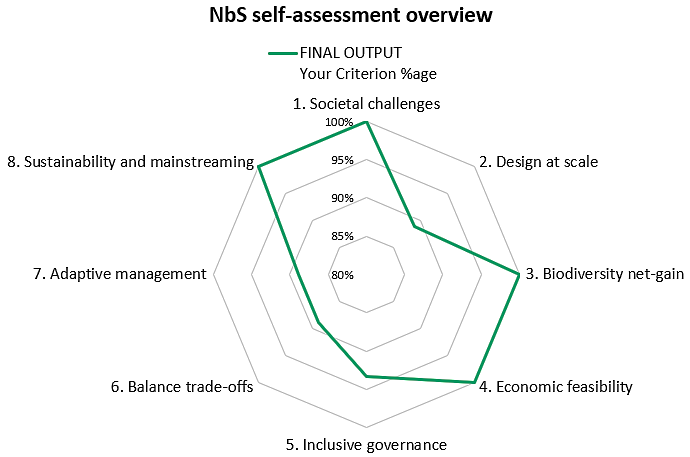


Figure 71 Spider Chart for self-assessment for Case -2 Netherlands - (Source- IUCN 2020, adapted)

3. Case Study 3 *(Overall Study – 18)*

NBS for building a waterproof city, Rotterdam

i. Description

The Dutch cities want to send the message to the world by being one of the first of its kind and becoming climate-proof by 2025. Rotterdam has a population of 633,471 (in 2016) in the core city (CBS, 2022). With its location in the delta of two rivers, Rhine and the Maas, and the sea, Rotterdam is quite vulnerable to the effects of climate change from floods risk, rise in sea levels, etc. (Ramjiawansingh et al., n.d.). Climate change adaptation is important for the city to survive, and water plays an integral part in it.

Figure 72 Water Square in Benthemplein (Source- https://www.publicspace.org/works/-/project/h034-water-square-in-benthemplein)

With a combination of paving and greenery, the concept of a "waterproof city" is solid and durable. The emphasis is on adaptable techniques by which the drainage is slowed and rainfall is captured. The drainage capacity and storage are being increased to deal with heavier rain in the future. The sponge function will be restored by improving the surfaces to store water and slow the drainage. The examples of solutions being used are green roofs and façades, less grey paving and more vegetation and

vegetated paving. For instance, the Benthemplein plaza in Rotterdam, which combines a basketball court with skateboarding and performance art pits, has a capacity of 1.7 million litres of water (Petsinaris et al., 2020). It is conveniently positioned in a region with paved, heavily populated metropolitan areas.

Another adaptation technique used in outer dike areas is multi-layer floodproofing., e.g., flood-proofing the public areas and the buildings, building with nature, etc. While inner-dike areas focuses on prevention measures, like optimisation of storm surge barriers, reinforcement of the existing dikes, and making them merged into the city and usable by the people(Wu, 2022).

A Tidal park programme was initiated, and outer dikes were enhanced by using techniques apart from solid constructions to help reduce floods. Restoration of various wetland-related ecosystem services is also happening.

Increasing the water capacity for storage of the canals and the lakes and building green-blue corridors inside the city would significantly help to make the city climate-proof. This city's green-blue transformation is a "no regrets" move that will help make it more climate-proof and make it a more attractive and enjoyable place to live (Wu, 2022).

Working together is essential to the plan; different municipal services, other government offices, port, and the locals all work together. There are numerous participatory approaches where the locals are asked and their ideas are incorporated, like urban farms, child-friendly districts, etc. (Ramjiawansingh et al., n.d.). The issue which arises is that, in some places, grey solutions are integrated with the NBS. The best example is the Museum Park's underground parking garage in Rotterdam, which was built to take in, hold, and discharge 10,000 m^3 of water in the event of heavy precipitation, significantly lowering drainage peaks(Paul de Ruiter Architects, n.d.).

ii. Classification of action/solution-

a) Degree of intervention

TYPE 3 – Design and management of new ecosystems

b) NBS approaches used

- Climate adaptation approaches
- Community-Based adaptation
- Ecosystem based adaptation
- Ecosystem based management
- Ecosystem based mitigation
- Ecosystem based disaster risk reduction
- Ecological Restoration
- Ecological Engineering
- Infrastructure related approaches

c) NBS challenge to be solved/SDGs

The following SDGs are covered by this action/solution-

- Goal 3: Good health and well-being

- Goal 11: Sustainable Cities and Communities
- Goal 13: Climate action
- Goal 14: Life below water
- Goal 15: Life on land

iii. Climate Hazards addressed- Prevention of floods, enhancement of biodiversity.

Heat	Floods				Water		Others
	River	Surface Water	Coastal	Landslide	Scarcity	Quality	
							None

iv. Societal problems addressed: Disaster risk, climate change, Economic and social development.

v. Benefits and co-benefits (Eco system services) provided-

Environmental	Social/Cultural	Economic
River flood mitigation	Regeneration of degraded areas	Income generation (less floods means less repair, thus saving on income)
Coastal flood mitigation	Amenity value (C)	
Groundwater recharge		
Biodiversity (C)		

vi. Potential disadvantages / negative impacts-

There are no disadvantages. As already discussed, some aspects of the plan need grey solutions; maybe in the future nature-based solutions can be used to bring them close to nature.

vii. IUCN assessment-

Table 19 NBS self-assessment for Case 3 – Netherlands - (Source- IUCN 2020, adapted)

Criterion	Your Criterion Score	Maximum Criterion Score	Normalised criterion	FINAL OUTPUT Your Criterion %age
1. Societal challenges	7	9	0.78	78%
2. Design at scale	8	9	0.89	89%
3. Biodiversity net-gain	8	12	0.67	67%
4. Economic feasibility	11	12	0.92	92%
5. Inclusive governance	12	15	0.80	80%
6. Balance trade-offs	6	9	0.67	67%
7. Adaptive management	3	9	0.33	33%
8. Sustainability and mainstreaming	9	9	1.00	100%
Total Percentage match				76%
Is this in adherance with the IUCN Global Standard for NbS?			In adherance	

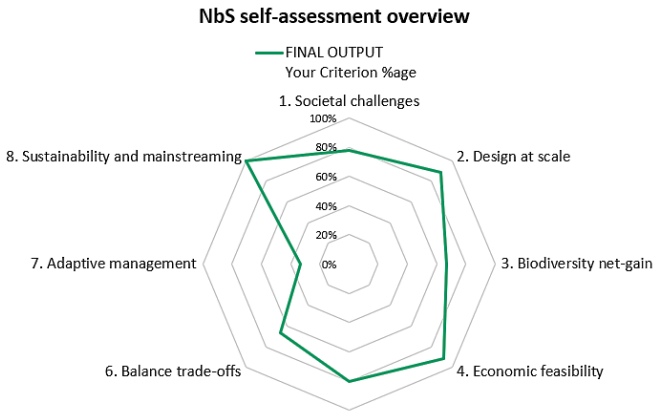


Figure 73 Spider Chart for self-assessment for Case -3 Netherlands - (Source- IUCN 2020, adapted)

4.2.2 Spain

Figure 74 Location of Spain in Europe (Source- https://upload. wikimedia.org/ wikipedia/commons/thumb/f/f7/Spain_in_ Europe.svg/1198px-Spain_ in_Europe. png)

Spain is a developed country located in Southwestern Europe. UN had kept it in High-income countries by Economies by per capita GNI in June 2018 (United Nations, 2019). It borders France, Andorra and the Bay of Biscay, and to the west with Portugal. It has a population of approximately 47,326,687 people (World Bank, 2021) and faces many natural disasters like drought, floods, wildfires, epidemics, high temperatures, landslides, earthquakes, and storms (World bank, 2022) .

1. Case Study 1 *(Overall Study – 19)*

Social urban gardens of *"Pla Buits"* (Vacant Lots Plan), Barcelona

i. <u>Description</u>

Figure 75 Urban gardens, Barcelona- (Source- https://www.academia.edu/29851411/El_Pla_Buits_ de_Barcelona)

In 2012 a brand-new concept which involved citizen participation began in Barcelona, by the name *Pla Buits* (*Buits Urbans amb Implicació Territorial i Social*—Empty Urban Spaces with Social and Territorial Involvement). The project started the Empty Plots Plan in 2013, which was also a result of the economic crisis, as many areas were left vacant. This incorporated both the government and civil society. In this project, the government provided empty spaces which could be used for temporary uses or activities. The spaces developed depends totally on the locals and the local organisations, and it can be anything from an urban garden to bike racks. This was done to incorporate the feeling of social cohesion in the neighbourhoods in Barcelona. The locals made some urban gardens; the most famous one is ConnectHort, in Poblenou, with the ideology of Permaculture and is based on sustainable agriculture. They are self-managed projects. Some other categories of gardens are also

available in Barcelona like “Network of Municipal Gardens and Network of Communitarian Gardens”. (Calvet-Mir & March, 2019)

Urban gardening is not a new concept, and it has started since the emergence of cities. (Keshavarz and Bell, 2016). A lot of research has been written about urban gardens in North America and northern Europe. The urban gardens date back to Egyptians as agriculture within city walls and can be seen during the 19th century when the fortification of walls was destroyed and the suburbs were taken inside the city premises (Zaar, 2011). It has many benefits, like reducing urban heat island effects, recycling air, production of vegetables and flowers, good landscape views, etc. Most important are social cohesion and leisure.

In the case of Barcelona, its green cover is relatively low compared to the green cover needed by European (20m^2) and United Nations (30m^2) standards (Khalil, 2014). So, the government required more green spaces in the city. It finds urban gardens as places that can enhance biodiversity and help bring the city closer to nature. ‘Agenda 21’, the ‘Citizen Commitment for Sustainability 2012–2022’, encourages sharing among different stakeholders the task of planning and monitoring public space. It also considers environmental education and production by the locals(Calvet-Mir & March 2019).

Similar kinds of projects can also be seen in other European countries like Italy, Germany, etc.

ii. Classification of action/solution-

a) Degree of intervention

TYPE 3 – Design and management of new ecosystems –

b) NBS approaches used

- Climate adaptation approaches
- Community-Based adaptation
- Ecosystem based adaptation
- Ecosystem based management
- Ecosystem based mitigation

c) NBS challenge to be solved/SDGs

The following SDGs are covered by this action/solution-

- Goal 3: Good health and well-being
- Goal 11: Sustainable cities and communities
- Goal 13: Climate action
- Goal 15: Life on land

iii. Climate Hazards addressed- Prevention of urban heat islands, reduction in food shortage.

Heat	Floods				Water		Others
	River	Surface Water	Coastal	Landslide	Scarcity	Quality	
							None

iv. Societal problems addressed: Climate change, food security, and human health.

v. Benefits and co-benefits (Ecosystem services) provided-

Environmental	Social/Cultural	Economic
Temperature regulation	Regeneration of degraded areas	Food provision
Air quality	Amenity value (C)	Increased value of land/property (C)
Biodiversity (C)	Health and quality of life	
	Recreation, education & gathering	

vi. Potential disadvantages / negative impacts-

Cooperation between the municipality and locals is the most important aspect. NGOs help the people, but municipalities are also very much important.

vii. IUCN assessment-

Table 20 NBS self-assessment for Case 1 – Spain - (Source- IUCN 2020, adapted)

Criterion	Your Criterion Score	Maximum Criterion Score	Normalised criterion	FINAL OUTPUT Your Criterion %age
1. Societal challenges	5	9	0.56	56%
2. Design at scale	8	9	0.89	89%
3. Biodiversity net-gain	8	12	0.67	67%
4. Economic feasibility	9	12	0.75	75%
5. Inclusive governance	14	15	0.93	93%
6. Balance trade-offs	6	9	0.67	67%
7. Adaptive management	8	9	0.89	89%
8. Sustainability and mainstreaming	9	9	1.00	100%
Total Percentage match				79%
Is this in adherance with the IUCN Global Standard for NbS?			In adherance	

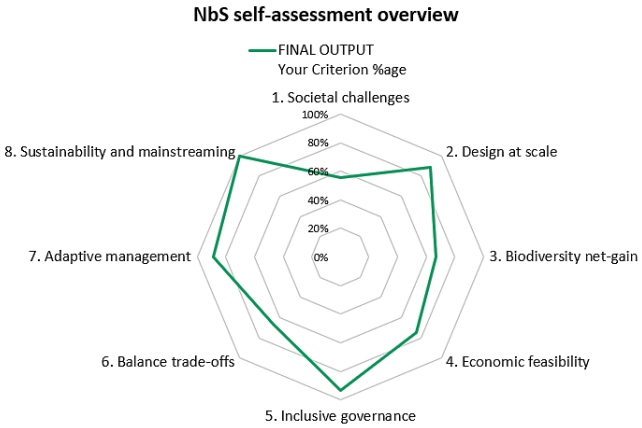


Figure 76 Spider Chart for self-assessment for Case -1- Spain (Source- IUCN 2020, adapted)

2. Case Study 2 *(Overall Study – 20)*

A Coruña: An Urban Gardens Green Network

i. Description

Coruña, is a city situated in the Galicia region of Spain and is very compact. With a huge population and scarcity of space, people have started going upward rather than having a horizontal expansion. Some apartments are 6-10 stories in height(Prieto, 2022). This also causes air pollution, and the situation is aggravated due to the lack of green spaces.

Figure 77 A person sitting next to a small garden (Source- https://connectingnature.eu/oppla-case-study/24711)

So, to breathe better, the city is focusing on "trees replacing cars" ideology(Ayuntamiento de A Coruna, 2022). It focuses on slower mobility, spaces for green areas, pedestrians, and bicycles. This will help positive effects on the citizens. Since 2020, a speed limit of 30km/h is set in the urban boundaries. With the approval of a preliminary Green Infrastructure Plan in 2018, the re-naturalization of some rivers and ponds, and the realisation of new, multipurpose projects like urban gardens, which shows that there has been a shift in policies over the past few years toward a more NBS-focused approach(Oppla, n.d.-a).

The city is working on "urban gardening" and is creating a "Network of Urban Greens." Urban gardens are small (or very small) scale gardens that can also be scaled to city-wide scale. Their low investment is their most important benefit. In 2018, three ecoHortas Urban gardens were set up in three areas by the municipality (Eiris, Agra do Orzán and Novo Mesoiro). It had 218 plots available to the people(Prieto, 2022). In addition, three gardens and two smaller urban gardens, and a greenhouse was also set up for educational aspects. These ecoHortas may not greatly help in environmental quality, but they help increase urban resilience and cohesion. The urban gardens are located on abandoned plots and other underused spaces.

These plots work on a mechanism of lease(assigned) to the citizens. The lease is for 2 years at the start but can be extended for 3 years. Organic agriculture is a necessity to be given the plot of land. Some plots are also given to educational institutions and used for educational

purposes. And some plots are reserved for retired, old people and lower-income people. By 2018, more plots were created (Around 218 now).

In 2018, workshops (online and in-person) were conducted, and people were trained by experts in organic agriculture and urban gardens(Prieto, 2022). Initial gardens had some issues, like lacked a maintenance model, a top-down approach, and not good spaces for socialising. The Environment department has managed the programme, and the Employment and Education departments are also involved.

Figure 78 Gardening (Source- https://connectingnature.eu/oppla-case-study/24711)

These gardens have numerous benefits. Firstly, they are cost-efficient, enhance biodiversity, help in combating climate change, help in the health of the locals, promote social cohesion among the citizens (a similar concept was also seen in Barcelona pocket gardens), and make new economic opportunities for the citizens (sometimes also enhancing tourism). For the current time, even they may help in preserving the historical and ethnographic agricultural heritage of the area. This helps in intergenerational and intercultural relationships and helps in transferring skills from one generation to another(McCann et al., 2022). Most importantly, it is pretty understandable that SDGs also cover similar goals and targets. These gardens help both students and adults with the environment.

With the participation in the URBACT Ru:rban project (2018-2021), an active group of stakeholders meet and share their experiences. Currently, in March 2022, the available plots were as follows(Connecting Nature, 2022):

- Agra: 112 plots à 117 individual plots + 1 common plot
- Eirís: 77 plots à 88 individual plots + 1 common plot
- Novo Mesoiro: 29 plots à 36 individual plots + 1 common plot

Coruña has submitted a funding request to Fundación Biodiversidad (Ministry for the Ecological Transition) for financing in the year 2022 to create an urban greening plan that would incorporate a strategy for urban gardens and would adhere to the findings of the Green Infrastructure Plan created in 2018(Ayuntamiento de A Coruna, 2022).

ii. Classification of action/solution-

a) Degree of intervention

TYPE 3: Design and management of new ecosystems

b) NBS approaches used

- Climate adaptation approaches (check)
- Community-Based adaptation
- Ecosystem based management
- Ecological based mitigation

- Infrastructure related approach

c) NBS challenge to be solved/SDGs

The following SDGs are covered by this action/solution-

- Goal 1: No Poverty
- Goal 2: Zero Hunger
- Goal 3: Good Health and Well-being
- Goal 4: Quality Education
- Goal 8: Decent Work and Economic Growth
- Goal 11: Sustainable cities and communities
- Goal 12: Responsible Consumption and Production
- Goal 13: Climate action
- Goal 15: Life on land
- Goal 17: Partnerships for the Goals

iii. Climate Hazards addressed- Directly none of the below. But helps in enhancement of biodiversity.

Heat	Floods				Water		Others
	River	Surface Water	Coastal	Landslide	Scarcity	Quality	
							None

iv. Societal problems addressed: Disaster risk, climate change, food security, human health, economic and social development.

v. Benefits and co-benefits (Eco system services) provided-

Environmental	Social/Cultural	Economic
Biodiversity	Regeneration of degraded areas	Increased tourism
Air quality	Recreation, education & gathering	Food provision
Temperature regulation	Amenity value (C)	Income generation

Pollination (C)	Employment	Increased value of land/property (C)
Regulation of the water cycle (C), very less	Health and quality of life	

vi. Potential disadvantages / negative impacts-

Urban gardens are not new, but people have trust issues with them and prefer to leave them. There is a thought that people would not be able to self-manage the plots. Municipality helps with water, equipment and training for all. Maintenance is a challenge because if not maintained, the plants may die, or they will overgrow. Maintenance should be in a green way, but the locals prefer more neatly mowed lawns than outgrown shrubs.

vii. IUCN assessment-

Table 21 NBS self-assessment for Case 2 – Spain - (Source- IUCN 2020, adapted)

Criterion	Your Criterion Score	Maximum Criterion Score	Normalised criterion	FINAL OUTPUT Your Criterion %age
1. Societal challenges	9	9	1.00	100%
2. Design at scale	9	9	1.00	100%
3. Biodiversity net-gain	11	12	0.92	92%
4. Economic feasibility	11	12	0.92	92%
5. Inclusive governance	14	15	0.93	93%
6. Balance trade-offs	7	9	0.78	78%
7. Adaptive management	7	9	0.78	78%
8. Sustainability and mainstreaming	9	9	1.00	100%
Total Percentage match				92%
Is this in adherance with the IUCN Global Standard for NbS?			In adherance	

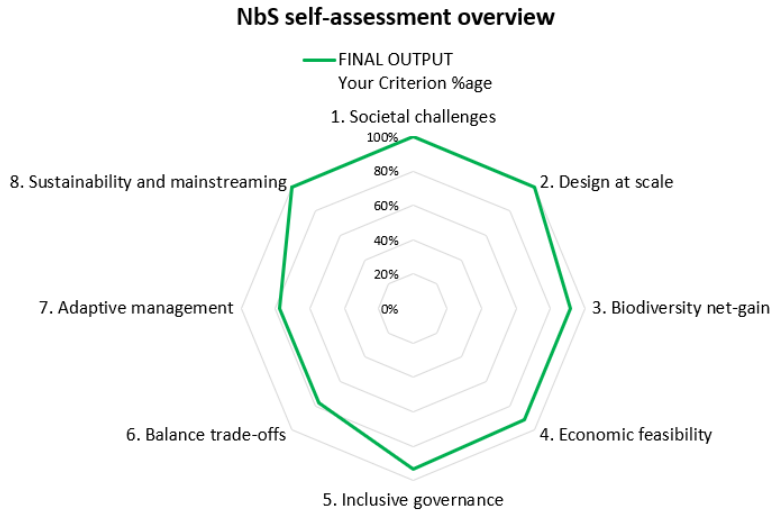


Figure 79 Spider Chart for self-assessment for Case -2- Spain- (Source- IUCN 2020, adapted)

3. Case Study 3 *(Overall – 21)*

The edible forest of *Alcalá de Henares*

i. Description

The astounding diversity of edible forest gardens are intricate multi-strata agroforests with perennial plants at every structural level, including high trees and low trees, shrubs, herbs, soil coverings, tubers, and climbers (Jacke & Toensmeier, 2005). Owners of small farms in the southern hemisphere have a long tradition of cultivating edible forest gardens, sometimes known as "home gardens," which have been proven to provide social and ecological advantages in tropical regions on all continents (Landreth and Saito 2014; Pulido et al. 2008; Bardhan et al. 2012; Matsson et al. 2015; Willeman et al. 2013). In addition, these gardens are small-scale systems that help urban or suburban homes become self-sufficient throughout Europe, with central and eastern Europe having the most prevalence (Mosquera-Losada et al. 2009).

Figure 80 Edible forest- (Source- https://oppla.eu/casestudy/19654)

Alcalá de Henares (Spain), Milan (Italy) and Szeged (Hungary) are the four pilot cities chosen for the Nature4Cities Project. Choosing different cities in different climatic zones helps understand if the techniques used can be applied to other places (Nature4Cities, 2018).

Alcalá de Henares is a city located about 35 kilometres from the capital of Madrid. It has a green space of 21.53 m^2 for each inhabitant. According to WHO (2009) report, a minimum of 9 m^2 is a minimum amount for a person. While some countries also have higher as well (Like Italian law specifies 18 m^2, which is double of WHO's level) (European Commission, n.d.). Understandably, the available space in Alcalá de Henares is more than needed.

Alcalá de Henares has a natural heritage in the form of river *Henares* and its banks which are in the protected area of RED Natura 2000, with Site code: ES4240003 (banks), with Site code: ES3110001 (river basin), (*Natura 2000 Network Viewer*, n.d.). And as the climate is changing rapidly, the city wanted to make it adapt to the harsh climate effects and protect the river as well, as the river needs special care.

The main aim was to boost the biodiversity of a peri-urban area and re-naturalizing it through peri-urban edible forest. The edible forests benefit not just humans but animals and help the soil as well. The animals help further in spreading the seeds for further increase of forests, this helps in lower maintenance, and it does not need more trees (Dream Alcalá, 2017; Oppla, n.d.-b). Shrubs, for instance, fruit and berry shrubs were planted (blueberries, rose, currant, etc.), herbs, for instance, perennial woody plants (flowers, herbs and ground plants) were planted, and some other types of tall trees (apple, pear, etc.), low trees (almond, peach, etc.), vines(grapes, hops, etc.), rooted plants (garlic, onion, etc.), and some other types of trees and plants were planted(Uforest, n.d.).

Further to the forests, the city has the problem of waste separation(Nature4Cities, 2018). Since the river had a 100m strip of protected land, natural separation was created with thorny shrubs, and the start of forests(Oppla, n.d.). With excessive use of pesticides and chemical fertilizers, pollinating animals were disappearing, so nectar species were planted, which attract more pollinator insects(Oppla, n.d.-b).

The city wants to increase selective waste collection. According to Waste Framework Directive 2008 (applied in Spain with Law 22/2011), the selective collection of organic waste should be at least 50%(Nature4Cities, 2018).

Along with the municipality, even citizens were involved. The first trees were planted by the volunteers, who were the locals(Dream Alcalá, 2017). Private companies fund the plantation programmes and play their part in protecting the environment.

Figure 81 Volunteers helping in the project- (Source- https://oppla.eu/casestudy/19654)

The project had many benefits. It helped in reducing floods, reducing the temperatures, carbon sequestration, connecting ecosystems, enhancing biodiversity, social cohesion among the locals, and more green spaces, which help the people's health and well-being and sense of ownership (Dream Alcalá, 2018).

In order to assess the scenarios and determine the value of the NBS improvement, Nature4Cities took into account the baseline, the edible forest's present condition (as of 2020), two future scenarios for 2025, and many indicators for each of the scenarios. The main aim of Nature4Cities was to test the tool(UK Green Building Council, 2022).

ii. Classification of action/solution-

a) Degree of intervention

TYPE 1 – Better use of protected/ natural ecosystems

TYPE 3: Design and management of new ecosystems

b) NBS approaches used

- Climate adaptation approaches
- Community-Based adaptation
- Ecosystem based adaptation
- Ecosystem based management
- Ecological based mitigation
- Ecological engineering
- Ecological restoration
- Infrastructure related approach
- Natural resources management
- Agro-forestry

c) NBS challenge to be solved/SDGs

The following SDGs are covered by this action/solution-

- Goal 2: Zero Hunger

- Goal 3: Good Health and Well-being
- Goal 4: Quality Education
- Goal 8: Decent Work and Economic Growth
- Goal 11: Sustainable cities and communities
- Goal 12: Responsible Consumption and Production
- Goal 13: Climate action
- Goal 15: Life on land

iii. **Climate Hazards addressed-** Protection from floods, enhancement of biodiversity, enhancement of soil nutrients, better air quality and reduction in temperature (reduction of UHI).

Heat	**Floods**				**Water**		**Others**
	River	**Surface Water**	**Coastal**	**Landslide**	**Scarcity**	**Quality**	**Enhancement of biodiversity**
							Solved

iv. **Societal problems addressed:** Disaster risk, climate change, food security, human health, economic and social development.

v. **Benefits and co-benefits (Ecosystem services) provided-**

Environmental	Social/Cultural	Economic
Biodiversity	Regeneration of degraded areas	Increased value of land/property (C)
Air quality	Recreation, education & gathering	Food provision
Temperature regulation	Amenity value (C)	
Pollination	Health and quality of life	
Regulation of the water cycle		
River flood mitigation		
Soil quality & erosion prevention		
Carbon storage		

Groundwater recharge		

vi. Potential disadvantages / negative impacts-

Theft of plants is a problem for the project. The project does not have a set budget, while the municipality allocates certain money when needed, but mainly the projects get the money from private companies who funds different parts of the projects. Also, it gets money from the EU. But no availability of a specified budget might be a problem.

vii. IUCN assessment-

Table 22 NBS self-assessment for Case 3 – Spain - (Source- IUCN 2020, adapted)

Criterion	Your Criterion Score	Maximum Criterion Score	Normalised criterion	FINAL OUTPUT Your Criterion %age
1. Societal challenges	8	9	0.89	89%
2. Design at scale	8	9	0.89	89%
3. Biodiversity net-gain	9	12	0.75	75%
4. Economic feasibility	5	12	0.42	42%
5. Inclusive governance	10	15	0.67	67%
6. Balance trade-offs	5	9	0.56	56%
7. Adaptive management	6	9	0.67	67%
8. Sustainability and mainstreaming	8	9	0.89	89%
Total Percentage match				72%
Is this in adherance with the IUCN Global Standard for NbS?			In adherance	

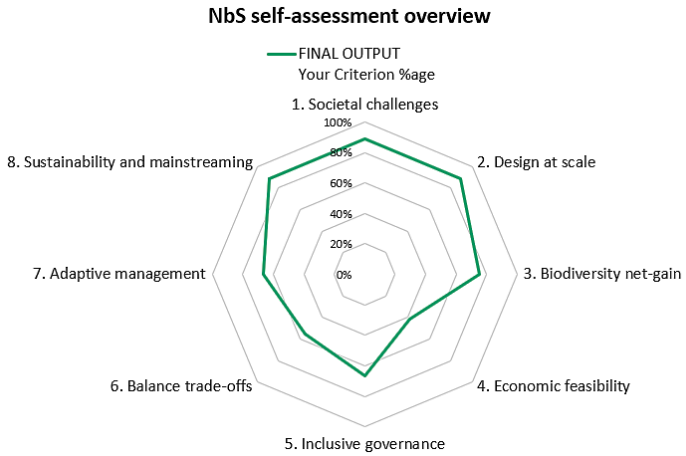


Figure 82 Spider Chart for self-assessment for Case -3 Spain- (Source- IUCN 2020, adapted)

4.2.3 Sweden

Sweden is a developed country located in Northern Europe. It is a Nordic country in Scandinavia. UN kept it in High-income countries based on Economies by per capita GNI in June 2018 (United Nations, 2019). It borders Norway and Finland, and is connected to Denmark with a bridge tunnel. It has a population of approximately 10,415,811 (World Bank, 2021) and faces many natural disasters like floods, high temperatures, wildfires, epidemics, and storms (World bank, 2022) .

Figure 83 - Location of Sweden in Europe (Source- https://commons.wikimedia.org/)

1. Case Study 1 *(Overall Study – 22)*

Urban farming, Högdalen

i. <u>Description</u>

The aim of the project was to introduce build farms which use less labour and are also climate-safe. These farms are located underground in the space below the shopping and the community centre in *Högdalen* in Sweden. This is a high-technology farming system which can remain active for the whole year. Being underground does not helps much in creating clean air and reducing heat island, but it has other benefits like job opportunities(Radio Sweden, 2017) and fresh food for the residents. It also helps in creating an integration between the commercial centre and nature.

Figure 84 Urban farming in the basement - (Source- https://link.springer.com/ article /10.1007/s12571-020-01045-8#citeas)

The effects of climate change are increasing, so what's the alternative? Shift indoors, maybe. Indoor farming is practised by different names in many parts of the world. Even plants have been tried to be grown in outer space (Heiney, 2019). Many techniques have evolved over the years and are used from in-soil to soil-less cultivation. The main advantages of these systems are that the crops do not need soil for growing as they are grown in pots or hydroponic methods. Moreover they can be grown vertically, thus takes less space. The space which they do not occupy outside can be used for other purposes like housing, industries, etc. (Despommier, 2010). According to Despommier (2010), as the world population is increasing rapidly and needs more food, so conventional farming would harm the environment; thus, vertical farming should proceed. This will help to free up the land and the environment can recover over time. While other authors like (Kalantari et al., 2017), also say that use of indoor and outdoor vertical farming may help in reducing starvation. Urban indoor farms can be small-scale pocket farms to whole skyscrapers. According to research by Bonow & Normark, (2018), which was carried out in Stockholm, found that many people participated in urban farms as they said it was fun, also it shows their consciousness towards the environment.

The indoor farm is run by People's House in Rågsved (NRFH), which is made up of civil organisations of the area. The farm is in partnership between the NRFH, state and municipal agencies. Firstly, 80m^2 of chamber was built for cultivation, in which the cultivation table was fitted with lamps, a water tank and pipes, humidifiers and heaters. Most importantly, the exhaust gas from a nearby shop was used to add CO_2 to the chamber. In plastic pots, the soil was added, and seeds were planted and harvested after growing. The workers need to understand the timings of switching the lights and heaters on or off. Also, the initial and final steps from growing to harvesting need to be taken care of; thus, it needs proper training.

Some benefits include the use of unused indoor space, which provides income to the owner of the space, then produces jobs, fresh and healthy vegetable options, use of exhaust from nearby shops could be used for plants. Also, it created an interest among the people to buy the product from the indoor garden. It was not affected by the outdoor environment and grew in an artificial environment. But according to a study by Milestad et al., (2020), it needs investment and innovation in technology to better utilise indoor farming and to compete with commercial urban greenhouses. This study also discusses the GHGs emissions and describe that the GHGs

emission in the production of lettuce was lesser in the open than inside (Milestad et al., 2020). An important consideration is that a lot of electricity is needed to grow crops in an indoor environment. It is also to be pointed out that this farm does not help in food security, but further scaling up might help this cause as well.

In this case, the electricity comes mostly from hydro and wind energy, but to utilise it in other places, it needs careful consideration before implementing the project.

ii. Classification of action/solution-

a) Degree of intervention

TYPE 3 – Design and management of new ecosystems –

b) NBS approaches used

- Climate adaptation approaches
- Community-Based adaptation
- Ecosystem based management
- Ecological engineering
- Infrastructure related approaches

c) NBS challenge to be solved/SDGs

The following SDGs are covered by this action/solution-

- Goal 2: Zero Hunger
- Goal 8: Decent work and economic growth
- Goal 11: Sustainable cities and communities
- Goal 12: Responsible consumption and production
- Goal 15: Life on Land (Though its located, still it can be considered as part of this goal)

iii. Climate Hazards addressed- Helps in increasing green space (though inside now), reduction in food shortage.

Heat	**Floods**				**Water**		**Others**
	River	**Surface Water**	**Coastal**	**Landslide**	**Scarcity**	**Quality**	**Food shortage**
							Solved

iv. Societal problems addressed: Climate change, food security, economic and social development.

v. Benefits and co-benefits (Ecosystem services) provided-

Environmental	Social/Cultural	Economic
Biodiversity	Regeneration of degraded (unused) areas	Food provision
Air quality (C)	Amenity value (C)	Increased (have some) value of land/property
	Health and quality of life (C)	Income generation

vi. Potential disadvantages / negative impacts-

The disadvantages will be discussed for this project, not of indoor farms as a whole. This project does not fulfil the benefits of urban farms and indoor farming. First, it is small in scale; thus, it does not provide enough food, so it does not fulfil the need for food shortage. Second, it needs trained personnel to work, and since the products do not produce much profit, so it is impossible to give salaries to the personnel at this moment. Third, it cannot be used as an urban green space as it is in a closed indoor space. Air purification is also not possible. But overall, these negative points can be solved easily by enhancing the scale and other innovative measures, which will help get more positives from this process.

vii. IUCN assessment-

Table 23 NBS self-assessment for Case 1 – Sweden - (Source- IUCN 2020, adapted)

Criterion	Your Criterion Score	Maximum Criterion Score	Normalised criterion	FINAL OUTPUT Your Criterion %age
1. Societal challenges	8	9	0.89	89%
2. Design at scale	7	9	0.78	78%
3. Biodiversity net-gain	11	12	0.92	92%
4. Economic feasibility	11	12	0.92	92%
5. Inclusive governance	11	15	0.73	73%
6. Balance trade-offs	9	9	1.00	100%
7. Adaptive management	8	9	0.89	89%
8. Sustainability and mainstreaming	9	9	1.00	100%
Total Percentage match				89%
Is this in adherance with the IUCN Global Standard for NbS?			In adherance	

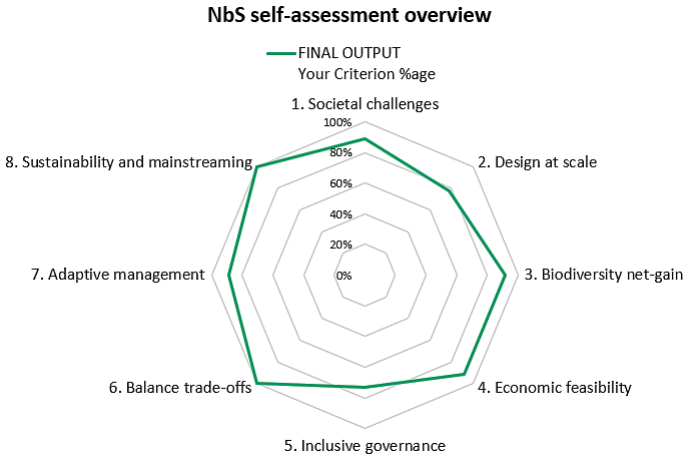


Figure 85 Spider Chart for self-assessment for Case -1-Sweden- (Source- IUCN 2020, adapted)

2. Case Study 2 *(Overall Study – 23)*

Storm water management and urban regeneration, *Malmö*

i. Description

The neighbourhood of Augustenborg, in Malmö experienced a decline socially and economically due to floods and drainage issues. Between 1998-2002, the neighbourhood was regenerated(Kazmierczak & Carter, 2010). To resolve the problem "Sustainable Urban Drainage Systems" method was used. The aim was to reduce the amount of water which flows from the roofs and other surfaces going into the sewage system (sewer). Since the 1980s, Malmö started the eco-friendly process, and SUDS was a part of this. The aim was to make the neighbourhood socially, economically, and environmentally sustainable.

Figure 86 Sustainable Urban Drainage Systems (Source- https://blogs.nottingham.ac.uk/blue-greencities/2017/09/01/malmo/)

The solution incorporated a "collaboration and participation between the planners (city and water), Malmo housing company and the local citizens(Life Tree Check, n.d.)". It involved stakeholder engagement, sophisticated knowledge and technical skills. A system of canals and water channels were created, along with a channel of retention ponds which help in slowing the water and help in collecting water and act as either infiltration systems or evaporation of water systems. The project incorporated the aim of reduction of urban flooding to enhancement of nature in the area and reduction of CO2.

Figure 87 Sustainable urban drainage systems (Source- https://blogs.nottingham.ac.uk/blue-greencities/2017/09/01/malmo/)

This protects the residents from flooding during storms, which are expected to increase due to climate change. The project has improved the local biodiversity, increasing wetland habitat for animals and plants, and has provided additional spaces for recreation for the residents. All of these form the system of "Sustainable Urban Drainage Systems". The water is first collected in this system from roofs, parking, etc. and slowly sent to the conventional sewage system.

These ponds help in adding retention capacity of water and also help in enhancing the landscape and can be used by the locals as well. The system also helps enhance biodiversity as new spaces can be planted with trees, and birds and animals can use them.

ii. Classification of action/solution-

a) Degree of intervention

TYPE 3 - Design and management of new ecosystems

b) NBS approaches used

- Climate adaptation Approaches
- Community Adaptation Approaches
- Ecosystem Based Adaptation
- Ecosystem Based Management
- Ecosystem Based Mitigation
- Ecosystem Based Disaster risk reduction
- Ecological Engineering
- Ecological Restoration
- Infrastructure related approaches

c) NBS challenge to be solved/SDGs

The following SDGs are covered by this action/solution-

- Goal 6: Clean water and sanitation
- Goal 11: Sustainable Cities and Communities
- Goal 13: Climate action
- Goal 15: Life on land

iii. Climate Hazards addressed- Protection from floods.

Lower crop produce	Floods				Water		Others
	River	Surface Water	Coastal	Landslide	Scarcity	Quality	
							None

iv. Societal problems addressed: Climate change, disaster risk, Economic and social development, water security and human health.

v. Benefits and co-benefits (Ecosystem services) provided-

Environmental	Social/Cultural	Economic
Biodiversity (C)	Regeneration of degraded areas	Income generation (protection from floods)
River flood mitigation	Health and quality of life	
Regulation of the water cycle		

vi. Potential disadvantages / negative impacts-

It was important to construct an additional system which firstly did not hamper the working of the existing system but instead helped the conventional system(Johansson, 2017). It was a new system for the people, so the people raised many doubts and questions. It was also taken care that open or similar systems should be made safe near places like schools or hospitals.

The system was underlined with geotextile, which led to the insufficiency of the system of infiltration and just worked as retention. The locals were disturbed by the noise during the construction phase, and residents also raised doubts about algae growth in the ponds, but a solution was used to resolve this problem.

vii. IUCN assessment-

Table 24 NBS self-assessment for Case 2 – Sweden - (Source- IUCN 2020, adapted)

Criterion	Your Criterion Score	Maximum Criterion Score	Normalised criterion	FINAL OUTPUT Your Criterion %age
1. Societal challenges	9	9	1.00	100%
2. Design at scale	9	9	1.00	100%
3. Biodiversity net-gain	12	12	1.00	100%
4. Economic feasibility	12	12	1.00	100%
5. Inclusive governance	14	15	0.93	93%
6. Balance trade-offs	7	9	0.78	78%
7. Adaptive management	8	9	0.89	89%
8. Sustainability and mainstreaming	9	9	1.00	100%
Total Percentage match				95%
Is this in adherance with the IUCN Global Standard for NbS?			In adherance	

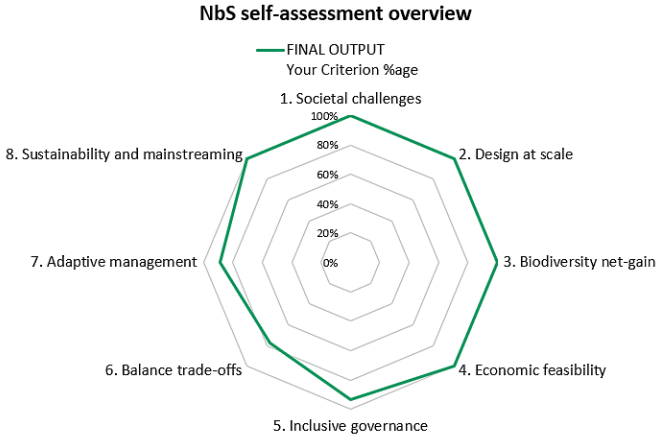


Figure 88 Spider Chart for self-assessment for Case -2-Sweden (Source- IUCN 2020, adapted

3. Case Study 3 *(Overall Study – 24)*

Water park treats, Laduviken

i. Description

With an approximate amount of 5 million Swedish Krona (91.775,20 according to the exchange rate on 10 November 2022, google exchange rate), a water park was constructed to reduce the pollutants which enter the lake along with stormwater(Envirobase, 2017). According to the natural water cycle, the water rises in the sky due to evaporation, and it forms clouds; it is considered to be the purest form of water as only water is evaporated and impurities are left behind. But as the precipitation begins, the water droplets come to the earth's surface, taking the polluted particles floating in the air along with them.

In Laduviken, the rainwater goes into the lakes (sedimentation basin) and other water channels without purification. The water also moves from roads and the nearby leaking subway to this polluted basin. According to this new system built between 2008-2009 (VA Guide, n.d.), the stormwater, rather than going to the lakes directly, its firsts run through an open stormwater string, which adds to the purification step. It also helps in enhancing the beauty of the area. The project also aims at reducing the Phosphorus content by 25%, from 27 kg/year to 20 kg/year kg/year (VA Guide, n.d., & Envirobase, 2017). The plant consists of a silting surface and a dry pond. A sedimentation basin will be constructed to relieve the stress on the older one (Envirobase, 2017).

Figure 89 A small pond- (Source- https://vaguiden.se/dagvatten/anlaggningswiki/dammar-och-vatmarker/laduvikens-vattenpark-dagvattenhantering-i-flera-steg/)

The system is divided into two parts. Firstly, the impure water from the subway is pumped into a small dam, which is later transferred through a system of channels which has two small ponds on the way into a drainage area just west of the main basin. While in the other part, the stormwater comes from the road and the university campus to the stormwater treatment plant. In this, first the stormwater flows through a flat grassy slope, and then it is collected in a dry pond. When the pond is filled with stormwater, it is drained slowly either through infiltration in the ground or through a small ditch, through which the water goes to the same marshy area as before(Stockholm Vatten AB, 2009).

The project involved many stakeholders working together like the Swedish transport administration, Stockholm vatten, Royal Djurgården Administration (KDF), local governmental agencies and locals who live nearby. There is a monitoring system in place, which also helps in maintenance of the system as some plants and grasses grow, which are to be removed so that functionally and aesthetically, the system works properly.

The project has many benefits. Most importantly, the existing stormwater treatment plant will not get overloaded and can work with better function. The phosphorus content will reduce in the water. The solution helps fulfil the goal of reducing soil and groundwater pollution, which is a goal of Stockholm's environmental programme. Also, it adds the benefit of recreational space for the people by providing an urban park with a water body. This has also become a place for educating people and the students from the university about stormwater and the work process. It is also to be scaled and copied at other places by a company (Ramboll).

ii. Classification of action/solution-

a) Degree of intervention

TYPE 3 – Design and management of new ecosystems

b) NBS approaches used

- Climate adaptation approaches
- Ecosystem based adaptation
- Ecosystem based management

- Ecosystem based mitigation
- Ecosystem based disaster risk reduction
- Ecological Restoration
- Ecological Engineering
- Infrastructure related approaches
- Natural Resource Management

c) NBS challenge to be solved/SDGs

The following SDGs are covered by this action/solution-

- Goal 4: Quality Education
- Goal 6: Clean water and sanitation
- Goal 11: Sustainable Cities and Communities
- Goal 13: Climate action
- Goal 15: Life on land

iii. Climate Hazards addressed- Prevention from floods, reduction in soil and water pollution, enhancement of biodiversity.

Heat	**Floods**				**Water**		**Others**
	River	**Surface Water**	**Coastal**	**Landslide**	**Scarcity**	**Quality**	**Soil pollution**
							Solved

iv. Societal problems addressed: Disaster risk, climate change, human health, water security.

v. Benefits and co-benefits (Eco system services) provided-

Environmental	**Social/Cultural**	**Economic**
River flood mitigation	Regeneration of degraded areas	Water provision (C)
Regulation of the water cycle	Recreation, education & gathering	Increased value of land/property
Groundwater recharge	Health and quality of life	
Biodiversity	Amenity value (C)	

Water Quality		
Soil quality & erosion prevention		

vi. Potential disadvantages / negative impacts-

There are no disadvantages by the solution, but it needs good maintenance by the removal of the silts and the excess vegetation; otherwise, the flow of water will not be good, and it will be a problem for the system. The system is transferred from a government body to a private company called Ramboll. Though the transfer was smooth in future reference, this private company has to coordinate properly with the government agencies and the people.

vii. IUCN assessment-

Table 25 NBS self-assessment for Case 3 – Sweden - (Source- IUCN 2020, adapted)

Criterion	Your Criterion Score	Maximum Criterion Score	Normalised criterion	FINAL OUTPUT Your Criterion %age
1. Societal challenges	7	9	0.78	78%
2. Design at scale	9	9	1.00	100%
3. Biodiversity net-gain	11	12	0.92	92%
4. Economic feasibility	11	12	0.92	92%
5. Inclusive governance	11	15	0.73	73%
6. Balance trade-offs	7	9	0.78	78%
7. Adaptive management	8	9	0.89	89%
8. Sustainability and mainstreaming	8	9	0.89	89%
Total Percentage match				86%
Is this in adherance with the IUCN Global Standard for NbS?			In adherance	

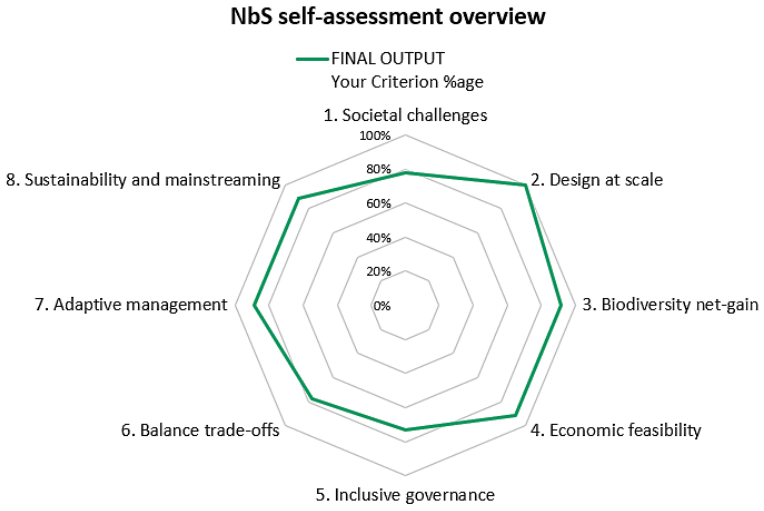


Figure 90 Spider Chart for self-assessment for Case -3 -Sweden- (Source- IUCN 2020, adapted

4.2.4 Germany

Germany is a developed country located in Central Europe. UN kept it in High-income countries based on Economies by per capita GNI in June 2018 (United Nations, 2019). It borders France, Denmark, Poland, Czech Republic, Austria, Switzerland, Luxembourg, and Belgium. It is the second most populous country in Europe and has a population of approximately 83,129,285 people (World Bank, 2021) and faces many natural disasters like floods, high temperatures, epidemics, earthquakes, landslides and storms (World bank, 2022) .

Figure 91 Location of Germany in Europe (Source- https://commons.wikimedia.org/wiki/File:Germany_in_Europe.svg)

1. Case Study 1 *(Overall Study – 25)*

Green corridors: Network of Ventilation corridors, Stuttgart

i. Description

Stuttgart is particularly vulnerable to poor air quality due to its location in a basin of the valley, which is also the reason for its warm temperature, low wind speeds, industrial activity, and large amount of traffic. The development on the slopes of the valley has also stopped the air from moving outside and worsened the effects. According to a report in 2016 study by the state capital of Stuttgart and the German Weather Service, shows that the heat exposure (with days maximum recorded temperature above 32°C) in Stuttgart city centre can double compared to 1971-2000 to 2031-2060(Schlegel & Koßmann, 2017). To understand the effects and distribution of temperature and flow of cold air, which follows patterns of the city's topography and land use, a Climate Atlas was developed. These findings led to the recommendation of many changes in the planning and zoning rules that added more open spaces and preserved the existing ones in highly populated regions. This led to the protection of nearly 39% of the Stuttgart area, expansion of green spaces (urban forests, trees in parks, and streets), and preservation of ventilation corridors from urban growth(*Green corridors: Ventilation corridors network, Stuttgart*, n.d.). Four cool air corridors—the Nesenbachtal valley, Feuerbachtal valley, Lindenbachtal valley, and Rohrakker valley systems—were identified for special zoning and a prohibition on construction

Figure 93 Green corridor- (Source- https://energy-cities.eu/best-practice/green-ventilation-corridors/)

Figure 92 Stuttgart tramway tracks -(Source- https://climate-adapt.eea.europa.eu/en/metadata/case-studies/stuttgart-combating-the-heat-island-effect-and-poor-air-quality-with-green-ventilation-corridors/11198431.png/view)

encroachment based on urban climatic mapping, which was worked upon in the Regional Plan of Stuttgart (1998)(*Green corridors: Ventilation corridors network, Stuttgart*, n.d.).

Many other adaptation strategies have also been implemented in the city to increase resilience to hotter summers and more frequent heatwaves, like installing green roofs, landscaping tram tracks and buildings, using street trees to shade building facades, and converting smaller public spaces into "cool spots". Improvements are also being made to blue infrastructures like, drinking fountains, etc. Some others(Ministerium für Verkehr und Infrastruktur Baden-Württemberg, 2012) new rules are-

- The developed areas should be surrounded by vegetation, and green spaces should be connected to facilitate air exchange.
- The urban sprawl has to be avoided, and the valleys should be left vacant as it is a medium of air delivery into the city. Also, the hillsides should be left undeveloped.
- Saddle-like topographies should be developed as it works as an air induction corridor.
- The trees with a circumference of more than 80 cm over a height of 1m should be protected.

The "Climate Atlas 2008" was developed with a close collaboration between Verband Region Stuttgart (the association of regional cities and municipalities) and the City of Stuttgart. Hillside Development Outline Plan (dated 02/10/2007 / 01/02/2008) existed for districts of Stuttgart; it had an important role in the protection of green spaces in the city. Green spaces with higher vegetation also reduce the extreme wind speeds during storms and act as windshields. Natural green belts are created by topographic features like streams and meadow valleys, which also serve as the best routes for air circulation(State Capital Stuttgart, 2010). Given that components of the landscape and environment protection also help the urban climatology arguments, keeping these free of encroachment by structures does not require a great deal of persuading. On one side of the scale, efforts to increase housing stock and acquire land for construction must be evaluated against efforts to increase fresh air supply and reduce thermal stress on the other. The balance will probably be overturned by the projected consequences of climate change, which will significantly outweigh any known effects on urban climate.

These measures help reduce the effects of the heat island, which will worsen because of hotter summers and become much more frequent with intense heatwaves. By dispersing and lowering air pollutants, ventilation corridors and expanding green spaces will help to improve the quality of air in cities. The City of Stuttgart has been paying about two million euros every year since 2016 as part of a green funding scheme, which is currently going strong.

ii. Classification of action/solution-

a) Degree of intervention

TYPE 2 – NBS for sustainability and multifunctionality of managed ecosystems

TYPE 3 - Design and management of new ecosystems

b) NBS approaches used

- Climate adaptation Approaches
- Community Adaptation Approaches
- Ecosystem Based Adaptation

- Ecosystem Based Management
- Ecosystem Based Mitigation
- Ecosystem Based Disaster risk reduction
- Ecological Engineering
- Infrastructure related approaches

c) NBS challenge to be solved/SDGs

The following SDGs are covered by this action/solution-

- Goal 6: Clean water and sanitation
- Goal 11: Sustainable Cities and Communities
- Goal 13: Climate action
- Goal 15: Life on land

iii. Climate Hazards addressed- Protection from floods.

Heat	Floods				Water		Others
	River	Surface Water	Coastal	Landslide	Scarcity	Quality	
							None

iv. Societal problems addressed: Climate change, disaster risk, and human health.

v. Benefits and co-benefits (Ecosystem services) provided-

Environmental	Social/Cultural	Economic
Biodiversity	Amenity value	Increased value of land/property
	Health and quality of life	

vi. Potential disadvantages / negative impacts-

To stop new buildings from being constructed in the ventilation corridors, it is necessary to give lands at other places for the construction of building, because due to immigration from other cities and from abroad, Stuttgart needs more buildings and services for the increasing population. Also, it should be taken care that locals' points of view should also be considered at all relevant steps during the implementation of various appropriate measures.

vii. IUCN assessment-

Table 26 NBS self-assessment for Case 1 – Germany - (Source- IUCN 2020, adapted)

Criterion	Your Criterion Score	Maximum Criterion Score	Normalised criterion	FINAL OUTPUT Your Criterion %age
1. Societal challenges	8	9	0.89	89%
2. Design at scale	9	9	1.00	100%
3. Biodiversity net-gain	11	12	0.92	92%
4. Economic feasibility	11	12	0.92	92%
5. Inclusive governance	14	15	0.93	93%
6. Balance trade-offs	6	9	0.67	67%
7. Adaptive management	9	9	1.00	100%
8. Sustainability and mainstreaming	9	9	1.00	100%
Total Percentage match				92%
Is this in adherance with the IUCN Global Standard for NbS?			In adherance	

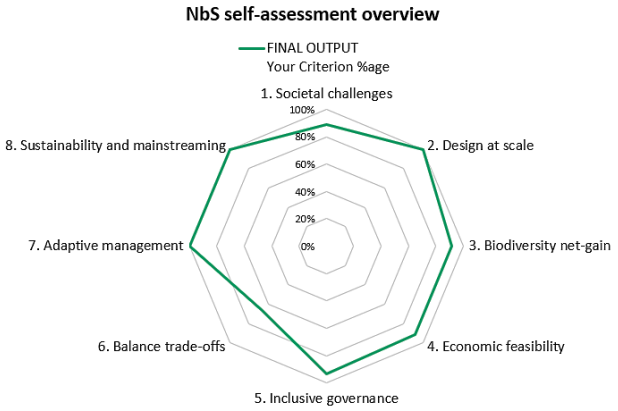


Figure 94 Spider Chart for self-assessment for Case -1-Germany- (Source- IUCN 2020, adapted)

2. Case Study 2 *(Overall Study – 26)*

Green-blue climate corridor, Kamen

i. Description

A green-blue corridor has been created to improve the climate and restore the natural water supply. The essential aspects of the project were the restoration of the streams and the disconnection of rainwater from sewage water.

"Heerener Mühlbach" was a canal but used as a wastewater stream, creating many challenges. The water body had a concrete bed containing waste and stormwater. The wastewater created problems for both people and the biodiversity of that area. It had a foul smell due to the waste and rotting process. During heavy rains, it was not possible for the canal to remove water from the area, which led to flooding of the surrounding areas.

Figure 95 Restored Heerener Mühlbach in Kamen (Source- Lippeverband)

To make the area better, the first priority was to disconnect the wastewater and the freshwater(rainwater). So, an underground sewer pipe was laid along the river. Wherever possible, the concrete bed was removed. The hard banks of the river were changed to natural (or nature-like) banks. The river started to flow on a more natural course and on a natural bed.

It was called the “No regret system”, meaning that the measures used to show benefits in all cases and not just in the worst effects of climate change(Ploteau, 2013). Since the sewage system won't have to handle the same volume of precipitation, the ecological development and sustainable use of rainwater can lessen floods.

In case of heavy downpours, the run-off of water is slowed by these solutions, which help in water infiltration. The water cycle is regulated in its original form; during summer, it is easy to cope with heatwaves. The participatory approach also helps the residents gain knowledge about sustainable development and climate change. These methods also showed the strategical linkages between demographic and economic factors (Ploteau, 2013).

Overall, the initiative succeeded in many ways like it helped in improving the microclimate, boosting ecosystem resilience, and long-term, cost-effectively adapting the local water infrastructure. As a result of the old "mixed canalised system," which combined rainwater and sewage, there was a greater risk of flooding during storms. After the solutions, the regions of low water during summer do not face any problems, while heavy rainfall doesn't result in much flooding. The natural water supply balance has been enhanced by directing precipitation into the restored stream, benefitting local animals and offering better recreational areas for locals.

ii. Classification of action/solution-

a) Degree of intervention

TYPE 2 – NBS for sustainability and multifunctionality of managed ecosystems

TYPE 3 – Design and management of new ecosystems

b) NBS approaches used

- Climate adaptation approaches
- Community-Based adaptation
- Ecosystem based adaptation
- Ecosystem based management
- Ecosystem based mitigation
- Ecosystem based disaster risk reduction
- Ecological Restoration
- Ecological Engineering
- Infrastructure related approaches
- Natural Resource Management

c) NBS challenge to be solved/SDGs

The following SDGs are covered by this action/solution-

- Goal 3: Good health and well-being
- Goal 6: Clean water and sanitation
- Goal 11: Sustainable Cities and Communities
- Goal 13: Climate action

- Goal 14: Life below water
- Goal 15: Life on land

iii. Climate Hazards addressed- Prevention from floods, enhancement of biodiversity and prevention from heat and scarcity of water during summer months

Heat	Floods				Water		Others
	River	Surface Water	Coastal	Landslide	Scarcity	Quality	
							None

iv. Societal problems addressed: Disaster risk, climate change, human health, water security.

v. Benefits and co-benefits (Eco system services) provided-

Environmental	Social/Cultural	Economic
River flood mitigation	Regeneration of degraded areas	Water provision (C)
Regulation of the water cycle	Amenity value (C)	Increased value of land/property
Groundwater recharge	Spiritual, religious &artistic values	
Biodiversity (C)	Recreation, education & gathering	
Water Quality(C)	Health and quality of life	

vi. Potential disadvantages / negative impacts-

There are no disadvantages, but the restoration of water bodies should be done carefully under expert supervision as sometimes, after the restoration works, the plants and trees are planted in excess, and they grow excessively and sometimes take excess water from the water body passing through.

vii. IUCN assessment-

Table 27 NBS self-assessment for Case 2 – Germany - (Source- IUCN 2020, adapted)

Criterion	Your Criterion Score	Maximum Criterion Score	Normalised criterion	FINAL OUTPUT Your Criterion %age
1. Societal challenges	9	9	1.00	100%
2. Design at scale	7	9	0.78	78%
3. Biodiversity net-gain	10	12	0.83	83%
4. Economic feasibility	10	12	0.83	83%
5. Inclusive governance	11	15	0.73	73%
6. Balance trade-offs	5	9	0.56	56%
7. Adaptive management	7	9	0.78	78%
8. Sustainability and mainstreaming	9	9	1.00	100%
Total Percentage match				81%
Is this in adherance with the IUCN Global Standard for NbS?			In adherance	

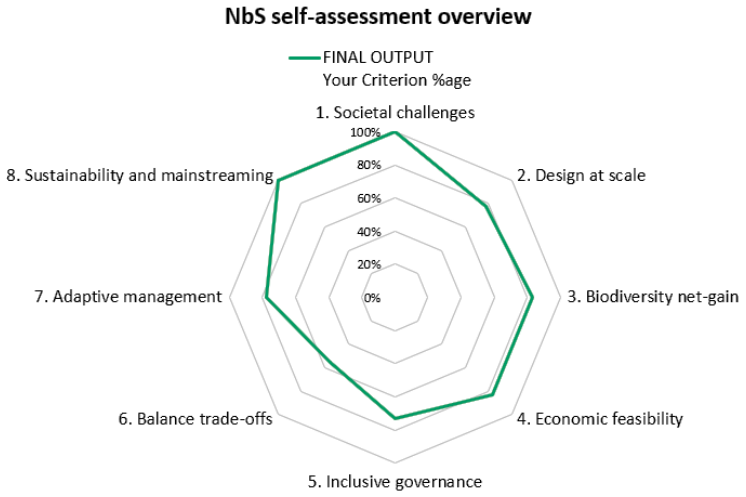


Figure 96 Spider Chart for self-assessment for Case -2 -Germany- (Source- IUCN 2020, adapted)

3. Case Study 3 *(Overall – 27)*

Hamburg green roof strategy

i. <u>Description</u>

Figure 97 Green roof in Humburg (Source- https://www.hamburg-news.hamburg/en/ location/ Hamburg-strengthening-its-resilience-climate-change)

Hamburg, one of the cities in Germany, is trying to become greener. It had developed a Green Roof Strategy and was the first in Germany to do . Hamburg Ministry for Environment and Energy is providing 3 million euros until 2024 for creation of green roofs(Rizzi et al., 2020). The ministry is providing a subsidy of 60% on installation costs of green roofs. These help lower maintenance costs compared to traditional roofs and save on building insulation. Also, it helps in a 50% on reduction of rainwater fees, which is due to added benefit of green roofs(Vignola et al., 2017).

Germany, just like other countries, is facing climate change effects. According to the National Assessment on Climate Change for Germany (2017), by the end of the 21st century, the average air temperature (near-surface) will increase between 1.2 - 3.2° C, or in the worst case scenario,

to 3.2 to 4.6° C. Green roofs will help in reducing these unpleasant scenarios and the increase of temperatures during the summers.

The Green Roof Strategy focuses on having at least 70% green roofs for the new buildings and flat or pitched roofs that will be renovated(Hamburg.de, n.d.; Rizzi et al., 2020). Then the government want to open 20% of these areas for the locals for recreational uses(Quanz, 2020). To promote green roofs, the city has started a campaign called "On Your Roofs, Get Set, Green!" They are promoting with the help of brochures, press, internet, posters, etc. (Urban Nature Atlas, n.d.-b). Adding to it, they have a full-time communication officer in the ministry. Also, the city is working in close partnership with HafenCity University. They are working on international findings and trying to use them in the city of Hamburg. They also want to prepare guidance techniques that other cities can use Davidse & Bornholdt, 2016). This part of the scientific work is funded by the Federal government of Germany within the "Measures to Adapt to Climate Change" project.

The project includes extensive, simply intensive, and intensive green roofs. The extensive green roofs are the cheapest and need very low maintenance. The city has worked on its own way of giving the subsidy. It is giving subsidies and compensations on the basis of the surface and thickness of the green roofs instead of the regularly used method of water retention capacity of the roofs(Bornholdt, 2018). A stakeholder group was made, with landscape architects, urban planners, companies, constructors, fire service, and cost estimators who had a common goal of "100 hectares in 10 years"(Davidse & Bornholdt, 2016). Locals were taught and trained about sustainable development.

Green roofs are a clear investment for the future. With a few investments, it helps a good return as it helps reduce the heating and cooling costs of the buildings. Intensive roofs save around 3-10 %, while extensive roofs save around 44% of energy. Along with this, it also helps save around 50% of the rainwater on average(Bornholdt, n.d.), so the rainwater does not go to the sewage system, thus protecting it from overburden. According to a study by *"Hamburg's green roof economic evaluation",* extensive green roofs costs around 40-45 € /m^2, the intensive green roofs costs around 58 € /m^2 and both of them can equal outs the costs in 40 years without including welfare benefits received by the green roofs(Vignola et al., 2017). Another important aspect is that green roofs last almost twice the flat roofs. Fraunhofer Institute for building physics (Fraunhofer-Institut für Bauphysik) did calculations and found that the lifespan of green roofs is around 40 years(Davidse & Bornholdt, 2016).

ii. Classification of action/solution-

a) Degree of intervention

TYPE 3: Design and management of new ecosystems

b) NBS approaches used

- Climate adaptation approaches
- Community-Based adaptation
- Ecosystem based management
- Ecological based mitigation
- Ecological engineering
- Infrastructure related approach

c) NBS challenge to be solved/SDGs

The following SDGs are covered by this action/solution-

- Goal 3: Good Health and Well-being
- Goal 11: Sustainable cities and communities
- Goal 12: Responsible Consumption and Production
- Goal 13: Climate action
- Goal 15: Life on land

iii. Climate Hazards addressed- Reduction of urban heat islands, water saving techniques.

Heat	Floods				Water		Others
	River	Surface Water	Coastal	Landslide	Scarcity	Quality	
							None

iv. Societal problems addressed: Climate change, human health.

v. Benefits and co-benefits (Eco system services) provided-

Environmental	Social/Cultural	Economic
Biodiversity	Recreation, education & gathering	Increased value of land/property (C)
Air quality	Amenity value (C)	Income generation
Temperature regulation	Health and quality of life	Energy savings
Pollination		
Regulation of the water cycle		

vi. Potential disadvantages / negative impacts-

There is a debate going on between different researchers that if green roofs provide water retention capacities. To get a solution, HafenCity University has been doing different researches to come to a conclusion to this problem with the "RISA Pilot Project"(Davidse & Bornholdt, 2016; Rizzi et al., 2020). Another aspect of the cities is focusing on affordable housing for all the people rather than going towards green roofs. The industry sector is reluctant to accept regulations about green roofs being made compulsory with solar panels. The problem of green roofs not being feasible for houses with pitched roofs is also a challenge, as green roofs can be made at a certain angle only.

vii. IUCN assessment-

Table 28 NBS self-assessment for Case 3– Germany - (Source- IUCN 2020, adapted)

Criterion	Your Criterion Score	Maximum Criterion Score	Normalised criterion	FINAL OUTPUT Your Criterion %age
1. Societal challenges	9	9	1.00	100%
2. Design at scale	9	9	1.00	100%
3. Biodiversity net-gain	10	12	0.83	83%
4. Economic feasibility	11	12	0.92	92%
5. Inclusive governance	14	15	0.93	93%
6. Balance trade-offs	7	9	0.78	78%
7. Adaptive management	7	9	0.78	78%
8. Sustainability and mainstreaming	9	9	1.00	100%
Total Percentage match				90%
Is this in adherance with the IUCN Global Standard for NbS?			In adherance	

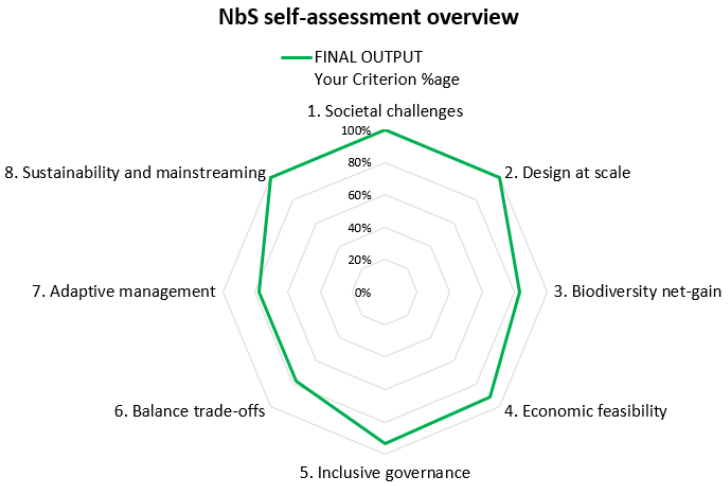


Figure 98 Spider Chart for self-assessment for Case -3- Germany- (Source- IUCN 2020, adapted)

4.2.5 Denmark

Denmark is a developed country located in Northern Europe. It is a Nordic country in Scandinavia. UN kept it in High-income countries based on Economies by per capita GNI in June 2018 (United Nations, 2019). It borders Germany and is connected to Sweden with a bridge tunnel. It has a population of approximately 5,856,733 people (World Bank, 2021) and faces natural disasters like floods, storms, and storms (World bank, 2022) .

Figure 99 Location of Denmark in Europe (Source- https://commons. wikimedia.org/wiki/File:Denmark_in_Europe.svg)

1. Case Study 1 *(Overall – 28)*

Climate adaptation practices in Risvangen, Denmark

i. Description

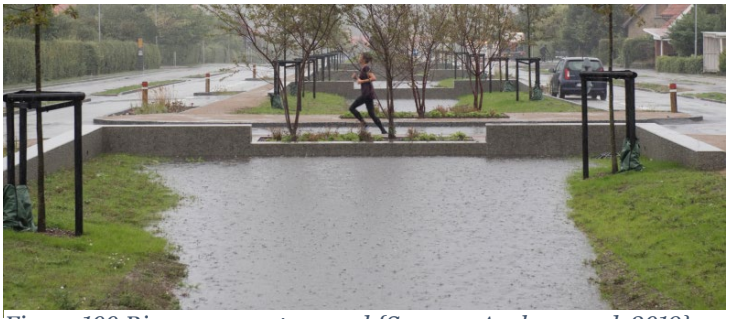


Figure 100 Risvangen water pond {Source- Aarhus vand, 2019}

Most important aspect of nature-based solutions is public participation in various stages and being able to raise their points; this is the main objective of this project in Risvangen district, which comes under Aarhus, Denmark. Here urban spaces are being used for local rainwater drainage (LRD) with the full support of the locals, government agencies and private companies(Nielsen, 2019). These spaces help in adapting to future heavy rains and for recreational purposes as well.

Figure 101 Climate adaptation in Risvangen - (Source- H Jensen)

Before the implementation of the solution, wastewater and stormwater passed together in single pipe. During heavy downpours it used to become impossible for the pipes to carry water, thus problems of water filling the basements and on roads happened. The overflowed water polluted the bathing waters nearby (Den Permanente). But now numerous pools, lakes, streams and water channels are created, which helps in creating enough space for water during excess rains (23 pools in *Risvang Allé*). In place of 4 lanes (2 in each direction), now *Risvang Allé* has 2 lanes (one in each direction), and in the centre, a big green space with trees is created to increase the green space of the area(Aarhus vand, 2019). This open water system makes the water visible, which helps the humans visibly and the residents can enjoy the scenery. According to research by Ishimatsu et al., (2017), rain gardens (used here in the form of ponds and open drains) may successfully postpone flood peaks, minimise overland runoff, and play a significant part in water cycle rehabilitation. Rain gardens can also lessen the reliance on traditional sewage systems even if rainwater cannot be handled entirely without them in metropolitan areas.

The project incorporated the residents from the start, and they were invited to understand the benefits of rainwater harvesting. Then they were asked if they wanted their houses to be attached with the water drainage system or to build a minor water management system in their garden/yard(Aarhus Vand, n.d.). Added values in the form of recreation areas were developed for the locals. Separation of water also reduced CO2, as now all the water does not have to pass through the sewage treatment plant. According to the City of Aarhus, 3.2 tons CO_2 has reduced annually(Gruppe F, 2019; Sustainia, 2018). While 85% of nitrogen and 70% of phosporus was reduced(Gruppe F, 2019). The visible rainwater solutions above the surface are also cheaper and add value to the area.

ii. Classification of action/solution-

a) Degree of intervention

TYPE 3 – Design and management of new ecosystems

b) NBS approaches used

- Climate adaptation approaches
- Community-Based adaptation
- Ecosystem based adaptation
- Ecosystem based management
- Ecosystem based mitigation
- Ecosystem based disaster risk reduction
- Ecological Restoration
- Ecological Engineering
- Infrastructure related approaches

c) NBS challenge to be solved/SDGs

The following SDGs are covered by this action/solution-

- Goal 3: Health and well-being
- Goal 6: Clean water and sanitation
- Goal 11: Sustainable Cities and Communities
- Goal 13: Climate action
- Goal 15: Life on land
- Goal 16: Peace, justice and strong institutions

iii. Climate Hazards addressed- Prevention from floods, reduction in CO_2 and other harmful elements in water and soil, enhancement of biodiversity.

Heat	**Floods**				**Water**		**Others**
	River	**Surface Water**	**Coastal**	**Landslide**	**Scarcity**	**Quality**	**Soil pollution**
							Solved

iv. Societal problems addressed: Disaster risk, climate change, human health.

v. Benefits and co-benefits (Ecosystem services) provided-

Environmental	Social/Cultural	Economic
River flood mitigation	Regeneration of degraded areas	Water provision (C)
Regulation of the water cycle	Recreation, education & gathering	Increased value of land/property
Groundwater recharge	Health and quality of life (C)	
Biodiversity	Amenity value (C)	
Water Quality		
Soil quality & erosion prevention		

vi. Potential disadvantages / negative impacts-

No disadvantages. Due to the reduced road size, some problems were faced by the people but they were soon accustomed to the new road. Also, these drains can be a little dangerous for kids, so where the kids play, they should be protected and have proper signboards.

vii. IUCN assessment-

Table 29 NBS self-assessment for Case 1 –Denmark - (Source- IUCN 2020, adapted)

Criterion	Your Criterion Score	Maximum Criterion Score	Normalised criterion	FINAL OUTPUT Your Criterion %age
1. Societal challenges	9	9	1.00	100%
2. Design at scale	5	9	0.56	56%
3. Biodiversity net-gain	10	12	0.83	83%
4. Economic feasibility	9	12	0.75	75%
5. Inclusive governance	11	15	0.73	73%
6. Balance trade-offs	6	9	0.67	67%
7. Adaptive management	8	9	0.89	89%
8. Sustainability and mainstreaming	9	9	1.00	100%
Total Percentage match				80%
Is this in adherance with the IUCN Global Standard for NbS?			In adherance	

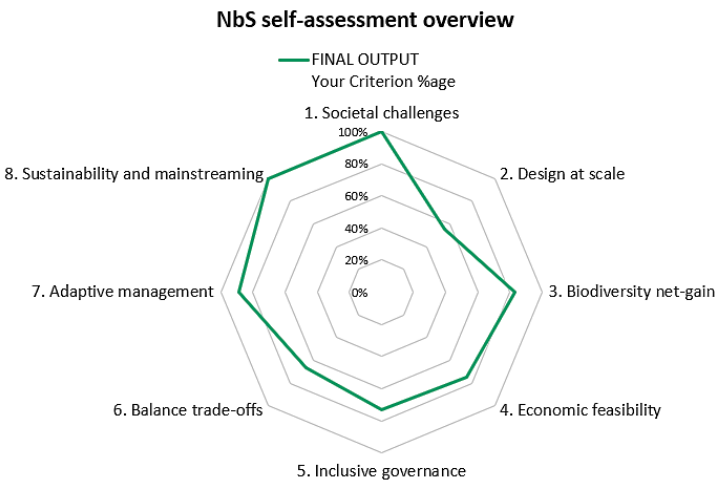


Figure 102 Spider Chart for self-assessment for Case -1 - Denmark- (Source- IUCN 2020, adapted)

2. Case Study 2 *(Overall Study – 29)*

Restoration of Lille Vildmose

i. Description

Figure 103 Lille Vildmose (Source- https://ec.europa.eu/environment/nature/natura2000/awards/previous-editions/2018-edition/finalists/html/3154.html)

Raised bogs are made of a deep body of peat and can be several metres higher than the surrounding terrain. They have a layer of characteristic bog shrubbery on top of them. This remarkable domed structure is difficult to realize due to the expanse of the bog and sometimes a border of secondary woods. Intact elevated bogs are typically recognised by their placement in lowland plains and flat valley bottoms, bog vegetation, and protected status. Raised bogs are significantly wetter than the surrounding terrain. As a sponge, the peat holds onto the moisture, releasing it gradually(The Wildlife Trusts, n.d.). They are a few habitat places which are self-sustaining which remain unchanged for a long period. Raised bogs occur at locations where precipitation is more than evaporation; also, they lie above the water table, so they receive water only from precipitation(Danish Nature Agency, Aalborg municipality, et al., n.d.).

They used to cover a huge part of Denmark but have disappeared due to peat cutting, extensive farming and drainage. Out of 55km^2, only 20km^2 of raised bog in Lille Vildmose remains today. More than 83% of the total preserved raised bog in Denmark is found in Lille Vildmose(Danish Nature Agency, Aalborg municipality, et al., n.d.). To preserve the raised bog and create a foundation for the restoration of Lille Vildmose, the project started in 2011 and ended on 31st December 2016(Nature Agency Denmark et al., n.d.). The project is also supported by Life+ Nature. It is essential in Natura 2000 network thus, it received 75% of the costs in place of the normal 50 % from Life+ Nature(Life Public Database, n.d.). “The approximate soil organic carbon in Lille Vildmose is roughly 7.4 million tons or roughly 10% of the Danish peat carbon volume (Joosten, 2009).

The land area which needed protection is 76 km^2. This raised bog was formed around 800 AD. From 1761, the government started to use its space for agriculture and thus drained some of its lakes. So, the first step was to stop draining the bog because once drained, the peats start to decompose. This leads to soil becoming less acidic, thus making a suitable environment for trees like Birch to grow, which sucks all the nutrients from the soil. Dams and retaining networks were built at various places to stop or slow the water. The next important part was to cut the trees in the bog. Bare hands were used to remove the trees to protect the bog. And bog was wetted again to prevent them from decomposing. Another aspect was to protect the birds which come here and who migrate here during certain seasons. For this, the populations of raccoon dog, mink and red fox (local species) were controlled by catching them through traps and monitoring(Lars et al., 2021) .

Sphagnum mosses turn into peat in the raised bog. So, they were required to be grown. Firstly, the top layer of soil was removed, and Sphagnum mosses were planted, then they were cut and spread all over to form peat(Danish Nature Agency, Aalborg municipality, et al., n.d.). Certain areas were fenced to prevent the grazing animals from entering while allowing wild animals to come (carts transported fencing materials with balloon tyres). The lake (Birkesø), which was

drained in the 1760s was restored; this helped in halting the drainage of a part of the bog(Ramboll Group, n.d.). Dikes were created so that seeping can be stopped in the upper part of the bog.

Figure 104 Restoration of Lille Vildmose bogland (Source- https://ramboll.com/projects/reh/restoration-lille-vildmose)

The project had many benefits. With a close partnership with the Danish Ornithological Society - Birdlife Denmark, birds are monitored, and Lille Vildmose has become an essential destination for birds. Deer and elk have also increased(Danish Nature Agency, Aalborg Municipality, et al., n.d.). It also had public participation, and people and students are now educated about the raised bog and its importance(Lars et al., 2021). In 2013 through the Ramsar Convention, Lille Vildmose was designated a wetland of international importance(Life Public Database, n.d.; Ramsar Sites Information Service, 2013).

In thesis research by Bachmore, (2018), the Delphi technique was used to interview important experts to assess biodiversity. The evaluations on birds, vascular plants, and mosses were part of the questionnaires, and they linked to the opinions of scientific experts on the results of restoration for certain indicator species within these groups. The restoration operations were anticipated to be "excellent" or "very good" for 11 of the 12 bird species. In contrast, the habitat quality was anticipated to be "good" for 6 of the 11 vascular plants and 6 of the 10 mosses. The foremost authorities anticipated that no species habitats to deteriorate in quality.

ii. Classification of action/solution-

a) Degree of intervention

TYPE 1 – Better use of protected/ natural ecosystems

b) NBS approaches used

- Ecosystem based adaptation
- Ecosystem based management
- Ecological Restoration
- Natural Resources Management

c) NBS challenge to be solved/SDGs

The following SDGs are covered by this action/solution-

- Goal 11: Sustainable cities and communities
- Goal 13: Climate action
- Goal 14: Life below water
- Goal 15: Life on land

iii. Climate Hazards addressed- Prevention of loss of bog, enhancement of biodiversity.

Heat	Floods				Water		Others
	River	Surface Water	Coastal	Landslide	Scarcity	Quality	Loss of bog
							Solved

iv. Societal problems addressed: Disaster risk, climate change.

v. Benefits and co-benefits (Eco system services) provided-

Environmental	Social/Cultural	Economic
Biodiversity	Regeneration of degraded areas	Increased tourism
Carbon storage	Recreation, education & gathering	
	Amenity value (C)	

vi. Potential disadvantages / negative impacts-

In the beginning of the project, some people had issues with the project, as they used to graze their animals in the area. The project experienced some resistance initially but slowly people understood the importance of the raised bog and cooperated in the project. The bog still produces GHGs, although at a reduced level. By using tier 1 (IPCC Wetlands Supplement 2014), the GHG emissions were 17,780 CO2-eq. per year before the restoration, which got reduced to 7,294 CO2-eq. per year after the restoration activities were done(Lars et al., 2021).

vii. IUCN assessment-

Table 30 NBS self-assessment for Case 2 –Denmark - (Source- IUCN 2020, adapted)

Criterion	Your Criterion Score	Maximum Criterion Score	Normalised criterion	FINAL OUTPUT Your Criterion %age
1. Societal challenges	8	9	0.89	89%
2. Design at scale	8	9	0.89	89%
3. Biodiversity net-gain	12	12	1.00	100%
4. Economic feasibility	11	12	0.92	92%
5. Inclusive governance	9	15	0.60	60%
6. Balance trade-offs	7	9	0.78	78%
7. Adaptive management	8	9	0.89	89%
8. Sustainability and mainstreaming	9	9	1.00	100%
Total Percentage match				87%
Is this in adherance with the IUCN Global Standard for NbS?			In adherance	

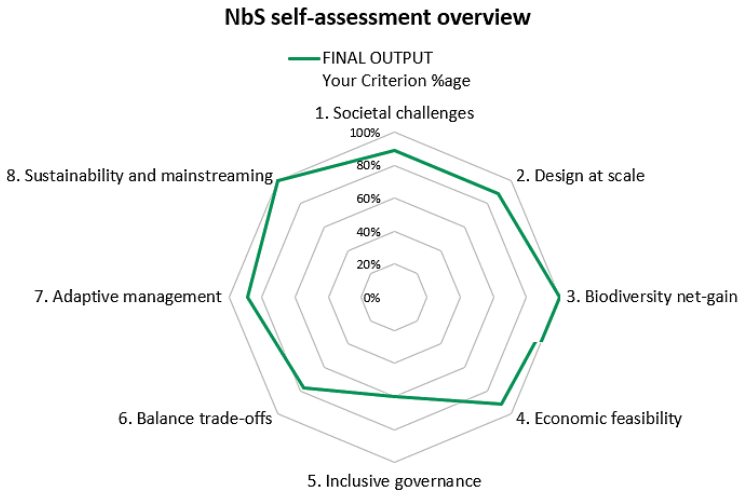


Figure 105 Spider Chart for self-assessment for Case -2- Denmark- (Source- IUCN 2020, adapted)

4.2.6 Belgium

Belgium is a developed country located in Northwestern Europe. UN had kept it in High-income countries by Economies by per capita GNI in June 2018 (United Nations, 2019). It borders Netherlands, Germany, Luxembourg and France. It has a population of approximately 11,587,882 (World Bank, 2021) and faces natural disasters like floods, high temperatures, earthquakes, and storms (World bank, 2022) .

Figure 106 Location of Belgium in Europe (Source- https://commons.wikimedia.org/wiki/File:Belgium_in_Europe.svg)

1. Case Study 1 *(Overall – 30)*

Community Garden Biodroom

i. Description

In Antwerp, the capital of Belgium, a community garden was created where locals can meet and make their vegetables grow organically. It is also a place where children can play freely(Biodroom, n.d.). It started as a place for gardening, technology and art in the city, but since 2014 it has been functioning as a community garden(Urban Nature Atlas, n.d.-a). It is taken care by the locals. It also works as a place where people are educated about ecological gardening and agriculture through different pieces of training and workshops(de Ceuster & Maelstaf, 2020). There are fruit trees, flowers and other kinds of trees planted in the garden. Gardening is done in large, big bags and a few greenhouses.

Figure 107 Biodroom - (Source- https://www.antwerpen.be/info/58ab0bdeca69bc22121ca3c7/samentuin-biodroom-2-0)

The project aimed to have social cohesion among people with the help of the work they will do in the community garden. The gardens have people singing,

music playing, children enjoying, students and people getting trained, many workshops happening, people chatting, etc. (Zuallaert, 2013).

The area allotted was 2 hectares, and in 500 bags, the vegetables were grown. Bags were used because it was thought that the project would be temporary and the soil in the area was not suitable for cultivation(Urban Nature Atlas, n.d.-a). Some programmes were started in the area. Like, workshops for foreigners to learn Dutch(Zuallaert, 2013), 'Seed Bib', where people can take seeds which they need and after the cultivation of fruits or vegetables, they can return the seeds. Then, local artists made some art and crafts from natural and reused materials.

The project was based on the ideas of Elke Bruno(Elke Bruno, n.d.) and was started by the municipality of Antwerp. Until 2013, the gardens were maintained by the municipality but since 2014, citizens have taken care of the gardens. An association of ecological gardening called Velt helps the people and keep in contact EcoHuis (Centre of Sustainability of the municipality of Antwerp). “The project is part of the 'Actieplan Lokaal Cultuurbeleid Antwerpen 2012' (Action Plan Local Culture Strategy of Antwerp)”(Gemeente Antwerpen, 2011). The funds from the municipality and NGOs are involved. Citizens in the form of labour help in the project.

It helps the locals get organic food that can be eaten or sold in the market. It increased the health of the people, and social relationships are developed(de Ceuster & Maelstaf, 2020). The connection of a person to person and person to nature is developed. It can be concluded that self-management of the ecosystems is the central ideology here.

ii. Classification of action/solution-

a) Degree of intervention

TYPE 3: Design and management of new ecosystems

b) NBS approaches used

- Climate adaptation approaches
- Community-Based adaptation
- Ecosystem based management
- Ecological based mitigation
- Infrastructure related approach
- Sustainable Agriculture

c) NBS challenge to be solved/SDGs

The following SDGs are covered by this action/solution-

- Goal 3: Good Health and Well-being
- Goal 10: Social justice, cohesion, and equity
- Goal 11: Sustainable cities and communities
- Goal 12: Responsible Consumption and Production
- Goal 15: Life on land

iii. Climate Hazards addressed- Reduction of urban heat islands.

Heat	Floods				Water		Others
	River	Surface Water	Coastal	Landslide	Scarcity	Quality	Food availability
							Solved

iv. Societal problems addressed: Climate change, human health, food security, and economic and social development.

v. Benefits and co-benefits (Eco system services) provided-

Environmental	Social/Cultural	Economic
Biodiversity	Recreation, education & gathering	Increased value of land/property (C)
Air quality	Amenity value (C)	Income generation
Temperature regulation	Health and quality of life	Food provision
Pollination	Employment	
Regulation of the water cycle	Spiritual, religious &artistic values	

vi. Potential disadvantages / negative impacts-

In the starting, the municipality had to take certain steps to make the people familiar with the approach of community gardens, but then after a few years people took it over. This shows that people need a push to start something new, and there are initial doubts. In addition, budget is a problem for the project because initially, the municipality was providing it but now the locals take care of everything with minor help from NGOs and a few talks with the municipality.

vii. IUCN assessment-

Table 31 NBS self-assessment for Case 1 –Belgium - (Source- IUCN 2020, adapted)

Criterion	Your Criterion Score	Maximum Criterion Score	Normalised criterion	FINAL OUTPUT Your Criterion %age
1. Societal challenges	7	9	0.78	78%
2. Design at scale	5	9	0.56	56%
3. Biodiversity net-gain	7	12	0.58	58%
4. Economic feasibility	5	12	0.42	42%
5. Inclusive governance	11	15	0.73	73%
6. Balance trade-offs	4	9	0.44	44%
7. Adaptive management	3	9	0.33	33%
8. Sustainability and mainstreaming	7	9	0.78	78%
Total Percentage match				58%
Is this in adherance with the IUCN Global Standard for NbS?			In adherance	

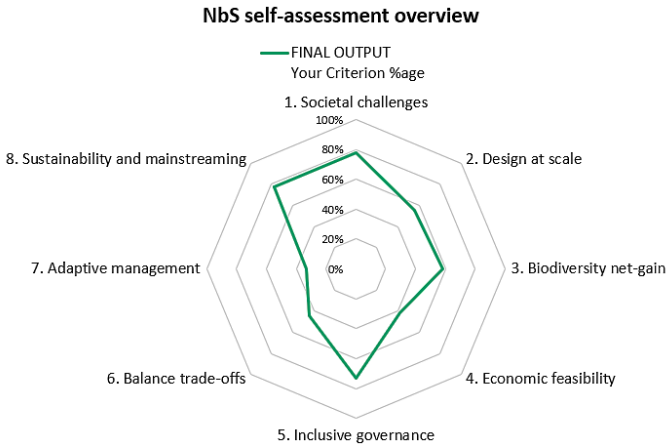


Figure 108 Spider Chart for self-assessment for Case -1-Belgium- (Source- IUCN 2020, adapted)

4.3. Analysis Within a Single Country

To understand what is happening inside a particular country, the research also checks how the different criteria behave within a specific country (before moving on to the next step of comparing with Europe).

4.3.1. Asian Studies

1. Cases in Indonesia

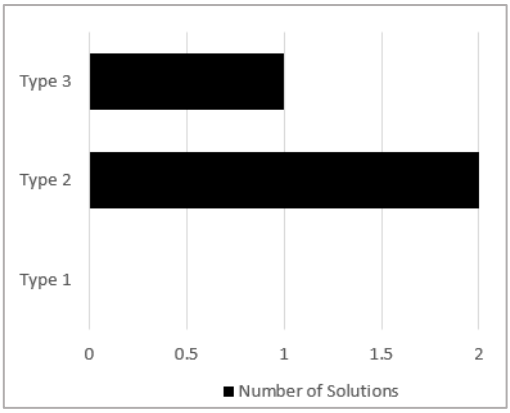


Figure 110 Graph showing number of solutions in either Type 1,2 or 3 category

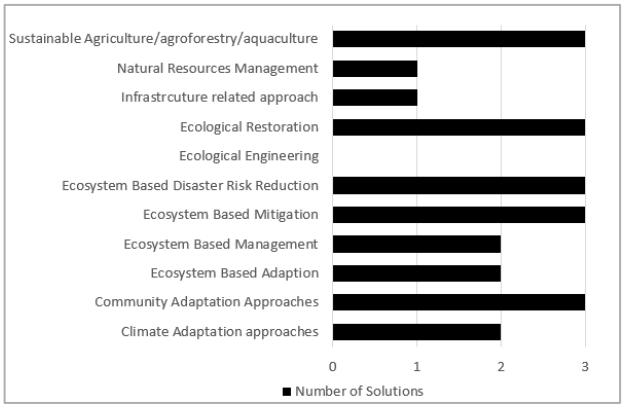


Figure 109 Graph showing number of solutions following different approaches in a country

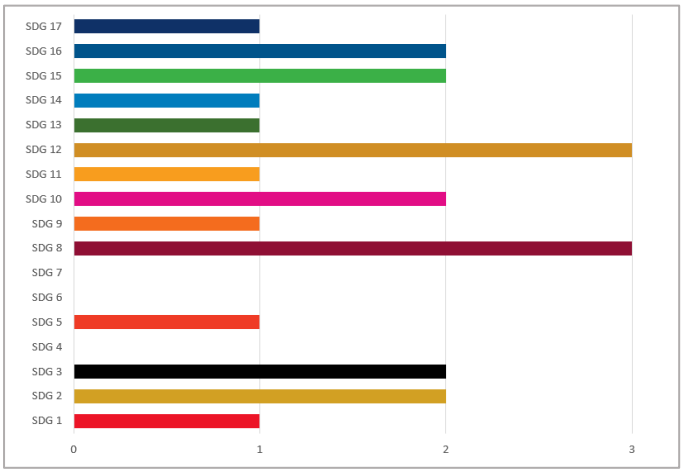


Figure 111 Graph showing solutions fulfilling the SDGs

We can see in fig. (110) that out of the three studies, one had Type 3, and the other two had Type 2 approaches. It tells that the major focus is to either have managed or new ecosystems. The reason for having Type 2 approach is that it manages an existing ecosystem rather than making a new one, also sometimes it gets harder in Type 1 to reap benefits for the people. While in the next graph fig. (109) we see that, most of the solutions had climate adaptation approach, ecosystem-based mitigation approach, ecological restoration, and sustainable

agriculture. There could be several reasons. Here it seems that all of these approaches are cost-effective.

Indonesia, which is a developing country in Southeast Asia, needs to focus on a number of problems. Fig. (111) shows that in just 3 cases, we see that 13 out of 17 goals were fulfilled. SDGs 8 and 12 are fulfilled in all 3 cases; this describes the benefits of NBS.

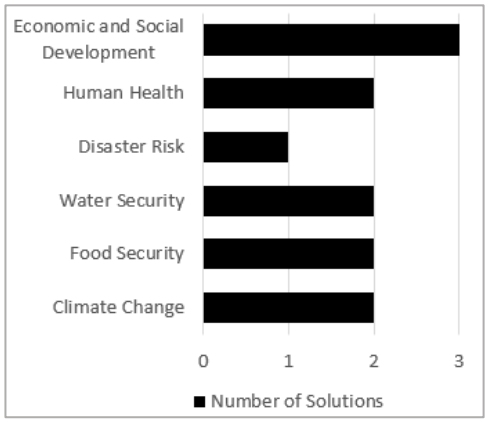


Figure 113 Graph showing number of solutions focussing on societal problems

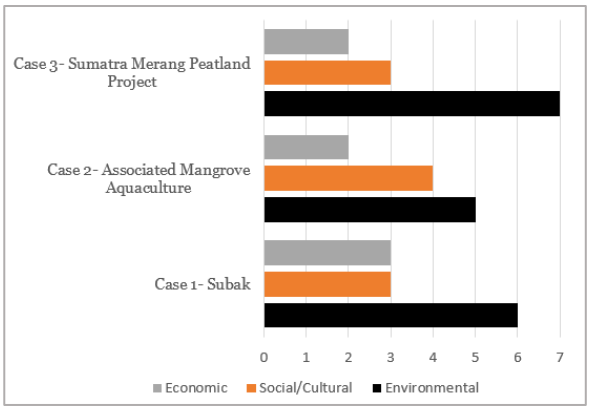


Figure 112 Graph showing each case giving different types of benefits

From Fig. (112), we can see that Economic and Social development is the most significant challenge which is being fulfilled by all three studies. While in next Fig. (113), we can see that Case 3 gives more environmental benefits, while Case 2 gives more Social/Cultural benefits. In the final IUCN standards analysis- Fig. (114), we can see that Criteria 1 and 8 are correctly fulfilled, with good percentages. While for Case 3, Criteria 6 and 7 have deficient scores, just partial.

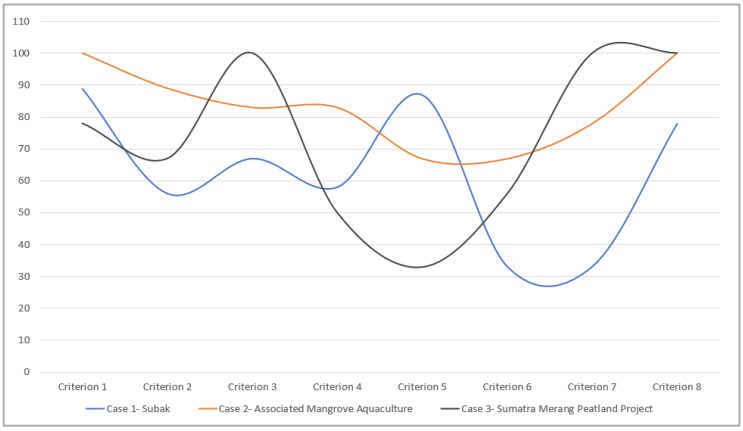


Figure 114 Graph showing the performance of the cases with respect to the eighth criteria of IUCN standards

2. Cases in India

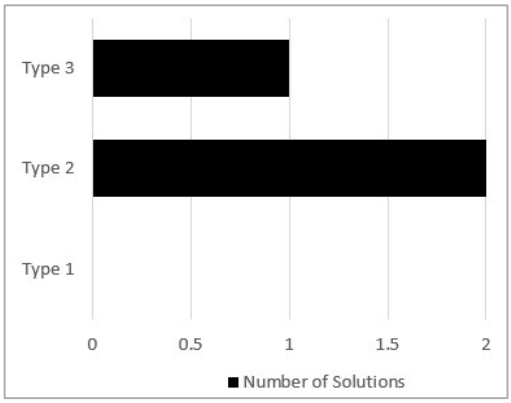


Figure 116 Graph showing number of solutions in either Type 1,2 or 3 category

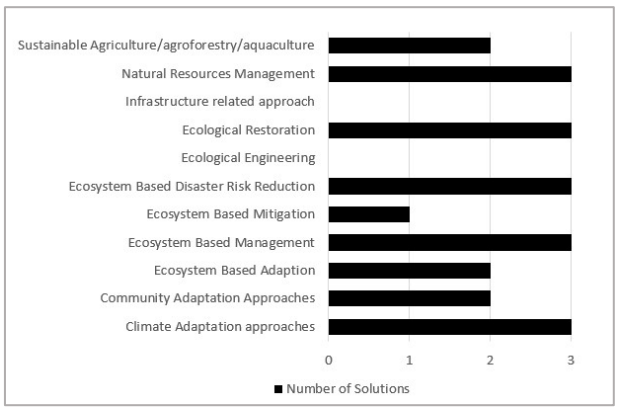


Figure 115 Graph showing number of solutions following different approaches in a country

We can see here in Fig. (115) that out of the three studies, one had Type 3 and the other two had Type 2 approaches (similar to the Indonesian Case). It tells that the major focus is to either have managed ecosystems or have new ecosystems. The reason of having Type 2 approach could be that in India, the techniques/solutions used by the people are cost-effective because they use it for themselves or their family, the government is not much involved in the initial cases. After a time when the local authority or some NGOs try to see some good techniques, they try to enhance its capacity.

While in the next graph - Fig. (116), we see that most of the solutions had a climate adaptation approach, ecosystem-based management approach, ecological restoration, and ecosystem-based disaster risk reduction.

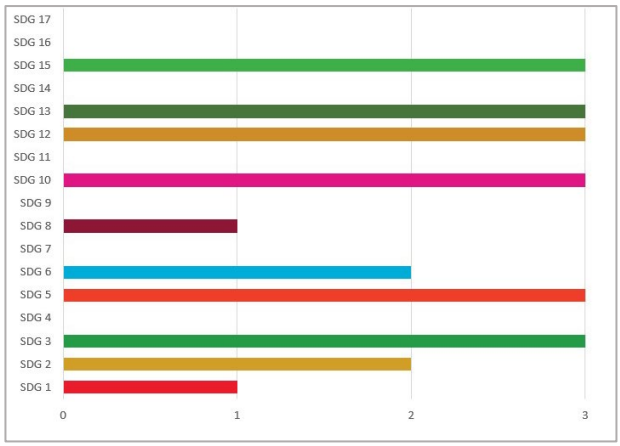


Figure 117 Graph showing solutions fulfilling the SDGs

India, which is a developing country in the South Asia, has the world's second-largest population, and will overtake China in 2023(Hegarty Stephanie, 2022). It needs to focus on several problems, poverty, hunger, hospital needs, and gender equality are a few of them. Thus, it becomes clearer that for India, the main SDGs will fulfil its basic needs then it can focus on other problems. In 3 studies carried out- Fig. (117), we can see that 11 out of 17 goals are fulfilled. SDGs 3, 5, 10, 12, 13, and 15 are fulfilled by all 3 studies.

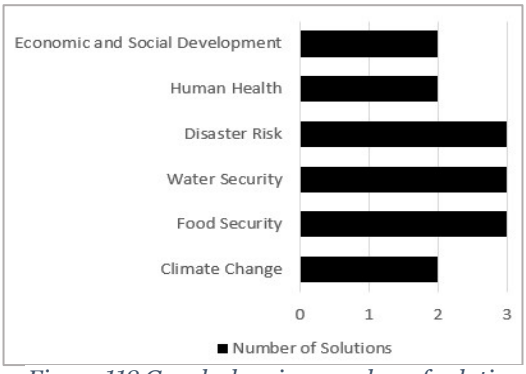


Figure 118 Graph showing number of solutions focussing on societal problems

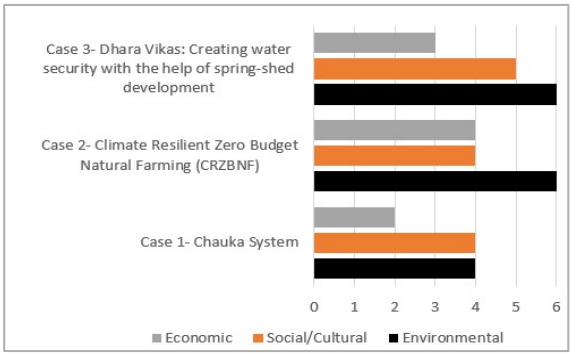


Figure 119 Graph showing each case giving different types of benefits

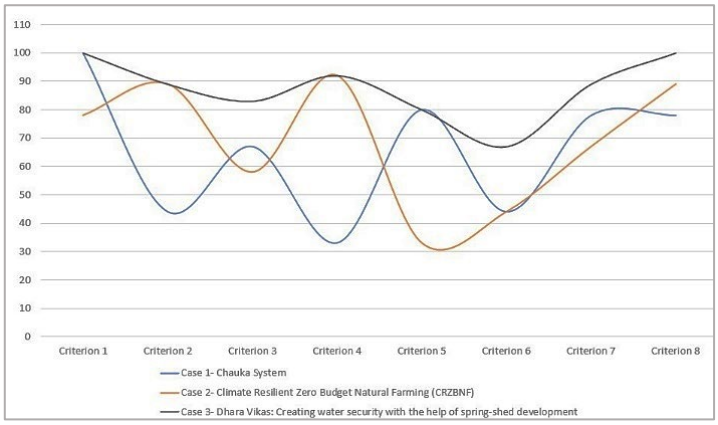


Figure 120 Graph showing the performance of the cases with respect to the eighth criteria of IUCN standards

From Fig. (118), we can see that the solutions considers all the 6 societal challenges, while Disaster risk, water security and food security is solved by all three studies. This shows the importance of NBS and the need to solve the problems. While in the next graph-Fig. (119), we can see that Case 3 gives a lot of benefits compared to the other two cases. Also, Case 3 and Case 2, give more environmental benefits, while

Case 3 gives the most Social/Cultural benefits. Case 1 has the least economic benefits.

In the final IUCN standards analysis- Fig. (120), we can see that Criterion 1 gets 100% for Cases 1 and 3, similar to criterion 8, which has good percentages for all three cases. Case 3 overall performs the best, while case 1 scored partially for Criteria 2, 4 and 6. And Case 2 scored partially in Criteria 5 and 6.

3. Case of Thailand

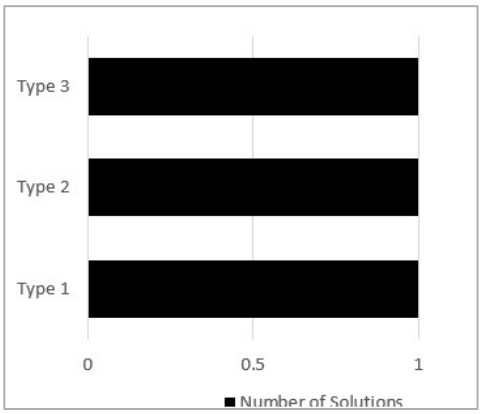


Figure 122 Graph showing number of solutions in either Type 1,2 or 3 category

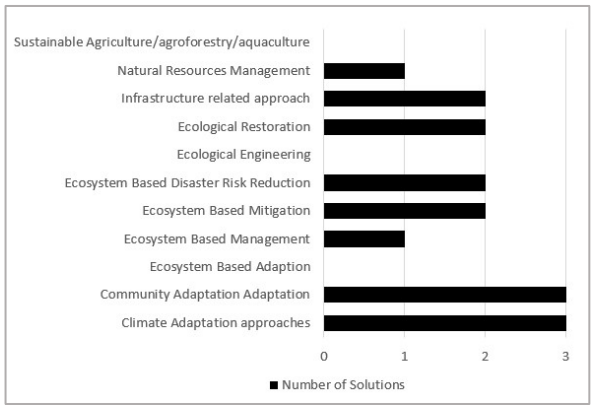


Figure 121 Graph showing number of solutions following different approaches in a country

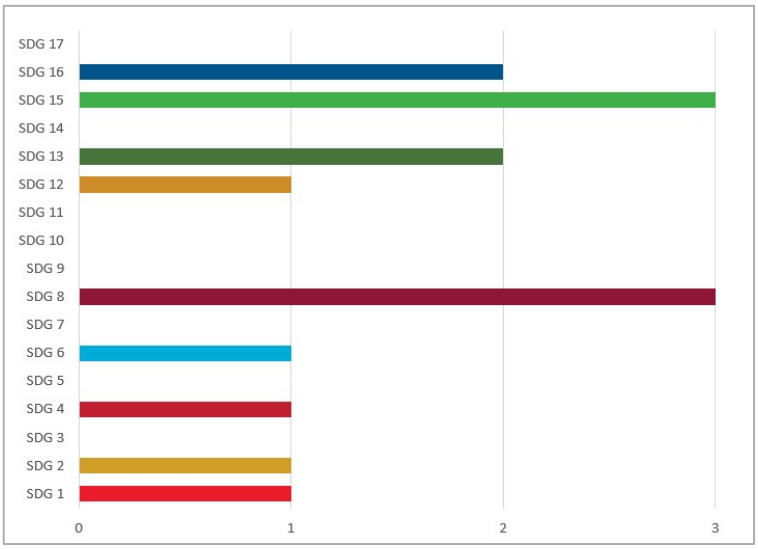


Figure 123 Graph showing solutions fulfilling the SDGs

In Fig. (122) we can see here that Types 1, 2 and 3 are equally distributed among the three cases studied. This is different from the other two countries studied (Indonesia and India). While in the next graph- Fig. (121), we see that, most of the solutions had climate adaptation approaches and community adaptation approaches.

Thailand is a developing country situated in Southeast Asia. It has many problems to solve. But here, a difference is seen compared to previous 2 countries considered. In the 3 cases Fig. (123), we see that only 9 out of 17 goals were fulfilled. SDGs 15 and 8 are fulfilled in all 3 cases.

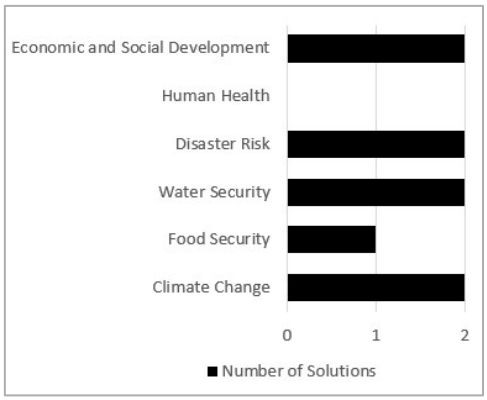


Figure 125 Graph showing number of solutions focussing on societal problems

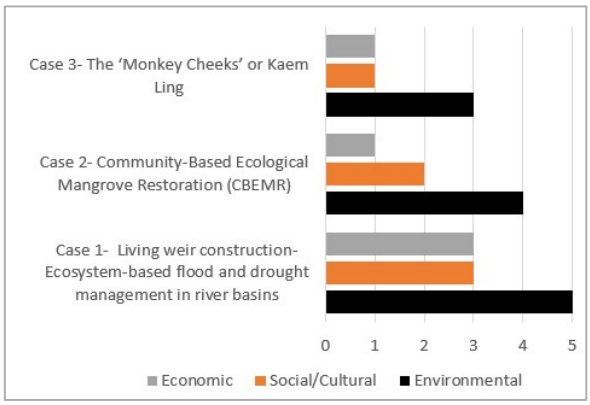


Figure 124 Graph showing each case giving different types of benefits

From this graph- Fig. (125), we can see that none of the cases solves human health. In contrast, others are solved by all three cases (leaving Food security which is fulfilled by one study). While in the following graph- Fig. (124), we can see that Case 1 gives a lot more benefits than the other two cases and has a lot more environmental benefits than other cases.

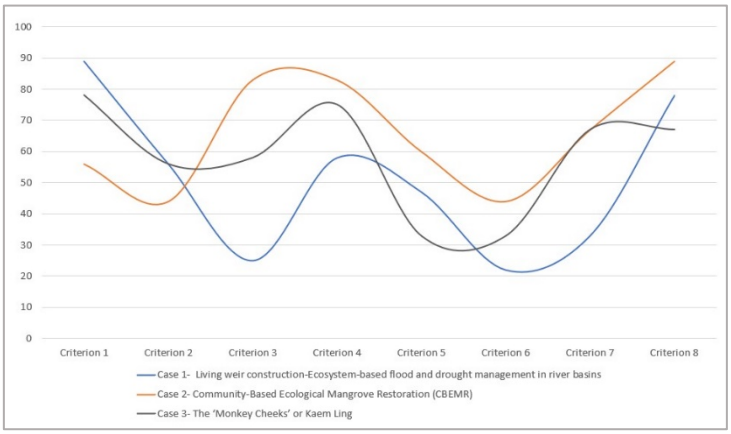


Figure 126 Graph showing the performance of the cases with respect to the eighth criteria of IUCN standards

In the final IUCN standards analysis- Fig. (126), we see that case 1 performs worse than the other two. For Criterion 6, Case 1 achieved a score of "insufficient", which tells that this case cannot be treated as NBS according to the IUCN global standards. Also, case 3 performed badly for criteria 5 and 6 and got "Partial scores".

4. Cases in Nepal

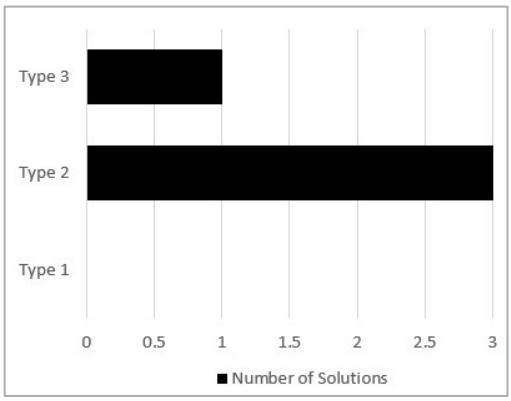


Figure 128 Graph showing number of solutions in either Type 1,2 or 3 category

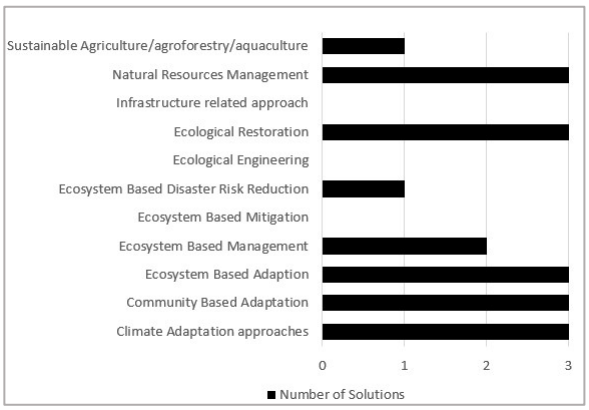


Figure 127 Graph showing number of solutions following different approaches in a country

In Fig. (128) we can see that out of the three studies, one had Type 3 and others had Type 2 approaches. There was no Type 1 approach. The focus is mainly on having managed ecosystems. The reason of having Type 2 approach is that it manages an existing ecosystem rather than making a new one (like green wall), so Type 2 could be cost-effective to the people.

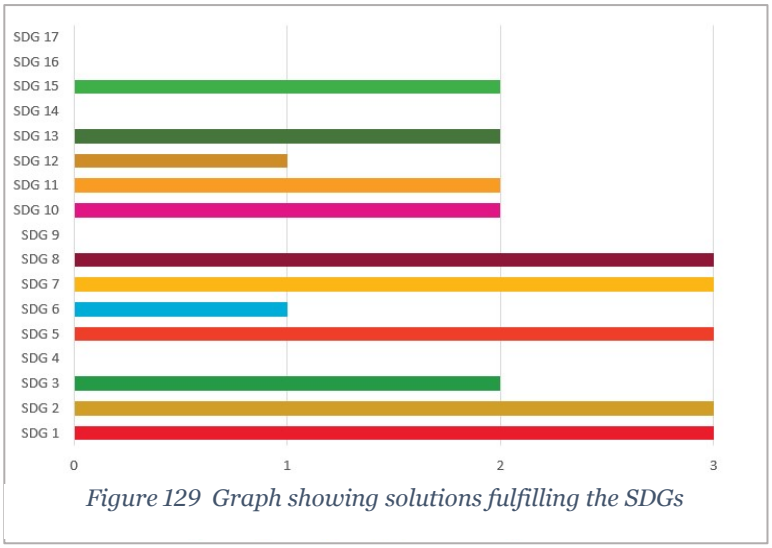


Figure 129 Graph showing solutions fulfilling the SDGs

While in the next graph- Fig. (127), we see that most of the solutions had a climate adaptation approach, community-based adaptation, ecosystem-based adaptation, ecological restoration, and natural resources management.

Nepal is a developing country (called underdeveloped also) in the South Asia. Its main issue is landslides, floods and extreme climate. Also, poverty, hygiene, and lack of medical needs are some of the problems faced. It needs to solve these problems and then fulfil other SDGs. In the 3 cases- Fig. (129), we see that 13 out of 17 goals were fulfilled, which is quite impressive. And SDGs 1,2, 5, 7, and 8 were fulfilled in all 3 cases; this describes the importance of these SDGs in the case of Nepal. Especially SDGs 1, 2 and 3 are essential to solve first so that all people in Nepal eat properly and have a good livelihood.

From the graph- Fig. (131), we can see that Disaster risk and Water security is the most important problem which is fulfilled by all three studies. As already discussed, Nepal is prone to serious climate disturbances, so need to work on that problem a lot.

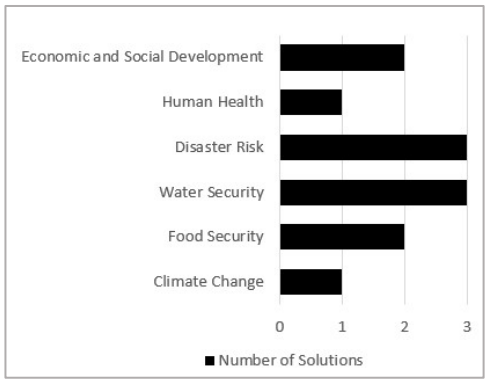


Figure 130 Graph showing number of solutions focussing on societal problems

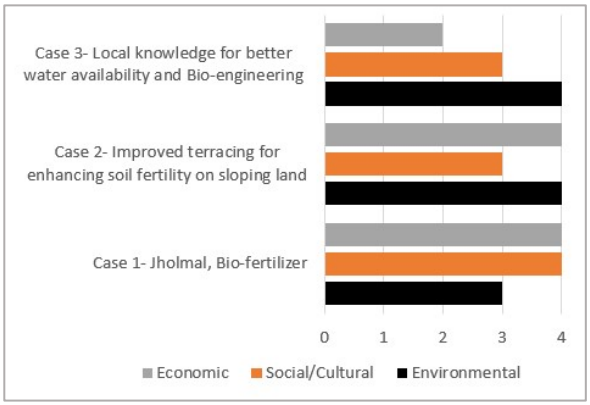


Figure 131 Graph showing each case giving different types of benefits

While in the next graph- Fig. (130), we can see that all three cases give good benefits and are very similar to each other. This tells us that although being a poor country, the solutions used have reaped good benefits.

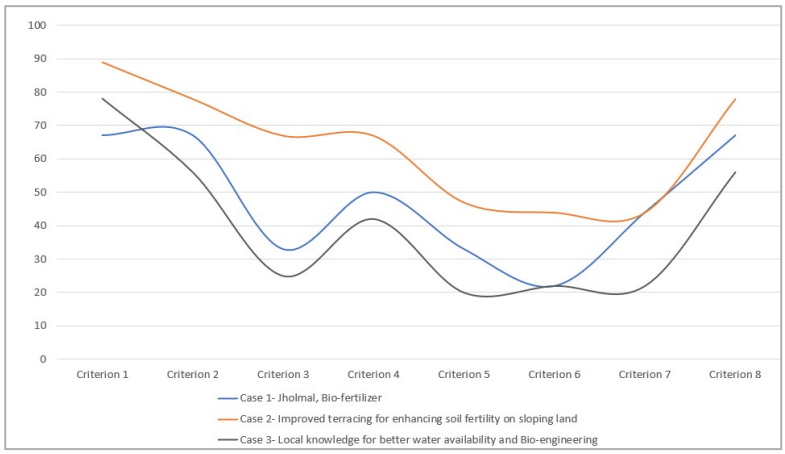


Figure 132 Graph showing the performance of the cases with respect to the eighth criteria of IUCN standards

In the final IUCN standards analysis- Fig. (132), we can see that case 1 does not fulfil IUCN standards, so it cannot be treated as NBS because it does not meet Criterion 6. While case 2 also just minutely satisfies IUCN standards.

5. Cases in Bangladesh

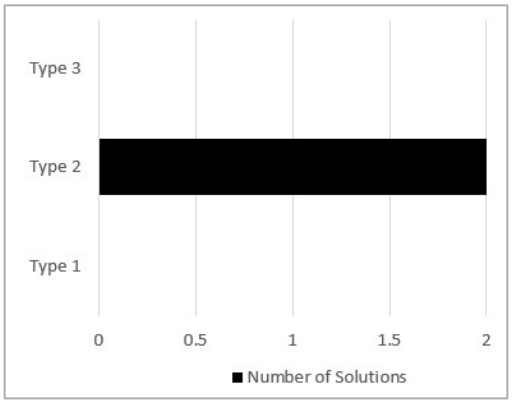


Figure 134 Graph showing number of solutions in either Type 1,2 or 3 category

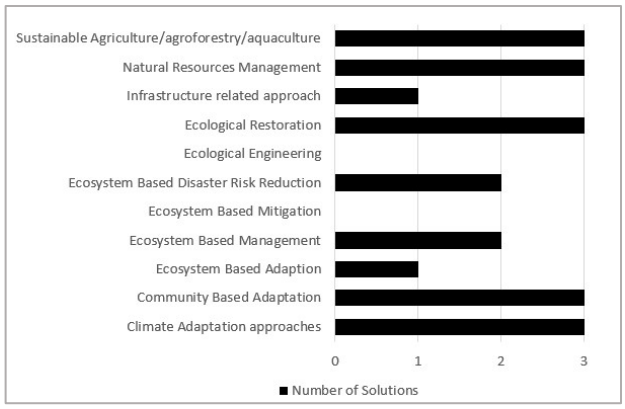


Figure 133 Graph showing number of solutions following different approaches in a country

We can see here- in Fig. (133), that both the cases considered follow the Type 2 approaches. Just like previous countries considered (apart from Thailand), the reason could be the money required for setting up a new ecosystem in Type 3. In contrast, Type 1 does not reap many benefits for people (though it has a lot of benefits for the environment, which indirectly affects humans).

While in the next graph- Fig. (134), we see that most of the solutions had a climate adaptation approach, community-based adaptation, ecological restoration, natural resource management and sustainable agriculture. Two cases considered can be placed in many of the given approaches.

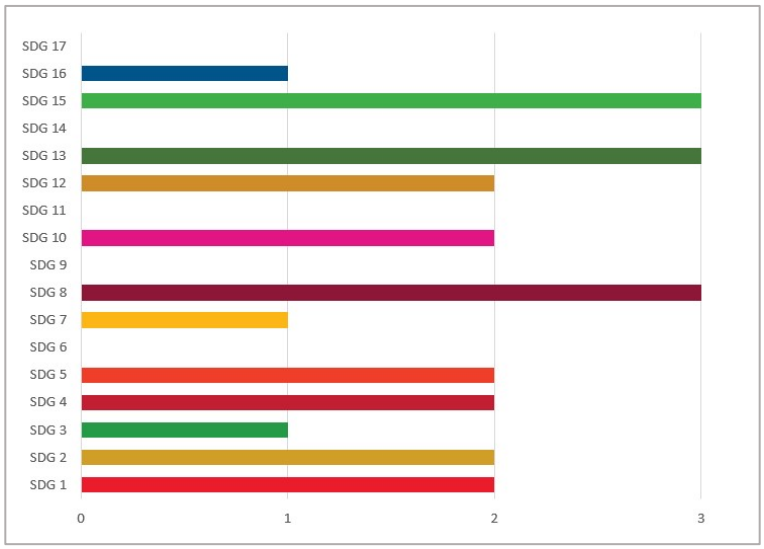


Figure 135 Graph showing solutions fulfilling the SDGs

Bangladesh, a developing country in South Asia (also referred to as underdeveloped), just like India and Nepal, has many problems to solve. It needs a robust approach and good solutions. From the graph-Fig. (135), it is visible that the two cases fulfilled 12 out of 17 goals. SDGs 8, 13 and 15 are fulfilled in all cases. This means that Bangladesh may use NBS as a mechanism to solve the harsh effects of climate change, and also to solve its hunger and poverty problems.

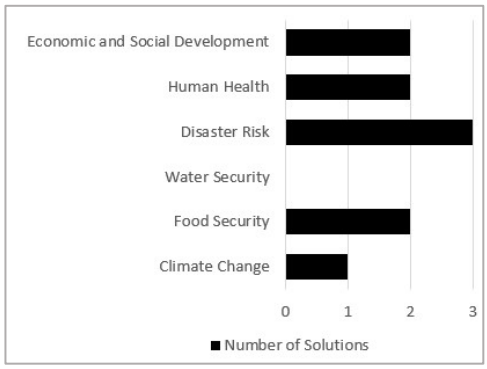


Figure 136 Graph showing number of solutions focussing on societal problems

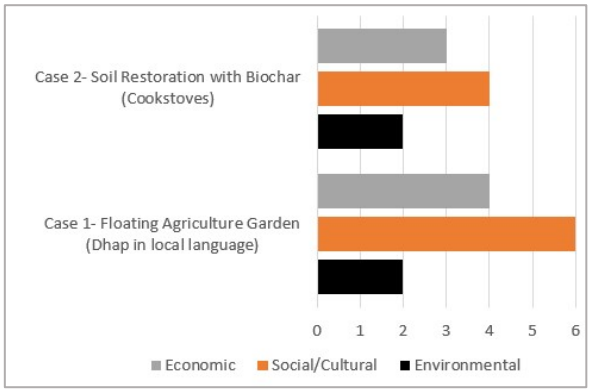


Figure 137 Graph showing each case giving different types of benefits

From this graph Fig. (136), we can see water security is a societal problem which is not solved. The reason could be that Bangladesh has excess water, and it does not have issue of less water but has problems of floods, which is a natural disaster while both cases solve disaster risk. While in next graph-Fig. (137), we can see that Case 1, gives a lot of social/cultural benefits, overall it gives more benefits than case 2.

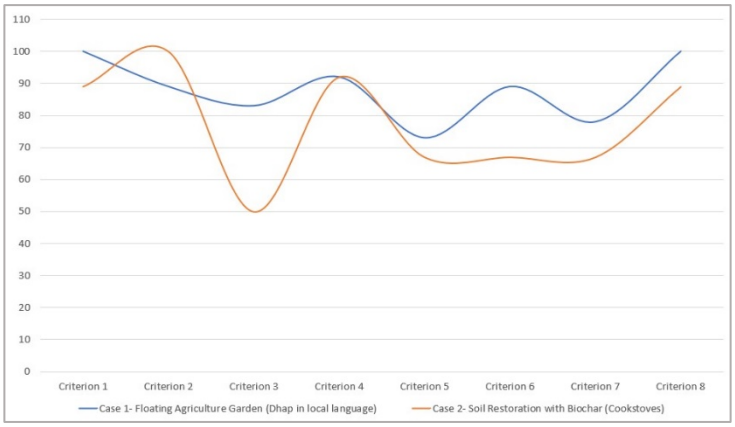


Figure 138 Graph showing the performance of the cases with respect to the eighth criteria of IUCN standards

In the final IUCN standards analysis - Fig. (138), we can see that both cases perform very well with most in "Adequate" and "Strong" categories.

6. Cases in Vietnam

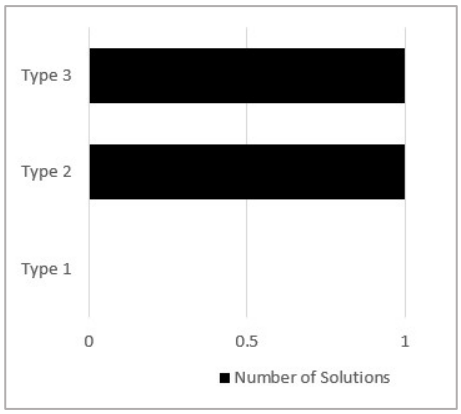


Figure 140 Graph showing number of solutions in either Type 1,2 or 3 category

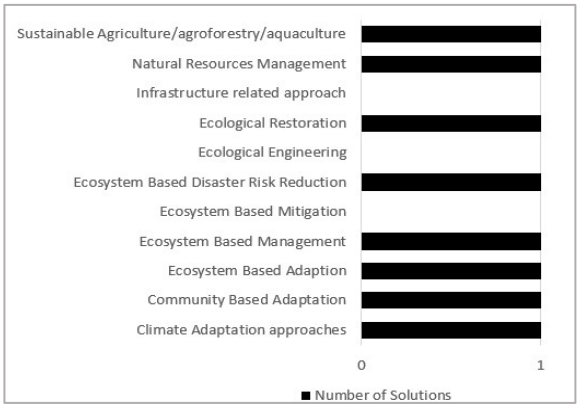


Figure 139 Graph showing number of solutions following different approaches in a country

Just one case was considered in Vietnam. We can see here- Fig. (140), that the case had both Type 2 and 3 approaches. While in the next graph- Fig. (139), we see that, although only one case was considered, it can still be grouped into many approaches – 8 out of 11.

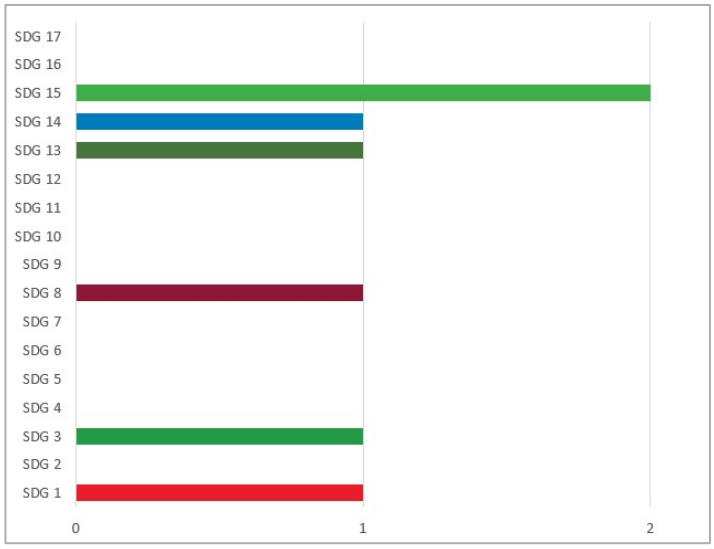


Figure 141 Graph showing solutions fulfilling the SDGs

Vietnam is a developing country in Southeast Asia and faces many disasters, especially floods and droughts. The studied case covers 6 out of 17 SDGs- Fig. (141). Maybe if more studies are taken for Vietnam, then more SDGs would be achieved.

From the graph- Fig. (143), we can see that Disaster risk, Economic and Social development, and food security is fulfilled. While in next graph -Fig. (142), we can see that though it's just one case, but still gives good benefits.

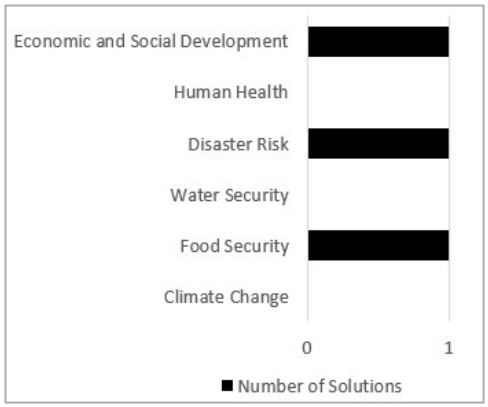


Figure 143 Graph showing number of solutions focussing on societal problems

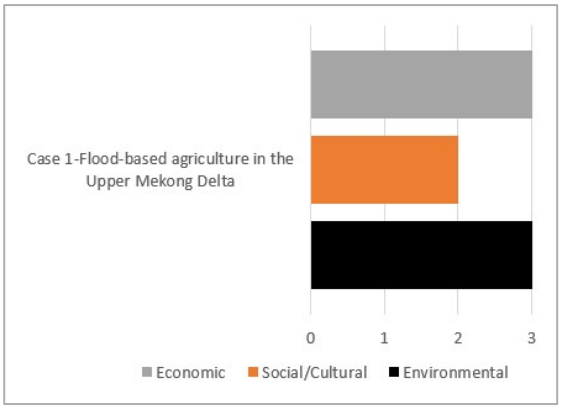


Figure 142 Graph showing the case giving different types of benefits

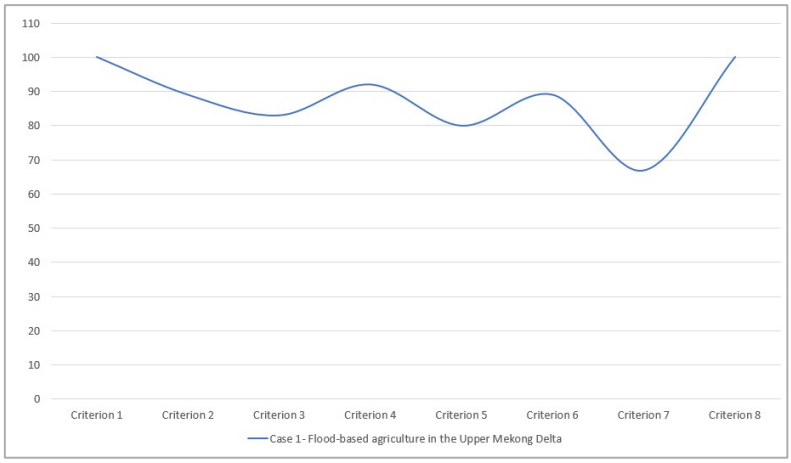


Figure 144 Graph showing the performance of the cases with respect to the eighth criteria of IUCN standards

In the final IUCN standards analysis- Fig. (144), we can see the case performed very well. As, it involved the government and international organisations thus, data also is readily available for this case.

4.3.2. European Studies

1. Cases in the Netherlands

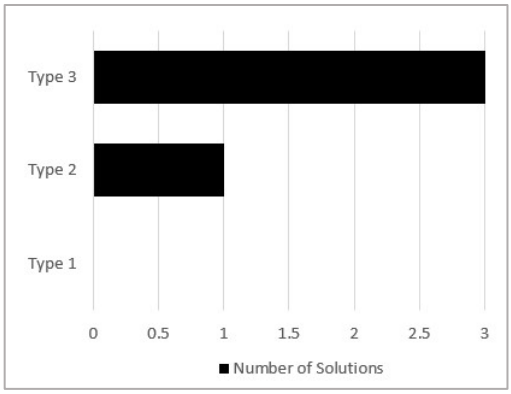


Figure 146 Graph showing number of solutions in either Type 1,2 or 3 category

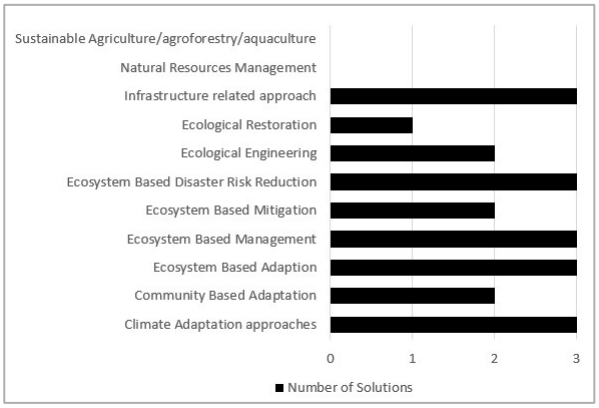


Figure 145 Graph showing number of solutions following different approaches in a country

First country to be studied in Europe (the Netherlands) brought a change in the type of approach. We can see in Fig. (146) that 3 cases follow the Type 3 approach, which talks about new ecosystems (green walls, rain gardens, etc.). While the one had Type 2 approach. As we were talking about money issues in some Asian countries, here it is opposite, money is available so the country can spend properly on different and costly solutions.

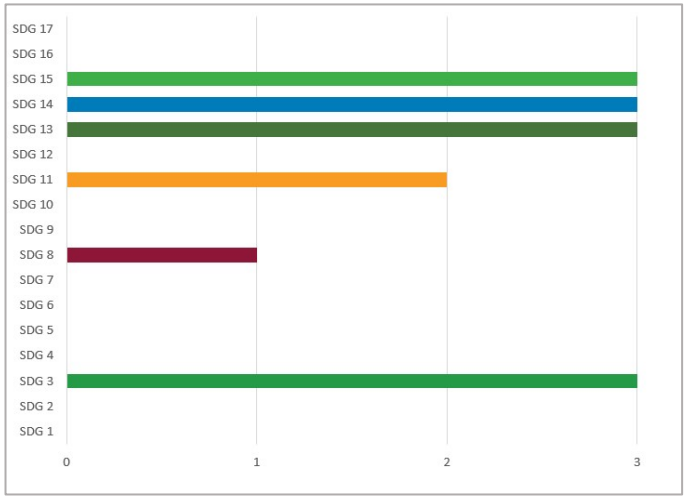


Figure 147 Graph showing solutions fulfilling the SDGs

While in the next graph- Fig. (145), we see that the approaches used by the cases are evenly distributed, just leaving beside Natural resource management and sustainable agriculture. The building with nature approach is very much prevalent in the Netherlands.

The Netherlands is a developed country in North-western Europe. Different to the Asian scenario, where the cases discussed solved SDGs related to poverty, hunger and sanitation, here SDGs solved have a different approach. Only 6 out of 17 goals were fulfilled- Fig. (147). SDGs 3,13,14, and 12 are fulfilled by all 3 cases.

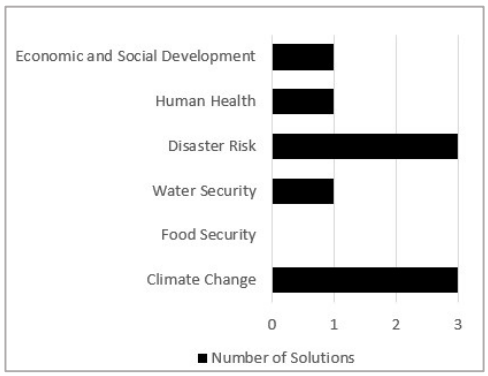


Figure 149 Graph showing number of solutions focussing on societal problems

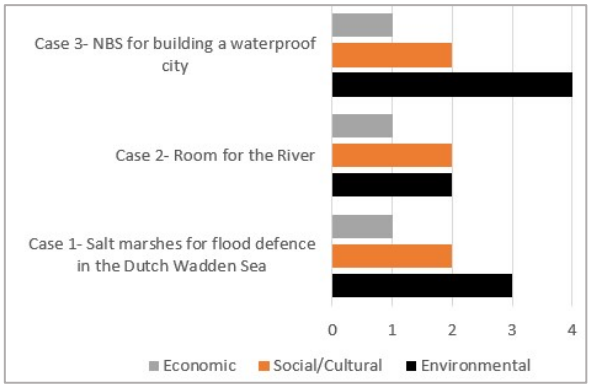


Figure 148 Graph showing each case giving different types of benefits

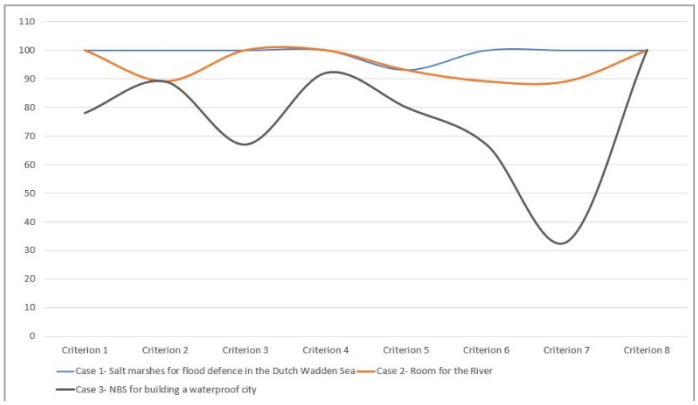


Figure 150Graph showing the performance of the cases with respect to the eighth criteria of IUCN standards

From the graph Fig. (149), we can see that Disaster risk and climate change are solved by all three studies, while food security is solved by none. Being a developed country, it could mean that it does not have a problem with lack of food. While in the next graph Fig. (148), we can see that Case 3, gives a lot of environmental benefits compared to the other two cases, while there was just one economic benefit for all three cases (there will be economic benefits but the table which was created to assess, does not have any).In the final IUCN standards analysis Fig. (150), we can see Cases 1 and 2 performed extraordinarily well. While case 3 performed well for all leaving besides Criterion 7.

2. Cases in Spain

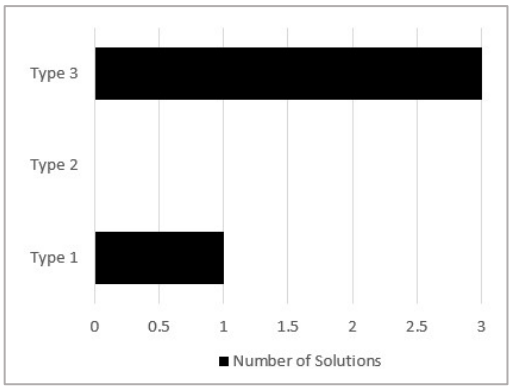


Figure 152 Graph showing number of solutions in either Type 1,2 or 3 category

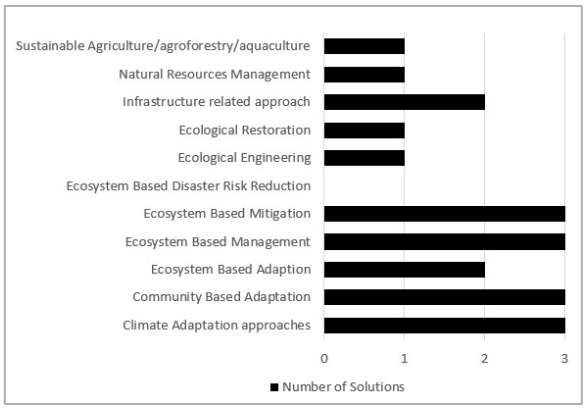


Figure 151 Graph showing number of solutions following different approaches in a country

We can see here Fig. (152), that there is no Type 2 approach while 3 Type 3 and one Type 1 approach. The reason could be similar to the Netherlands, as being a developed nation, they can spend more. Also EU helps a lot in green programmes like Horizon 2020, etc.

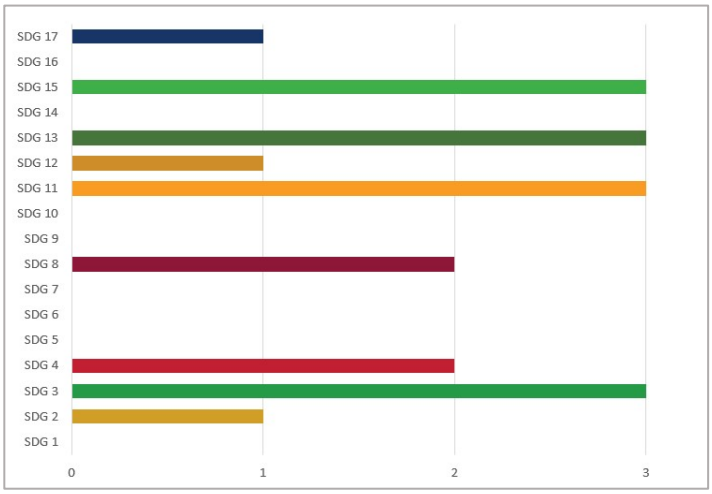


Figure 153 Graph showing solutions fulfilling the SDGs

While in the next graph Fig. (151) we see that most of the solutions had a climate adaptation approach, community-based adaptation, ecosystem-based management, and ecosystem-based mitigation approach.

Spain is a developed country in southwestern Europe. Here we can see in Fig. (153), only 9 out of 17 SDGs are solved. All three cases solve SDGs 3, 11, 13 and 15.

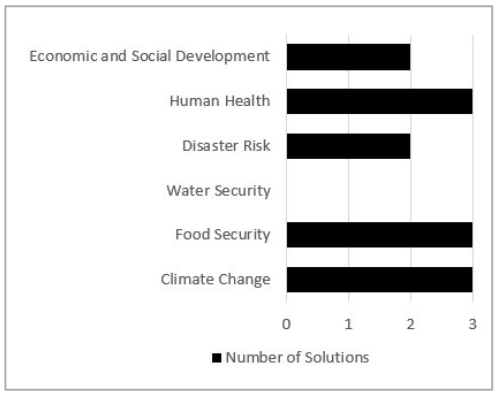


Figure 155 Graph showing number of solutions focussing on societal problems

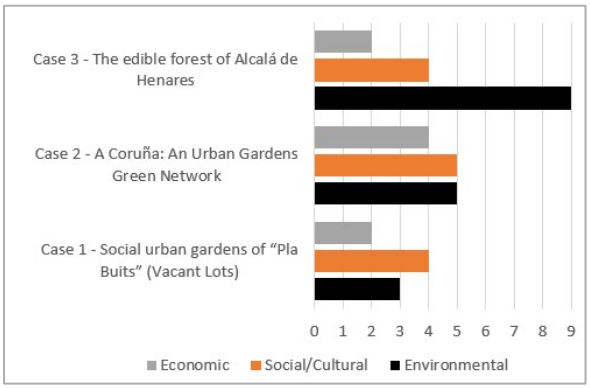


Figure 154 Graph showing each case giving different types of benefits

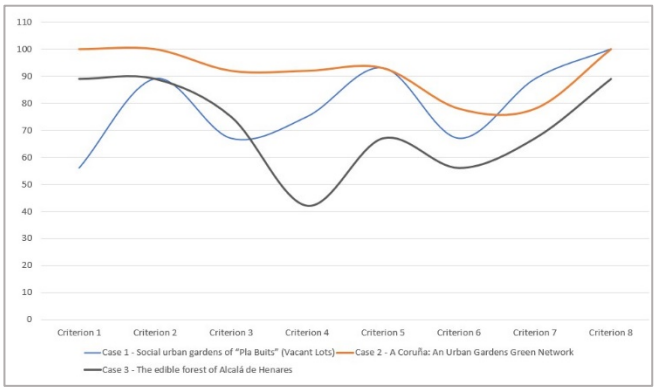


Figure 156 Graph showing the performance of the cases with respect to the eighth criteria of IUCN standards

From this graph Fig. (155), we can see that the problem of water security is not solved by any of the cases, while human health, food security and climate change are solved by all 3. While in the next graph Fig. (154), we can see that Case 3, has a lot more environmental benefits(9 have not seen before), while Case 2 gives more Social/Cultural benefits.

In the final IUCN standards analysis Fig. (156), we can see that all three cases fulfil the IUCN standards, but Case 3 scored less than others.

3. Cases in Sweden

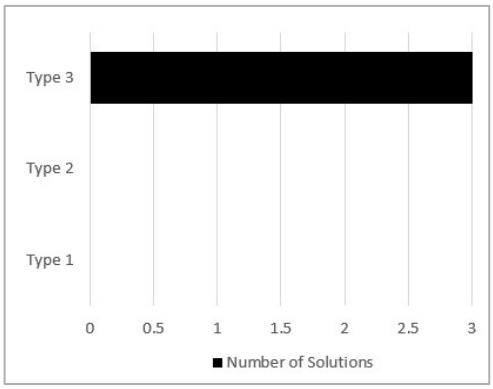


Figure 158 Graph showing number of solutions in either Type 1,2 or 3 category

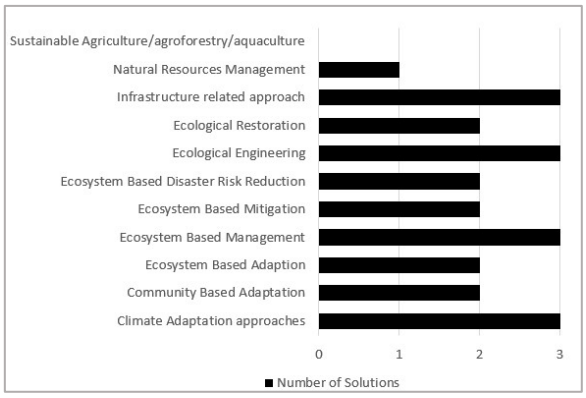


Figure 157 Graph showing number of solutions following different approaches in a country

We can see here- Fig. (158), that all three cases are Type 3 approaches. This means all deal with creating new ecosystems like urban gardens, and SUDS. While in the next graph -Fig. (157), we see that the cases can be put in all the approaches besides sustainable agriculture/ agroforestry/ aquaculture.

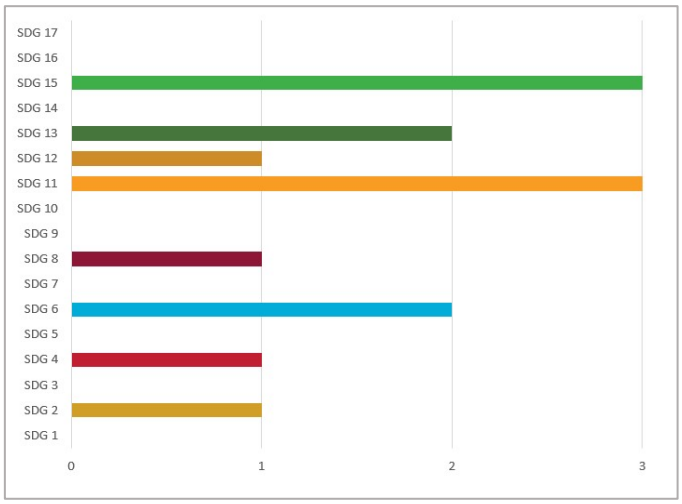


Figure 159 Graph showing solutions fulfilling the SDGs

Sweden is a developed country in a Nordic country in Northern Europe. In the 3 cases, we see that 8 out of 17 goals were solved - Fig. (159). SDGs 15 and 11, Sustainable cities and communities and Life on Land, respectively, are fulfilled. Since being rich and developed, we do not see the problem of poverty and hunger.

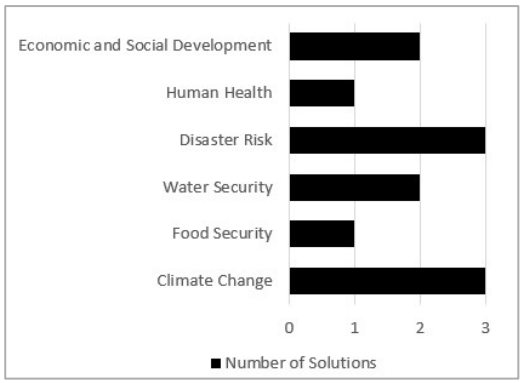


Figure 160 Graph showing number of solutions focussing on societal problems

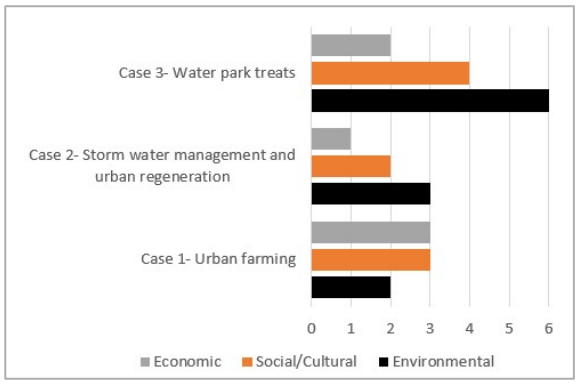


Figure 161 Graph showing each case giving different types of benefits

From this graph- Fig. (161), we can see that disaster risk and climate change are solved by all three cases. While in the next graph - Fig. (160), we can see that Case 3, gives more benefits, all three environmental, social/cultural and economic benefits are more. This shows that Case 3 is a good NBS.

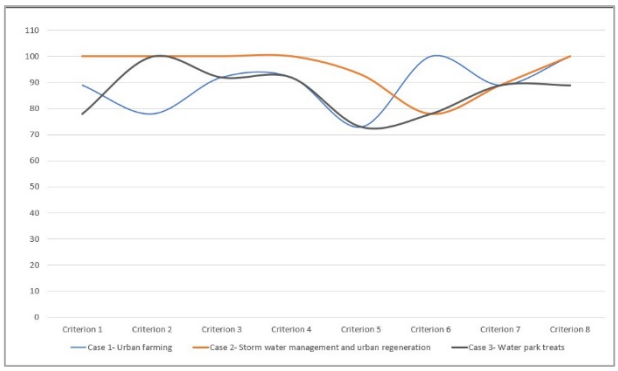


Figure 162 Graph showing the performance of the cases with respect to the eighth criteria of IUCN standards

In the final IUCN standards analysis- Fig. (162), we can see that all cases performed very well. All were in "Strong" or "Adequate" region. This NBS is applied considering all categories of stakeholders, government officials and private companies, which helps make the solution a good NBS.

4. Cases in Germany

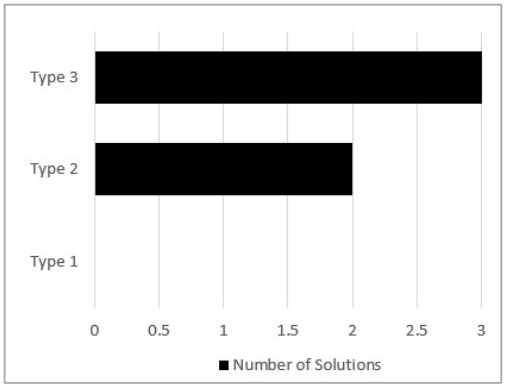


Figure 164 Graph showing number of solutions in either Type 1,2 or 3 category

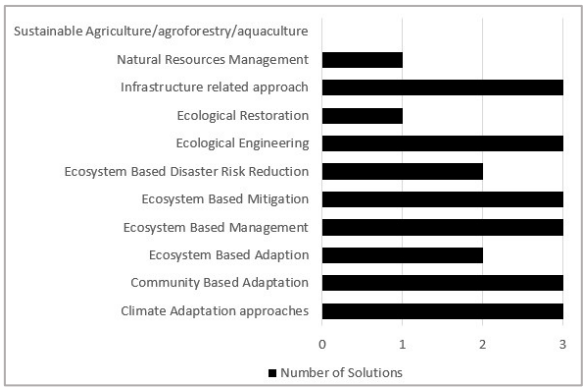


Figure 163 Graph showing number of solutions following different approaches in a country

We can see here- Fig. (164), that there is no NBS with Type 1 approach. And like other European cases which we saw before, Type 3 is the most used. While in the next graph- Fig. (163), we see that the cases can be put in all the approaches leaving besides Sustainable agriculture/agroforestry/aquaculture. And majority of approaches are Climate adaptation approaches, Community-based adaptation, ecological engineering and Infrastructure related approach.

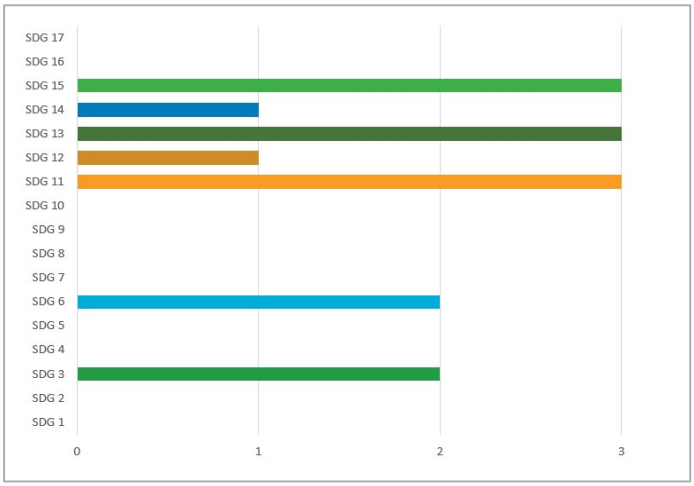


Figure 165 Graph showing solutions fulfilling the SDGs

Germany is a developed country in Central Europe. In the 3 cases which were studied, we found that only 7 out of 17 goals were fulfilled- Fig. (154). SDGs 11, 13 and 15 were fulfilled in all 3 cases. The SDGs covered are different from Asian countries.

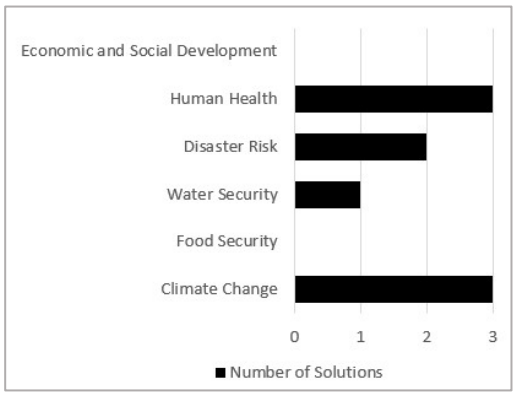


Figure 167 Graph showing number of solutions focussing on societal problems

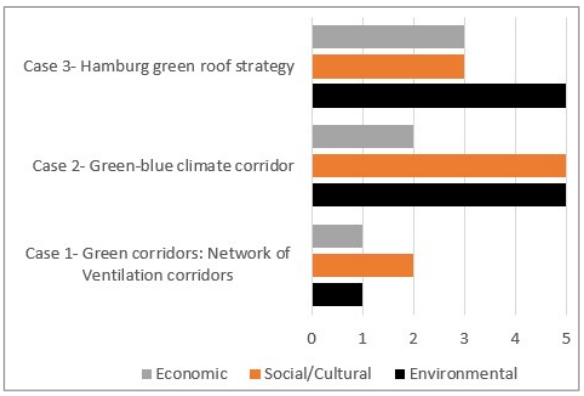


Figure 166 Graph showing each case giving different types of benefits

From this graph - Fig. (167), we can see that Economical and Social development and food security were not solved by the NBS, as maybe they do not have these problems. In contrast, human health and Climate change were solved in all three cases. While in next graph- Fig (166), we can see that Case 3 and 2 had the same environmental benefits, while Case 2 had more Social/Cultural benefits.

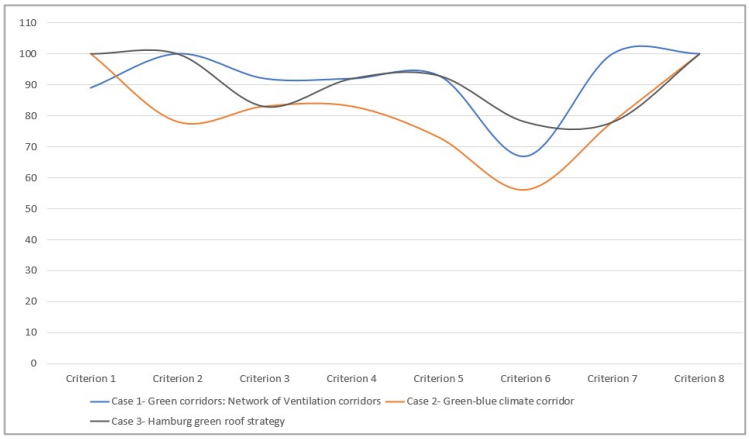


Figure 168 Graph showing the performance of the cases with respect to the eighth criteria of IUCN standards

In the final IUCN standards analysis - Fig. (168), we can see that, like other European countries, the cases scored quite well, and all fulfilled the criteria.

5. Cases in Denmark

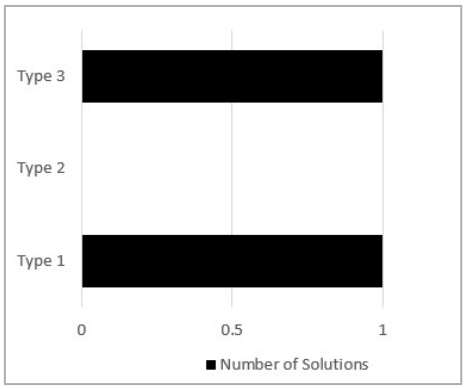


Figure 170 Graph showing number of solutions in either Type 1,2 or 3 category

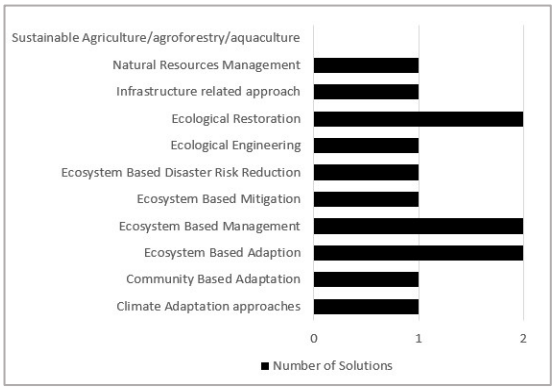


Figure 169 Graph showing number of solutions following different approaches in a country

We can see here- Fig. (170), that Type 2 approach were not there for any case while one case had Type 1 and one had Type 2 approach. Managing the ecosystem is not considered because we used only 2 studies; if we had taken more, the results could have been different.

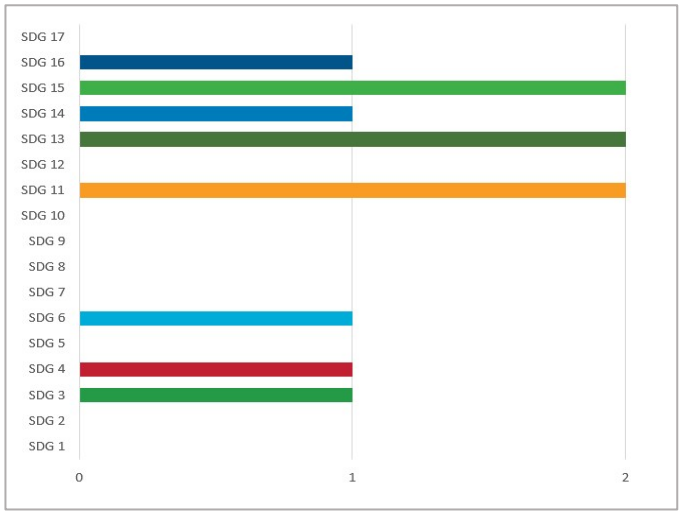


Figure 173 Graph showing solutions fulfilling the SDGs

While in the next graph- Fig. (169), we see that most of the solutions had ecosystem-based adaptation, ecosystem-based management and ecological restoration approaches. Just like the previous two, only Sustainable agriculture/ agroforestry/aquaculture approach is not used in any case

Denmark is a developed Nordic country in Northern Europe. In the two studies, we see that 8 out of 17 goals were fulfilled - Fig. (171). SDGs 11, 13 and 15 are fulfilled in both cases.

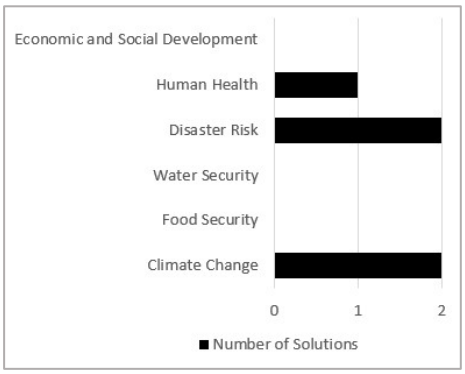


Figure 171 Graph showing number of solutions focussing on societal problems

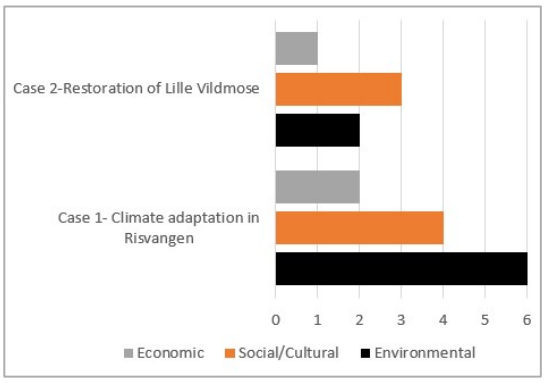


Figure 172 Graph showing each case giving different types of benefits

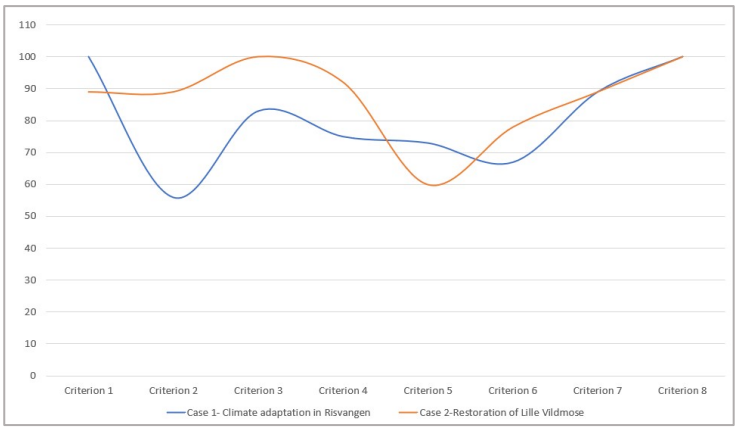


Figure 174 Graph showing the performance of the cases with respect to the eighth criteria of IUCN standards

From this graph- Fig. (172), we can see that only Climate change and disaster risk problems are solved by both cases, while human health is solved by only 1, while others are not solved by any case. While in the next graph - Fig. (173), we can see that Case 1, gives more environmental and overall benefits.

In the final IUCN standards analysis - Fig. (174), we can see that both cases fulfil the IUCN standards, but Case 1 scored less in criterion 2.

6. Cases in Belgium

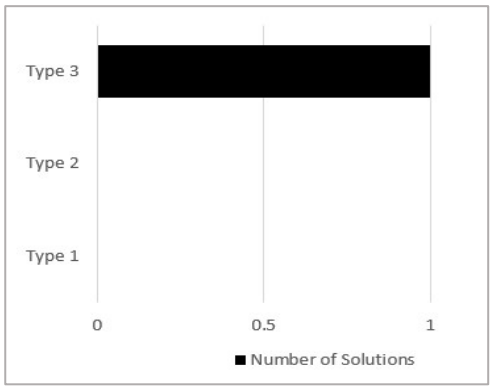


Figure 176 Graph showing number of solutions in either Type 1,2 or 3 category

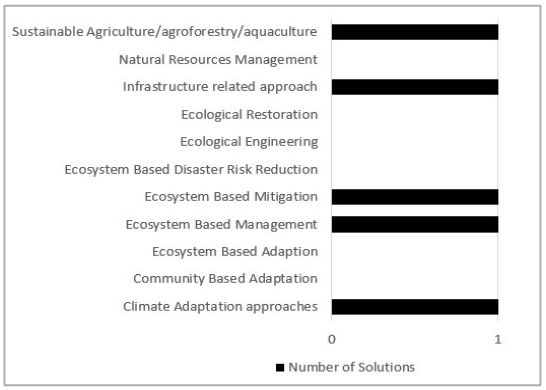


Figure 175 Graph showing number of solutions following different approaches in a country

Only one study was done for this country.
And it fell in the category of Type 3 - Fig. (176). This is not a new phenomenon and has been observed since the start of European countries.

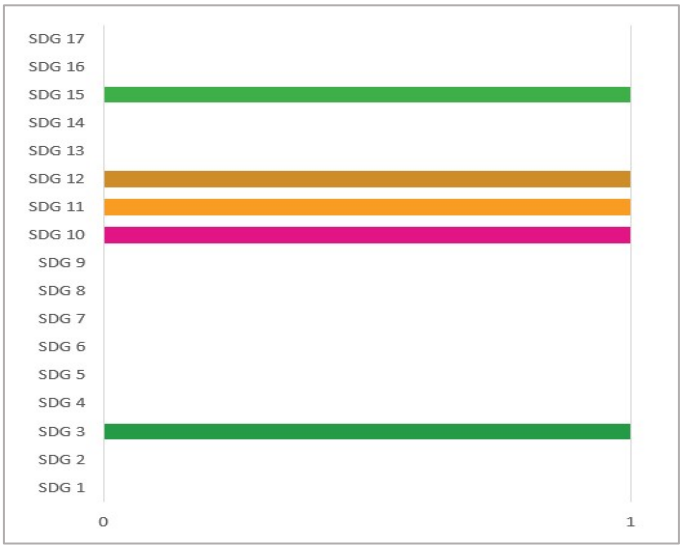


Figure 177 Graph showing solutions fulfilling the SDGs

While in the next graph - Fig. (175), we see that the case can be in the following approaches- Climate adaptation approaches, ecosystem-based management, ecosystem-based mitigation, infrastructure related approach and Sustainable agriculture/ agroforestry/aquaculture approach.

Belgium is a developed country in North-western Europe. In the sole study done - Fig. (177), 5 out of 17 goals were fulfilled.

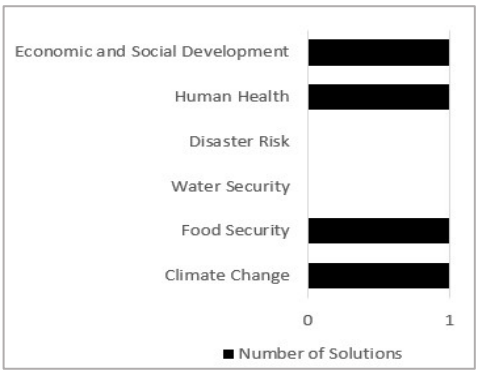


Figure 179 Graph showing number of solutions focussing on societal problems

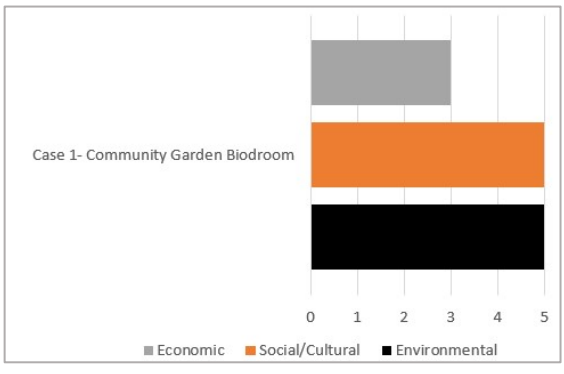


Figure 178 Graph showing each case giving different types of benefits

From this graph - Fig. (179), we can see that Economic and Social development, food security and climate change are solved by this approach. While in the next graph - Fig. (178), we can see 5 each environmental and social/cultural benefits are received.

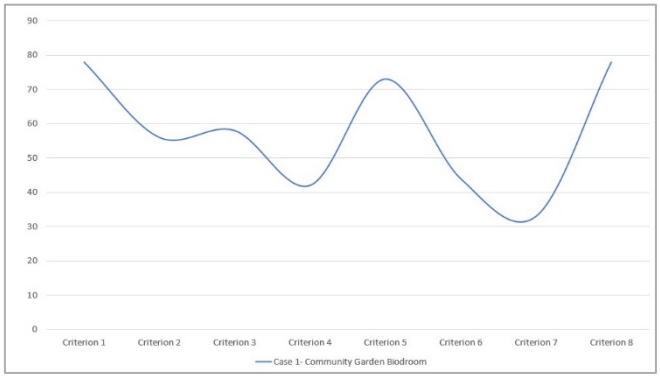


Figure 180 Graph showing the performance of the cases with respect to the eighth criteria of IUCN standards

In the final IUCN standards analysis - Fig. (180), we can see that the case fulfils the standards, though it performs poorly for Criterion 4,6 and 7.

4.4. Comparison between Europe and Asia

We have discussed 30 cases and found that just 2 of them did not fulfil the requirements of being an NBS. But now let's shift to the comparison between Asian and European countries, which is the ultimate goal.

From the graph on the right - Fig. (181), we can see that in both Asian and European countries, Type 1 is the least used approach by the NBS, which is "Better use of protected/natural ecosystems". In contrast, Asian countries have more Type 2 approach, which is "NBS for sustainability and multifunctionality of managed ecosystems", than the European countries. Alternatively, European countries have more Type 3 approaches which are "Design and management of new ecosystems", than Asian countries. There could be several reasons for this cause.

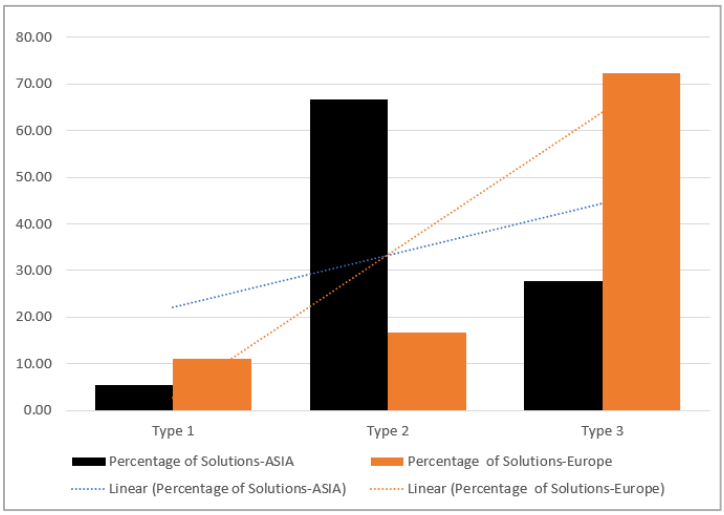


Figure 181 Comparison of solution on the basis of Type 1,2 or 3

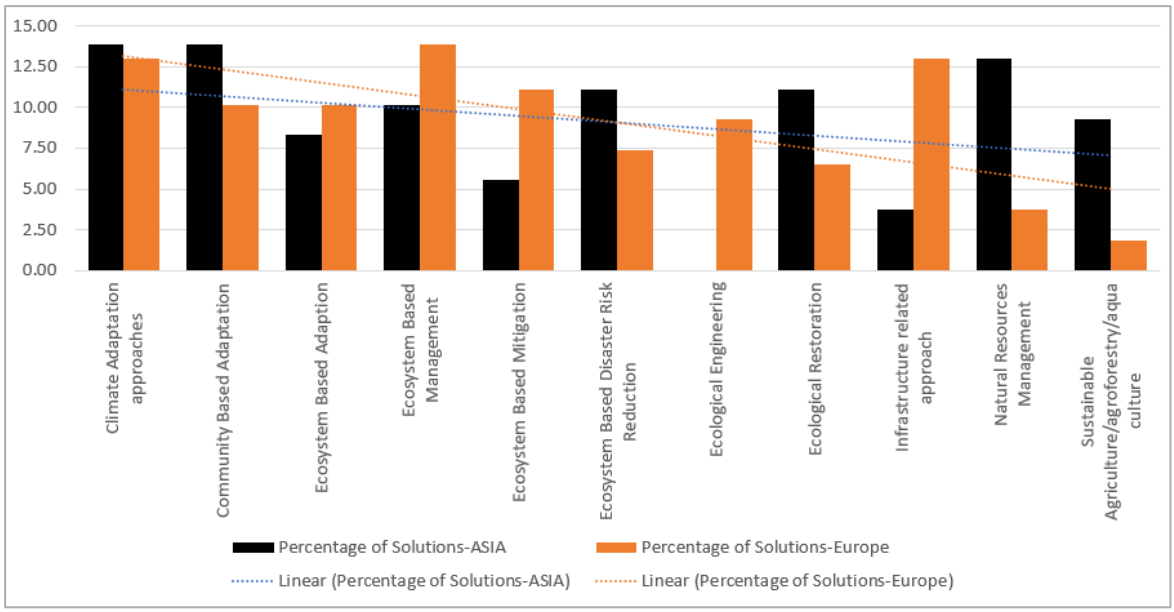


Figure 182 Comparison of solutions on the basis of approaches used

In the above graph - Fig. (182), the major difference can be seen in Infrastructure related approach and Natural resources management. For European countries, there are a lot more solutions in the "Infrastructure related approach" compared to Asian countries, while for Natural resources management, it is vice-versa, meaning, in Asian countries, there are a lot more solutions for Natural resources management then European countries. The reason could be that the solutions studied in Asian countries are smaller in scale and incorporate local and traditional knowledge; also, people are spiritually linked to nature, like hills, trees, etc., so more solutions are focussed on natural resource management. There are also a lot more Sustainable agriculture/agroforestry/ aquaculture in Asian countries than in European countries. In contrast, there is no case of Ecological engineering in Asian countries. Both show a similar trend for Climate adaptation approaches.

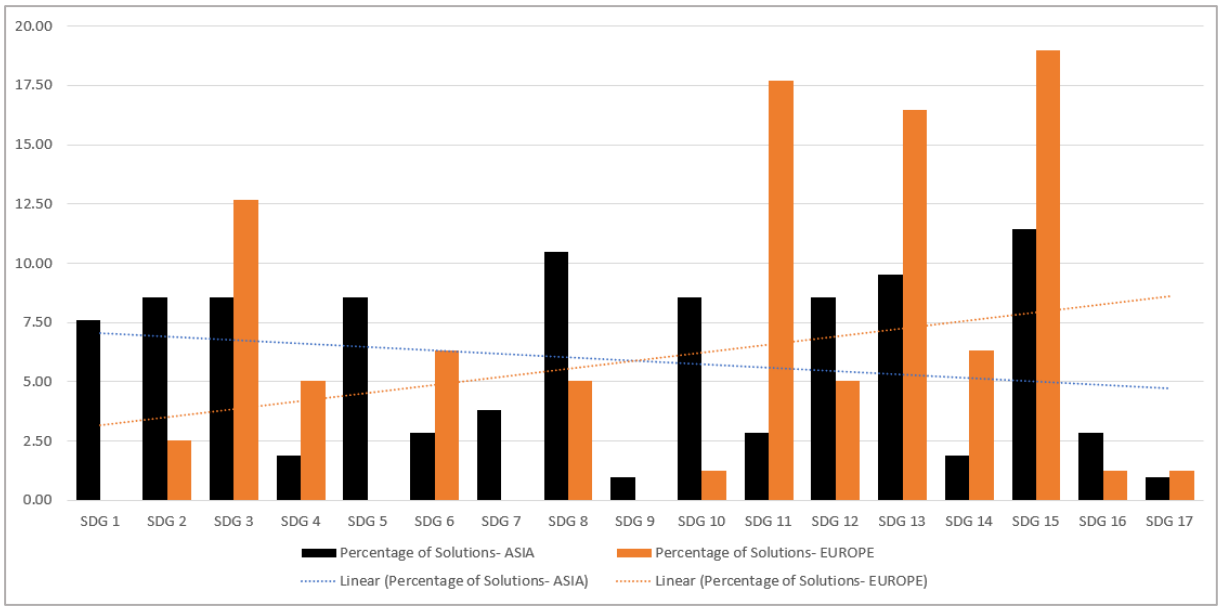


Figure 183 Comparison of solution on the basis of SDGs fulfilled

In the above graph - Fig. (183), SDG 1, which is "No Poverty", is not solved by any case in European countries. This is undoubtedly because the countries considered in Europe are

developed and do not need to fight the menace of poverty. Similarly, we see that the proportion of cases in Asian countries are a lot more for SDG 2, which is "Zero Hunger", than in European countries. The reason would be the same as before, the countries in Europe are developed and they do not have the problem of hunger compared to Asian countries. Similarly, in SDG 10, which is "Reduced Inequalities", and SDG 5, which is "Gender inequality", Asian Countries have more solutions covered then European countries. Though these problems exist in both types of countries, the capacity of NBS to solve these problems is more in Asia than in Europe. SDG 11, which is "Sustainable cities and communities", SDG 13, which is "Climate Action", and SDG 15, which is "Life on Land", are more covered by the solutions in Europe than in Asia. This could be explained by the fact that Asian countries are fighting the menace of poverty, hunger, etc, so they had to solve those problems before focusing on other issues.

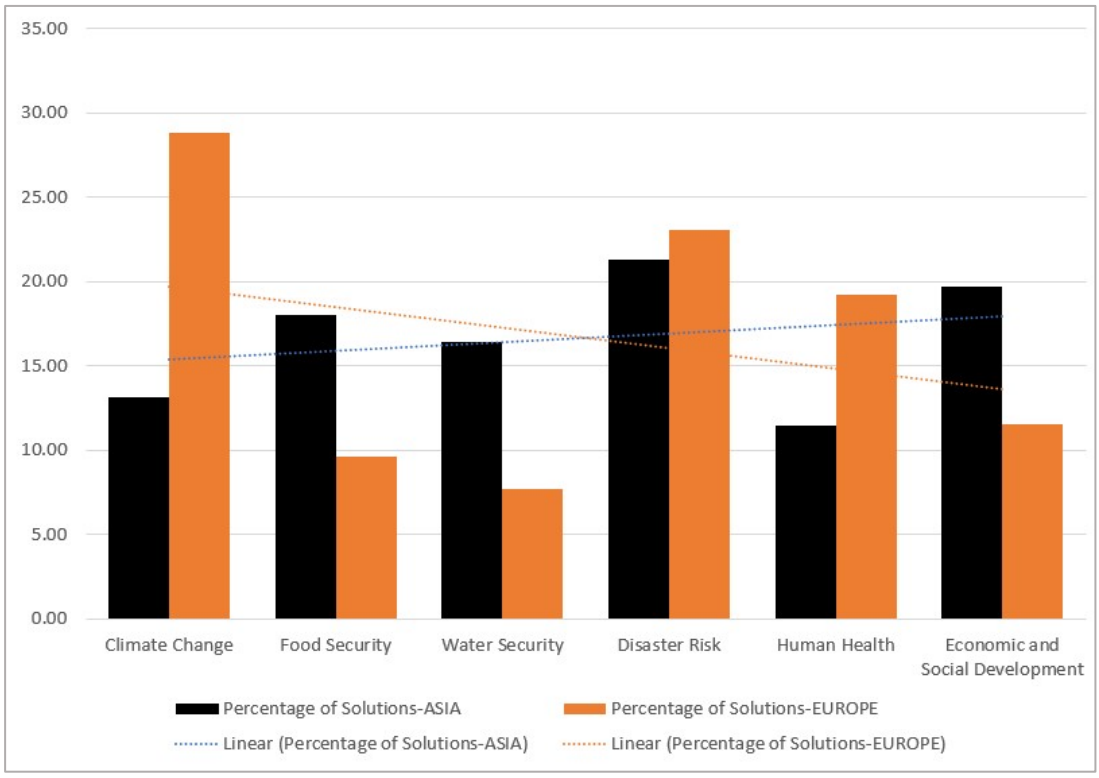


Figure 184 Comparison of solution on the basis of the focus on societal problems

From the above graph- Fig. (184), we can see that a lot more solutions which we studied solve the problem of Climate change in European countries than in Asian Countries. The answer can be found in the previous section that it depends on the main problems on which the Asian countries have to focus upon. Also, we see that food security, water security and economic development are solved more by Asian countries due to their need. Therefore, overall we can conclude that Asian countries solve more societal problems than European countries.

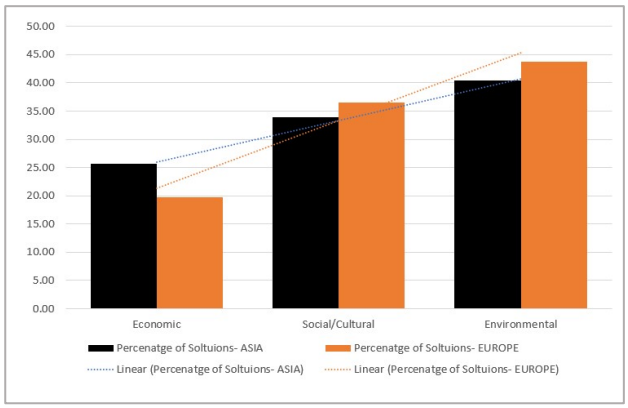


Figure 185 Comparison of solution on the basis of Comparison of solution on the basis of different types of benefits provided

From the graph of ecosystem services or the benefits - Fig. (185), we can see that most cases give Environmental benefits. There is a strong reason as the table developed for the benefits consisted more benefits for the

Environmental part. While Social/Cultural and Environmental benefits are more for European countries than Asian. In contrast, a reverse case is observed for Economic benefits.

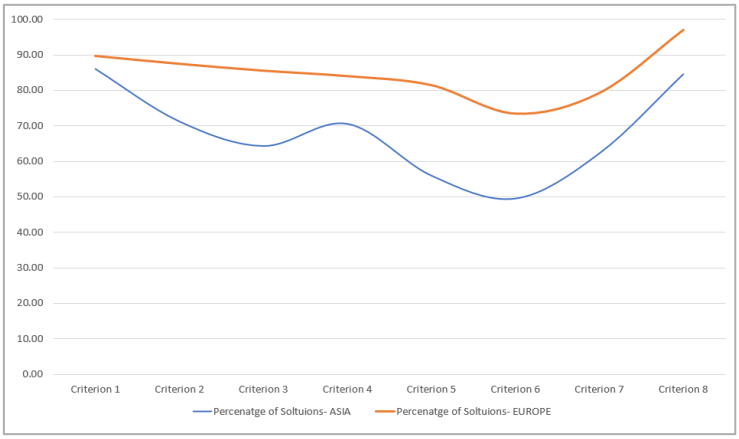


Figure 186 Comparison of solution on the basis of percentage of 8 criteria of IUCN standards

From the graph on the left - Fig. (186), which shows the percentage achieved for all the criteria in both types of countries, we can observe that the percentage of criteria is always above for European countries than Asian countries. The reason is that the governments of European countries are focussing more on the techniques to prevent disasters and climate change, while the Asian countries are not concentrating much on these issues. Also, there is a lot of cooperation between different stakeholders, the government, consumers and other people involved in the European countries, which is necessary for NBS to become effective. Though some cases are not considered an NBS or fulfil less the standards, they may still have more benefits and solve more societal problems.

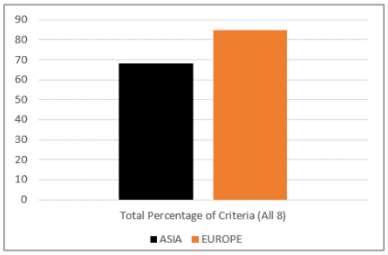


Figure 187 Total percentage of criteria in Asia and Europe

The graph - Fig. (187), is an extension of previous graph, and it shows the total percentage of all the criteria in both types of countries. We can observe that the overall percentage is more for European countries than for Asian countries.

In the Asian countries, 2 out of the 15 cases taken did not adhere to the IUCN global standards - Fig. (189). For the Case- *Jholmal*, Bio-fertilizer, Kavre Palanchowk District, Nepal, though it yielded many benefits, solved 9 out of 17 SDGs, and solved 5 out of 6 societal problems but still, it did not fulfil as an NBS as the scale was small and it could not deal with the trade-offs. Another case- Local knowledge for better water availability and Bio-engineering (Panchase and Makwanpur District), Nepal, though solved 11 out of 17 goals, have a lot of benefits and solved 5 out of 6 societal problems but still the case did not qualify as an NBS as it got inadequate scores in three criteria – 5- "Inclusive governance", 6- "Balance trade-offs" and 7- "Adaptative management".

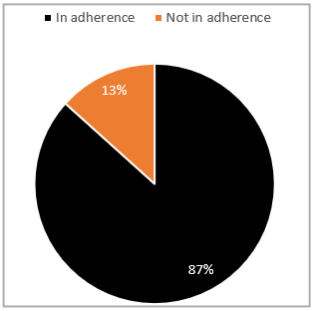


Figure 189 Solutions in Asia -Percentage adhered

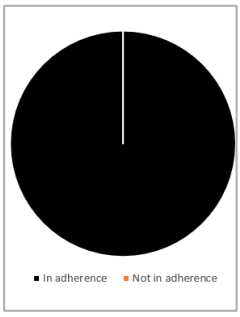


Figure 188 Solutions in Europe - Percentage adhered

For the European countries, all the cases considered could adhere to the IUCN global standards - Fig. (188) .

4.5. Start Park Workshop – Observations and details

1. The story about the site -INDIA

The site is located in Vijayawada, Andhra Pradesh, India.

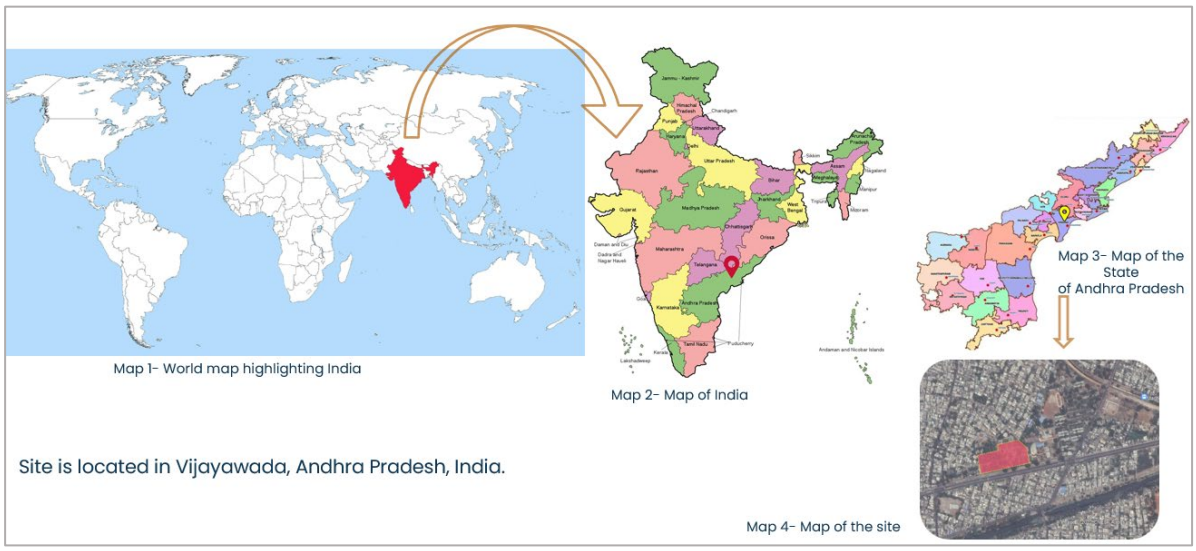


Figure 190 Location of the site in India (Source- Author, https://commons.wikimedia.org/)

The site consists of an existing green area and a neighbouring area which has a few buildings of illegal inhabitants - Fig. (190) . According to the proposal, both areas are to be considered as one and developed into a park - Fig. (190). It comes under the property of the railways, so currently, the Railway's Residential Welfare Association takes care of the park. There are existing boundary walls in some parts, but boundary walls need to be on all sides, if possible.

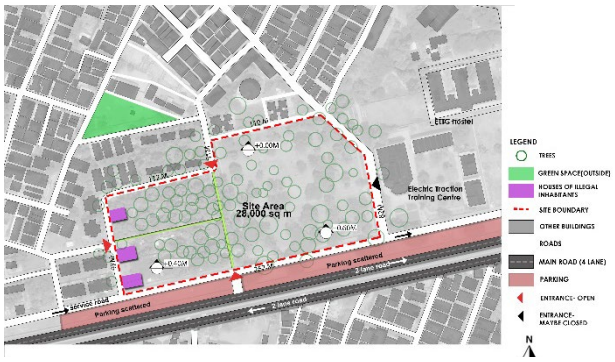


Figure 191 Current Site layout (Source- Author)

Also, the park needs four entrances, out of which one can be closed (facing the training centre). Some illegal homeless inhabitants (with brick wall houses) are living inside the area. They have migrated here from other places. The municipality does not like them, but they cannot show this to others since these people can make a change through their power of the vote. People from the neighbourhood (of all ages) come here to jog, exercise and play. Also, elderly citizens come here to talk with their friends. They would like to have more and better facilities. There are many commercial activities in the vicinity of the park, e.g., tea stalls, grocery markets, pharmacies, and restaurants Fig. (190). Development of this area is better for them also as more people will be attracted here. *"Electric Traction Training Centre"* and its hostel are located on the east side of the site; these buildings can be used for collecting rainwater since it's also part of the railway's property. Currently, the site is crossed by an asphalt road from north to south and west to this road (it can be altered). On the southern side of the site, there is a 4-lane road which connects the city's railway station to the highway and has a system of BRT for the city (Bus rapid transit). Also, approximately 2.5 km in the NE direction from the site, there exists a railway line.

Figure 192 Site with surrounding images (Source- Author)

2. **Proposal-** The railways and the municipality have come up with a proposal to develop this space into a park which will act as an important landmark for the city.

3. **Problems-** There are three of them as follows-

Problem 1- Improper management of water (*Green-Blue Infrastructure cards)*

- The climate of the city is rapidly changing with very high temperatures, more extended dry periods and sudden heavy water spells.
- The water flows off after the rain, and there is no place to hold water for gardening.
- Due to the effect of the above points, the area gets too dry during the summer season, and some plants die.

Problem 2- *Lack of proper spaces and furnishings to enjoy in the park (Furniture Cards)*

- Leaving beside some random seating, the area does not have appropriate seating for people.
- People avoid the space at night as it gets dark, and they feel unsafe.
- No proper waste bins, so people throw waste here and there.
- People look for a place to eat and relax, but due to unavailability, they have to go outside.
- The space for illegal habitants needs to be made better and sustainable.
- The area currently is not aesthetically pleasing.

Problem 3- Lack of activities to do in the area (Activities cards)

- There are no special activities for different age groups which would attract people to this area.
- The younger generation and the commercial spaces nearby prefer to have some events so that they can use the area more.

- The municipality gets almost no income from the area, and they and the investors prefer to have income from it.

4. Roles- Different stakeholders

i. Municipality-

Description: They are powerful. They have the power of money, but they need investors for the money. They need to take care of local citizens to win the next election.

Interests: They want a good development of the site. They wanted to remove the homeless from the area, but they could not do this. They want to construct kiosks. They also prefer to have some extra activities in the park for income.

ii. Old resident-

Description: They have been visiting the park for a long time. They have less power, but they have the power to vote, so they are to be considered significant. They have more experience.

Interests: They hesitate much change but prefer to have a space to sit and relax. Also, some take their dogs for a walk. There is no space for drinking water, so they get plastic bottles. They like yoga and light music and want to contribute to the park.

iii. Young resident-

Description: They have been coming here since birth but now don't use it often. They are not interested in the discussions, but if the area is developed, they will use it more for their exercises, etc.

Interests: They are more into sustainability and need a play area and a better boundary wall. They will also be happy if they get space for events, music, games, and some entertainment.

iv. Illegal inhabitants –

Description: They came here from other areas. They have good indigenous knowledge of nature protection and water harvesting. They work in the neighbouring houses as housekeepers and in the shops as helpers.

Interests: Leaving besides residents, others do not like them. They want their houses to be made better. They will be happy if given small jobs like gardening, etc. Planners prefer their thoughts.

v. Central Government representative-

Description: This person represents the Indian railways and the Ministry of Road Transport and Highways. Their power is more than the municipality. They may act as a mediator if an issue arises.

Interests: They want to develop the area to have a good view of the site from the front road (on the south side). They are here for consultation and prefer the municipality and the planner to put their ideas first.

vi. Environmental Planner-

Description: They are a private agency hired by the municipality. They have the main aim to develop the park and protect the environment. They do not have much power, but their ideas are valued by all others.

Interests: They want to make the park beautiful and user-friendly but prefer using nature-based solutions and not activities which harm nature.

vii. Investment agency-

Description: They are powerful and can influence the decisions as they invest money, and the municipality needs money. They prefer to have many activities and new furnishings in the area.

Interests: They care for the betterment of the area and want to invest money and get a good return. If shattered houses remain inside, then they want to make them better and involve these people for better monetary gains.

viii. Owner of the commercial associations-

Description: They represent the commercial businesses in the vicinity. They want this area to be better aesthetically.

Interests: Making this area better will influence an increase in the number of people in the area and thus increase their sales. They would like to have some events in the area like yoga, events, music, etc. and more furnishings.

5. Observations

i. <u>GROUP 1</u>

-Chosen GBI cards and their opinions-

- **Wet Canals (Linear)-** These canals connect the new naturalistic pond. These will help in taking water and help in flooding during excessive rain.

  Benefits- 7

  Initial Costs of GBI- 1

  Maintenance cost of GBI- 2

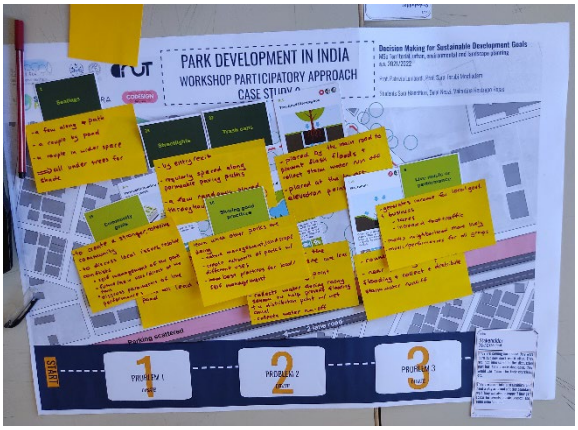


Figure 193 The board worked upon by students- Group 1

- **Tree-lined filtering box (Point)-** They are placed in the southern part as that is the lowest elevation part of the site, and water flows towards that side, and it will help take water and in infiltration and will also prevent floods during excess rains.

  Benefits- 12

  Initial Costs of GBI- 3

  Maintenance cost of GBI- 2

- **Naturalistic pond (Point)-** Pond is placed at the centre of the site, as there are fewer trees, this will add a more naturalistic look to that part and will make a central gathering point with seating as well. It will help in collecting water during rains and prevent flooding. The water will be infiltrated slowly and can also be used for gardening.

  Benefits- 14

Initial Costs of GBI- 1

Maintenance cost of GBI- 1

- **Permeable flooring- blocks with grass joints (Surface)-** This will create a better walking path connecting the entrances and will lead to the pond.

  Benefits- 5

  Initial Costs of GBI- 3

  Maintenance cost of GBI- 1

Total benefits coming from the GBI used- 38 out of 60

Total initial costs of the GBI used- 8 Euros

Total maintenance costs of GBI used- 6 Euros

-Chosen furniture cards and their opinions-

- **Seating-** Few are put along the path, and some near ponds. It is taken care that all of them are placed under the trees for people for shade purposes.
- **Trash cans-** They are placed along the path and near the pond. They will help in waste segregation.
- **Streetlights**- Used along the path and near the pond for the people to enjoy the area at night as well. They are spaced at equal intervals to scatter light equidistantly and also at the entrances. Some people are scared to pass by the park at night. While some also near the trash cans so that people do not throw the trash outside.

-Chosen Activity cards and their opinions-

- **Community Goals-** This is chosen for a more robust and cohesive community. Also, to discuss local issues and resolve conflicts if any arise related to park issues or other neighbourhood issues. Examples of topics which can be goals are self-management of the park, future uses which can be done in the park, performance parameters, etc.
- **Live music or Performance-** This is an opportunity for the municipality and local neighbourhood businesses to generate income through taxes, tickets and advertisements. Music will invite more people of different age groups. Different genres of music can be organised, adding recreational activities for the locals.
- **Sharing good practices-** This was chosen so that different neighbourhood parks can learn from each other's good approaches. This will help not just this park's development but also the development of all neighbouring parks.

ii. Group 2

-Chosen GBI cards and their opinions-

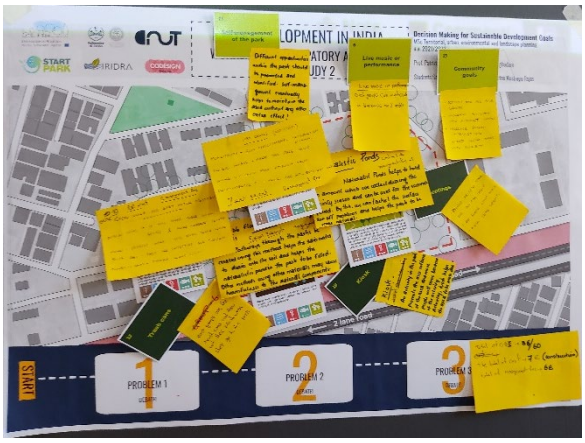


Figure 194 The board worked upon by students- Group 2

- **Wet Canals (Linear)-** The group suggested a reference from Japan and asked if this can be altered and if fishes can be added to this GBI technique. This will help in transferring water from one place to another. In addition, it will make the area cooler and more aesthetically pleasing, as the group said that the sound of water is pleasing to humans.

  Benefits- 7

  Initial Costs of GBI- 1

  Maintenance cost of GBI- 2

- **Green wall for greywater treatment (Point)-** The aim behind this by the group was that the green walls could be made on the houses of the illegal inhabitants who are living inside the park. This will help in making their houses cooler and look aesthetically pleasing. This will also help the municipality in getting votes from these people. Furthermore, younger people will support this as they like sustainability, while the other people nearby will also like this initiative as the area will be more pleasing to see.

  Benefits- 10

  Initial Costs of GBI- 2

  Maintenance cost of GBI- 2

- **Naturalistic pond (Point)-** The aim was that these ponds would hold water collected during rain and could be used during the dry season for gardening and other purposes. This will help solve the problem of excess runoff and make the park look more natural.

  Benefits- 14

  Initial Costs of GBI- 1

  Maintenance cost of GBI- 1

- **Permeable flooring- blocks with grass joints (Surface)-** Using pathways will make a proper way for the people to walk than going in the grass and mud while using permeable is to make the water infiltrate or go to the naturalistic pond.
  Benefits- 5

  Initial Costs of GBI- 3

  Maintenance cost of GBI- 1

Total benefits coming from the GBI used- 36 out of 60

Total initial cost of GBI used- 7 Euros

Total maintenance costs of GBI used- 6 Euros

-Chosen furniture cards and their opinions-

- **Seating -** Near ponds and under trees for people of all categories to enjoy the area. These are also provided near the kiosk and pond for people to sit, relax, eat and enjoy the beauty.
- **Trash cans-** Proper waste disposal mechanism is not available at present, so this will help in waste segregation and disposal. Currently, the area is untidy, and people do not have anywhere to segregate garbage.
- **Kiosk**- They are provided near the pond so people can sit there and have some snacks while enjoying the beauty. This will generate income for the municipality as well.

-Chosen Activity cards and their opinions-

- **Community Goals-** Incorporate local issues and discuss them with all the people living in the neighbourhood so that all people are involved in decision-making. This will make the people involved and will create a feeling of happiness.
- **Live music or Performance-** This is an opportunity for the municipality to generate income. Music will invite more people of all age groups. Different genres of music can be organised. And various stakeholders, like younger and older generations, may participate together in the programmes.
- **Self-management of the park-** This means sharing and learning from each other and helping not just this park in developing but developing all neighbouring parks. This will help the locals manage the park without much dependency on the municipality.

6. Overall observations were -

- Different location gives a different solution- The GBI cards, activity and furniture cards, which were chosen by the students, were different in the case of Torino in Europe than in Vijayawada in India. This tells that by keeping them in the position of the stakeholders, they try to think according to the given stakeholders and not from where they belong. They come up with different solutions and, after a proper discussion with others, finally finalise one of them. Since the problems are different in different places thus, the solutions are different in different places.
- Both groups chose the same 3 out of 4 GBI cards (75% same). However, they had different perspectives as to why they chose those. In contrast, they chose 2 out of 3 same furniture cards (66.67% same). Adding to it, they chose 2 out of 3 same activity cards (66.67% same). This shows that both groups tried to solve the problems they were given, and in reality too, the stakeholders could come up with a resolution accepted by all.
- Different people have different opinions on the same problem- Two groups worked on the case in India. They had the same problems, but they came up with slightly different

solutions. The cards used may be the same, but where they used them was different and their opinion of that card was different among those two groups.

Groups also took care of the ideas and powers of a particular stakeholder to which they were allotted, not just focussing on the main problems faced by the site. But this too depended on person to person. Sometimes the less powerful stakeholder was not taken care of, while sometimes, it was taken care (Seen in the case of the municipality, as they need to take care of the lesser power stakeholders, otherwise they would lose the next election, even though they need money from the investors and investors were very powerful).

5

Conclusion

The question we started with was, “Are the Nature-based solutions used in the European countries (West) better than the Asian Countries (East)?” After going through several methodologies and developing my own methodology, the question remains intact. The answer is complicated. The exact answer to this question seems impossible (or at least needs more extensive research).

The solutions used in European countries and Asian countries are pretty different. In European countries, there is extensive cooperation between the stakeholders, government bodies, consumers, and other important people or organisations. Thus, they can achieve the inclusivity part of the NBS better than their Asian counterparts.

The workshop conducted in Polito also confirms the need for inclusivity, and transparency within the framework, be it implementation or maintenance of the solutions. Different stakeholders have different thoughts and opinions about the resolution of the problem. The location of the problem also changes the thinking of the people. Though this thesis discusses only the Indian (Asian) scenario, but during the workshop, one more scenario in Turin (Italy, Europe) was presented. And it was clear that students chose different GBI, activity and furniture cards in both these cases (Europe and Asia). The most crucial point observed was all the stakeholders were considered, and less powerful ones were not left out because, in the end, IUCN clarifies that to be a good NBS and to reap its benefit to a maximum level, it is essential to incorporate participative approach and bottom-up approach.

The European countries are developed, and there are several programmes undertaken by the EU and the individual countries. They have no money problems and can spend it wherever needed. In contrast, Asian countries are developing nations and have money problems. Though United Nations, European Commission, IUCN, ADB, WWF and companies like GIZ, Ramboll, KPMG, etc., are helping the Asian nations with technology, money and knowledge, but still the development of NBS is less. This is also visible in criterion 4 – Economic Feasibility, of the IUCN standards.

We observed that the NBS used in Asian countries were very cost-effective. For instance, Dhara Vikas: Creating water security with the help of spring-shed development in India, Soil Restoration with Biochar (Cookstoves) in Nepal and Jholmal, Bio-fertilizer in Nepal, are utilising the existing or the so-called waste materials. Biochar which is a form of carbon, involves the use of plant materials decomposed at high temperatures. It just has an initial investment and then many benefits to health, nature and the economy. Similarly, making organic fertiliser in the form of Jholmal from the waste of animals and plants gives many benefits by reducing the waste and providing the benefits of utilising organic fertilisers. At the same time, the Chauka system in India, initially started by one person’s initiative, is also quite intriguing. Normally it is said – “one person cannot change anything”, but this Chauka system

is a live example of one person making a difference. Living weirs which are living dams, are used in many places in Asia, be it Thailand or India, but they are researched less.

Local knowledge or the knowledge of ancient practices is observed a lot in Asian cases considered. Different cases which were studied discuss the need for local knowledge. For instance, Dhara Vikas: Creating water security with the help of spring-shed development in Sikkim in India and Local knowledge for better water availability and bioengineering in Nepal. While European countries also have many local practices and understandings but most of the cases which were studied have become already famous and are also copied at several different places, for instance, water square in Rotterdam, Denmark.

The sustainable development goals, which were fulfilled in Asia, involved mainly those which could help them come outside poverty. While the European context considers SDGs focussing on climate change, sustainable communities and life below water and on land.

Some solutions like Jholmal (Bio-fertilizer from Nepal), living weir construction-Ecosystem-based flood and drought management in river basins from Thailand, Soil Restoration with Biochar (Cookstoves) from Bangladesh, and Improved terracing for enhancing soil fertility on sloping land from Nepal, can also be used in the European countries with some changes because they are cost-effective and effectively help both nature and humans.

To finally conclude the research, it can be said that Asian countries have a lot of intriguing "solutions" which are not adequately researched. Still, if explored, they can be considered NBS (according to IUCN global standards) and utilised in other countries as well.

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