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The status and prospect on nature-based solution in South Asia: A policy-based analysis

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Abstract

South Asian countries face a disproportionate impact from disasters due to their unique topography, poverty, low literacy rates, and socio-economic status. Human activities, such as unplanned urbanization and poorly designed rural road networks, have further contributed to disasters in the region. The article explores the potential of nature-based solutions (NbS) as a means of addressing these challenges through the integration of green, blue, and grey infrastructure. The analysis evaluates the significance of NbS and examines policies and regional cooperation in Bangladesh, Bhutan, India, Nepal, and Sri Lanka, highlighting the importance of incorporating NbS into national policies and promoting collaboration among these countries. The study identifies the current low implementation of NbS in South Asia, with limited research in this area. While there are existing policy tools related to coastal zone management, water, forest, and urban development, policies related to NbS should be coherent, connected, and integrated with natural resources, climate change, disaster risk reduction, and socio-economic growth to achieve sustainable development in the region. Overall, the article emphasizes the need for effective policy implementation and research to enhance resilience to climate change and promote sustainable development in South Asia.

1. Introduction

The practice of nature-based solutions (NbS) is getting global attention for a series of solutions inspired by nature that support the idea of sustainable development by targeting economic growth, strengthening social cohesion, and restoring degraded ecosystems [1–4]. NbS promises to limit the negative consequences of changed climatic variables and disaster risks, especially by utilizing the synergy of green (vegetation areas), blue (water bodies), and grey (built environment) infrastructure that allows for the enjoyment of the benefits of preserving and

restoring biodiversity and ecosystem services [1–9] This idea highlights the need to incorporate NbS into national policies for combating climate change impacts and disaster risks in any country, including the countries of South Asia. South Asia, due to its diverse topography, changed climatic variables, high levels of poverty, political unrest conditions, unplanned urbanization, low literacy rates, and challenged socio-economic status, is particularly susceptible to extreme events such as irregular rainfall, drought, extreme heat, flash floods, landslides, earthquakes, rising sea levels, cyclones, salinity intrusion, and glacial lake outburst floods (GLOFs) [1,10–12]. The rapid growth of urbanization by changing the natural landscape results in a reduction in biodiversity and ecosystem services, thereby exacerbating the impact of disasters on its populations [5,13].

However, adoption of NbS in South Asia is currently low, and research on this topic is rare. One of the possible reasons for this is the lack of attention given to NbS in public policy, which fails to address the complexities of existing and projected vulnerabilities [12]. The objective of this paper is to evaluate and analyze the NbS major policy documents of five South Asian countries (Bangladesh, Bhutan, India, Nepal, and Sri Lanka) (Fig 1) and investigate how much

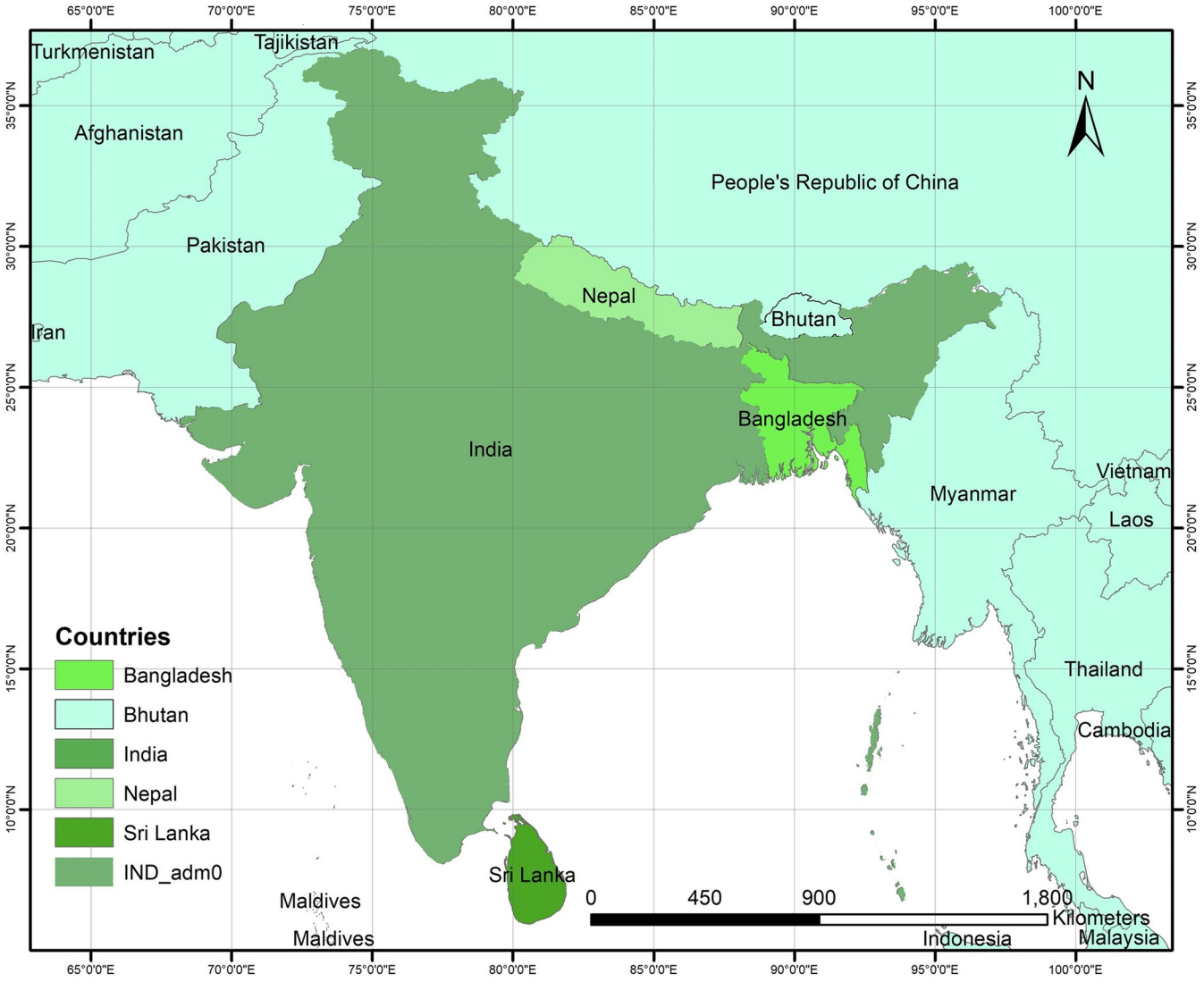

Fig 1. Map of Study area. Source: Author generated map.

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the documents acknowledge the importance of NbS. These countries were chosen due to their shared cultural, environmental, political, historical, and economic characteristics. As well as these countries are the member countries of the South Asian Alliance of Disaster Research Institutes (SAADRI). The paper emphasizes the importance of integrating NbS into the national policies of these countries, as NbS helps to improve human resilience by mitigating and adapting to climate change and addressing climate-related challenges and disaster risks [6,14,15]. This paper identifies gaps in current policies and suggests to explore opportunities for incorporating NbS through further research and implementation.

2. Importance of nature-based solution in South Asia

The South Asian region is highly susceptible to natural disasters, as previously discussed. Climate change and its related disasters are currently the most significant challenges in the area [11], compounded by the increasing population, environmental and social issues, which weaken adaptive capacity and have a severe impact on ecosystems and the provision of natural services to humans. Several studies indicate that without action, the majority of the population will be at high risk of climate change [16]. It is crucial for policymakers to incorporate sustainable disaster risk resilience building through NbS into national policies and programs. NbS plays an essential role in enhancing the resilience of vulnerable communities, biodiversity, and ecosystems.

In the late 2000s, the World Bank introduced the nature-based solutions (NbS) approach to promote ecosystem-based methodologies in their projects aimed at addressing climate vulnerability and increasing disaster risks [12]. The concept was later adopted by the European Commission (EC) in their Horizon 2020 research program, with the aim of promoting the use of NbS in growing urban sprawls and establishing Europe as a world leader in this area. Over time, ecosystem-based adaptation (EbA), urban natural infrastructure (UNI), urban green infrastructure (UGI), and ecosystem services (ESS) have been increasingly included and mainstreamed in policymaking discussions and have become important topics in theoretical arguments [17].

Nature-based solutions (NbS) have gained significant attention in recent years as a strategy for addressing various societal and environmental challenges, especially climate change, water security, food security, human health, disaster risk reduction, and socio-economic development. NbS includes diverse concepts such as green infrastructure, ecological engineering, ecological restoration, forest landscape restoration, area-based conservation, ecosystem-based management, natural infrastructure, ecosystem-based adaptation, ecosystem-based disaster risk reduction, ecosystem-based mitigation, and climate adaptation services.

The importance of NbS has been recognized by international initiatives, including the UN General Assembly's sustainable development goals (SDGs), the Paris Agreement, the Ramsar Convention, and the Sendai Framework for Disaster Risk Reduction [2,3,9,15]. NbS was one of the five primary themes of 2021 UN climate conference (COP26) Day 7- Sticking points and Nature-based solutions [18–20].

Restoration of degraded landscapes using natural practices has proven to be more sustainable and effective than engineering solutions, as it involves the natural course of matter and energy flow with solutions based on local and traditional knowledge that includes the understanding of periodic changes in ecosystems [21]. NbS has emerged as a sustainable and efficient approach for rehabilitating degraded ecosystems and reducing climate and disaster risks, as proved by established field-based experiences [14].

3. Study framework and methodology

This study employed the PRISMA2020 guidelines for systematic reviews and meta-analyses to investigate the scientific, policy, and practical aspects associated with nature-based solutions

and ecosystem-based adaptation in five South Asian countries, namely Bangladesh, Bhutan, India, Nepal, and Sri Lanka (S1 Checklist). A thorough search was conducted in google scholar, ScienceDirect and Scopus, using a variety of relevant keywords, including "nature-based solutions in South Asia," "nature-based resilience," "national policy," "nature-based solution," "science policy in South Asia," "ecosystem-based adaptation," "blue green infrastructure," and "regional cooperation," which led to the identification of over 1000 scholarly publications. However, since the primary focus of this review was to examine the policies and their implementation details from the governments of these countries, the nature-based or ecosystem-based adaptation policies were not included in the identified list. The authors noted that such policies and relevant documents are often published in local languages and diverse formats, such as Nepali documents in the "Preeti" font, which are not searchable online. To collect all available policies in each country, all co-authors studied policies related to nature, natural resource conservation, and management, and reviewed the relevant documents published by the government agencies.

A total of 33 policy documents were identified, with Bangladesh (6), Bhutan (5), India (8), Nepal (8), and Sri Lanka (6) each contributing to the list. All of the documents were thoroughly reviewed for this manuscript, and only policies related to the environment and natural resources were considered (S1 Text). In the second stage, these policies were assessed and categorized into six distinct categories, namely Environment Policy (12), Water Policy (5), Land Use and Land Cover Policy (6), Climate Change Policy (3), Disaster-related Policy (4), and Other policies (3).

The third step involves evaluating the policies to determine whether they are effective, efficient, and appropriate in addressing the identified problem. Additionally, this stage involves assessing the level of synergy between the specific policy and other related policies that address the same issue. This includes evaluating how the policy interacts with other policies and actions aimed at resolving the problem.

In the fourth step, the policies were compared across the five countries to highlight their core values, implementing agents, and the year of introduction. A policy matrix was then created to map Nature-based Solutions (NbS) policies into the existing policies, followed by a comparative analysis across the different countries. The analysis aimed to identify which policies were present in each country and those that were absent, helping to identify gaps and strengths in the policies. For instance, some countries addressed water and forests in a single policy, while others had separate policies. Based on the findings, recommendations were made to address these gaps and leverage the strengths to improve policy coherence and effectiveness.

4. The key policy environment in South Asia

Ecosystem-based adaptation (EBA) and ecosystem-based disaster risk reduction (Eco-DRR) have been considered in South Asia to enhance the resilience of vulnerable communities. It is recommended that these approaches should be integrated into plans and programs to effectively address the impact of climate change. Furthermore, to fully realize the potential of Nature-based solution, it is important to integrate it into existing national governance.

However, South Asia faces several governance challenges such as poor coordination and institutional arrangements, inadequate financial resources, and insufficient monitoring and implementation of plans and policies. To overcome these issues, it is crucial to address these governance challenges and incorporate Nature-based solution into national governance. It is also advisable for each country in South Asia to include Nature-based solution in their Nationally Determined Contributions (NDCs). By incorporating nature-based solutions into their NDCs, countries can mitigate the impact of disasters and increase their resilience to climate change.

Case 4.1 Bangladesh

The vast floodplain and active delta, proximity to active seismic zones, and exposed and vast coast have made Bangladesh naturally prone to many hazards. The Intergovernmental Panel on Climate Change (IPCC) also identifies it as one of the worst victims of climate change and extreme events [22]. Along with preparing various plans, policies, and programs for addressing disaster risks and impacts of climate change, the Government of Bangladesh prioritizes this issue in all relevant plans, policies, and programs, believing in the concept of mainstreaming disaster [23]. Nature-based solutions are often considered as sustainable measures for adapting to climate change and reducing disaster risks [24,25]. In this context, major national policies have been reviewed that acknowledge the components of Nature-based solution in Bangladesh.

National water policy 1999. The National Water Policy 1999 aims to ensure efficient, equitable, and decentralized management of surface and groundwater, to develop sustainable water supply systems, considering water rights, water pricing, gender equity, and social justice and to ensure public participation in water management with environmental awareness. As a comprehensive document, it covers issues, like river-basin management, planning and management of water resources, water rights and allocation, public and private involvement, public water investment, water supply and sanitation, water and agriculture, water and industry, water and fisheries and wildlife, water and navigation, water for hydropower and recreation, water for the environment, water for preserving various kinds of wetlands (ecological systems and biodiversity), economic and financial management, research and information management, and stakeholder participation. The document highlights the issue that most of the country's environmental resources are linked to water resources and the continued development and management of the nation's water resources should include the protection, restoration, and preservation of the environment and its biodiversity including wetlands, mangrove, and other national forests, endangered species, and the water quality. The main target will be to ensure environmental protection, restoration, and enhancement measures for preparing the National Environmental Management Action Plan (NEMAP) and the National Water Management Plan (NWMP).

The document aims to protect natural waterbodies like rivers, swamps, marshlands, lakes, ponds, canals, tanks, and estuaries from degradation due to man-made intervention. It recommends developing water resources for conserving forestry and aquatic wildlife, and using rivers for irrigation, fisheries, and navigation. It recommends massive afforestation for increasing tree coverage in declining water tables, taking special measures to minimize disruption to the natural aquatic environment, and planning water development projects to avoid environmental damage, maintain aquatic life movement, migration, and breeding, and ensure adequate upland flow in water channels to maintain the coastal estuary eco-system.

National land use policy 2001. The National Land Use Policy 2001 aims to protect agricultural lands for ensuring enough food production, to regulate non-agricultural uses of lands, to prepare guidelines for ensuring the best use of lands based on their qualities, to ensure the optimum utilizations of lands that are acquired for urbanization or any other development projects, to preserve lands which can be used for future projects, to ensure the acceptable use of lands considering the natural environment, to ensure the proper utilization of lands for reducing poverty and increasing employment opportunities and to assist to minimize the number of landless population. Additionally, it highlighted the importance of nature-based solutions by increasing the forest cover and extending it to 25% of the total geographical area.

Coastal zone policy 2005. The Coastal Zone Policy 2005 aims to eliminate vulnerabilities from natural hazards and preserve Critical Ecological Zones (CEZs). It focuses on socio-

economic development, adaptation to changing climatic scenarios, and contribution to national development. It includes components for economic growth, livelihood creation, empowering communities, reducing vulnerabilities, ensuring women's development, managing natural resources, and conserving and enhancing CEZ quality. However, science-based strategies are not proposed for preserving and managing CEZ resources.

Disaster management policy 2015. The National Disaster Management Policy 2015 suggests national approaches for reducing risks of all natural, environmental, and human induced hazards and proposes strategies for managing any emergency condition so that sustainable development can be ensured. It also portrays the broad national objectives for addressing the impacts of climate change, unregulated urbanization, and environmental degradation. It suggests changing the disaster management paradigm by focusing more on risk reduction, mitigation, and preparedness.

National forest policy 2016 (Draft). This policy admits the need of preserving the biodiversity and ecosystem for ensuring rational utilization of resources, reducing disaster risks and adapting to climate change. Though it does not provide a definition for designating forest areas it admits that the natural forest cover is decreasing. It primarily targets to increase the forest cover to at least 20% of the country's geographical area to address emerging environmental challenges. Along with afforestation in various areas (natural forest areas, denuded hilly areas, newly accreted inland river islands and coastal islands, roadside lands, etc.), expansion and sustainable management of zoological and botanical gardens, arboretums and other related categories of protected areas are proposed. But it did not propose anything for Ecologically Critical Area (ECA) s, whereas the National Sustainable Development Strategy 2013 asks to declare ECAs and prepare management plans for those areas. The policy is also unaware of the important issue of controlling Invasive Alien Species (IAS), Genetically Modified Organisms (GMO), and the agreement signed with India for preserving the shared mangrove forest of Sundarbans.

National environment policy 2018. It targets to have environment-friendly economic development, sustainable production, and consumption and proposes science-based specific strategies for different sectors, i.e. land resource management, water resource management, air pollution control, safe food and water, agriculture, public health and health service, accommodation housing, and urbanization, education and mass awareness, forest and wildlife, fisheries and livestock, biodiversity-ecosystem conservation and biosafety, hill ecosystem, coastal and marine ecosystem, disaster management, climate change preparedness and adaptation, management of chemical substances, other pollution control, ecotourism, industrial development, energy and mineral resources, communication and transportation, science research information and communication technologies, and human resources management.

Case 4.2 Bhutan

Bhutan being one of the Himalayan countries, it is extremely exposed to the adverse impacts of climate change and its disasters due to its fragile mountainous environment. Moreover, with the economic development of the country, there is more human intervention in nature triggering more natural disasters like landslides and flood. Therefore, Nature-based solution strategies are emphasized in all the national policies, strategies and guidelines, which is monitored under the umbrella of National Environment Commission [26].

To achieve ecologically balanced sustainable development, Article 5 of the Constitution of the Kingdom of states that the country should maintain a minimum of 60% of forest cover for all the time [26]. Thus, Environment conservation has become one of the four pillars of the country's Gross National Happiness (GNH) philosophy. This is reinforced by a Bhutanese

belief of actual development takes place only when socio- economic, spiritual and environmental well-being complement and reinforce each other [27]. Today, all the developmental activities of different scale, including five-year plans are assessed and monitored based on GNH indicators, where environmental indicators must be fulfilled [28].

Bhutan water policy 2007. The Bhutan water policy calls for integrated water resource management and provides directive to protect all forms of water resources and water related problems. It comprises principles of environmental conservation, integrated water resources management, economic efficiency and good governance. This policy seeks comprehensive watershed management soil conservation, watershed area protection, protection and increment of forests area to reduce flood related disaster [28]. It also assured all Bhutanese people to have access to adequate, safe, and affordable water to enhance the quality of their lives as enshrined in Water Act of Bhutan, 2011 [29].

National forest policy of Bhutan 2009. Bhutan has been gifted with a rich forest cover and renewable natural resources. The forest policy 1974 has been successful in conservation and protection as per the Forest Act of 1969 [30]. With change of emphasis in forest management Forest policy 2009 focus on balancing conservation with sustainable utilization guided by Article 5 of the Constitution of the Kingdom of Bhutan [29]. This policy is framed flexible manners that can be adapt and support on-going changes. Bhutan also ensured to maintain minimum of 60% of country's land area under forest cover for all time as per 1974 policy and later included in the Constitution of Bhutan [30].

Climate change policy of the Kingdom of Bhutan 2020. Being highly vulnerable to the consequences of climate change, Bhutan endeavors to achieve healthy and ecologically balanced sustainable development in accordance with GNH's Middle path philosophy aligned with National Environmental Protection Act 2007. This policy focus on having carbon neutral development which can be implemented with effective and coordinated actions. This policy also tries to protect the wellbeing of the people by adapting to climate change by addressing the challenges at appropriate levels [31].

Economic development policy 2016. With the Bhutan's vision of a green and self-reliant economy. It intends to ensure green and sustainable economic development while developing Brand Bhutan theme [32]. All the strategies in this policy ensures to have environmental sustainability through diverse economic base with minimal ecological footprint; harness and add value to natural resources in a sustainable manner; promote Bhutan as an organic brand by reducing dependency on fossil fuel [32].

National Human Settlement Policy of Bhutan (NHSPB) 2019 and National Housing Policy (NHP) 2019. With rapid socio-economic development leading to adverse impacts on environment and cultural landscape triggering climate change induced disaster risks and rural-urban migration, NHSPB 2019 intends to guide development of human settlements by providing framework of environmentally sustainable, culturally and economically vibrant and disaster resilient human settlement plans [33] supported by Bhutan National Urbanization Strategy (BNUS) 2008 and Bhutan National Human Settlement Strategy (BNHSS) 2017 [33]. This ensures to balance rapid urbanization and protect fragile ecology though limiting conversion of farmland and forests for infrastructure developments. It also guides to protect encroachment of environmentally sensitive and disaster-prone areas as per the Land Act of Bhutan. Further the NHP 2019 ensures all housing development projects to put efforts in preserving local ecosystems with adequate monitoring to have minimal disturbance on it without compromising on community vitality [33].

Bhutan prioritized focusing on SDG 13—Climate Action and SDG 15- Life on Land as per Comprehensive development plan of Bhutan 2030 [33]. Thus, the entire above listed policies act as guiding principles to achieve sustainable socio-economic development of the country

aligned with international commitments on implementing 2030 Agenda for Sustainable Development.

Case 4.3 India

India being the largest country in the south Asian region with the maximum population in the world which is approximately 1.4 billion, faces great threats from the natural disasters and adversities of climate change. India's natural resources like water, air, and soil are under extensive pressure due to the huge population and are additionally being impacted by climate change. India is facing issues of urban heat island [34], drought [35], urban flooding, water, and air pollution change in precipitation patterns, soil erosion, and slope destabilization [36] due to alteration and depletion in the natural system and green covers, especially in urban areas of India. Nature-based solutions using a mix of gray and green infrastructure [5] could be very effective and have been proven to be effective in various cases in India. A successful example of the implementation of Nature-based Solutions (NbS) to achieve resilience has been seen in the case of Gurugram through the concept of "Greening cities" including eco-corridors, vegetation belts, biodiversity parks to tackle against the adversities like UHI, air pollution and water stress [5]. Some of the major policies linked to Nature-based resilience are discussed below.

National forest policy, 1988. The National Forest Policy was articulated in 1988 for the management of state forests in the country sighting to the severe depletion of forests in then-recent periods. It aimed to have a minimum of one-third of the total plains and two-thirds of the total hills under the forest cover through eco-centric approach. It also focused on the involvement of the local community in promoting afforestation along with joint programs like society forestry and farm forestry. The policy also brought the perspective of education and research on the importance and management of forests into the mainstream. As a result of this policy, the forest cover increased in the nation from around 19% in 1987 to over 23% [37] in 2005.

National water policy 2012. The National Water Policy was first adopted by National Water Resource Council (NWRC) in 1987 and was revised in 2002 with the aim to ensure the minimum flow in perennial streams maintaining ecology and social considerations. The Water Policy, 2002 also brought the concept of "polluter pays"[38] into the picture to bring accountability towards water resources and the related ecosystem.

The latest National Water Policy 2012 was to cope with the threat of Climate change on water resources and maintain ecological sustainability. The policy addressed the threat of Climate change on water resources through the National Water Mission, which was one of the eight missions launched by GoI [38]. The new policy also highlighted the threat of urbanization and industrial developments to the natural aquifers and water bodies and suggested to keep a check on them.

National conservation strategy and policy statement on environment and development, 1992. The policy established certain priorities and strategies for action which indirectly promoted nature-based solutions to enhance the resilience in society. Classification and zoning of land based on the uses were suggested to ensure the forest cover, agriculture, catchment area, grasslands, etc. Traditional knowledge like contour trenching, contour bounding, small storages, and catchments, of minimizing soil and run-off losses were to be promoted extensively throughout the country. Conservation of wetlands was directed to ensure sustainable ecological and economic benefits. Green belts with pollution-tolerant species were to be raised to tackle the issue of air pollution [39].

National environment policy, 2006. The National Environment Policy intended to integrate environmental concerns into all forms of development. The seven objectives of this

policy emphasize the wise use of the environment to protect the natural resources and environment as well as focuses on the equitable and efficient distribution of natural resources [40]. The policy also established fourteen principles. These principles require that the services of environmental resources be given economic value, and such value to count with the economic values of other goods and services, in the analysis of alternative courses of action. One of the principles also repeats the concept of "polluter pays" with more legal liability to achieve economic efficiency and sustainable use of natural resources at the same time. The NEP 2006 also formulated strategies and actions to establish Environmentally Sensitive Zones, use of economic principles in environmental decision-making, enhance and conserve environmental resources and check the degradation of land, deserts, forests, wetlands, and water bodies.

National policy on disaster management, 2009. The National Policy on Disaster Management (NPDM) was created in compliance with the Disaster Management Act, 2005. The Policy covers all facets of disaster management, including institutional, legal, and financial arrangements; preparedness for, and mitigation of, disasters; a techno-legal framework; response, relief, and rehabilitation; reconstruction and recovery; building capacities; and knowledge management and research and development (National Disaster Management Authority, 2009). The policy intended to encourage mitigation measures based on technology mixed with traditional knowledge to achieve environmental sustainability. A special highlight on the nature-based traditional knowledge of mitigating and managing risks was given in the policy. Such nature-based resilience against flooding, slope destabilization, biodiversity degradation, and water and air pollution could be very useful and hence needs to be promoted.

National Agroforestry Policy, 2014. The National Agroforestry Policy was launched in 2014 which creates the framework for the nation's targeted national policy and appropriate institutional architecture for promoting agroforestry as a tool to mitigate the impacts of climate change [41]. The main objectives of the policy were to (i) to create a National Agroforestry Mission or Agroforestry Board to implement the National Policy, (ii) improve the productivity; employment, income, and livelihood opportunities of rural households, especially women and children, (iii) enhance the effectiveness of the National Agroforestry Mission, (iv) to promote agroforestry through incentives and government support.

National Urban Policy Framework (NUPF), 2020. The core of the policy lies with the 10 principles of the policy which emphasize the implementation of nature-based solutions as a tool to achieve sustainable urbanization [42]. Further, the urban areas are classified into 10 functional areas based on the field of interventions. Under the environmental sustainability functional area of the policy, it suggests expanding the green spaces as a tool of resilience against issues like air pollution and urban heat island. The preservation and conservation of lands with significant environmental functions, such as those designated as national parks, wildlife sanctuaries, reserve forests, or eco-sensitive zones, as well as regulating land use for the aforementioned areas to lessen land-use conflicts or adverse environmental impacts, are some pertinent policy goals that align with the NbS approach.

Recent Initiatives in India. Apart from this, several initiatives and programs like MISHTI (Mangrove Initiative for Shoreline Habitats & Tangible Incomes), 2023 with the objective of exploring the possible area for development, sharing best practices on plantation techniques, conservation measure, management practices for mangroves has been started by GOI. Another such scheme named, Amrit Dharohar, 2023 encompasses promoting the conservation of wetlands to enhance the bio-diversity, carbon stock, ecotourism and economy generation for the local communities. National Afforestation Programme (NAP), 2019, was a similar program which aimed to restore and afforest degraded forests and non-forest lands to increase forest and tree cover while sequestering carbon and improving local livelihoods. The Green India Mission (GIM), 2014, focused on restoring ecosystems, afforestation, and biodiversity

conservation to improve the quality and extent of forest and tree cover in the country. Namami Gange (Clean Ganga Mission), 2014 was a mission that focused on cleaning and rejuvenating the Ganges River by promoting afforestation along the river's bank and also through sustainable river management practices.

Case 4.4 Nepal

The mountainous country Nepal is one of the most disaster-prone countries in the world. Frequently occurring natural disasters such as earthquakes, landslides, floods, fires and thunderstorms are weakening the ecosystem of the country. Similarly, the increasing number of natural hazards such as landslides and floods [43] are causing large number of lives and economic losses every year. In addition to that, there is always a high risk of Glacier Lake outburst floods (GLOFs), avalanches and epidemics. The heterogeneous topography with young mountain ranges is fragile to heavy monsoon rainfall leading to a wide range of geological and hydro-meteorological disasters across the country [5]. Several types of research have shown that haphazard development and human intervention in the environment contribute to the increased number of natural disasters [6]. And on the other hand, human behavior may also play an imperative role in resilience building to disasters. Nature-based solution is one of the measures to adapt to changing climate and frequently occurring natural disasters. In this context, managing disaster risk through Nature-based solution should be emphasized in all the programs and policies of the government of Nepal. Here, we reviewed the major national policies and programs that acknowledge the importance of Nature-based solution in Nepal.

National Water Resource Policy 2020. The National Water Resources Policy 2020 has been released with a long-term vision of promoting equitable and sustainable development of water resources for economic prosperity and social transformation through multi-purpose uses [44]. The primary objective of the policy is to achieve economic prosperity and social transformation by conserving, enhancing, and utilizing the available water resources in a sustainable manner. Additionally, the policy aims to develop and use water resources while reducing water-induced disasters and minimizing the negative impacts on the economy, society, and environment. By prioritizing integrated water resource management and multi-purpose use of water resources, the policy aims to maximize the benefits derived from these resources while minimizing negative impacts.

Nepal Climate Change Policy 2019. Nepal's climate change policy was initially formulated in 2011 and replaced by the latest policy in 2019 [45]. One of the objectives of Nepal's climate change policy is to build the resilience of ecosystems that are at risk of adverse impacts of climate change. Nepal Climate Change Policy aims to reduce the vulnerability to climate change enhancing the climate change adaptation capacity of local people to utilize the maximum products and services provided by natural resources and their efficient management [45]. The main strategies of climate change policy are: agro-forestry development in sloppy and low-grade forest areas and riverbeds that are affected by climate-induced risk; to formulate the action plan and implement it to conserve rare and endangered wildlife and plants as well as sensitive ecosystems that are at risk of climate change.

National Land use policy 2015. Land use policy 2015 prioritizes and focuses on to preparing green certificates through map-survey and demarcation of forest and Reserves Areas. It also stresses on the protection of Churia Bhabhar Hill Areas that provides abandoned natural resources to the Tarai region of Nepal. Relocation of the human settlement that is in the hill areas having low productivity and high risk of natural disasters is another priority of the policy. The principle of sustainable development is adopted in development works to keep a balance between land, environment and development in view of the impact of climate change.

National policy for disaster risk reduction 2018. This policy came into effect after the approval of the Disaster Risk Reduction and Management National Council as per the mandate of the Disaster Risk Reduction and Management Act 2017. The goal of this policy is to reduce disaster mortality and the number of affected people substantially, increase resiliency by reducing disaster damage to means of livelihoods as well as critical infrastructures and disruption of basic services such as agriculture, industry, roads, communication, water supply and sanitation, education and health facilities, and reduce direct disaster economic loss. It focuses on participatory disaster risk management and resilience-building especially community-based disaster risk reduction activities by the maximum utilization of local knowledge, skill, recourses and materials.

National Wetland policy 2003. Nepal has formulated the National Wetland Policy in 2003 to conserve and manage wetlands resources wisely and in a sustainable way with local people's participation [46]. Nepal has various types of wetlands that cover almost 5.5% of the total land. The major objective of the policy is to identify local people's knowledge, skill and practice regarding wetlands and promote their innovations and traditional research for the sustainable use of wetlands resources. Furthermore, it focuses on the integration of scientific knowledge and technology to identify the wetlands and prepare detailed management plans for each of them to prevent the degradation and disappearance of wetlands in Nepal. Nepal has shown its commitment to wetlands conservation, especially the conservation of waterfowl habitats of international importance, by signing the Ramsar Treaty 1971.

Rangeland policy 2012. The "Rangeland policy 2012" is published in 2012 by the Ministry of Agricultural Development [47]. It has defined rangeland as natural pastureland that includes grasslands and shrublands. The National Rangeland Policy 2012 has recommended to establish various rangeland management institutions at the ministry, departmental, district and user levels with their corresponding roles and responsibilities. It aims to increase the quality and productivity of range land and increase the industry based on range land as well as increase biodiversity through the protection.

National Agroforest policy 2019. The national agroforest policy has been implemented to promote the farmers to practice the integrated practices of agriculture, livestock and forest activity on the same piece of land [48]. The major objectives of the policy include: increasing the productivity of land through the multipurpose use of land, conserving the environment and biodiversity by reducing the pressure over forests, enhance the climate resilience ecosystem. Similarly, it aims to increase income generation along with food security in marginalized communities, promote research and development in the agroforestry field and increase the investment opportunities in agroforestry to contribute in the national economy.

Case 4.5 Sri Lanka

Sri Lanka is an island country located in the Indian Ocean off the southern tip of India. As in many other countries, impacts of climate change are increasingly felt in and experienced by Sri Lanka. Although a natural phenomenon, climate change is augmented by various anthropogenic activities. The island is experiencing a wide array of natural hazards including two extreme events of the water cycle, namely floods and drought caused by uneven rainfalls [49,50]. In general, reports indicate that the annual mean surface air temperature has been increasing in many parts of the country. On the contrary, studies identify that precipitation has been declining in most districts in the island [51–53].

Impacts of rainfall induced landslides are sometimes accelerated by unsustainable human activities [54]. Sri Lanka frequently faces disturbances in the atmosphere that include winds and tropical cyclones [55]. The risk of disasters is linked with many environmental issues

including the rapid deforestation, destruction of natural habitats involving coastal and inland wetlands, land degradation and over-extraction of resources [56–58]. Cascading effects and compounded impacts of diverse disasters together with poverty affect the capacity of disaster preparedness and reduce the risk of future hazard events.

Increasing preparedness to impacts of climate change and adopt mitigatory measures while meeting the Millennium Development Goals could be challenging for a developing country such as Sri Lanka. Yet, country's rich natural habitats and ecosystems could present "regret-free" solutions. Against this backdrop, Nature based solutions could offer an attractive and cost-effective, solution to reduce disaster risks and promote climate change mitigation and adaptation. Even though being an emerging concept, NbS have developed in some countries as a promising concept and practice to address societal issues. Therefore, analysis of polices related to environment and development provides policy makers a powerful tool to understand whether NbS are incorporated sufficiently.

National Environmental Policy (NEP) (2003). Sri Lanka's National Environmental Policy (NEP) which was introduced in 2003 by the Ministry of Environment and Mahaweli Development, has become a main guide for the environmental conservation and sustainable development in the country. However, as policies need to be revived periodically, the Ministry currently is in the process of revising and further develop the policy.

The Constitution of Sri Lanka emphasizes that the duty of every person to protect nature and conserve its components. The NEP recognizes the essential need to conserve the island's rich ecosystems and environment and pursues to provide necessary guidance to identify, plan and execute steps in order to different aspects of the environment, namely land, water, atmosphere and living (biodiversity) components. Thus, this Policy is supported by many other policies and strategies developed for other sectors.

Nowhere in this policy mentions about NbS directly. Yet, there are various secondary directives mentioned that could help and enhance NbS.

Land and Water

The policy emphasizes a special protection provided for highly erodible areas, inland and coastal, and areas prone to landslides. It also mentions the need of catchment conservation of water maintaining existing natural vegetation and adopting other conservation measures as appropriate. Protection of wetlands to support their ecological functions is emphasized.

Biological Diversity

Under this section restoring degraded ecosystems, conservation of high priority forests where important habitats and biodiversity exist, adequate protection given to key coastal and marine ecosystems are mentioned. All species of fauna and flora that are threatened, including the wild relatives of cultivated species have gained special attention.

National policy on protection and conservation of water sources, their catchments and reservations in Sri Lanka (2014). This policy was prepared by the Ministry of Land and Land Development with adequate emphasis paid on micro catchments which include rivers and streams, their reservations and their spouts and flood plains of the rivers. In addition, natural or manmade tanks and reservoirs and shallow lakes (villu), their reservations and "immediate catchments" of these habitats are to be protected.

The policy emphasizes that as global warming, other climatic changes and the natural disasters could affect water sources and accordingly, when formulating future strategies for conservation adequate attention should be paid to include management measures. The document also recommends identifying the institutions which contribute directly or indirectly for the

protection and conservation of the areas related to the water sources and establishing a National Level Operational Committee.

National Land Use Policy of Sri Lanka (2012). This policy focuses on the sustainable management of land resources. Many recommendations are presented in relation to the protection, conservation and improvement of the quality of natural resources,

The policy places high priority on natural forests which have a high biological and hydrological value and other forests with multiple uses are to be protected. All such natural vegetation will be managed through management plans based on bio-diversity conservation principles.

Land in landslide prone areas should be developed with adequate care and appropriate conservation measures to be taken. River catchments receive a special attention together with conservation and management of wetlands. Another salient feature in this policy is its concern over natural disasters in the coastal zone. Appropriate zoning with regulated activities will be demarcated to conserve such areas.

National Climate Change Policy (NCCP) 2012. The NCCP communicates broad national policy statements to ameliorate the impacts and challenges of climate change. The preamble to the NCCP recognizes that present and future generations will have to live with climate change and the vulnerability of developing countries such as Sri Lanka due to inadequate adaptive capacity.

The major points that have been elaborated is to maintain ecosystems stability, conservation of water resources and biodiversity. The policy recommends taking action to minimize the impacts on water resources due to erratic precipitation patterns temperature rise and sea water rise.

The document highlights the essential need of enhancing climate change resilience of natural ecosystems and its diversity.

National policy on Disaster Management (2013). The Disaster Management Act No 13 of 2005 (DM Act) provides the basis for the current disaster management approach.

Unfortunately, this policy doesn't pay adequate attention to NbS and focusses only on disaster management. It emphasizes that during pre-disaster phase the highest priority will be accorded to early warning, preparedness for response, mitigation, prevention, awareness and training. The policy advises on formulation and issuance of early warning for many disasters. Highest priority during a disaster will be placed on to save and protect life and environment.

5. Comparison among countries

The nature-based solutions are more effective, eco-friendly and sustainable in nature and require a comparatively very less initial investment and almost no operational cost. The World is now concentrating more on green interventions and nature-based solutions and investing a lot in the field and projects. The countries of South Asia do not have direct policies related to Nature-based solutions and resilience; still, they have aptly emphasized the nature-based solutions to be incorporated in various policies related to environmental protection, water management, land utilization, disaster management and others. Table 1 shows the major policies from the five nations, i.e., Bangladesh, Bhutan, India, Nepal and Sri Lanka, related to the environment, water, land use, disaster management and others that have incorporated or highlighted the use of nature-based solutions to achieve resilience.

Bangladesh, in its National Water Policy, 1999 emphasized preserving and maintaining water bodies and resources with natural intervention to achieve biodiversity sustainability. The policy also outlined afforestation as one of the measures to conserve natural resources and biodiversity. The National Land Use Policy, 2001 of Bangladesh targeted to achieve 25% forest

Table 1. Policy Matrix from the selected countries.

Country	Environment Policy	Water Policy	LULC Policy	Climate Change Policy	Disaster-related Policy	Others
Bangladesh	Coastal zone policy 2005 National Forest Policy 2016 National Environment Policy 2018	National Water Policy 1999	National Land use Policy 2001		National Disaster Management Policy 2008 (Draft)	
Bhutan		Bhutan Water Policy, 2007	National Forest Policy of Bhutan 2009	Climate Change Policy of the Kingdom of Bhutan 2020		National Human Settlement Policy of Bhutan (NHSPB) 2019 Economic Development Policy, 2016
India	National Conservation Strategy and Policy Statement on environment and development, 1992 National Forest Policy, 1988 National Environmental Policy, 2006 National Agroforestry Policy, 2014	National Water Policy (1987, 2002, 2012)	National Land utilization policy (Draft), 2013 National Urban Policy Framework (NUPF), 2020		National Policy on Disaster Management, 2009	
Nepal	National Wetland Policy 2003 National Rangeland Policy 2012 National Agroforestry policy 2019	National Water Resource Policy 2022	National Land use policy 2015	Climate Change Policy 2019	National Policy for Disaster Risk Reduction 2018	
Sri Lanka	National environmental policy and strategies 2003	National Policy on Protection and Conservation of Water Sources, their Catchments and Reservations in Sri Lanka	National Land Use Policy of Sri Lanka 2012	The National Climate Change Policy of Sri Lanka 2012	National policy on Disaster Management 2013	Sri Lanka Energy Policy 2019

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cover of the total geographic area. As discussed above, other policies related to NbS in Bangladesh have also focused on incorporating nature-based solutions to enhance resilience to the degradation of natural resources and natural disasters. The prime objective of these policies has been to keep a balance between economic development and environmental sustainability.

Similarly, Bhutan has also been proactive in mentioning the NbS as a tool to attain environmental sustainability and quality of life for its citizens. They have targeted maintaining about 6% of their total geographic area under forest cover. The Economical Development Policy, 2016, advocates economic development with a minimal ecological footprint. The policy on human settlement and housing intend to ensure a culturally and economically vibrant disaster-resilient human settlements plan without compromising the environmental sustainability of the nation.

India, the largest country in terms of geographical area, population and diversity in the South Asian region, faces challenges ranging from almost all-natural disasters, huge population density and urbanization since its independence. India has seen rapid growth in terms of urbanization and infrastructure development in the recent few decades, which has severely impacted the natural resources of India. The Indian policymakers have been aware of this beforehand and were considering using natural solutions to issues like water resource management, air quality management and disaster resilience. The focus on the use of NbS in policies started in the late 1980s with a major focus on preserving and maintaining the forest cover of the nation to conserve biodiversity and environmental and ecological balance. The National

Forest Policy 1988 paved the path of achieving 23% forest cover in 25 from 19% in 1987. The national water policy of India has majorly focused on using a mix of gray and green infrastructure to manage water bodies and ensure water availability to its citizens. Other policies on disaster management, environment, and afforestation have highlighted the ability of nature-based solutions to achieve resilience from natural disasters, improved air-water-soil quality, a tool against the adverse effects of Climate Change and hence, recommends adopting the NbS as much as possible.

Major policies related to NbS in Nepal have been majorly focused on achieving resilience to natural disasters and the effects of Climate Change due to its higher vulnerability and exposure. Nepal is one of the most upfront nations from the South Asian region in terms of incorporating NbS to achieve resilience in its national policies. The National adaptation proclamation (NAPA), 2010 identified cross-sectoral, multi-stakeholders and multi-criteria adaptations likely to be the Nature-based solution approaches. The Nepalese policy on climate change recommended environmentally friendly strategies, such as agro-forestry in sloppy and low-grade forest areas and riverbeds. Nepal's National Land use policy governs assessing the high-risk hilly regions with human settlements and relocating them to safer locations. Nepal also has a dedicated policy for conserving and managing wetlands. Wetlands are a tool against the adverse effects of climate change and regulate the water and air quality, flood and drought prevention, providing habitat to several species and livelihood opportunities to the nearby community.

Sri Lanka, also, like other countries in the South Asian region, does not have a direct mention of NbS in their policies but indirectly promotes the application of NbS against landslide and soil erosion and water conservation for maintaining existing natural vegetation. The Sri Lankan National Environmental Policy of 2003 emphasized the conservation of high-priority forest that supports biodiversity and provides habitat to several flora and fauna. The policy also advocates the protection of wetlands and the promotion of nature-based tourism. The National Policy on Protection and Conservation of Water Sources, their Catchments and Reservations in Sri Lanka (2014) emphasizes the protection of the river catchments and small water bodies through management measures as a preparatory solution to the impending effects of global warming and changing climate. The National land Use Policy of Sri Lanka prioritizes the conservation of natural forests because of their high biological and hydrological value. Policy Matrix from the selected countries is shown in Table 1 and Policy and NbS linkage is shown in Table 2.

Though these nations of the South Asian region have incorporated NbS mostly indirectly in their policies, there is a dire need to have focused and dedicated policies on Nature-based Solutions to achieve resilience and environmental sustainability. The dedicated policies will promote the implementation of NbS in the development projects which are lagging at the current time. The position of the South Asian countries, in terms of the number of projects approved in the DRM portfolio and the amount of investment in project Components Containing Nature-based Solutions, is far below that in cases of Africa & the Middle East and East Asia & the Pacific.

6. Need for regional cooperation on science and policy practice

The broader aim of this paper is to pinpoint opportunities for enhancing decision-making and integrating actions by optimizing the structure and organization of different institutes and policies that use concepts of NbS and to learn from each other. In South Asia, the governments are investing in disaster risk reduction and improving response capabilities at various levels. To integrate these efforts, the NbS should be included in the objectives and action plans of the

Table 2. Policy and nature based solution linkages.

Country	Policy	Target resource	NbS Linkage
Bangladesh	National Water Policy 1999	Water and water-side land/forest	• Protection of natural waterbodies from degrading due to any man-made intervention or action • Management of all types of water resources, including protection, restoration, and preservation of the environment and biodiversity of wetlands, mangroves, and other natural forests, natural habitats of aquatic vegetation, wild life, and aquatic wild life • Maintenance of natural drainage, water flow, and water quality • Maintenance of the coastal estuary eco-system is threatened by the intrusion of salinity from the sea
	National Land Use Policy 2001	Land, Water, and Forest	• Uses of land resources, considering the natural environment of the area • Control of unregulated use of lands for agricultural and non-agricultural purposes • Targets to increase the forest cover to 25% of the country's geographical area Maintaining the natural water quality of all natural water sources
	Coastal Zone Policy 2005	All Natural Resources of Coastal Area	• Preservation and improvement of the quality of the Critical Ecological Zones (CEZ) of coastal areas Mitigation of the gradual deterioration of the natural environment due to climate change impacts and anthropogenic causes
	Disaster Management Policy 2015	Life, Livelihood and Well-beingness	• Mitigation of the impacts of climate change, unregulated urbanization, and environmental degradation
	National Forest Policy 2016 (Draft)	Forest	• Conservation of biodiversity and ecosystems for ensuring rational utilization of resources • Targets to increase the forest cover to at least 20% of the country's geographical area • Expansion and sustainable management of zoological and botanical gardens, arboretums and other related categories of protected areas
	National Environment Policy 2018	All-natural Resources	• Science-based specific approaches for land resource management, water resource management, air pollution control, safe food and water consumption, agricultural practices, forest and wildlife conservation, fisheries and livestock production, biodiversity-ecosystem conservation and biosafety, coastal and marine ecosystem, disaster risk reduction, climate change preparedness and adaptation, management of chemical substances, other pollution control etc.
Bhutan	Water Policy, 2007	Water, Land, Forest	Calls for Integrated Water Resource management. Seeks Comprehensive watershed management, soil conservation and water related disaster.
	National Forest Policy of Bhutan, 2009	Forest, renewable resources	• Maintain 60% of country land under forest cover. • Balance conservation and sustainable utilization of forest resources.
	Climate Change Policy of the Kingdom of Bhutan, 2020	Environment, Livelihood and Well-beingness	• Achieve healthy and ecologically balanced sustainable development • Focus on having carbon neutral development • Safeguard the welfare of people by addressing climate change challenges with appropriate levels.
	Economic Development Policy, 2016	Environment, Economy	• Ensure green and sustainable economic development • Ensure environmental sustainability through diverse economic base with minimal ecological footprint
	National Human Settlement Policy of Bhutan (NHSPB) 2019	Livelihood, Well-beingness, Environment	• Guides developments by providing environmentally sustainable, culturally and economically vibrant and disaster resilient human settlement plans • Balance urbanization and protect fragile ecology though limiting conversion of farmland and forests. • Protect encroachment of environmentally sensitive and disaster-prone areas
	National Housing Policy (NHP) 2019	Livelihood, Well-beingness, Environment	• Preserve local ecosystems with adequate monitoring and minimal disturbance without compromising community vitality

(*Continued*)

Table 2. (Continued)

Country	Policy	Target resource	NbS Linkage
India	National Forest Policy, 1988	Forest	• An ecology-centric approach for protection, management, and raising the forest cover.
	National Water Policy, 1987, 2002, and 2012	Water	• Conservation of water through green and grey infrastructure was introduced and emphasized.
	National Conservation Strategy and Policy Statement on Environment and Development, 1992	Water, Land, and Forest	• Classification and zoning of land under forest cover, agriculture, catchment area, and grasslands.
	National Environment Policy, 2006	All-natural Resources	• Establishment of Environmentally Sensitive Zones.
	National Policy on Disaster Management, 2009	Life, Livelihood and Well-beingness	• Encourage mitigation measures based on technology mixed with traditional knowledge to achieve environmental sustainability
	National Agroforestry Policy, 2014	Food and Land	• Promoting agroforestry as a tool to mitigate the impacts of climate change
	National Urban Policy Framework (NUPF), 2020	Air, land, well-beingness	• Expanding the green spaces as a tool of resilience against issues like air pollution and urban heat island designated as national parks, wildlife sanctuaries, reserve forests, or Eco-sensitive zones
Nepal	National Water Resource Policy 2020	Water and water-side land	• Sustainable development and multipurpose use of water resources. • Sustainably conserve, manage and to carry out multipurpose development of available water resources to contribute to the economic prosperity and social transformation of the country • Minimize the impact of water induced disasters and maintenance of natural drainage, water flow, and water quality
	Nepal Climate Change Policy 2019	Ecosystem, Land, Water, and Forest	• Build the resilience of ecosystems that are at risk of adverse impacts of climate change • Utilize the maximum products and services provided by natural resources and their efficient management • Agro-forestry development in sloppy and low-grade forest areas and riverbeds that are affected by climate-induced risk • Watershed and landscape management
	National Land Use Policy 2015	Forest, Reserve Area and Land	• Preparation of green certificates through map-survey and demarcation of forest and Reserves Area • Keep a balance between land, environment and development in view of the impact of climate change.
	National Policy for Disaster Risk Reduction 2018	Life, Livelihood resilience and Well-beingness	• Enhance resilience by disaster damage to means of livelihood, community-based disaster risk reduction and mitigation of the impacts of climate change • Maximum utilization of local knowledge, skill, recourses and materials
	National Agroforest policy 2019	Agriculture, Forest and Environment	• Promote the farmers to practice the integrated practices of agriculture, livestock and forest activity on the same piece of land Conservation of environment and biodiversity by reducing the pressure over forests enhance the climate resilience ecosystem
	National Wetland policy 2003	Wet lands, Livelihoods, Indigenous knowledge	• Conservation, maintenance and development of country's wetlands • Identify local people's knowledge, skill and practice regarding wetlands and promote their innovations and traditional research for the sustainable use of wetlands resources • Integration of scientific knowledge and technology to identify the wetlands and prepare detailed management plans.
	Rangeland policy 2012		• Increase the quality and productivity of rangeland and increase the industry based on rangeland • Increase biodiversity through the protection, and sustainable and scientific resources uses by the balanced use of the environment

(*Continued*)

Table 2. (Continued)

Country	Policy	Target resource	NbS Linkage
Sri Lanka	National Environmental Policy 2003	Environment- water, soil, air, biodiversity	• Conservation of the environment including water, soil, air and biodiversity and their interconnections to ensure healthy and sound functioning of nature • Highlighting conservation of the special areas such as sensitive areas/ elements • Restoration of degraded ecosystems
	National Policy on Protection and Conservation of Water Sources, their Catchments and Reservations in Sri Lanka (2014)	Water	• Conservation of water sources, both natural and manmade and the catchments is emphasized. • Remedial management measures to mitigate the impacts of climate change and disasters on water resources are highlighted.
	National Land Use Policy of Sri Lanka (2012)	Land	• Wise use and sustainable management of land resources to ensure smooth functioning of environmental components • Special emphasis on managing sensitive and environmentally important land
	National Climate Change Policy (NCCP) (2012)	Environment and resources	• To mitigate the impacts of climate change on the environment • Elaboration on maintaining ecosystem stability, conservation of resources including water and biodiversity
	National Policy on Disaster Management, (2013)	Environment and resources	• Emphasizes saving and protecting life and the environment before, during and after natural disasters • Emphasizes post-disaster recovery in land, water, and ecosystems

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South Asian Association for Regional Cooperation (SAARC), with capacity-building initiatives included in bilateral and multilateral collaborations. India could play a significant role in sharing its knowledge from its green revolution program with other South Asian nations, as it is the leading economic partner for most countries in the region and has supported various fields.

Given the challenges posed by increasing populations, urbanization, climate change, food security, natural and human-induced disasters, collaboration is crucial. Each country in the region has unique characteristics that require individual consideration when formulating regional policies and plans. For instance, mountainous countries like Nepal and Bhutan face different challenges than Sri Lanka and Bangladesh. The level of urbanization varies significantly between countries, with widespread slums in Dhaka and Mumbai compared to Kathmandu and other SAARC countries. Despite these differences, the region shares similarities, such as economic development trajectories in India's Uttar Pradesh and Nepal's western region, and Bihar State and Nepal's Tarai region.

The Hindu Kush-Himalaya Mountain range, which spans eight countries from Afghanistan to Myanmar, has more than 25,000 glaciers and provides water and energy to 1.9 billion people [59]. Unfortunately, these glaciers are retreating faster than ever, posing a high risk of glacial lake outburst floods (GOLFs) in the region. South Asian countries must build their resilience and enhance adaptive capacity to overcome common challenges caused by natural phenomena. Furthermore, agriculture is the livelihood of the majority of the population in the region and highly vulnerable to climate change. Therefore, prompt action is necessary in the SAARC policies to enhance the resilience of the agriculture sector and farmers in the region.

7. Conclusion and future direction

Nature-based solution offers a chance to improve the resilience of susceptible communities and cities, as well as to attain sustainable development goals. Although none of the countries in the region specifically refer to NbS, all five nations have expressed the conservation of nature and ecosystems to achieve several environmental and socio-economic objectives in various

ways. Environmental and land use policies indirectly address NbS in all countries. However, policies for managing the impacts of climate change and disaster risk are not evident in all countries, necessitating a reassessment of policy dialogues. However, there are several barriers to the adoption of NbS in South Asia due to the specific environmental, social, geopolitical, and structural characteristics of the region. It is crucial for future research to examine the application of NbS in the region and learn from both successful and unsuccessful approaches to NbS. In all the countries under review, policies related to NbS are scattered in many organizations and it is apparent that these organizations act "in solo" without focusing the "integrated picture". This research can help propose solutions to overcome these barriers.

The above points clearly indicate that governments have not given sufficient attention to policies that reflect and promote "Nature-based Solutions" (NbS). Direct policies on NbS are inadequate in all countries, leaving ample room for the initiation and introduction of new tools and further research. This situation requires urgent attention from governments, as existing policies do not effectively respond to the current needs of utilizing nature's free services to reduce disaster risk, particularly given the double burden of poverty and escalating depletion of natural resources.

Planning and developing new policies should consider learning from other countries where strong policies are implemented. One of the objectives of this article is to share information about NbS across participating countries and create a way to share experiences and status quo. As some sectors in the region share common features, issues, and challenges, sharing baseline and key information would be a good starting point to enhance knowledge. For example, the destruction of nature's green infrastructures such as Mangroves is evident in many countries. In such cases, organizing information-sharing and capacity-building platforms involving from each country to share knowledge and good practices could be more practical than feasible.

At the local level, each policy should produce an appropriate mix of intersectoral interventions. For instance, sectors where common resources are covered, such as forests, wildlife, and coastal habitats, should be carefully analyzed and integrated to produce meaningful, practical, and effective policies.

Moreover, evidence-influenced policymaking is vital, including essential information from the sectors. In many instances, academic research is focused merely on professional fora or journal articles where essential information is not communicated to policymakers. Both academics and policymakers should discuss a common platform to identify research gaps necessary to formulate effective policy tools. For instance, a policymaker may include a new closure to conserve seagrass beds without knowing or ignoring the fact that these habitats are important for fishery, carbon sequestration, and biodiversity. Introducing new management tools requires an understanding of policy gaps, which calls for more theoretical and applied research.

This section highlights the key policy tools required for managing ecosystems towards NbS, but many governments have additional instruments related to coastal zone management, water, forest, and urban development. To develop well-articulated policy tools, it is crucial to consider the following factors:

a. Nature appraisal and environmental awareness should be explicitly incorporated in all phases of policy formulation.

b. Proper management plans should be in place for effective allocation of financial, human, and technological resources.

c. Quantitative targets and performance indicators should be specified for monitoring and evaluating success.

d. Social accountability, innovation, and adaptive governance should be aligned with policy formulation and implementation.

To ensure efficiency and effectiveness, policies related to NbS should be coherent, connected, and integrated with natural resources, climate change, disaster risk reduction, and socio-economic growth, to achieve sustainable development in the region.

Supporting information

S1 Checklist. Supplementary information for methodology and process of literature review.
(PDF)

S1 Text. Supplementary information for Table 1 and Table 2. These files include the list of literatures reviewed while writing this paper.
(DOCX)

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