

## TYPOLOGY AND MATRIX OF NATURE-BASED SOLUTIONS FOR CLIMATE ADAPTATION

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### THE NEED FOR A TYPOLOGY OF NATURE-BASED SOLUTIONS FOR CLIMATE ADAPTATION

Nature-based solutions (NbS) are actions to protect, conserve, restore, sustainably use, and manage natural or modified terrestrial, freshwater, coastal, and marine ecosystems that address social, economic, and environmental challenges effectively and adaptively while simultaneously providing human well-being, ecosystem services and resilience, and biodiversity benefits<sup>1</sup>. Conservation International and Nature-based Solutions Initiative (<https://www.naturebasedsolutionsinitiative.org>) worked together to prepare a typology of Nature-based solutions (NbS) for climate adaptation that identifies specific nature-based solutions (e.g., restoration, management) implemented in specific ecosystems (e.g., tropical forests, rangelands, mangroves) shown to be effective in reducing specific climate impacts (e.g., landslides, mudslides, droughts, coastal erosion).

This typology is based on the data collected for Chausson, Turner et al. 2020 (<https://onlinelibrary.wiley.com/doi/full/10.1111/gcb.15310>), the first global systematic map of evidence on the effectiveness of nature-based solutions for addressing the impacts of climate change and hydrometeorological hazards on people. The typology of NbS for climate adaptation was prepared as a need to further specify a suite of NbS effective in reducing the effects of specific climate impacts, as presented in Chausson, Turner et al. 2020. As such, this typology presented here, and the associated matrix, can help practitioners, policy makers, non-governmental and governmental organizations and researchers to implement specific NbS that are likely to deliver desirable climate adaptation outcomes.

Please note that this typology captures nature-based interventions only: those that directly intervene in a natural or semi-natural ecosystem, involving measures of ecosystem management, restoration and/or protection. Further, the typology is bounded by the types of interventions included in the underlying database, which does not capture the full scope of Nature-based Solutions for adaptation. For example, the underpinning database does not include interventions within urban or agricultural production zones, but certain practices providing benefits to agricultural production are included. This typology, and associated matrix, will be updated on a regular basis as more information is published.

### METHODOLOGY USED TO DEVELOP THE TYPOLOGY OF NATURE-BASED SOLUTIONS FOR CLIMATE ADAPTATION

#### Original Database

We developed this NbS for adaptation typology presented here based on information within the NbS evidence platform database (<https://www.naturebasedsolutionsevidence.info/>), which stems from evidence on the effectiveness of NbS interventions<sup>2</sup> in addressing the impacts of climate change within

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<sup>1</sup> NEA (2022). Fifth Session of the United Nations Environmental Assembly (United Nations).

<sup>2</sup> Note that interventions included in the database may not conform to all aspects of what makes an intervention a 'solution' as per the IUCN standard on Nature-based Solutions (IUCN, 2021), as in most cases, not enough information is provided to comprehensively evaluate whether the applied intervention meets all criteria in the standard.

the academic journal literature. From the database<sup>3</sup>, we extracted information on article ID, title, author, journal, Year, DOI, ecosystems, broad NbS intervention type, Targeted Climate Change Impact (CCI) and effect of NbS on CCI. This was then combined with detailed descriptions of each intervention extracted from the source article.

### **Ecosystem types**

The “ecosystems” column extracted from the NbS evidence platform database (see 1) were further specified into “ecosystems” based on [IUCN’s global ecosystem typology 2.1](#). This was achieved by combining or aligning available information on the ecosystem reported within the article with 1) description and maps presented in the IUCN's global ecosystem typology 2.1, 2) the specific species associated with the case studies or 3) the location where the case studies took place.

When the intervention was described to be implemented in “croplands”, “urban systems”, “farmland and abandoned pastures and fields and/or old fields and/or less productive fields” and “overgrazed pastures” in the articles, we changed those to “croplands”, “cities, villages and infrastructure”, “derived semi-natural pastures and old fields” and “intensive livestock pastures”, respectively, to follow IUCN’s global ecosystem typology.

The ecosystem type in natural regeneration on abandoned cropland was determined based on the species that have colonized the area if this information was available or the ecosystems natural regeneration was leading to.

Ecosystems were defined as “unknown”) when: i) tree planting was implemented using exotic species, ii) the intervention was implemented in eroded land or arable lands, or iii) the ecosystem could not be identified after using the options listed above.

### **Types of interventions**

Intervention descriptions extracted from the articles were iteratively summarized to produce a more refined typology of interventions based on emerging categories. Those emerging intervention categories were identified independently and cross-checked by 2 people (Camila Donatti and Jamie Blatter) to ensure accuracy. Discrepancies were solved by re-reading and discussing the complete descriptions of the interventions extracted from the articles. The final emerging types of interventions included:

- a. Assisted natural regeneration: when barriers were created to protect the area, including fencing of degraded areas and establishing tree barriers to protect the area.
- b. Restoration by removing exotic species: when exotic plant species were removed to restore the ecosystem
- c. Restoration with native species: when native species were planted to restore the ecosystem
- d. Restoration by controlling erosion: when actions to control erosion were implemented to restore the ecosystem
- e. Natural regeneration after clearcut: when the area was left to regenerate after all vegetation was removed in the past
- f. Restoration by reconnecting river and other water bodies: when embankment sluice gates were opened or when breaches were cut to facilitate connection between river and floodplains or lakes
- g. Restoration by removing sediments: when sediments were removed from wetlands to restore those ecosystems
- h. Restoration by adding sediments: when sediments were added to restore submerging marshes
- i. Restoration with boulders, gravel, logs and/or branches: when large boulders, gravel, logs and/or branches were returned or added to the riverbed to restore habitats and ecosystems

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<sup>3</sup> See the supporting material associated with Chausson, Turner et al. 2020 for the full framework and definitions.

- j. Restoration (other): when restoration was implemented but specific information was not presented.
- k. Tree planting: when trees were planted/introduced sparsely in the area
- l. Afforestation: when trees or shrublands were planted in non-forested areas (such as abandoned croplands, arable lands, farmland, eroded land, less productive fields, grasslands, unused coastal areas) and when more than one plant species were used.
- m. Plantation: when tree planting was done using a single plant species.
- n. Protection: when protected areas and no take reserves were established, when areas were protected by limiting grazing and relocating settlements or when other specific areas were physically or legally protected
- o. Forest thinning: when slower-growing, small diameter trees, and/or trees of different sizes were removed to increase productivity, reduce fire risk or maintain an uneven-aged forest canopy
- p. Salvage logging: when dead or damaged trees were removed from the area
- q. Fallowing: when a cropland was left unused for a given period
- r. Tree-surrounding dugouts: when trees were planted around dugouts (areas that trap freshwater used by local and livestock) to mitigate droughts
- s. Strip cutting: when trees in forest plantations are harvested in rows to regulate stand density and allow natural regeneration
- t. Grazing management: when livestock were only allowed to be grazing in certain areas, in certain periods of the year or in certain years
- u. Windbreaks: when trees and shrubs were planted around a cropland to protect crop production
- v. Fire management: when practices such as pruning and prescribed burning were implemented to protect areas from fire events
- w. Water management: when rainwater harvesting was established
- x. Fishing Bans: when fishing bans were lifted at various time intervals
- y. Assisted migration of plant species: when plant species from other locations were transplanted into the area to adapt to future climates
- z. Sustainable use: low intensity use of natural resources such as grass, timber, or NTFP harvesting
- aa. other forms of ecosystem creation: when grasslands, shrublands and wetlands were implemented in abandoned croplands, arable lands, farmland, eroded land; when grasslands, shrublands and wetlands were implemented where they did not exist before or when the information about the previous ecosystem that occupied the area was not mentioned in the case study.

### **Nature-“basedness”**

For each case study, we then identified those that were “Nature-based” using the following criterion: the case study does not report intervention design elements that may harm biodiversity (e.g. monocultures (of grasses, trees, or shrubs) unless it is explicitly stated that these are on degraded lands, and that these actions do not harm people or biodiversity), Based on that, the following was established:

Afforestation and habitat creation were not considered nature-based when:

- a. no information is provided regarding what existed in the area before it became a monoculture, a pasture, a farmland and/or
- b. implemented for biomass production and when the previous ecosystem was not identified and/or
- c. exotic species are used

Habitat Creation was not considered nature-based when:

- a. no information is provided regarding what the landscape was comprised of prior to the intervention (e.g. establishment of a forest plantation, or managed grassland), which prevents assessing whether no harm was done to biodiversity and/or
- b. the intervention is implemented in systems other than urban and/or
- c. the intervention does not have components that support biodiversity and provide ecosystem services and/or
- d. exotic species are used

Plantation was not considered nature-based when:

- a. exotic species were used, except when those were used to diversify livelihood, fruits, medicinal plants, bee keeping and legumes and were planted in small scale
- b. use native species but convert existing forests to plantation
- c. the plant species used are not mentioned
- d. no information is provided regarding what existed in the area before it became a monoculture, a pasture, a farmland.

### **Nature-based solutions**

NbS, by definition, aim to address a societal challenge. Therefore, we only included case studies that addressed societal challenges, i.e., included case studies that had a positive effect under “effect of NbS on CCI”, “ecological outcomes”, “social outcomes” or “effect on GHG”. We also disregard case studies that may infringe on one or more aspects of local rights (e.g. access to land, resources).

### **Nature-based solutions for climate adaptation**

Interventions were not considered Nature-based solutions for adaptation if they had a negative or unclear results under “Effect of NbS on CCI” listed in the original database.

### **TYPOLOGY AND MATRIX OF NATURE-BASED SOLUTIONS FOR CLIMATE ADAPTATION**

The interventions identified as Nature-based and Nature-based solutions for climate adaptation were then included for the definition of the typology. The emerging interventions categories and “ecosystem function group from IUCN typology of ecosystems 2.1” were used to create the matrix that presents the types of NbS effective in addressing specific climate change impacts. The matrix includes the number of case studies where specific interventions (interventions categories) in specific ecosystems, implemented in specific countries, presented a positive effect on climate change impacts. Numbers included in the matrix represent the number of case studies. The matrix also presents types of interventions that report positive or negative ecological, social or climate mitigation outcomes as assessed in the original articles.